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**BIOTECHNOLOGY IN THE FOOD INDUSTRY:  
AN EVALUATION OF PUBLIC CONCERNS IN ITALY**

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## **1. Introduction**

One relevant issue of debate is the regulation of Genetically Modified Organisms (GMO). The recent “Biosafety Protocol” signed in Montreal will require for exporting countries to label products obtained from GMO, but, more important, it will allow importing countries to ban imports of GMO on a “precautionary basis”, in the absence of an uncontroversial scientific evidence. The WTO conference in Seattle has raised public concern about GMO products, on an international basis: European consumers have been concerned on GMO products for years, and public opinion is that their acceptance of these products is extremely low, and this is the major reason for technical barriers to GMO products and prohibition in food production.

The issue of consumers’ acceptance of biotechnology has been largely debated; first of all, we need to clarify what acceptance means (Thompson 1996, 1998); this may be some sort of philosophical question, and the fact the a product is purchased on a market may not be sufficient for acceptance. Of course, in evaluating consumers’ acceptance, the role of information is crucial, and this is even more important for innovative products, as it is the case of biotechnology.

It is commonly believed that European consumers’ attitude towards biotechnologies is generally negative, although researchers may not agree on explanations. This argument is taken by public authorities to justify a strong resistance towards biotechnologies themselves. International comparisons of consumer acceptance on biotechnology have shown significant differences between Europe and North-America (Hoban, 1997), with a generally higher resistance recognised to European consumers.

Aim of our paper is to provide some further insight to the discussion on public concern on biotechnology, by a direct evaluation of the attitude of a sample of Italian consumers.

## **2. Survey design and sample**

Information has been obtained by a phone survey, conducted on 384 people, randomly selected from the province of Piacenza in Northern-Italy; the co-operation rate was about 52%, with 200 questionnaires fully completed. Main purpose of the survey was to try to measure the individual’s WTP and to collect the main explanatory variables which, from other similar studies, are believed to affect individual purchasing

behaviors. Respondents were asked to answer several questions classified in the three main sections of the questionnaire, which tried to measure what we believed to be the main variables suggested in the literature able to explain WTP for food products obtained from biotechnology.

The first section is dedicated to the elicitation of the degree of the respondent's knowledge about products obtained from the application of biotechnologies: if she has ever heard of biotechnologies, with reference to what topic, if she knows that products obtained from biotechnologies are currently sold, her overall degree of knowledge, and so on.

In the second section respondents were asked to tell their willingness to pay for four particular categories of products: products obtained from biotechnologies with a lower use of pesticides, with improved nutritional characteristics, with improved organoleptic characteristics, with a longer shelf-life.

In the third section, we identified the *socio-demographic* individual characteristics of respondents: age, gender, education, working position, household income, place of residence, number of children.

The sample presents the following characteristics:

- average age: 43;
- sex: 58% female and 42% male;
- place of residence: 28.5% downtown, 39.5% in suburbs, 32% in countryside
- yearly income: 64% earn more than 16,000 EURO ;
- working condition: 58% of the interviewed people are employed; 18.5% are housewives, 12.5% are retired, 9% are students, 2% are unemployed;
- purchasing habit: 66.5% are usual purchasers;
- place of purchase: 71% purchase in supermarkets.

### *2.1 Awareness of consumers*

Regarding the respondents' degree of knowledge on biotechnology, 38% of the sample indicate no knowledge at all, while another 44.5% rate their level of knowledge as low; only 13.5% rate their level of information as sufficient and 4% as good; overall, consumers do not show a high degree of awareness about the issue of biotechnology. As

a consequence, when we asked to the respondent if she knew that biotech products are already present on the market, 51.5% of respondents answered “yes”.

### *2.2 Acceptance of biotech products*

A somewhat surprising result is that 46% of the sample have a positive attitude towards biotech food, while only 27.5% are negative; in both cases, the most important explanation is related to health risks. The rate of acceptance seems to increase when consumers are confronted with specific alternative: in fact, while with generic biotech products 17.5% of respondents do not buy biotech food at any condition, this percentage decreases to about 12% under explicit alternatives. Furthermore, with the same price and quality, 57.5% are indifferent between biotech and traditional products.

