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On consumers' willingness to purchase nutritionally enhanced genetically modified food

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ON CONSUMERS' WILLINGNESS TO PURCHASE NUTRITIONALLY ENHANCED GENETICALLY MODIFIED FOOD

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1. INTRODUCTION

Farm-level adoption of genetically modified (GM) crops has increased dramatically since their commercial introduction in the mid-1990s. GM crops have also experienced faster adoption rates in the US than other agricultural innovations such as the hybrid corn (Kalaitzandonakes, 1999). However, while agbiotechnology is oriented towards products (food and non-food) with a wide range of economic, nutritional and social benefits, it also faces a lot of resistance due to fears about hypothetical risks to human health and the environment[1]. One argument is that the expected benefits of this kind of innovation may be basically private, shared between industry, farmers and consumers (Falck-Zepeda et al., 1999, cited by Traxler et al., 2004), but the prospected costs seem to be mainly public or at least spilling over a broader audience.

To some extent, the food industry, scientific community and government have neglected the issue of consumer acceptance of GM food. The first generation of GM crops was marketed to agricultural producers on the basis of having important input traits such as disease or pest resistance, offering better performance and cost-saving opportunities to farmers (Marra et al., 2002; Traxler et al., 2004). Until recently, scientists and the biotechnology industry operated under the presumption that 'sound science' would automatically lead to consumer acceptance of GM products (Krueger, 2001) and that potentially adverse consequences can be effectively managed through government regulation (Comstock, 2000).

However, contrary to the biotechnology industry's initial optimism, GM food products have faced mixed regulatory and public acceptance around the world, particularly in the European Union (EU). As opposed to the situation in the health care (“red”) biotechnology sector, the agricultural and food biotechnology market (“green” biotech) appears to offer much less growth in Europe, due to a low level of acceptance and to difficulties in the regulatory approval (Champenois et al., 2006). For example, in Italy, even farmers' associations have mixed positions regarding the issue of transgenic crops, some of them raising doubts about the need of this kind of innovation in an agricultural system facing abundance problems. Presently, except for a GM corn-based beer (whose headline is "Go trans!"), no known GM

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labeled food is actually marketed and/or advertised in Italy. Furthermore, several Italian retail chains have excluded sales of GM food, thus enacting as a *de facto* ban throughout Europe. Even in the US, where GM crops entered the food system without evoking major public resistance, there are signs of increased consumer anxiety about the safety of these crops (Priest, 2000). This is reflected in recent declines in public support for the use of this technology in food production (International Food Information Council, 2004). Worries about compatibility between GM crops and organic agriculture, or traditional/local unique food products are also widespread.

While GM-derived foods are produced and sold in the US without a label signaling their GMO content, the EU has enacted labeling laws, asking producers to label the food products as GM if more than 0.9% of any ingredient is GM-based. A similar legislation with a 5% limit was introduced in Japan (McCluskey et al., 2003; Chern and Rickertsen, 2002).

However, even within the realm of plant genetic modification, it is possible that consumers will have different views about use of specific technologies such as plant-to-plant technology and animal-to-plant technology (Onyango and Nayga, 2004). Moreover, GM animals are generally less supported than GM plants (Frewer et al., 1998), and the purpose of the gene modification may also matter, considering that biotechnology applications aimed at developing new medicines are seldomly questioned, while the support of the use of the same technology to increase farm animal productivity is scarce (Hoban, 2004).

Proponents of biotechnology view current consumer resistance to GM foods as being due in part, to the lack of tangible consumer benefits derived from this technology. Consequently, proponents believe that the next wave of food biotechnology innovations, which are expected to bring new and improved products with enhanced quality attributes or nutritional benefits desired by consumers, will see much greater public acceptance than the first generation of GM agricultural and food products (Dunahay, 1999; Riley and Hoffman, 1999; Schmidt, 2000; Feldmann et al., 2000; Gamble et al., 2002; Cook et al., 2002).

This article examines the factors that affect Italian consumers' willingness to buy GM food products with two different types of benefits: the traditional input trait benefit (i.e., reduced pesticides) and an output trait benefit (i.e. nutritionally enhanced). Probit models are estimated to examine the effect of

[1] Little scientific evidence is still available both for stating and excluding damages to health and environment. As an example of this situation of uncertainty rather than risk, the disclaimer of a web site designed to spread a positive image of GM food as food for the future, http://www.foodfuture.org.uk (promoted by the UK Food and Drink Federation), may be cited: 'The contents of the foodfuture website and its associated materials are available for information, research, review, reference and

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various factors on consumers' willingness to buy GM foods with or without nutritionally enhanced attributes. A price sensitivity analysis is also conducted and discussed in the paper. The article is organised as follows: the next section gives a short overview of previous related studies, followed by sections about the theoretical framework and survey methodology, empirical model, results, and concluding remarks.

