Hispanic Consumer's Preferences for Genetically Modified Ethnic Produce: An Econometric Analysis

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This study predicts Hispanic consumer's willingness to buy genetically modified (GM) ethnic produce. Specifically, this paper analyzes the effects of Hispanic consumers' socio-economic characteristics and their expressed value judgments on their willingness to buy genetically modified ethnic produce using an ordered probit model. An ordered probit model framework is used and the dependent variable is defined with three possible answers which include willing, indifferent, and less willing to buy genetically modified ethnic produce. The results from the analysis can be used by GM produce growers and marketers to target consumers.

Adoption of genetic modification (GM) among producers is driven by demand and is affecting public life. Science and industry are pursuing a wide variety of genetically modified foods. Positive views of GM include such potential benefits to society as reduction of hunger, prevention of malnutrition, curing of diseases, and promotion of health and quality of life. Some people are opposed to the use of biotechnology due to its potential negative impact on the environment. Others are against it on ethical, cultural, and moral grounds. Public debate on biotechnology has centered mainly on its potential benefits and implications to individuals, society, and the environment. The potential benefits suggest a need for more efforts to enhance consumer awareness so that consumers can better understand the importance of biotechnology and make a real and informed decision.

Over more than a decade, studies have been undertaken in various parts of the world seeking insight into public perceptions toward biotechnology. The results of these studies on public perceptions on biotechnology vary in their findings due to sampling variation, cultural differences, location, consumer technological knowledge, awareness of benefits, and confidence and trust in governmental and scientific institutions.

Previous studies that have analyzed American consumer attitudes and awareness of biotechnology (Hoban and Kendall 1993; Hoban 1994; FMI 1995) revealed that the results have been significantly consistent throughout the studies. A majority of U.S. consumers believe that they will gain from biotechnology, particularly via enhanced food benefits. For example, surveys of American consumers indicate that they would try new varieties of fruits and vegetables that taste better with reduced use of pesticides (Hoban 1997). Additionally, Americans are more likely to support medical and crop biotechnology, compared to applications with animals and food ingredients with GM (Hoban 1997).

Both U.S. consumers and Canadians were found to be more supportive toward biotechnology in general than were Europeans. More Canadians believe that genetic engineering will improve life than do Europeans (Einsiedel 1997). A Canadian survey also revealed that consumers were not adequately familiar with the risks associated with biotechnological advances and that consumers desired a clearer role for government in regulating and publicizing such advances (May 1999). Thus while most of the respondents were willing to accept the risks as a tradeoff for expected health benefits, that acceptance came with the demand that the government be rigorous in managing risks, make exhaustive research into the safety of biotechnology applications, and make them publicly available.

Consumers' perceptions of food-related risks and support for and confidence in the food supply show strong correlation to trust in food safety regulators (Dittus and Hillers 1993; Frewer, Shepherd, and Sparks 1994). People who demonstrate low trust in

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regulatory agencies also have the highest concern about possible risks regarding agricultural biotechnology. Various survey results indicated that consumer acceptance of biotechnology is driven by a sizable number of inter-related factors. The major influences on consumer acceptance seem to be knowledge level, awareness of benefits, and confidence and trust in government/scientific institutions (Hoban 1996). A large number of consumers have confidence in their respective regulatory systems for food safety issues, with North Americans showing the most confidence. Americans demonstrate more trust than either Canadians or Europeans that organizations and companies will provide safe products, except when the products are genetically engineered (Ipsos-Reid 2001).

In general, public objections to biotechnology are focused on those applications involving animals or human genetic material (Frewer et al. 1997). That is, previous studies found that more people were against using animal- and human-based genetically modified foods. A Korean study also found that the majority of the consumers were more supportive toward genetic modification of plants rather than of animals (Govindasamy et al. 2004). According to an study of Argentinean consumers (Mucci, Hough, and Ziliani 2004), 15 percent of respondents were willing to consume genetically modified foods. Another Taiwanese consumers study (Chen and Li 2007) found that respondents rely on their accumulated actual knowledge to decrease their risk perceptions from GM foods. Very few studies reported the views of ethnic consumers in biotechnology sector. Given the existence of extreme viewpoints, it is important to examine ethnic consumers' perceptions towards acceptance of biotechnology. Implementation of biotechnology will be determined by the quality of life based on the benefits of technology. Since it is a controversial issue, researchers and policy makers widely should consider the perceptions of ethnic consumers about biotechnology as they go about implementing genetic modifications in the produce sector.

However, some countries have already begun implementing biotechnology in the vegetable sector to take advantage of reducing pesticide consumption and increased production. The Ghanaian government is also pursuing the viability of implementing GM technology in the vegetable sector to reduce the consumption of pesticides. According to a study conducted by the IFPRI (International Food Policy Research Institute) in Ghana, there are high probabilities of higher profits in tomato, cabbage, and garden egg crops if farmers implement GM technology (Horna, Al-Hassan, and Timpo 2008). Maharashtra Hybrid Seeds Company (Mahyco), an Indian seed company, has developed Bt Brinjal (Indian Egg Plant). In India, Bt Brinjal commercialization would benefit farmers through reduced investment in pesticides and increased income from higher production (Jha 2008).

