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Risk Perceptions of Urban Italian and United States Consumers for Genetically Modified Foods

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The effects of Italian and US consumers' risk perceptions, knowledge and awareness of GM foods, and trust in government agencies on willingness to buy GM foods is examined. Results indicated that effects of risk perception of GM foods to human health and the environment are similar between urban consumers in Italy and the United States. However, Italian consumers were found to be more sensitive to the potential risks that GM foods may pose to human health and the environment, relative to the US consumer. In general, Italians were also less likely to purchase GM foods relative to US consumers.

Key words: genetically modified organisms, consumer risk perceptions

Genetically modified organisms (GMOs) are defined as plant and animal products produced using scientific techniques that involve taking the genes from one plant or animal species and inserting them in another species to transfer a desired trait or characteristic. For agricultural producers, GM crops have led to reduced production costs, enhanced yields, and the potential for increased profits. Other potential benefits include reductions in pesticide and herbicide use, as well as the potential for "phase II" biotechnology that enhances nutritional value, flavor, and shelf life of foods.

Despite the benefits of GM foods, consumer acceptance in the European Union (EU) has been quite limited, and although less controversial in the United States, acceptance of GM foods among some consumer and environmental groups there has been mixed. Consumers' reluctance to embrace GM foods is related to concerns of potential long-term negative effects on wildlife and the environment or unforeseen health risks. Environmental concerns include the potential for biotech crops to interact with non-GMO plants, leading to contamination of organic crops and/or herbicide-resistant weeds.

Recent food crises in Europe such as "mad cow" and "dioxin chicken" have led to heightened health and environmental concerns among EU consumers, leading to specific and stringent controls of GM products in the European Union (Soregaroli, Boccaletti, & Moro, 2003). United States regulatory policies regarding introduction and marketing of GM foods are less stringent—GMOs are regulated under special provisions under the same laws that govern conventional foods. Differences in EU and US regulatory policies are determined by numerous factors; an important factor is the public's perceptions regarding the safety and environmental risks of GMOs.

This paper compares the effects of these perceptions on the acceptance of GM foods by Italian and US consumers. Metropolitan areas of Northern Italy and the United States are similar in that they represent affluent developed economies, yet their regulatory policies for GM foods represent extreme opposites. We present evidence from surveys conducted in affluent metropolitan areas of the United States and northern Italy and analyze the effects of risk perceptions, nationality, and trust of government agencies on the willingness of consumers to accept GM foods.

Related Literature

Consumer surveys regarding the acceptance of GM foods have been conducted in the European Union and the United States since the early 1990s. For instance, between 1997 and 2001, International Food Information Council Foundation (IFIC) surveys found that 51–77% of US consumers were willing to purchase GM foods (IFIC, 2001). The Pew Initiative (2001) published results that suggested links between consumers' knowledge of GMOs, their socioeconomic status, and their attitudes toward acceptance of GM foods. Hamstra's results suggested that consumer acceptance of GMOs was influenced by consumers' subjective perceptions of improved product characteristics but found no link between knowledge of the technology and attitudes (Hamstra, 1991, 1993, 1995). Other studies indicated that two thirds to three quarters of US consumers were supportive of crop GMOs but also found significant differences among several countries in consumer acceptance of biotechnology (Hoban, 1998).

Eurobarometer surveys indicate that Europeans view modern food biotechnology with suspicion (Gaskell, 2000). Comparisons of US and European attitudes suggest that US consumers support GM crops and foods more than European consumers (Gaskell, 2000). Gaskell, Bauer, Duran, and Allum (1999) found that effects of consumer knowledge were significantly higher in Europe as compared to consumers in the United States. Zechendorf (1998) concluded that Northern Europeans are concerned about nature and see nature threatened by man and technology, whereas Southern Europeans are more concerned with human issues. Lusk, Roosen, and Fox (2002) found that EU consumers were much less accepting of beef from animals fed GM corn. EU consumers were willing to pay over twice as much as US consumers for meat coming from animals fed GM-free corn. Moon and Balasubramanian (2001, 2004) found that respondents who perceived risks to human health or the environment were more likely to oppose GM foods, while those who perceived benefits were more likely to have a favorable attitude. They also found that knowledge and awareness of GMOs, and the degree of trust in regulatory agencies, tended to increased willingness to accept GM foods.