Further information can be derived by a cross-analysis of the results; we see that the higher is the (subjective) degree of knowledge on biotechnology the higher is the percentage of people that show a positive attitude towards biotechnology, while the lower that of people with a negative attitude. Among people that rate their degree of awareness as good, 87.5% are positive or indifferent. Furthermore, we suspect that there is an “information bias” among consumers: in fact, going from no knowledge to a low level of knowledge, the negative attitude increases, but then, when consumers collect more information the rate of acceptance increases.

An important issue is related to information; evidence comes from the fact that 94% require a specific label for biotech products.

### **3. Methodology and estimated models**

We have used a contingent valuation approach to evaluate the consumers’ response to aspects not already present on the market; thus, the contingent valuation approach allows to describe the behavioural intention of the respondents, through the value elicitation, that is a question on the Willingness To Pay (WTP) for a specific alternative: under certain conditions, the WTP represent a correct measure of the objective value of the alternative. Although there are several economic methodologies to value non-market items, such as nutritional properties, food safety, environmental issues, etc., researchers usually consider Contingent Valuation (CV) the most appropriate one for measuring food safety, especially for its flexibility and relatively low cost compared to other

methods which try to replicate a real purchasing situation, such as experimental markets.

CV allows a direct estimation of WTP by means of different (direct) elicitation techniques, but consumers simply indicate their WTP without purchasing an ideal product. Several concerns about the reliability of direct methods like both CV and experimental markets have been raised: for example consumers may have little information about the risks involved and therefore they may give a wrong monetary evaluation of the benefit from risk avoidance. A possible solution could be to give to consumers some information regarding the risks involved during the interview or the experiment (Buzby et al., 1995; Fox et al., 1995).

A second problem regards the product specificity of the analysis and the extension possibility of WTP results to other foods: results found for specific risks and food products can not necessarily be generalized to other risks and products (Caswell, 1998). Within the specific field of CV analysis, the reliance of this method on consumers' subjective responses makes the results vulnerable to several potential biases. First of all consumers face hypothetical purchasing situations: they probably take this scenario less seriously than the real one and therefore they may tend to overestimate their true WTP (Blumenshein et al., 1998).

Nevertheless, the selection of appropriate survey and elicitation methods would concur to minimize these biases. Surveys may encompass personal interviews, mail surveys or telephone surveys. Moreover, WTP elicitation using a payment card method is appropriate mainly for its simplicity and in order to give to basically uninformed individuals a detailed choice among a range of pre-defined price premiums. In fact this method asks respondents to select the amount they are willing to pay from a checklist of possible payments, either in absolute terms or as a percentage of price.

We decided to use telephone interviews with a payment card elicitation: respondents were asked to choose among four classes of WTP. This survey method allows to limit costs and to help respondents in defining their propensity to pay higher prices for unfamiliar products.

Answers have been analysed using models for discrete (qualitative) dependent variables, where we may relate the probability of making a certain choice (for example "buy" or "not buy") to some explanatory variables (individual characteristics). The

discrete structure of WTP implies the adoption of a probit/logit like procedures (Maddala, 1983).

Moreover, given the ordinal ranking of the WTP variable, the multinomial probit/logit model would fail to account for the ordinal nature of the dependent variable, therefore the ordered version of probit estimation was applied (Greene, 1990). The LIMDEP econometric software (Greene, 1995) was used for probit estimations.

Overall probabilities were calculated at the variables mean values using estimated intercept and coefficients.

Model significance was verified calculating the chi-square statistics resulting from the restricted and unrestricted log likelihood functions.

Four different models were estimated. The idea is to evaluate the different individual perception of biotechnology applied in order to reach different productive results: we considered biotechnology aimed to:

- reduction in the use of pesticides (LP);
- improvement of nutritional profiles (N);
- improvement of organoleptic characteristics (O);
- longer shelf life (SL).

Independent variables were selected applying a stepwise procedure.

Variables before selection referred to two main categories: variables reflecting demographic and social economic factors, such as age, gender, education, occupational status, income, household composition, place of residence, and variables revealing behavioural and knowledge factors, such as most frequent shopping area, if the respondent ever heard about biotechnology, if she is in charge of the family shopping, if she believes that GMO can be currently purchased, degree of knowledge about GMO, if she thinks that these products should be labelled differently.