The U.S. census figures show that Asians and Hispanics are the fastest-growing minority populations in the United States. This growth among Asians and Hispanics is largely being fueled by immigration. The Hispanic or Latino population grew from about nine percent of the country's population in 1990 to 13 percent in 2000, a total of 35 million people. According to the U.S. Census Bureau, Hispanic population mushroomed by 58 percent from 1990 to 2000, making it the fastest-growing minority group in the United States. About one-fourth of the Hispanic population lives on the East Coast of the United States. New York has the third-largest Hispanic population, 2.8 million, after California and Texas, and followed by Florida and New Jersey with 2.6 million and 1.1 million, respectively (U.S. Census Bureau 2000). Small farms, rapid urbanization, and continued land development on the East Coast of the U.S. have put pressure on profitability in agricultural production. Using New Jersey as a case in point, between 1987 and 1997 there was a 6.9-percent drop in total farmland acreage (Tubene 2001). This puts New Jersey farmers at a competitive disadvantage against larger commodity growers from other states where production costs are comparatively lower. A good strategy for the local farmers might focus on production of alternative and high-valued crops. The size and rapid expansion of ethnic populations presents significant opportunities for vegetable producers in the East Coast region of United States. Economic opportunities have arisen in the last decade for specialty-rop agriculture, catering to the ethnically diverse consumers along the eastern coast of the United States. Specialty and ethnic vegetables are defined as vegetables or herbs that are not traditionally grown in the U.S. but are imported to the U.S. and are currently grown on a limited scale in the U.S. Ethnic and specialty vegetables are also

referred to as exotic, unusual, or world vegetables, or high-value crops (Tubene 2004). According to the results of the Hispanic survey, the ten vegetables most commonly bought by Mexican consumers are Chili Jalapeno, Tamatillo, Calabaza, Chili Poblano, Calabacita, Cilantro, Chili Serrano, Anaheim Pepper, Chili Habanaro and Tutuma; the ten vegetables most commonly bought by Puerto Rican consumers are Batata, Aji Dulce, Cilantro, Calbaza, Fava Beans, Pepinillo, Chili Caribe, Berenjena, Calabacita, and Verdolaga (Govindasamy et al. 2007). The perceptions of consumers toward GM ethnic produce vary among population groups.

This study identifies and estimates the influence of Hispanic consumers' socio-economic and value attributes on their perceptions toward willingness to buy genetically modified ethnic produce.

Conceptual Framework

The willingness to buy genetically modified ethnic produce (WTBGMP) is used as a categorical variable in this model. The ordered probit econometric technique was chosen based on the discrete and ordinal nature of this dependent. Unlike ordered probit models, ordinary least squares (OLS) models neglect the discrete nature of the data and treat them as continuous ratings rather than discrete rankings. Because the latter may cause potential heteroscedasticity in the OLS estimates, these estimates may not be efficient (Johnston 1984). Multinomial logit and probit models, on the other hand, do not account for the ordinal nature of the dependent variables, and are associated with undesirable properties such as the independence of irrelevant alternatives (Ben-Akiva and Lerman 1985) or, in the case of a multinomial probit, lack of a closed-form likelihood (Greene 1997). Thus the ordered probit model applied here is most suitable for this analysis compared to alternative models. The maximum-likelihood method used for ordered probit estimation yields consistent, asymptotically efficient, and asymptotically normal estimates (Judge et al. 1988). Hence hypothesis testing can be performed even if the distribution of the estimates is not known for the small-sample case. In the ordered probit model, $Y_i = 0$ implies less willing to buy GM ethnic produce, $Y_i = 1$ implies indifferent to buying GM ethnic produce, and $Y_i = 2$ implies willing to buy GM ethnic produce. The variable was transformed into a 0-to-2 scale for computational reasons. The ordered probit model builds on the conceptual model and assumes that the willingness to buy GM ethnic produce variable is a latent variable, which can be estimated using a regression (Greene 1997, pp. 736–738):

$$(1)\quad y_i^* = x_i'\beta + \varepsilon_i,\ \varepsilon_i \sim F(\varepsilon_i \mid \theta),\ E[\varepsilon_i] = 0,\ Var[\varepsilon_i] = 1.$$

The ordered probit model generates estimates for different categories of $\boldsymbol{y_i}$ (WTBGMP) as follows:

$$\begin{aligned}
&y_i = 0 \ if\ y_i^* \le 0,\\
&y_i = 1 \ if\ 0 \prec y_i^* \prec \mu_1,\\
(2)\quad &y_i = 2 \ if\ \mu_1 \le y_i^* \le \mu_2,\ ,\\
&.\\
&.\\
&y_i = J \ \text{if}\ \mu_{j-1} \le y_i
\end{aligned}$$

where the μ's are the unknown threshold parameters to be estimated along with the parameter vector β, and i is the number of categories of the dependent variable WTBGMP (j = 0 to J = 2). Because the estimated coefficients in an ordered probit model cannot be interpreted easily (Greene 1997, p. 737), the marginal effects are calculated for further discussion. The marginal effects for this model are calculated at the sample means of the regressors, as the effects of changes in the covariates on the probabilities for each category of the dependent variable (Pennings et al. 2004):