The present study contributes to this growing body of literature, which examines the effects of nationality, consumers' risk perceptions, knowledge and awareness, and government trust on acceptance of GM foods. Improved understanding of how risk perceptions differ across trading partners, such as Italy and the United States, will aid government agencies in revising food policies to better match consumer preferences.

Methods

A binary probit model is used to analyze the effects of Italian and US consumers' risk perceptions and knowledge of GMOs on consumers' willingness to purchase GM foods. As the basis for the analysis, buying preferences are expressed as a function of consumers' risk perceptions, trust in government regulatory agencies, knowledge of GMOs, and selected socioeconomic and demographic variables.

The structural equation for the binary probit model is specified as follows:

$$\Pr(y = 1|x) = \int_{-\infty}^{x'\beta} \phi(t)dt = \Phi(\mathrm{x}'\beta), \quad (1)$$

where $\phi(t)$ is the standard normal density function, y is a binary variable indicating the respondent's willingness (or unwillingness) to purchase GM foods, and **x** is a matrix of explanatory variables. The regression model for the structural equation is given by $y_i = \mathbf{x}'\mathbf{b} + \varepsilon_i$, where y_i is defined by respondent i's response to a question asking if they would be willing to buy GM food products. A response indicating they would purchase GM foods is coded as 1, and a response indicating they would not purchase GM foods is coded as 0. The coefficient vector **b** is estimated using maximum likelihood techniques and is interpreted as the change in the conditional mean of y given a change in **x**. The error term (ε_i) is assumed to be normally distributed with mean of zero and variance equal to one.

The **x** matrix defines the respondent's risk perceptions, knowledge, and awareness of GM foods using responses to three attitudinal statements and two questions (Table 1). Statement S1 is coded using a 10-point scale, where +5 indicates strong disagreement and -5 indicates strong agreement. Statements S2 and S3 are also coded using a 10-point scale, but here +5 indicates strong agreement and -5 indicates strong disagreement. Preliminary examination of the data indicated that responses to S1 and S2 resulted in multicollinearity, so a composite risk index was constructed to capture information from both statements. The risk perception index ranges from 0 to 100, where index numbers of 0 and 100 indicate a combined score of -10 and +10, respectively, to statements S1 and S2. Question Q1 is coded 1 if the respondent indicated they considered themselves informed about GM foods, 0 otherwise. Similarly, Q2 is coded 1 if the respondent indicated they were aware that GM foods are sold in their local grocery store, 0 otherwise.

Socioeconomic and demographic variables include age, education level, gender, household size, and whether the respondent has children. The coding is as follows: Age_{ij} = 1 if the ith respondent's age corresponds to the jth group, 0 otherwise; Edu_{ij} = 1 if the ith respondents' education level corresponds to the jth category, 0 otherwise; $Male_i$ = 1 if the ith individual is male, 0 otherwise; and $Child_i$ = 1 if the ith respondent has children, 0 otherwise. Household size is reported as the number of individuals in the household.

The Surveys

The analysis utilizes data collected from two independent surveys to compare the risk perceptions and atti-

Table 1. Risk perception, knowledge, and awareness statements and questions for Italian and US surveys.

Statement/question
S1. GM foods are reasonably safe for human consumption.
S2. GM crops may have adverse effects on wildlife and the environment.
S3. There is no need to be concerned about the safety of GM foods because government agencies would not let these products be sold if they are not safe.
Q1. How well informed would you say you are about GM foods?
Q2. Are GM foods currently being sold in your grocery store?

tudes of Italian and US consumer regarding consumption of GM foods.

The US survey was administered by mail using a modified version of Dillman's total design method. Surveys were mailed to 3,450 randomly selected households in the metropolitan areas of Denver, Chicago, Atlanta, Los Angeles, New Orleans, New York, and Houston. A cover letter accompanied the questionnaire, which provided information regarding the benefits and drawbacks of biotechnology, food labeling, the reason the study was being conducted, and the importance of the subject's response to the success and usefulness of the study. A reminder letter and a follow-up questionnaire were sent to nonrespondents two weeks after the initial mailings. Five hundred nine usable questionnaires were returned.

The Italian survey was administered during October 2002. Personal interviews of 500 Italian consumers were conducted outside large supermarkets near the metropolitan area of Piacenza, which is in the Emilia-Romagna region of northern Italy. The use of personal interviews for the Italian survey was motivated by the resistance of Italian consumers to respond to mail surveys. Four hundred fifty-nine usable questionnaires were collected. This sampling frame is similar to that of an earlier study, which represents a more comparable sample relative to the US socioeconomic sample (Boccaletti & Moro, 2000).