Eventually, after selection procedures, only three of the four models were statistically significant. WTP for “SL” products was not related to what we believed to be the most effective explanatory variables for buyers’ behaviour. One possible explanation could be that shelf life is individually perceived to be a product characteristic which could be improved without resorting to biotechnology.

The three final models estimated take the following form:

$$WTP_{LP} = a_0 + a_1 INC + a_2 EDU + a_3 AGE + a_4 KNOW$$

$$WTP_N = b_0 + b_1 \text{ INC} + b_2 \text{ HEARD} + a_3 \text{ SOLD}$$

$$WTP_O = c_0 + c_1 \text{ INC} + c_2 \text{ SOLD} + c_3 \text{ KNOW}$$

Where WTP = willingness to pay for a GMO obtained with a lower use of pesticides ( $WTP_{LP}$ ), with improved nutritional characteristics ( $WTP_N$ ) and with improved organoleptic characteristics ( $WTP_O$ ).

The definition of explanatory variables is the following:

INCOME: monthly income

1: <1.5 million lire

2: 1.5 – 2.5 million lire

3: 2.5 – 3.5 million lire

4: >3.5 million lire

EDU: education level of the respondent

1: grade 5; 2: grade 8; 3: high school; 4: university.

AGE: 1: <20; 2: 20-29; 3: 30-39; 4: 40-49; 5: 50-59; 6: 60-70; 7: >70.

KNOW: respondent's self evaluation of her degree of knowledge

1: none; 2: low; 3: sufficient; 4: good.

HEARD: Has the respondent ever heard about biotechnologies?

1: yes; 2: no.

SOLD: Does the respondent know that GMO products are currently sold?

1: yes; 2: no; 3: don't know.

#### 4. Results

Results for the four estimated models are reported in table 1.

Income affects consumer's behaviour in the first three models: the positive sign indicates that a higher income increases the probability of higher WTP.

Knowledge also plays an important role in the decision regarding GMO implying a lower use of pesticides (LP) and those with improved organoleptic characteristics (O). If we consider the variable "HEARD" also a kind of knowledge indicator, even if weaker than "KNOW", because just stemming from a "word of mouth" diffusion process, then we can say that (proper) information is a key variable in the individual purchasing process. Signs are always positive, and therefore information makes individuals more confident regarding GMO products, increasing their WTP.

This clearly implies that economic agents interested in the production and sale of GMO products should pay particular attention to this aspect, adopting specific reputational strategies. This objective seems particularly hard to pursue in the negative environment which seems to emerge today, mostly determined by a negative propaganda.

To know that products are actually sold, and therefore that they have a market, also reassures individuals and makes them less afraid to buy these products: SOLD variable is positive and significant for products with improved nutritional characteristics (N) and for “O” products. This could be interpreted as a positive imitation process, which generally applies to new products. In the particular case of GMO products, health implications probably make individuals more cautious, and therefore this variable may not stand alone. If this is the case, then the diffusion of these products in retail outlets should be sustained by appropriate complementary strategies, such as product certification and information.

Regarding the weight of the different explanatory variables on WTP we know that, for qualitative choice models, estimated coefficients affect marginal probabilities. Probability derivatives (marginal probabilities) can be calculated from the estimated model: they measure the change in the probability of each WTP outcome with respect to a change in each explanatory variable. Unfortunately, for binary variables the probability derivatives do not exist: therefore, the predicted probabilities for these variables are calculated by holding all other variables at the sample means. Probability derivatives (marginal probabilities) are reported in table 2. In each row, the sum of marginal probabilities is 0: a higher probability attached to a WTP category means a lower probability for another.

Regarding LP products, income and education seem to be the variables with the strongest impact on the consumer’s decision to change her behavior from a WTP lower than 5% to higher premiums. Individuals show a strong propensity to pay the highest price premium: the probability of paying a premium greater than 20% of regular price for LP products increases by 0.0347, and the second largest value is an increase of 0.0243 in the probability of paying a premium between 11 and 15%.

Marginal effects for education are quite similar to those for income: probability attached to the maximum premium increases by 0.0359 with higher education; knowledge on the biotech problem affects WTP slightly less, with an increase of 0.0271.