$$(3)\quad \partial\ \text{Prob[category j]}/\ \partial x_i = [f(\mu_{j-1} - x_i'\beta) - f(\mu_j - x_i\beta)] \times \beta,$$

where $f(.)$ is the appropriate density for the standard normal, $\Phi(.)$ logistic density, and $\Lambda(.)(1 - \Lambda(.))$ Weibull density. Each vector is a multiple of the coefficient vector. For all the probabilities to be positive, the following condition must be satisfied:

$$(4)\quad 0 < \mu_1 < \mu_2 < \ldots < \mu_{j-1}.$$

The model was estimated using LIMDEP econometric software. The marginal effects can be interpreted as a change in the probability that

WTBGMP equals a given level per unit change in the independent variable, conditional on other covariates [e.g., Prob(WTBGMP$_i$ = j | X_i)] (Powers and Xie 2000).

The following empirical model is used to estimate the relation between the consumer perception toward willingness to buy genetically modified ethnic produce and his/her personal attributes:

$$
\begin{aligned}
Y_i = {} & \beta_0 + \beta_1 \text{ VISIT\_TIMES} + \beta_2 \text{ ETH\_SPND} + \\
& \beta_3 \text{ ETH\_BUY\_AMER} + \beta_4 \text{ DISTANCE} + \\
& \beta_5 \text{ STORE\_AVBL\_IMP} + \beta_6 \text{ LANG\_IMP} \\
& + \beta_7 \text{ PRICE\_IMP} + \beta_8 \text{ PACKG\_NOT-} \\
& \text{IMP} + \beta_9 \text{ FRESHNESS\_BETTER} + \beta_{10} \\
& \text{QUALITY\_BETTER} + \beta_{11} \text{ PRICE\_BET-} \\
& \text{TER} + \beta_{12} \text{ PACKG\_SAME} + \beta_{13} \text{ ORG-} \\
& \text{NIC\_MORE\_WTB} + \beta_{14} \text{ COOL\_MORE-} \\
& \text{WTB} + \beta_{15} \text{ NEWMRKT\_WTB} + \beta_{16} \\
& \text{OUT\_STORE\_ADD}_{+} \beta_{17} \text{ POINTOFPUR} \\
& + \beta_{18} \text{ URBAN} + \beta_{19} \text{ YEARS\_LIVE} + \beta_{20} \\
& \text{HSIZE} + \beta_{21} \text{ BELOW17} + \beta_{22} \text{ AGE36TO50} \\
& + \beta_{23} \text{ HSCHOOL} + \beta_{24} \text{ EMPLOYED} + \\
& \beta_{25} \text{ SELF\_EMP} + \beta_{26} \text{ RETIRED} + \beta 27 \\
& \text{INC\_LES20} + \beta_{28} \text{ INC\_20TO40} + \beta_{29} \\
& \text{INC\_125TO150} + \beta_{30} \text{ MARRIED} + \beta_{31} \\
& \text{FEMALE} + \beta_{32} \text{ ETH\_ LANG} + \beta_{33} \text{ US\_} \\
& \text{BORN},
\end{aligned}
\tag{5}
$$

where $Y_i = 0$ if the respondent is less willing to buy GM ethnic produce, $Y_i = 1$ if the respondent is indifferent to buying GM ethnic produce, and $Y_i = 2$ if the respondent is willing to buy GM ethnic produce. The independent variables have been defined in Table 1.

Data Description and Summary Statistics

The data were collected from an ethnic-produce survey prepared for the Hispanic ethnic groups including Mexicans and Puerto Ricans. Sixteen states—Connecticut, Delaware, Florida, Georgia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Pennsylvania, Rhode Island, South Carolina, Vermont, and Virginia—plus Washington, DC were selected from the U.S. East Coast and, based on random sampling, 542 respondents were interviewed by a private company to collect data using a computer assisted telephone survey in 2006. In addition to consumers' value attributes and attitudes, respondents were asked about perceptions pertaining to willingness to buy genetically modified ethnic produce. Residents in the household who are primarily responsible for produce purchasing decisions were interviewed. Of the total 1,255 leads, 681 households including both purchasers (542) and non purchasers (139) of produce were interviewed, a response rate of 54; hence the present data set includes a total of 542 surveys of purchasers of ethnic produce. After deleting observations with missing values from 542 surveys, 493 observations were used in the ordered probit model analysis.

The dependent variable, "the intensity of willingness to buy genetically modified ethnic produce if made available to the respondents," is an ordered variable that takes on a value of 0 if a respondent was less willing to buy genetically modified ethnic produce, 1 if a respondent was indifferent to buying genetically modified ethnic produce, and 2 if a respondent was willing to buy genetically modified ethnic produce. According to the Hispanic consumer survey results, about 13 percent of the survey respondents were willing to buy genetically modified ethnic produce, 22 percent were indifferent to buying genetically modified ethnic produce, and 65 percent of them were less willing to buy genetically modified ethnic produce (Figure 1). The response variable used to explain the intensity of willingness to buy genetically modified produce includes respondent's behavioral, attitudinal and demographic variables. The variables used in the analysis are explained in Table 1. Excluding VISIT_TIMES, ETH_SPEND, DISTANCE, YEARS_LIVE, HSIZE and BELOW17, all other variables used in this model are dichotomous.