Questionnaires for both surveys were developed following focus groups and pretests regarding consumers' perceptions of potential benefits and risks of GM foods in the respective countries. Although somewhat different, both US and Italian questionnaires included statements and questions consistent with those presented in Table 1. Statements S1 through S3 pertained to consumer beliefs about GM foods, and questions Q1 and Q2 pertained to the consumers' knowledge of GM foods. We also included questions pertaining to the individual's sociodemographic characteristics, including gender, age, education, household size, and whether the household included children. The questionnaire presented background information on GM foods, including a definition of genetic modification and a description of the present and future uses of biotechnology. This was followed by several questions pertaining to the respondents' general knowledge of biotechnology. Demographic characteristics of the respective samples are presented in Table 2.

Table 2. Distributions of socioeconomic and demographic characteristics and preferences for Italian and United States surveys of GMO foods.

Sample demographics	Italian (*N* = 459) Number	%	United States (*N* = 509) Number	%
Gender				
Male	255	55.92	274	53.83
Female	201	44.08	235	46.17
Age (years)				
18–24	93	20.31	12	2.36
25–34	66	14.41	56	11.00
35–44	99	21.62	99	19.45
45–54	109	23.80	135	26.52
55–65	53	11.57	93	18.27
65 or older	38	8.30	114	22.40
Education				
Less than high school	169	36.82	2	0.39
High school graduate	203	44.23	214	42.04
College graduate	87	18.95	293	57.56
Size of household	3.47		2.24	
Children in home				
Yes	140	30.50	159	31.24
No	319	69.50	350	68.76
Respondents indicating willingness to purchase GMO foods				
Would buy	224	51.20	281	55.21
Would not buy	235	46.80	228	44.79

It should be noted that the somewhat low response rate in the US survey and the convenience sampling technique used in the Italian survey may lead to nonresponse and sampling bias, as compared to the wider sampling frame of the Eurobarometer and other surveys that include less affluent areas of the European Union. It is possible that respondents are more interested in GM foods relative to nonrespondents and are therefore more sensitive to the risks and benefits of biotechnology relative to the general population. This may lead to an upward bias in the estimates of consumer attitudes

toward GM foods. Moreover, selection bias may also be present, because both surveys targeted primarily urban consumers. Attitudes may be different for individuals living in rural areas. Another limitation is that most respondents in the US survey had either some college or higher levels of education. Less educated consumers may have different preferences relative to the highest educated consumers.

Results

Three probit models were used in the analysis. All models included the previously described independent variables. Model I was estimated by pooling Italian and US data sets, and contains an intercept-shifting dummy variable that equals 1 if the respondent is Italian, 0 otherwise. Models II and III were estimated using US and Italian data independently. Results are presented in Tables 3 and 4.

All models are significant at the $\alpha = .01$ level, as indicated by their respective χ^2 statistics. The risk index and government trust variables are significant in all three models at the $\alpha = .01$ level, and the coefficients have the expected signs. In general, the results indicate similarities between US and Italian consumer regarding willingness to purchase GM foods. For instance, the negative signs associated with the risk index variable indicate that as perceptions of risk to human health and the environment increase, both US and Italian consumers' willingness to purchase GM foods decreases. Moreover, marginal effects for the risk index indicate that concerns regarding health and environmental risks are the most important factors affecting consumer acceptance in both countries (Table 4).

Positive signs associated with the government trust variables indicate that as respondents' confidence in food regulatory agencies increases, their willingness to buy GM foods also increases. Some studies suggest that trust of government regulatory agencies and perceived risks may be interrelated. For instance, Moon and Balasubramanian (2004) found that a "trust" effect has two sources. The first is a direct effect of trust on consumer attitudes toward GM foods, and the second is an indirect effect of trust on consumers' perceived risks of GM foods (i.e., greater trust leads to lower perceived risks and greater support for GM foods). Our results are consistent with Moon and Balasubramanian's findings regarding the direct effect of trust on consumer attitudes toward GM foods. However, data limitations prevent a causal test of the indirect effect in the present study.