2. PREVIOUS LITERATURE

Several studies have examined the factors that affect consumers' acceptance of GM food. For example, Lusk and Sullivan (2002) found that consumer acceptance of GM products improved when genetic modification was achieved by inserting an extra gene from the host plant than when it involved a gene transfer from a different plant. Hobbs and Plunkett (1999) found that health, environmental, moral and philosophical concerns about the 'new' practice mainly drove consumer resistance to GM. A number of studies have also found that consumer acceptance of GM foods is related to risk perceptions (e.g., Moon and Balasubramanian 2001; Baker and Burnham 2001; Bredahl 2001) and trust in various information sources (e.g., Hunt and Frewer 2001; Moon and Balasubramanian 2004, Costa-Font and Mossialos, 2005; Chakraborty, 2005). In a comprehensive qualitative study using means-end chains, Grunert et al. (2000) revealed that consumers in Denmark, Finland, Norway and Sweden generally associated non-GM foods with safety and good health. GM foods, on the other hand, carried negative connotations and linked to negative concepts such as uncertainty, unnatural, diseases/deformities, loss of species and ecological imbalance. Although consumers were more supportive of GM foods that provided specific health benefits, product attributes such as improved taste or functionality did not fully compensate the negative perceptions of GM foods. In general, they also found that consumers in these countries held a more negative view of animal genetic modification than plant genetic modification.

A number of studies have also assessed consumers' willingness to pay for GM-free foods. For example, Burton et al. (2001) found that organic food buyers were willing to pay considerably more for GM-free foods than others. Lusk et al. (2001) found that consumer willingness to pay GM foods was related to their concern about GM food products, but was unrelated to their socio-economic attributes.

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A few studies (Rousu et al., 2002; Jaeger et al., 2004; Lusk et al., 2004a; and Lusk et al., 2005) also used experimental auctions in US, UK and France to model the welfare effects of a labeling policy for GM food. They concluded that the US and EU policies are both welfare enhancing, consistent with the citizens' average willingness to accept a compensation for consuming a GM labelled food instead of a regular one.

Few studies have been published related to the Italian situation. For example, Saba and Vassallo (2002) found a strongly negative attitude towards eating tomatoes produced by gene technology. Another survey conducted in Italy and in the US (McGarry Wolf et al., 2004) found that the Italian consumers are far less willing to buy genetically modified food, believe much more that it is important to label GM food, and support mandatory labelling more intensively than US consumers. These findings are generally consistent with findings from other studies in Italy (e.g., Saba et al., 1998; Boccaletti and Moro, 2000; Saba et al., 2000; Soregaroli et al., 2003; Harrison et al., 2004; Cembalo et al., 2003; Roselli et al., 2004). In all these studies, however, the benefits taken into consideration were related to input traits. As far as we know, the only studies that have specifically taken into consideration improved nutritional features obtained by genetic modifications are those by Hu et al. (2004), using latent class models to show interactions allowing for a trade-off between health benefits and GM attribute of a food product among Canadian consumers, Onyango and Nayga (2004) and by Canavari et al. (2005). On a limited extent, Chern et al. (2002; 2003), also reported findings from survey data on US and Norway students and consumers. No other known study has examined Italian consumers' willingness to purchase nutritionally enhanced GM food products.

3. EMPIRICAL FRAMEWORK AND METHODOLOGY

According to Lancaster (1966a,b), consumers' choices can be analysed in terms of the product attributes. Consumers derive utility (U) from the characteristics of the product (**z**) they buy. Further developments of the Lancaster model considered utility to depend om consumers' personal characteristics and beliefs (**x**) as well. Hence, the utility of the *i*-th consumer (considering *n* characteristics) from the consumption of the *j*-th product (with *m* attributes) may be specified as follows:

$$U_{ij} = U(x_{1j}, x_{2j}, \ldots, x_{nj}, z_{i1}, z_{i2}, \ldots, z_{im}) \qquad (1)$$

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This study uses a random utility discrete choice model to analyse the willingness to consume nutritionally enhanced GM foods. Discrete choice models have their roots in the original work of Thurstone (1927) in the context of individual responses to different levels of psychological stimuli. Marschak (1960) viewed utility as the underlying stimulus and applied the utility maximising principle to derive the random utility model of discrete choice. In this study it is assumed that a consumer faces a choice between buying a traditional (T) or a GM (G) variety of a product whose other characteristics remains equal. The GM product is then produced using ingredients from transgenic organisms and provides additional specific benefits compared to the traditional one. Utilities derived from the GM and the non-GM product varieties are given by U_G and U_T, respectively.

However, these utility levels are not directly observable. The observable variables for each choice are:

- a vector of consumer characteristics (**x**),
- a vector of product attributes (**z**), and
- the choice made by the consumer (y = T, G or y = 0, 1).

It may be assumed that the unobservable utility function is expressed as:

$$U_{ij} = V_{ij} + \varepsilon_{ij} \qquad (2)$$

where:

- U_{ij} is the unobserved or latent utility level attained by the *i*-th consumer,
- V_{ij} is the explainable part of the latent utility that depends on the levels of the product attributes and the consumer characteristics, under the hypothesis that the effect of all the attributes is the same for all the individuals, and
- ε_{ij} is the 'unexplainable' random component of utility associated with the choice of the product *j* attributes at a certain level and consumer *i* characteristics, that is the part of variance that may be assigned to individual-specific interactions among product attributes and consumer characteristics.