The first group of variables explains the survey respondent's purchasing behavior such as expenditure on produce, the distance traveled to the produce store, the number of visits to the produce store in a month, and whether the respondents purchased all ethnic produce from a typical American grocery store. The average Hispanic respondent visited the ethnic store 3.75 times to purchase produce items (VISIT_TIMES). On average, those who were willing to buy genetically modified produce spent $26.68, those who were indifferent to buying GM produce spent $20.93, and those who were less willing to buy GM produce spent $21.40 on ethnic produce per visit. The overall average expenditure on produce by Hispanic respondents was

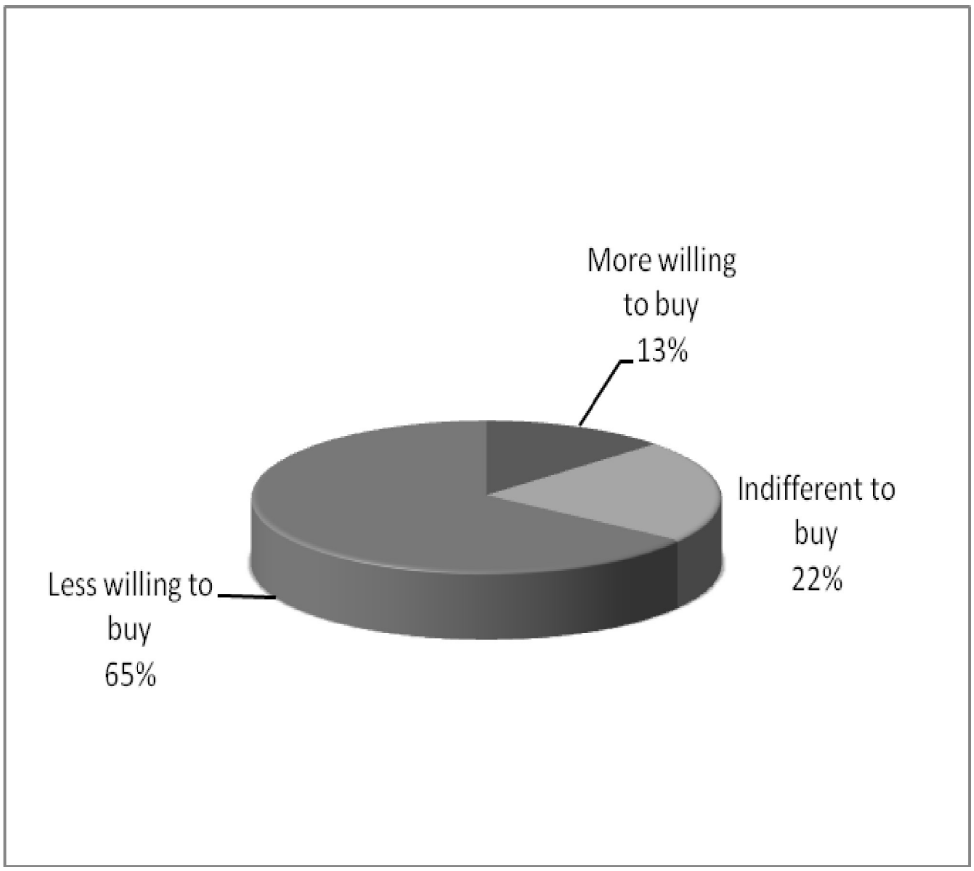

Figure 1. Hispanic Ethnic Respondents Intensity of Willingness to Buy Genetically Modified Ethnic Produce.

about $21.98 per visit with the standard deviation of $19.14 (ETH_SPEND). The average distance from the home to the ethnic store (DISTANCE) was about 14.24 miles. About one-fourth (28 percent) of the survey respondents bought ethnic produce from typical American grocery stores (ETH_BUY_AMER).

The second group of explanatory variables relating to perceptions of consumers includes importance of store availability, language attribute, price, packaging, freshness, willingness to buy organic, country of origin labeled, newly introduced produce items, and influence of out-of-store advertisements and point-of-purchase advertisements. About 67 percent of the respondents reported that store availability (STORE_AVBL_IMP) is very important to them and 39 percent felt that the language attribute (LANG_IMP) is very important when they visit the store. Furthermore, 61 percent had a preference for price (PRICE_IMP), 75 percent for packaging (PACKG_NOTIMP), and 37 percent for freshness (FRESHNESS_BETTER). When the respondents were asked whether they find the Hispanic ethnic outlets to be better than the conventional stores in terms of fruits and vegetables, about 34 percent of the respondents felt that quality is better (QUALITY_BETTER) and 44 percent of them felt price is better (PRICE_BETTER). In the case of packaging (PACKG_SAME), 55 percent of the respondents felt the packaging of produce to be the same in ethnic stores as in other conventional stores. In terms of willingness to buy, 55 percent of the survey respondents were willing to buy organic ethnic produce (ORGNIC_MORE_WTB), 47 percent of

Table 1. Description of Explanatory Variables.