Table 3. Probit estimates of Italian and US consumers' purchase preferences for GMO foods.[a]

Variable	Model I: Italian & US	Model II: Italian	Model III: US	Italian–US differences
Constant term	1.79*** (6.32)	1.58*** (4.20)	-0.74 (-1.47)	2.316
Risk perception	-3.04*** (-10.71)	-3.00*** (-9.35)	-2.54*** (-5.24)	-0.455
Government trust	0.29*** (7.36)	0.20*** (3.61)	0.22*** (5.06)	-0.026
Knowledge of GMOs	0.04 (0.31)	-0.02 (-017)	0.23* (1.74)	-0.255
Awareness of GMOs	0.12 (0.85)	0.17 (1.03)	0.11 (0.75)	0.071
Nationality (Italian = 1)	-0.43** (-2.52)			
Age[b]				
25–34	-0.35* (-1.63)	-0.19 (-0.81)	0.09 (0.21)	-0.283
35–44	-0.57*** (-2.88)	-0.51** (-2.42)	0.16 (0.33)	-0.664
45–54	-0.83*** (-4.24)	-0.89*** (-4.031)	0.42 (0.92	-1.309
55–64	-0.89*** (-4.09)	-1.06*** (-4.03)	0.55 (1.19)	-1.617
Over 65	-0.80*** (-3.439)	-0.69** (-2.28)	0.32 (0.70)	-1.020
Education[c]				
Less than high school	0.35** (2.27)	0.37** (2.15)	0.67 (1.08)	-0.306
College graduate	0.27** (2.00)	0.20 (1.06)	0.44*** (3.28)	-0.235
Gender (Male=1)	-0.0002 (-0.21)	-0.0002 (-0.35)	0.48*** (3.80)	-0.477
Household size	0.07 (1.55)	0.04 (0.84)	0.14*** (2.68)	-0.095
Child	-0.06 (-0.43)	0.03 (0.21)	-0.32* (-1.64)	0.351
Sample size	774	459	509	
Model ^{2}	280.44***	144.14***	134.52***	57.69***

[a]The dependent variable is coded 1 if the respondent indicated they would purchase a GM food and 0 if the respondent indicated they would not purchase a GM food.
[b]Excludes the 18–24 age group category.
[c]Excludes high school graduate category.
**p < .1. **p < .05. ***p < .01.*

The knowledge and awareness variables are not significant, with the exception of the knowledge variable in the US model, which is positive and significant at the $\alpha = .10$ level. This provides evidence that greater knowl-

Table 4. Marginal effects of Italian and United States consumers' purchase preferences for GMO foods.[a]

Variable	Model I: Italian & US	Model II: Italian	Model III: US
Constant term	0.68***	0.63***	-0.29
	(6.42)	(4.20)	(-1.47)
Risk perception	-1.15***	-1.19***	-1.01***
	(-10.72)	(-9.35)	(-5.24)
Government trust	0.11***	0.08***	0.09***
	(7.40)	(3.61)	(5.06)
Knowledge of GMOs	0.01	-0.008	0.09*
	(0.31)	(-0.13)	(1.75)
Awareness of GMOs	0.04	0.07	0.04
	(0.85)	(1.04)	(0.75)
Nationality (Italian = 1)	-0.16***		
	(-2.60)		
Age[b]			
25–34	-0.13	-0.07	0.04
	(-1.602)	(-0.81)	(0.20)
35–44	-0.22***	-0.20**	0.06
	(-2.89)	(-2.54)	(0.33)
45–54	-0.32***	-0.33***	0.17
	(-4.34)	(-4.57)	(0.92)
55–64	-0.34***	-0.37***	0.22
	(-4.36)	(-5.26)	(1.23)
Over 65	-0.31***	-0.26**	0.13
	(-3.60)	(-2.61)	(0.70)
Education[c]			
Less than high school	0.13**	0.15**	0.26
	(2.39)	(2.17)	(0.70)
College graduate	0.10**	0.08	0.17***
	(2.04)	(1.07)	(3.35)
Gender (Male=1)	-0.00007	-0.0001	0.19***
	(-0.21)	(-0.35)	(3.88)
Household size	0.03	0.04	0.14***
	(1.55)	(0.84)	(2.68)
Child	-0.02	0.02	-0.05**
	(-0.43)	(0.84)	(-2.68)
Sample size	774	459	509
Model χ^2	280.44***	144.14***	134.52***

[a]The dependent variable is coded 1 if the respondent indicated they would purchase a GM food and 0 if the respondent indicated they would not purchase a GM food.
[b]Excludes the 18–24 age group category.
[c]Excludes high school graduate category.
**p < .1. **p < .05. ***p < .01.*

edge of GMOs increases the probability of purchase for the US consumer. This factor has little effect on purchase decisions of Italian consumers.