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In this framework, if the other characteristics of the product do not vary, the different utility derived by consumer *i* from the consumption of the product *j* only depend on the level of attribute z_{i1} (where z_{i1} = T, G) and by the unexplained error term (Onyango and Nayga 2004). Then, the consumer i's choice for the GM food (over the non-GM variety) is assumed to depend on the additional utility or disutility derived from the GM product relative to that from the non-GM product. The choice to buy the non-GM/GM product Z_i is then modelled as a function of the i-th consumer's attributes as follows:

$$Z_i = \beta_0 + \beta_1 x_1 + \beta x_2 + \ldots + \beta_m x_m + \nu_i = \beta' X_i \qquad (3)$$

where $x_1, x_2, \ldots, x_m$ denote the m characteristics of the i-th respondent, $\beta_0, \beta_1, \ldots, \beta_m$ are the parameter vector to be estimated and ν_i is the random error or disturbance term.

The choice of the variables were made on the basis of existing literature on consumer choice and recent studies on public attitudes towards biotechnology (Hallman et al., 2002; House et al., 2001), as well as on previous studies on the US consumers performed using a similar approach (Hossain et al., 2004; Onyango and Nayga, 2004). The following empirical equation is specified to model a consumer's likelihood of choosing the GM food:

$$Z = \beta_0 + \beta_1 \text{ FEMALE} + \beta_2 \text{ BUYER} + \beta_3 \text{ HEARD} + \beta_4 \text{ YOUNG} + \beta_5 \text{ MIDAGE} + \beta_6 \text{ EDUC1} + \beta_7 \text{ EDUC2} + \beta_8 \text{ EDUC3} + \beta_9 \text{ OPINORG} + \beta_{10} \text{ TRUSTSCI} + \beta_{11} \text{ TRUSTGOV} + \beta_{12} \text{ GMQUIZ} + \beta_{13} \text{ INCOME1} + \beta_{14} \text{ INCOME2} + \beta_{15} \text{ INCOME3} + \beta_{16} \text{ ADULMEMB} + \beta_{17} \text{ KIDSMEMB} + \beta_{18} \text{ REGION2} + \beta_{19} \text{ REGION3} + \beta_{20} \text{ REGION4} + \beta_{21} \text{ REGION5} + \beta_{22} \text{ TOWNMEDI} + \beta_{23} \text{ TOWNLARG}$$

where the variables are as defined in Table 1.

[Table 1]

In terms of the data, this study uses a national telephone survey of adult Italian consumers. We used a national telephone survey instead of a national mail survey or personal intercept survey due to time, response rate, and monetary considerations. The questionnaire was developed to collect information on the attitudes of respondents towards the use of biotechnology in agriculture and food production and their willingness to buy GM foods. To avoid a lengthy survey, excessive respondent burden, and achieve

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reasonable response rate, questions related to other factors such as lifestyles, information sources and subjective norms were not collected.

Specifically, the survey was designed to gather information on:

a. public awareness on the use of biotechnology in food production;
b. respondents' willingness to consume hypothetical GM foods instead of the conventional daily food, in this case exemplified by cookies and eggs to represent both plant-derived and animal-derived products;
c. public views about private and public institutions associated with biotechnology research and product development and the attitude towards organic agriculture;
d. the respondents' socio-economic and demographic characteristics.

The survey was completed in April-July, 2004. The targeted sample frame for the survey was the Italian adult aged 18 years or older. A random stratified proportional probability sample drawn from about 20 million telephone households in Italy was extracted from an internet-based telephone directory. The objective was to attain a sample size of 400 to achieve a sampling error rate of +/-4.9 percent at a 95% confidence interval for the yes/no answers. Quotas were set to ensure a balanced representation of geographical areas within the country, and the distribution among small, medium and large size towns. In addition, careful efforts were made to ensure that the sample drawn was representative of the Italian population by age and education levels. Each of the 1725 working telephone number was called a maximum of three times, at different times of the week and at different daytimes, to reach people who were infrequently at home or were otherwise difficult to reach. In any case, 599 listed numbers were never reached.

While 433 respondents completed the survey, another 673 individuals refused to participate and 20 respondents terminated in the middle of the interview (then their answers were eliminated). This gave us a response/cooperation rate of about 38 percent. Calculating the response rate using the total number of completed surveys divided by the total number of in-frame sample observations, the final figure is about 25 percent. Since in Italy the issue of GM food experienced a high level of exposure in the media it is important to mention that the refusals were not influenced by the topic, because the topic of the survey (i.e., GM) was mentioned only after the respondent agreed to participate in the survey.

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The length of the interview was between 5 and 16 minutes, with the average length being 7.5 minutes. All the interviews were conducted during the time range 11:00-20:00 hours to reduce the risk of an unequal selection of categories. The survey responses were registered into a database and accurately checked for errors.

Naturally, the GM products we used in the study are hypothetical since they do not exist yet in the Italian market. Due to the hypothetical nature of the study, there is a possibility that participants of the survey will provide responses that reflect hypothetical bias. Hypothetical bias is the difference that we continually see in the way people respond to hypothetical questions as compared to real situations. To address this issue, we employed a cheap talk script, which briefly addressed the issue of hypothetical bias to study participants prior to the conduct of the survey (see Figure 1). Cheap talk can be thought of as nonbinding communication between a researcher and respondent prior to administration of the consumer survey. As Lusk (2003) discussed, cheap talk has been found to effectively remove hypothetical bias for consumers relatively unknowledgeable about the good evaluated (e.g., Cummings and Taylor, 1999; List, 2001).