S.No	Variable	Description	Mean	Std.Dev
	Behavioral Variables			
1	VISIT_TIMES	Number of times to purchase produce items within a month	3.75	2.98
2	ETH_SPND	Expenditure on ethnic produce for visit	21.98	19.14
3	ETH_BUY_AMER	1 if the respondents purchased all ethnic produce from typical American grocery store; 0 = otherwise	0.28	0.45
4	DISTANCE	Ethnic store distance from the respondent home	14.24	21.08
	Perceptional Variables			
5	STORE_AVBL_IMP	1 if store availability attribute is very important; 0 = otherwise	0.67	0.47
6	LANG_IMP	1 if language attribute is very important; 0 = otherwise	0.39	0.49
7	PRICE_IMP	1 if price is very important; 0 = otherwise	0.61	0.49
8	PACKG_NOTIMP	1 if packaging is not important; 0 = otherwise	0.25	0.43
9	FRESHNESS_BETTER	1 if freshness of produce to be better in ethnic store when compared to other; 0 = otherwise	0.37	0.48
10	QUALITY_BETTER	1 if quality of produce to be better in ethnic store when compared to other; 0 = otherwise	0.34	0.48
11	PRICE_BETTER	1 if price of produce to be better in ethnic store when compared to other; 0 = otherwise	0.44	0.50
12	PACKG_SAME	1 if packaging of produce to be same in ethnic store when compared to other; 0 = otherwise	0.55	0.50
13	ORGNIC_MORE_WTB	1 if respondent more willing to buy organically grown produce; 0 = otherwise	0.55	0.50
14	COOL_MOREWTB	1 if respondent more willing to buy when country of origin label available; 0 = otherwise	0.47	0.50
15	NEWMRKT _WTB	1 if respondent more willing to buy when recently introduced or new to market; 0 = otherwise	0.54	0.50
16	OUT_STORE_ADD	1 if the respondent influence by out-of-store ads; 0 = otherwise	0.55	0.50
17	POINTOFPUR	1 if the respondent influenced by point of purchase ads; 0 = otherwise	0.22	0.41

Table 1. Description of Explanatory Variables (Continued).

S.No	Variable	Description	Mean	Std.Dev
	Demographic Variables			
18	URBAN	1 if the respondent lives in urban area; 0 = otherwise	0.39	0.49
19	YEARS_LIVE	years living at current location	13.29	12.17
20	HSIZE	Household size	3.82	1.80
21	BELOW17	Number of children below 17 years age group	1.43	1.41
22	AGE36TO50	I if the respondent age was between 36 and 50	0.42	0.49
23	HSCHOOL	1 if the respondent education was high school; 0 = otherwise	0.35	0.48
24	EMPLOYED	1 if the respondent was employed by someone else; 0 = otherwise	0.61	0.49
25	SELF_EMP	1 if the respondent was self-employed; 0 = otherwise	0.12	0.32
26	RETIRED	1 if the respondent was retired; 0 = otherwise	0.04	0.19
27	INC_LES20	1 if the respondent income was less than $20,000; 0 = otherwise	0.19	0.39
28	INC_20TO40	1 if the respondent income was between $20,000 and 39,999; 0 = otherwise	0.27	0.45
29	INC_125TO150	1 if the respondent income was between $125,000 and 149,999; 0 = otherwise	0.01	0.10
30	MARRIED	1 if the respondent was married; 0 = otherwise	0.61	0.49
31	FEMALE	1 if the respondent is Female; 0 = otherwise	0.76	0.42
32	ETH_ LANG	1 if the respondent does not speak ethnic language; 0 = otherwise	0.11	0.32
33	US_BORN	1 if the respondent born in U.S.; 0 = otherwise	0.63	0.48

them were willing to buy country-of-origin labeled ethnic produce if available (COOL_MOREWTB), and about 54 percent of the respondents were willing to buy recently introduced ethnic produce or produce new to the market (NEWMRKT _WTB). In terms of influence of the advertisements, 55 percent of the respondents were influenced by out-of-store advertisements (OUT_STORE_ADD) and 22 percent were influenced by point-of-purchase advertisements (POINTOFPUR).

The third group of variables includes demographics of the survey respondents such as the location of residence, years living at current location, household size, number of children below 17 years of age in a family, age, education, employment status, and income. About 39 percent of the respondents belong to the urban segment (URBAN). The respondent's average time living at the current location (YEARS_LIVE) was about 13 years, the average household size (HSIZE) was 3.82 persons, and the average number children below 17 years age (BELOW17) was 1.43 persons per family. About 42 percent of the respondents belong to the age group between 36 and 50 (AGE36TO50) and 35 percent of them had finished high school (HSCHOOL). In the case of employment, 61 percent of the respondents were employed by someone else (EMPLOYED), 12 percent were self-employed (SELF_EMP) and four percent were retired (RETIRED). In terms of income, 19 percent of the survey respondents earned less than $20,000 (INC_LES20), 27 percent earned between $20,000 and $39,999 (INC_20TO40), only one percent reported income between $125,000 and $149,999 (INC_125TO150). About 61 percent of the respondents were married (MARRIED) and 76 percent of them were females (FEMALES). Around 11 percent of the respondents had not spoken their ethnic language (ETH_LANG) and 63 percent of them were born in United States (US_BORN).