Although the results suggest similarities between US and Italian consumers with respect to signs of the coefficients, the results also show differences between the two groups. For instance, the coefficient associated with the nationality variable in the combined model (i.e., model I) has a negative sign and is significant at the $\alpha = .05$ level. This indicates that Italian consumers in general are less likely to purchase GM foods relative to US consumers. Moreover, a Wald test was used to compare differences in slope parameters across models II and III. The Wald statistic shows that differences in the slope parameters are significantly different across models at the $\alpha = .05$ level (Table 3).

There are also differences between US and Italian consumers with respect to the magnitudes of the marginal effects (Table 4). For instance, differences in the marginal effects for the risk perception variable indicates Italian consumers are relatively more sensitive to perceived risks relative to US consumers (-1.15; Table 4). This implies that changes in perceived risks of GM foods have a relatively larger affect on purchasing decisions for Italians relative to Americans. This may be because consumers in the European Union are generally exposed to more media coverage, relative to US consumers, regarding the potential long term and unforeseen risks of GM foods. On the other hand, the differences in marginal effects between Italian and US consumers are not particularly large with respect to the effect of government trust on purchase decisions.

Effects associated with demographic variables are also reported in Tables 3 and 4. Model I shows that age and education have significant effects on the average US and Italian consumer's willingness to purchase GM foods. In general, as the respondent's age increases, willingness to purchase GM foods decreases. This is indicated by negative and significant coefficients in model I on all age variables relative to the omitted less-than-25 age category. The education coefficients in model I indicate that both less educated and higher educated consumers are more willing to purchase GM foods than respondents reporting they had a high school degree. Gender, household size, and children in the household variables are not significant in model I.

On the other hand, comparison of models II and III indicates differences between Italian and US consumers with respect to some of the demographic variables. The age variables in the Italian model are consistent with model I, but were not significant in the US model. This is likely due to relatively few observations associated with the 18–24 age group in the US data set (Table 2). Moreover, the Italian model indicates that respondents with less than high school education are relatively more willing to purchase GM foods relative to the high school

graduate category, whereas the US model suggests that having a college education has a positive affect on the US consumer's willingness to purchase a GM food. Other differences include the significance of the gender, household size, and children in the home variables in the US model. The results indicated that US men are more likely to purchase GM foods relative to US women and that household size positively affects the US consumer's willingness to purchase GM foods. Other results suggest that a child in the US household has a negative affect on the consumer's willingness to purchase GM foods.

Conclusions

This paper has examined the effects of Italian and US consumers' risk perceptions, knowledge and awareness of GM foods, and trust in the government agencies on their willingness to buy GM foods. Data from independent Italian and US survey are analyzed using a binary probit model.

Results indicated that effects of risk perception of GM foods to human health and the environment are quite similar between Italian and US consumers. Higher levels of perceived risk decrease the likelihood of purchase in both countries. We also found that consumer confidence in government agencies that control GM foods is important to Italian and US consumers' willingness to purchase GM foods. As confidence in the government's ability to control and monitor GMOs increases, the consumer's willingness to purchase also increases.

On the other hand, differences were found between Italian and US consumers regarding the magnitude of the risk effects. Italians were more sensitive to the potential risks that GM foods may pose to human health and the environment, relative to the US consumer. Moreover, in general, Italians were less likely to purchase GM foods relative to US consumers. Other results showed differences between the effects of demographic variables on willingness to purchase. The consumer's age did not seem to affect the US consumer's willingness to purchase, whereas the Italian consumer's age had a negative effect (i.e., the greater the age, the less likely that Italian consumers will buy GMOs). Education also produced mixed results, as less education is linked to a greater willingness to buy for Italian consumers. In contrast, higher education was linked to a greater willingness to purchase among US consumers. United States men were also found to be more likely to buy GM foods relative to US women. Gender was not important in the Italian model. United States consumers were also affected by the size of the household and the presence of children in the home, whereas these factors did not affect Italian consumers' decisions to purchase GM foods.

We conclude that beliefs regarding risk perceptions and government trust in regulatory agencies play an important role in shaping consumer opinions toward GM foods in both countries. This finding is consistent with the findings of other studies investigating consumer attitudes toward agrobiotechnology (Moon & Balasubramanian, 2001, 2004). Therefore, it is paramount that government agencies continue to provide credible and objective information regarding the risks and benefits of GM foods. This is particularly true because misinformation—which may be provided by special interest groups and other private organizations—will also influence consumer attitudes.

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