[Figure 1]

The four key questions of interest in the questionnaire are:

- their willingness to buy breakfast cookies that are derived from genetically modified wheat, providing the benefits related to a reduced usage of pesticides (GMCOOKIE), thus introducing the environmental benefit via a plant-based genetical modification;
- their willingness to buy nutritionally enhanced breakfast cookies derived from wheat genetically modified to provide added vitamin E/antioxidant, believed to slow down the ageing effect (GMCOOVIT), thus introducing a nutritional benefit via a plant-based genetical modification;
- their willingness to buy eggs from hens fed with transgenic corn, providing the benefits related to a reduced usage of pesticides (GMEGGS), thus introducing an environmental benefit via plant-based genetical modification that reflects on animal-based food;
- finally, their willingness to buy eggs from hens fed with transgenic corn and genetically modified to produce low-cholesterol eggs, more suitable for preventing heart diseases (GMEGGCHO), thus introducing a nutritional benefit via genetic modification of animal-based food.

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After answering the attitudinal questions, each respondent indicated his/her willingness to buy each of the four products described above if it tasted and cost the same as regular product (i.e., non-GM), so that all the choices are made comparing the GM food with the non-GM food. The willingness to buy questions, introduced to respondents in the same order during the interviews, were asked using a binary Yes/No choice[2]. The choices are all made with respect to an ordinary non-GM food, so, even if it is probable that a certain degree of dependance and order effect exist, it is also reasonable to consider the four questions as independent.

Cookies and eggs are selected for the study since they are among the most popular food products regularly purchased and consumed by Italians. Virtually every Italian also knows about these products. While it is difficult to make direct comparisons between any of these four products, our aim is simply to assess possible differences in consumer acceptance rates among the products examined.

Four probit models, each corresponding to one of the key questions mentioned above were estimated to analyse willingness to buy GM foods.[3] Maximum likelihood (ML) estimation procedure was used to obtain the model parameters.

4. MODELS RESULTS

As mentioned above, four variables are of interest in our analysis: GMCOOKIE, GMCOOVIT, GMEGGS, and GMEGGCHO. The means of these dependent variables as well as the independent variables are exhibited in Table 2.[4] The means of the dependent variables suggest that a large majority of the respondents did not want to buy the GM products. When the technology involves gene transfer on plants, the acceptance is slightly higher (32%-39% for cookie product as opposed to 29% for egg product), and the introduction of a nutritional benefit in the GM plant based product seems to convince more people (39%) to accept the innovation. This result does not happen in the case of animal-based food – egg. The acceptance level for these two egg products (GMEGGS and GMEGGCHO) is both at about

[2] There are several alternative ways to measure the willingness to buy. E.g. the following scale could be developed: - I would choose the GM product certainly - I would choose the GM product probably - I do not know which one I would choose; - I would choose the traditional product probably - I would choose the traditional product certainly. This would have implied the use of ordered probit (or logit) models to estimate the effects of the factors. However, because of using a telephone survey, we agreed with Louviere et al. (2000), who comment on the preference for a binary choice setting that, despite the lower amount of information given, it is much more reliable and easier to respond.

[3] We also estimated the models simultaneously using multivariate probit but did not get convergence due to the number of variables and observations involved.

[4] There are different number of respondents for each choice due to deletion of observations with incomplete information of the variables used in the analysis.

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29%. The additional nutritional benefit in the egg product does not seem to increase respondents' willingness to buy. It is possible that a hypothetically higher acceptance rate for the nutritionally enhanced egg would have been compensated by the introduction of the genetical modification in the animal itself, instead of just putting it in the feed. These figures are not far from those available in other statistical sources. In fact, according to Eurobarometer (2006, p. 19) support for GM food in Italy is 34% among the 'decided' public (approximately 50 per cent of the citizens interviewed in their Europe-wide survey), i.e. those who have a view on key questions about GM food.

[Table 2]

The parameter estimates and the standard errors of the models are reported in Table 3. The models perform relatively well considering the statistically significant likelihood ratio test values and percentage of correct predictions in the range of about 68 to 74 percent. No degrading collinearity was detected among the variables in the model based on Belsley-Kuh-Welsh diagnostic procedures. Marginal effects are exhibited in Table 4. Statistical significance of marginal effects are the same as the statistical significance of the parameter estimates in binary probit models. Based on the statistically significant variables, two variables have a consistent effect across all four models which shows the robustness of the effect of the variables: GMQUIZ and TRUSTSCI. The results suggest that knowledge of science (GMQUIZ) is positively related to willingness to buy all four products. Those who trust scientists are also more likely to buy all four products. Specifically, those who trust scientists are about 20%, 34%, 13%, and 15% more likely to buy GMCOOKIE, GMCOOVIT, GMEGGS, and GMEGGCHO, respectively. Gaskell et al. (1999) also found that trust factors affect acceptance of genetically modified food.