Results

An ordered probit model was used to explain the Hispanic consumer preferences and acceptance of genetically modified ethnic produce. Table 2 provides the overall coefficients and estimated model marginal effects of the explanatory variables. The table also shows the estimated values of unrestricted (i.e., full model) and restricted (i.e., slope coefficients are zero) log-likelihood function, chi-square statistics of model significance, and model prediction success rate. The overall significance of the independent variables is tested using the chi-square distribution of the log-likelihood function. The null hypothesis of $\beta = 0$ was rejected at the 99-percent confidence level. The McFadden's R-square was 0.08, and represents the ratio of maximum likelihoods computed with and without the explanatory variable set. It is analogous to the R-square of the conventional regression model (Greene 1997). Estimated coefficients of threshold parameters μ_j satisfied the condition specified in the above equation. As expected, μ_j's are positive and statistically significant at the 99-percent confidence level, which implies no specification error in μ_j. Another statistical property available for probit models is productivity ability, which reflects the match between the actual rankings and those predicted by the model. The model predicted 223 of 326 cases correctly, or 68 percent, which is high for ordered probit models. The ordered probit model results in terms of marginal effects explain the degree of willingness to buy genetically modified ethnic produce (Table 2).

As can be seen from Table 2, the overall model indicates that variables NEWMRKT_WTB, EMPLOYED, INC_LES20, and INC_20TO40 positively influence Hispanic consumer's willingness to buy GM ethnic produce. The model indicates that PACKG_SAME, RETIRED, INC_125TO150 and US_BORN negatively influence Hispanic consumer's willingness to buy GM fruits and vegetables. Because the magnitude of the estimated coefficients in an ordered probit model itself provides limited information about the marginal effects of the independent variables on the probability of willingness to buy GM ethnic produce equaling intermediate values, the marginal effects are discussed below for those variables that are significant (Table 2).

The marginal effects in Table 2 show how an increase of one unit of the independent variable changes the probability of willingness to buy GM ethnic produce, if the independent variable is continuous. If the independent variable is binary, the marginal effect shows how the probability of willingness to buy ethnic GM ethnic produce change if the binary variable switches. For example, the marginal effect of NEWMRKT_WTB at willingness to buy GM ethnic produce value Y_3 is 0.0608, which means that a respondent who is willing to buy recently introduced products will be about six

percent more likely to be willing to buy GM ethnic produce compared to those who are not willing to buy recently introduced products. The signs of the marginal effects are potentially ambiguous, except when $Y_i = 0$ or 2, which are unambiguous and opposite each other (e.g., Greene 1997; Powers and Xie 2000).

The marginal effect shows that those who purchase all ethnic produce from typical American stores (ETH_BUY_AMER) are more likely to buy GM ethnic produce compared to those who do not purchase all ethnic produce from typical American stores. Those who think that the price of the produce is better in ethnic stores compared to American stores (PRICE_BETTER) are more likely to buy GM ethnic produce than are those who think otherwise. Those who are willing to buy recently introduced ethnic products (NEWMRKT_WTB) are more likely to buy GM ethnic produce than are those who are not willing to buy recently introduced ethnic products. Those who are willing to try recently introduced products are often open-minded and therefore may be more willing to buy GM ethnic produce. Those who are employed by others (EMPLOYED) are more likely to buy GM ethnic produce compared to homemakers and unemployed respondents. Those who earn less $20,000 (INC_LES20) and those who earn between $20,000 and $40,000 (INC_20TO40) are more likely to buy GM ethnic produce compared to those who earn between $40,000 and $125,000.

The marginal impact also shows that those who think store availability is important (STORE_AVBL_IMP) and those who think that packaging is not important (PACKG_NOTIMP) are less likely to buy GM ethnic produce compared to those who think otherwise. Those who are retired (RETIRED) are less likely to buy GM ethnic produce compared to homemakers and unemployed respondents. Those who earn between $125,000 and $150,000 (INC_125TO150) are less likely to buy GM ethnic produce compared to those who earn between $40,000 and $125,000. The model also indicates that females (FEMALE) are less likely to buy GM ethnic produce compared to males. Those who do not speak the ethnic language (ETH_LANG) and those who were born in the U.S. (US_BORN) are less likely to buy GM ethnic produce compared to those who speak ethnic language and those who were not born in the U.S., respectively.