Looking at the second category of GMO products, income is still the most important explanatory variable: higher incomes decrease (increase) the probability to pay the lower (higher) premiums (less than 10%, more than 10%) by 0.1138. The same is true for those individuals realizing that GMO products are currently sold: the probability of paying a premium higher than 15% increases by 0.1054.

Instead, to hear about biotechnology lowers the probabilities of higher premiums increasing those attached to the first two classes by 0.2214.

The third model still shows a strong impact of income, with the probability of the lowest WTP decreasing by 0.0941. The values related to SOLD and KNOW also indicate a slightly lower increase in the probabilities of higher WTP classes (more than 5%), 0.0882 and 0.0749 respectively.

## **5. Final remarks**

The empirical analysis developed in the paper supports the idea that one of the main reasons of the low acceptance of products obtained from biotechnology is the scarce knowledge that individuals have about this topic: those with higher knowledge are more akin to buy these products. It is also clear that, whenever consumers have a correct information, they accept to pay higher prices in order to have a quality improvement in the purchased products, which may indicate that, regarding the acceptance of GMO products, practical reasons often prevail on ethical reasons. This may be particularly true whenever the use of biotechnology reduces health risks, such as those caused by the use of pesticides. Certification of GMO products may represent a solution to informational problems: respondents asked for a precise guarantee of no risks for human health. In any case, acceptance of GMO products would not necessarily mean consumption. In this context, price plays an important role: the modal WTP class is between 6 and 10% of regular price for LP and N products, but less than 5% for O products. This result means that WTP may be differentiated across different degrees of risk type and risk avoidance.

These conclusions should be extended with caution: in fact, main limitations of this study and of other similar studies are the small sample size and the very limited geographical coverage, which make comparisons of WTP quite difficult. Moreover, we already emphasized that the use of a CV method raises the question if the hypothetical

choices correspond to real economic choices: therefore, an alternative could be an experiment with real purchase decisions, but this procedure would imply high implementation costs.

Table 1 – Regression results (ordered logit analysis)

Dependent variable:  $WTP_{LP}$

Variable	Estimated Coefficient	t-ratio	Level of significance
CONSTANT	-1.5595	-3.273	0.0011
INCOME	0.2284	2.589	0.0096***
EDU	0.2369	2.094	0.0362**
AGE	0.1014	1.721	0.0853*
KNOW	0.1789	1.736	0.0826*

Dependent variable:  $WTP_N$

Variable	Estimated Coefficient	t-ratio	Level of significance
CONSTANT	0.0386	0.100	0.9204
INCOME	0.3376	3.833	0.0001***
HEARD	0.6566	3.550	0.0004***
SOLD	0.3127	3.226	0.0013***

Dependent variable:  $WTP_O$

Variable	Estimated Coefficient	t-ratio	Level of significance
CONSTANT	-1.1908	-2.928	0.0034
INCOME	0.2458	2.702	0.0069***
SOLD	0.2304	2.584	0.0098***
KNOW	0.1957	1.820	0.0688*

Table 2 - Marginal effects

Variable	WTP=0	WTP=1	WTP=2	WTP=3	WTP4
<b>WTP<sub>LP</sub></b>					
CONSTANT	0.5663	-0.0826	-0.1657	-0.0815	-0.2366
INCOME	-0.0830	0.0121	0.0243	0.0119	0.0347
EDU	-0.0860	0.0125	0.0252	0.0124	0.0359
AGE	-0.0368	0.0054	0.0108	0.0053	0.0154
KNOW	-0.0650	0.0095	0.0190	0.0093	0.0271
<b>WTP<sub>N</sub></b>					
CONSTANT	-0.0129	-0.0001	0.0047	0.0035	0.0049
INCOME	-0.1127	-0.0011	0.0413	0.0302	0.0424
HEARD	0.2193	0.0021	-0.0802	-0.0587	-0.0825
SOLD	-0.1044	-0.0010	0.0382	0.0280	0.0393
<b>WTP<sub>o</sub></b>					
CONSTANT	0.4558	-0.0617	-0.1649	-0.0901	-0.1391
INCOME	-0.0941	0.0127	0.0340	0.0186	0.0287
SOLD	-0.0882	0.0119	0.0319	0.0174	0.0269
KNOW	-0.0749	0.0101	0.0271	0.0148	0.0229

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