[Table 3]

[Table 4]

As mentioned above, only GMQUIZ and TRUSTSCI variables have the consistent effect across all four models. The other explanatory variables have less consistent effects across the models. Specifically, respondents from large towns are more likely to buy cookies obtained from GM flour enhanced with vitamin E (GMCOOVIT) and eggs obtained from GM hens that lay eggs with less cholesterol (GMEGGCHO) than respondents from small towns. Those from large towns are 12.6% more likely to buy GMCOOVIT and 11.5% more likely to buy GMEGGCHO than those from small towns.

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Females are about 16% more likely to buy GMEGGS than males. Those who are in charge of household food purchases are about 12% less likely to buy GMEGGS and GMEGGCHO than others. Young respondents are around 15% less likely to buy GMCOOKIE and GMEGGS than those of mature age.

Individuals with less than middle school education (educ1) are 30% more likely to buy GMEGGCHO than those with laurea degree or higher (educ4). Those with only a middle school education (educ2) are also more likely to buy GMCOOVIT, GMEGGS and GMEGGCHO than those with a laurea degree or higher. These results suggest that higher educated individuals are less likely to buy GM food products. The reason for this result is not clear. Future research should attempt to decipher the mechanisms through which schooling or education is affecting consumers' willingness to buy GM foods.

The regional variables as a group are statistically significant in the GMEGGS and GMEGGCHO models. Specifically, individuals who live in the south (region4) are 12% to 13% more likely to buy GMEGGS and GMEGGCHO than those who live in region1, which is the longer time established industrial zone in Italy, in which the presence of high-earning professionals, together with blue-collar workers, is more widespread. In contrast, individuals who live in the islands are less likely to buy GMEGGS and GMEGGCHO than those who live in region1. The number of adults and the number of children are positively related to the probability of buying GMCOOKIE. Interestingly, none of the income variables are statistically significant in the models. These findings can be used in designing market segmentation strategies related to the marketing of the specific GM products examined in the study.

5. PRICE SENSITIVITY

While the findings discussed above provided some interesting insights, we also wanted to find out how few specific prices would affect willingness to buy GM products. This is not necessarily a matter of increased realism since, if the existence of market imperfections in one or more stages of the food chain prevents the transmission of hypothetical cost savings to the consumers, the price seen by consumers is probably not going to be affected by GM (Giannakas and Fulton, 2002). However, it would be interesting to test if the choices are affected by differences in price.

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Consequently, we asked respondents their willingness to buy the nutritionally enhanced products (GMCOOVIT and GMEGGCHO) at specific prices different from the price of the non-GM product. Due to the exploratory nature of the study, these questions were not designed to be analyzed as a double bounded willingness to pay model. Specifically, we asked the respondents who answered "no" to the original questions (i.e., same price with the non-GM product: 1.60 Euro for GMCOOVIT and 1.20 Euro for GMEGGCHO) if they would be willing to buy GMCOOVIT and GMEGGCHO at a price that is 10% lower than the price of the non-GM product. We also asked the respondents who said "yes" to the original questions if they would still be willing to buy the nutritionally enhanced GM product if the price is 10% and 20% higher. The results are exhibited in Table 5. Interestingly, of the respondents who said "no" to the original question, only 2.70% would buy GMCOOVIT and only 1.17% would buy GMEGGCHO even if the price is 10% lower. This finding reflects the strong disapproval of these group of individuals to GM food products, even with the nutritional enhancement and lower price.

For those respondents, however, who said "yes" to the original question, a vast majority of these individuals (i.e., 93% for GMCOOVIT and 96% for GMEGGCHO) indicated that they would still buy the nutritionally enhanced product at a price that is 10% higher than the price of a non-GM counterpart. At price that is 20% higher, the numbers are a little lower at 61% and 79% for GMCOOVIT and GMEGGCHO, respectively. These results seem to reflect that there could be opportunity to market nutritionally enhanced GM products at a premium towards this segment of the market.[5]

[Table 5]

6. CONCLUDING REMARKS AND AREAS OF FURTHER RESEARCH

Consumer acceptance of GM foods is a key factor that will influence the future of biotechnology in agriculture and food system. Proponents of biotechnology view the current consumer resistance to GM foods as due, at least in part, to the lack of tangible output trait benefits from this technology. They

[5] To further analyse these data, we run bivariate probit with sample selection models for willingness to buy GMCOOVIT and GMEGGCHO at 20% premium using the same set of independent variables listed in Table 1. Unfortunately, the results are not encouraging due to the limited number of statistically significant variables in the estimates. However, the results suggest that respondents who are educated up to high school are more likely to buy GMCOOVIT at 20% premium than those with a laurea degree or higher. Individuals who live in the islands (region5) are less likely to buy GMCOOVIT at 20% premium than those who live in region1. Respondents who have trust in scientists are more likely to buy GMCOOVIT at 20% premium than others. None of the variables are statistically significant in the GMEGGCHO premium model.

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believe that the next wave of food biotechnology innovations, which are expected to bring new and improved products with enhanced nutritional benefits, will see much greater public acceptance.