Figure 2 shows the marginal effects of some selected variables. These graphs present the magnitudes of several marginal effects on the same scale with statistically significant effects highlighted in shadow bars. All figures relate to the influence of demographic variables on the willingness to buy GM ethnic fruits and vegetables. As can be seen from the graphs, those who earn between $125,000 and $150,000 (INC_125TO150) have the most marginal negative impact on willingness to buy GM ethnic produce. Likewise, those who earn below $20,000 (INC_LES20) have the most positive impact on willingness to buy GM ethnic produce.

Discussion and Conclusions

The concept of genetically modified is not new to fruit and vegetable consumers. But the degree of acceptance of GM produce does vary among the ethnicities. According to Hispanic ethnic survey results, about 13 percent of Hispanic consumers were willing to buy genetically modified ethnic produce, around 22 percent of them were indifferent to buying GM ethnic produce, and 65 percent of the respondents were less willing to buy genetically modified ethnic produce. On average, those who were willing to buy genetically modified ethnic produce spent $26.68 on ethnic produce per visit, those who were indifferent to buying GM ethnic produce spent $20.93, and those who were less willing to buy GM ethnic produce spent $21.40 dollars.

The results from the ordered probit model indicates that variables NEWMRKT_WTB, EMPLOYED, INC_LES20, and INC_20TO40 influence willingness to buy GM ethnic produce positively, while the variables PACKG_SAME, RETIRED, INC_125TO150, and US_BORN negatively influence Hispanic consumer's willingness to buy GM ethnic fruits and vegetables. Those who earn between $125,000 and $150,000 (INC_125TO150) are less likely to buy GM ethnic produce compared to those who earn between $40,000 and $125,000. Those who are willing to buy recently introduced products (NEWMRKT_WTB) are more likely to buy GM ethnic produce than are those who are not willing to buy recently introduced products. Those who are willing to try recently introduced products are often open-minded and therefore may be more willing to buy GM ethnic produce.

This study examined the relationship between

Table 2. Coefficients and Marginal Effects of Ordered Probit Estimation of Willing to Buy Genetically Modified.

			Marginal Effects		
Variable	Coefficient	P–Value	Less Willing to Buy	Indifferent to Buying	Willing to Buy
Constant	–0.7662	0.0088	0.00	0.00	0.00
Behavioral variables					
VISIT_TIMES	0.0004	0.2138	–0.0001	0.0001	0.0001
ETH_SPND	0.0000	0.8241	0.00	0.00	0.00
ETH_BUY_AMER	0.2006	0.1286	–0.073***	0.0367**	0.0363
DISTANCE	0.0015	0.6191	–0.0005	0.0003	0.0002
Perceptional variables					
STORE_AVBL_IMP	–0.1794	0.1559	0.0648**	–0.0331***	–0.0318
LANG_IMP	0.0579	0.6498	–0.0208	0.0108	0.01
PRICE_IMP	0.1147	0.3914	–0.0407*	0.0214	0.0193
PACKG_NOTIMP	–0.1923	0.1914	0.067**	–0.0361***	–0.0309
FRESHNESS_BETTER	–0.0293	0.8427	0.0105	–0.0055	–0.005
QUALITY_BETTER	0.0373	0.7971	–0.0134	0.0069	0.0064
PRICE_BETTER	0.1425	0.2551	–0.051**	0.0265*	0.0246
PACKG_SAME	–0.1983	0.0980	0.0713**	–0.0367***	–0.0346
ORGNIC_MORE_WTB	0.1215	0.3197	–0.0432*	0.0227	0.0205
COOL_MOREWTB	0.0458	0.7228	–0.0164	0.0085	0.0078
NEWMRKT _WTB	0.3579	0.0053	–0.1269***	0.0661***	0.0608*
OUT_STORE_ADD	–0.0941	0.4852	0.0337	–0.0175	–0.0162
POINTOFPUR	–0.0490	0.7655	0.0174	–0.0092	–0.0082

the Hispanic consumer perception toward biotechnology in the produce sector and their economic, demographic, and value attributes. The results indicate that a majority of the Hispanic consumers do not have firm positions on biotechnology. More specifically, despite having reservations, particularly about its use, Hispanics are not prepared to reject this technology. Thus the results of the survey may be used to influence future acceptance of GM technology. The results of this study have important implications for the agricultural industry and can be used by GM ethnic produce growers and marketers to target consumers. Though this survey represents the East Coast region of the United States, results might be applicable to all Hispanic ethnic populations in the United States.