Our findings are relatively mixed. For example, contrary to the findings of Onyango and Nayga (2004) in the US, our results suggest that majority of Italians are not willing to buy GM food products even if they have a nutritionally enhanced benefit. However, our survey revealed that more consumers are willing to buy a nutritionally enhanced plant based GM product (GMCOOVIT) than an input trait plant based GM product (GMCOOKIE). Willingness to buy for the two egg products (GMEGGS and GMEGGCHO) are relatively the same. It is not clear why not more of our respondents did not indicate a willingness to buy the nutritionally enhanced egg product. However, previous studies have found that consumers generally disapprove of animal based genetic modification. For example, Onyango and Nayga (2004) revealed that majority of their US respondents are willing to consume the three types of nutritionally enhanced genetically modified breakfast cereal they examined but are less willing if the genetically modified product is derived from animal-to-plant gene transfer technology than from plant-to-plant gene transfer technology. Lusk et al. (2004b) also found similar results when they recently examined, using meta analysis, almost 30 studies and 60 valuation estimates.

Our results imply that nutritional enhancement could help increase consumer acceptance of GM food products in Italy but only if it is a plant based food product and not an animal based food product (i.e., if it does not involve use of animal gene transfer technology). While it is indeed possible that the presence of enhanced nutritional benefit in the product could moderate any negative attitude towards use of animal genes to genetically modify plants or animals, our survey results do not appear to support this hypothesis. More research on these issues is indeed warranted. The findings of our study suggest the relevance of not only examining specific types of enhanced nutritional benefits but also the need to examine specific types of gene transfer technology used in deriving GM food products, similar to those studied by Onyango and Nayga (2004) in the US.

Our results on price sensitivity may generally imply that consumers who disapprove of buying GM food products cannot be easily persuaded to change their mind even with the additional nutritional enhancement in the product and a lower price. On the other hand, our results seem to suggest that there is an opportunity to market nutritionally enhanced GM food products at a premium to those who approve of buying these products at the same price as their non-GM counterparts. However, the focus of our study is

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more on willingness to buy nutritionally enhanced GM products and not on the willingness to pay issue. Hence, since our pilot study only considered two types of products and sensitivity to few price levels, more research is needed to assess the robustness of our findings and to definitively determine consumers' willingness to pay for nutritionally enhanced GM products not only in Italy but also in other countries. More sophisticated willingness to pay studies should be considered in the future.

Our probit results generally provided two major factors that consistently affect Italian consumers' willingness to buy GM products: knowledge of science and trust in scientists. Our findings imply that an increase in these two measures can augment consumer's willingness to buy both input trait and output trait based GM food products in Italy.

Future studies should be conducted in various countries to assess the robustness of this finding and also assess main determinants of knowledge. The present paper is intended as an exploratory analysis on the reaction of Italian consumers to second generation (i.e. nutritionally enhanced) GM food. Several improvements are possible on the theoretical modeling, the data collection method and survey design. A first step should be the consideration of more information on the attitudes of the household's responsible of purchasing food, since demographics has not showed to be really effective in explaining behaviour in many segmentation studies. In addition, alternative methodologies, e.g., conjoint analysis, could be used to capture the part-worth of the GM-attribute in nutritionally enhanced food choice. Furthermore, the stated preference data could be combined with revealed preference data as soon a real marketed product will be made available.

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Table 1. Description of the variables used in the probit models

Dep. Variables	
GMCOOKIE	1 if respondent would choose to buy 500g cookie obtained from GM flour with less pesticide, rather than 500g non-GM traditional cookie at the same price of 1.60 Euro; 0 otherwise
GMCOOVIT	1 if respondent would choose to buy 500g cookie obtained from GM flour enhanced with vitamin E rather than 500g non-GM traditional cookie at the same price of 1.60 Euro; 0 otherwise
GMEGGS	1 if respondent would choose to buy a package of 6 eggs obtained from hens that eat GM maize with less pesticide rather than a package of 6 non-GM traditional eggs at the same price of 1.20 Euro; 0 otherwise
GMEGGCHO	1 if respondent would choose to buy a package of 6 eggs obtained from GM hens that lay eggs with less cholesterol rather than a package of 6 eggs from non-GM traditional eggs at the same price of 1.20 Euro; 0 otherwise
Covariates	
TOWNMEDI	1 if from a medium sized town (>20,000, <=100,000 inh.); 0 otherwise
TOWNLARG	1 if from a large sized town (>100,000 inh.); 0 otherwise
GMQUIZ*	number of correct responses to 5 scientific questions
FEMALE	1 if respondent is female; 0 otherwise
BUYER	1 if respondent is in charge for household's food purchases; 0 otherwise
YOUNG	1 if respondent is younger than 35; 0 otherwise
MIDAGE	1 if respondent is between 35 and 54 years old; 0 otherwise
EDUC1	1 if education up to basic school (up to 5 yrs); 0 otherwise
EDUC2	1 if education up to middle school (at least 8 yrs); 0 otherwise
EDUC3	1 if education up to high school (at least 13 yrs); 0 otherwise
EDUC4	1 if education laurea degree or higher (at least 17 yrs); 0 otherwise
REGION2	1 if live in North-east: Trentino-Alto Adige, Veneto, Emilia-Romagna, Friuli-Venezia Giulia; 0 otherwise
REGION3	1 if live in Center: Toscana, Marche, Umbria, Lazio; 0 otherwise
REGION4	1 if live in South: Abruzzi, Molise, Puglia, Campania, Basilicata, Calabria; 0 otherwise
REGION5	1 if live in Islands: Sicilia, Sardegna; 0 otherwise
OPINORG	1 if the respondent think organic agriculture is important; 0 otherwise
TRUSTSCI	1 if respondent express trust in self-regulating capacity of scientists; 0 otherwise
TRUSTGOV	1 if respondent express trust in capacity of government to set and enforce suitable rules for GM food; 0 otherwise
ADULMEMB	household's members older than 14, expressed in number of persons
KIDSMEMB	household's members younger than or equal 14, expressed in number of persons
INCOME1	1 if household's total net income is lower than 1,000 EUR; 0 otherwise
INCOME2	1 if household's total net income is between 1,000 and 1,999 EUR; 0 otherwise
INCOME3	1 if household's total net income is between 2,000 and 2,999 EUR; 0 otherwise
HEARD	1 if respondent was aware of the existence of GM food; 0 otherwise

Note: Baseline profile: small town; male, older than 54, education university degree; region of Valle D'Aosta, Piemonte, Liguria, and Lombardia; income of at least 3,000 Euros/month.
*The five questions are: (1) ordinary tomatoes do not contain genes, while genetically modified tomatoes do; (2) if a person eats a genetically modified fruit, his/her genes could be modified as a result; (3) genetically modified animals are always larger than ordinary animals; (4) it is possible to transfer animal genes to plants; (5) tomatoes, genetically modified with genes from catfish, would probably taste 'fishy'.
Source: Survey data

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Table 2. Descriptive means of the variables used in the probit models

Variable	GMCOOKIE	GMCOOVIT	GMEGGS	GMEGGCHO
Dependent variable	0.318	0.388	0.295	0.294
TOWNSMAL*	0.459	0.456	0.462	0.456
TOWNMEDI	0.304	0.303	0.306	0.305
TOWNLARG	0.237	0.240	0.231	0.239
GMQUIZ	2.842	2.836	2.861	2.832
FEMALE	0.699	0.702	0.699	0.703
BUYER	0.842	0.842	0.838	0.841
YOUNG	0.254	0.249	0.253	0.250
MIDAGE	0.482	0.484	0.482	0.481
MATAGE*	0.265	0.268	0.265	0.267
EDUC1	0.076	0.082	0.078	0.082
EDUC2	0.259	0.254	0.259	0.253
EDUC3	0.507	0.508	0.510	0.511
EDUC4*	0.158	0.156	0.153	0.154
REGION1*	0.251	0.246	0.251	0.250
REGION2	0.192	0.191	0.192	0.192
REGION3	0.197	0.197	0.195	0.192
REGION4	0.242	0.246	0.245	0.245
REGION5	0.118	0.120	0.117	0.121
OPINORG	0.890	0.891	0.891	0.890
TRUSTSCI	0.831	0.831	0.830	0.830
TRUSTGOV	0.423	0.432	0.426	0.431
HSIZE	3.425	3.418	3.423	3.409
ADULMEMB	2.839	2.844	2.841	2.832
KIDSMEMB	0.586	0.574	0.582	0.577
INCOME1	0.085	0.087	0.089	0.088
INCOME2	0.383	0.380	0.379	0.376
INCOME3	0.321	0.325	0.323	0.324
INCOME4*	0.211	0.208	0.209	0.212
HEARD	0.907	0.904	0.905	0.904
Observations count:	355	366	359	364

* Baseline profile: small town; male, older than 54, education university degree; region of Valle D'Aosta, Piemonte, Liguria, and Lombardia; income of at least 3,000 Euros/month.

Source: Survey data

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Table 3. Maximum Likelihood estimates (st. errors in parentheses) of the probit models

Variable	GMCOOKIE	GMCOOVIT	GMEGGS	GMEGGCHO
CONSTANT	-1.933*	-1.597*	-1.726*	-2.031*
	(0.600)	*(0.586)*	*(0.610)*	*(0.611)*
TOWNMEDI	-0.038	0.233	0.167	0.140
	(0.178)	*(0.171)*	*(0.180)*	*(0.178)*
TOWNLARG	0.128	0.334*	0.271	0.347*
	(0.195)	*(0.190)*	*(0.200)*	*(0.197)*
GMQUIZ	0.130*	0.105*	0.209*	0.157*
	(0.063)	*(0.062)*	*(0.069)*	*(0.065)*
FEMALE	0.100	0.159	0.476*	0.237
	(0.172)	*(0.168)*	*(0.181)*	*(0.177)*
BUYER	-0.155	-0.192	-0.371*	-0.363*
	(0.221)	*(0.216)*	*(0.225)*	*(0.220)*
YOUNG	-0.438*	-0.197	-0.435*	-0.140
	(0.242)	*(0.236)*	*(0.248)*	*(0.247)*
MIDAGE	-0.334	-0.104	-0.098	0.093
	(0.217)	*(0.208)*	*(0.217)*	*(0.216)*
EDUC1	-0.324	0.230	0.333	0.910*
	(0.403)	*(0.360)*	*(0.402)*	*(0.378)*
EDUC2	0.230	0.414*	0.488*	0.531*
	(0.269)	*(0.261)*	*(0.278)*	*(0.274)*
EDUC3	0.208	0.161	0.361	0.204
	(0.228)	*(0.221)*	*(0.239)*	*(0.239)*
REGION2	-0.102	-0.114	-0.088	-0.290
	(0.226)	*(0.222)*	*(0.234)*	*(0.239)*
REGION3	-0.316	-0.335	-0.189	-0.311
	(0.230)	*(0.224)*	*(0.232)*	*(0.234)*
REGION4	0.211	0.304	0.405*	0.366*
	(0.226)	*(0.222)*	*(0.233)*	*(0.229)*
REGION5	-0.361	0.186	-0.461*	-0.252
	(0.280)	*(0.258)*	*(0.296)*	*(0.273)*
OPINORG	0.232	-0.010	0.236	0.412
	(0.249)	*(0.231)*	*(0.254)*	*(0.263)*
TRUSTSCI	0.582*	0.909*	0.386*	0.452*
	(0.217)	*(0.220)*	*(0.219)*	*(0.219)*
TRUSTGOV	-0.069	-0.099	0.204	0.134
	(0.150)	*(0.145)*	*(0.152)*	*(0.151)*
ADULMEMB	0.145*	0.081	0.030	0.034
	(0.079)	*(0.077)*	*(0.081)*	*(0.080)*
KIDSMEMB	0.171*	0.034	-0.056	0.003
	(0.102)	*(0.101)*	*(0.108)*	*(0.105)*
INCOME1	0.190	0.056	-0.414	-0.150
	(0.339)	*(0.323)*	*(0.358)*	*(0.338)*
INCOME2	0.092	0.063	-0.098	-0.067
	(0.210)	*(0.210)*	*(0.216)*	*(0.217)*
INCOME3	-0.220	-0.239	-0.317	-0.251
	(0.206)	*(0.202)*	*(0.212)*	*(0.211)*
HEARD	0.154	-0.166	-0.309	-0.059
	(0.265)	*(0.247)*	*(0.260)*	*(0.255)*
CRAGG-UHLER R-SQUARE	0.134	0.176	0.183	0.169
Likelihood Ratio Test	35.759*	50.877*	49.307*	45.865*
% Right Predictions	0.715	0.675	0.735	0.739

* Statistically significant at the 0.05 level. Baseline profile: small town; male, older than 54, education university degree; region of Valle D'Aosta, Piemonte, Liguria, and Lombardia; income of at least 3,000 Euros/month.
Source: Survey data

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Table 4. Marginal effects of the significant variables of the probit models

Variable	GMCOOKIE	GMCOOVIT	GMEGGS	GMEGGCHO
TOWNLARG		0.126		0.115
GMQUIZ	0.045	0.040	0.069	0.052
FEMALE			0.158	
BUYER			-0.123	-0.120
YOUNG	-0.153		-0.144	
EDUC2		0.157	0.162	0.176
REGION4			0.134	0.121
REGION5			-0.153	
TRUSTSCI	0.203	0.344	0.128	0.150
ADULMEMB	0.051			
KIDSMEMB	0.060			
Wald Tests P-values				
Town Size	0.701	0.170	0.366	0.212
Education	0.318	0.401	0.356	0.046
Region	0.104	0.066	0.014	0.014
Income	0.339	0.359	0.344	0.633
Age	0.174	0.703	0.148	0.499

* Baseline profile: small town; male, older than 54, education university degree; region of Valle D'Aosta, Piemonte, Liguria, and Lombardia; income of at least 3,000 Euros/month.

Source: Survey data

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Table 5. Percentage of Respondents Willing to Buy Nutritionally Enhanced GM Food Products at Specific Prices

Price	GMCOOVIT	GMEGGCHO	Number of Observations
1.44 Euro (10% lower)	2.70%		223*
1.76 Euro (10% higher)	92.96%		142
1.92 Euro (20% higher)	61.42%		127
1.08 Euro (10% lower)		1.17%	257*
1.32 Euro (10% higher)		96.23%	106
1.44 Euro (20% higher)		79.41%	102

* Number of respondents who said "no" to the original question (i.e., same price with non-GM product).

Source: Survey data

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Figure 1. Cheap Talk Script Used in the Survey

In a moment, I am going to ask you questions about whether you would purchase new transgenic food products at a particular price level in a grocery store.

Transgenic foods are products where, to improve food characteristics, parts of the natural genetic code are replaced with those of others living. These organisms are also called genetically modified organism or GMO.

So you should assume that you are in a real grocery store and that you will choose between products with characteristics that I will explain to you.
The purchase is obviously hypothetical for you, but is very important that you tell me what you would do if you were really shopping in the grocery store and you had to pay Euros X if you decide to buy the food product.
If you decide to buy the food product, you should ask yourself: do I really want to spend my money this way?
If you really did, you should indicate YES to the willingness to purchase question at price Euros X. If you didn't want to spend your money this way, you should indicate NO to the willingness to purchase question at price Euros X.

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