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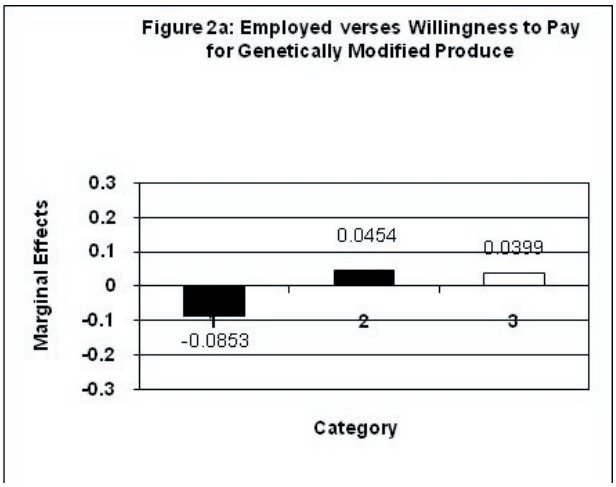
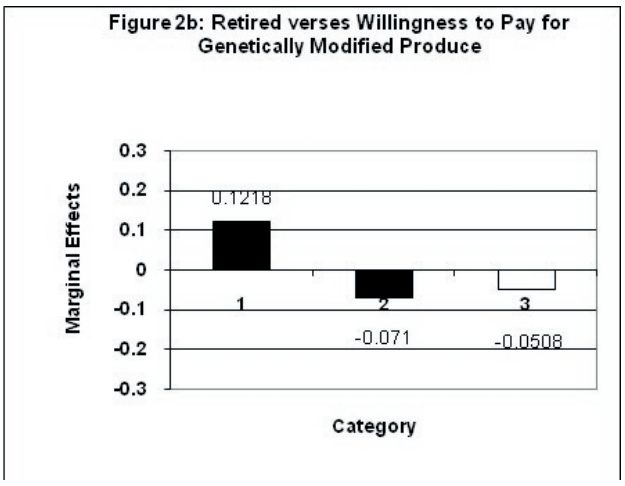
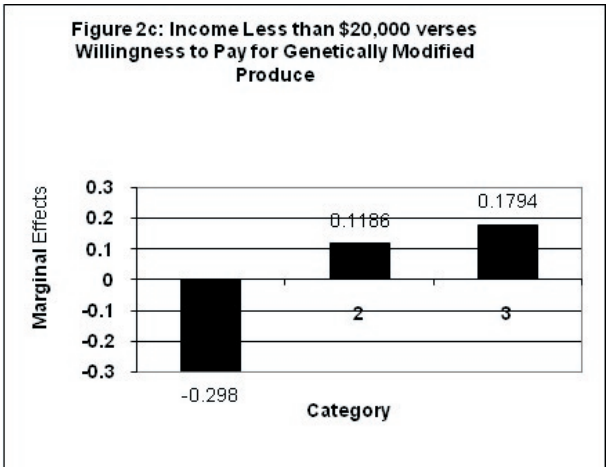
Table 2. Coefficients and Marginal Effects of Ordered Probit Estimation of Willing to Buy Genetically Modified (Continued).

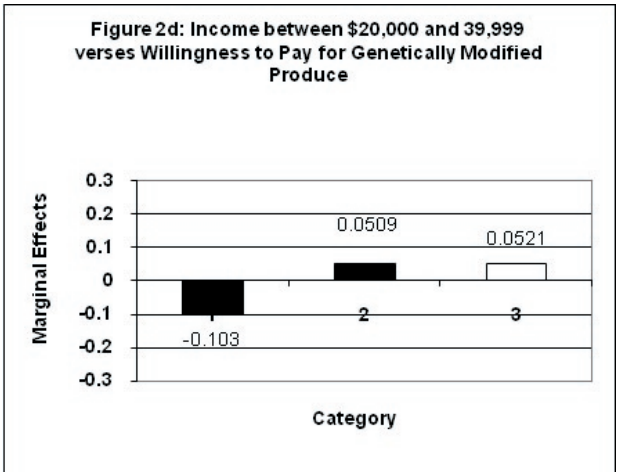
			Marginal Effects		
Variable	Coefficient	P–Value	Less Willing to Buy	Indifferent to Buying	Willing to Buy
Demographic variables					
URBAN	–0.1016	0.4106	0.0361	–0.019*	–0.0171
YEARS_LIVE	0.0048	0.3235	–0.0017	0.0009	0.0008
HSIZE	0.0262	0.6260	–0.0094	0.0049	0.0045
BELOW17	–0.0312	0.5650	0.0111	–0.0058	–0.0053
AGE36TO50	–0.0006	0.2606	0.0002	–0.0001	–0.0001
HSCHOOL	0.0009	0.1874	–0.0003	0.0002	0.0002
EMPLOYED	0.2427	0.0263	–0.0853***	0.0454***	0.0399
SELF_EMP	0.1343	0.3929	–0.0491**	0.0246	0.0245
RETIRED	–0.3776	0.0555	0.1218***	–0.071***	–0.0508
INC_LES20	0.7849	0.0000	–0.298***	0.1186***	0.1794***
INC_20TO40	0.2812	0.0666	–0.103***	0.0509***	0.0521
INC_125TO150	–1.0665	0.0001	0.2599***	–0.1706***	–0.0892*
MARRIED	–0.0001	0.8243	0.00	0.00	0.00
FEMALE	–0.1945	0.1579	0.0709**	–0.0356***	–0.0354
ETH_ LANG	–0.1726	0.4052	0.0596**	–0.0326***	–0.027
US_BORN	–0.2069	0.1079	0.0749***	–0.038***	–0.0369
Threshold μ_1	0.8328	0.0000			
LL Function	–394.97				
Restricted LL	–431.28				
Chi–Square	72.63				
DF	33				
McFadden R^2	0.08				
Overall Significance	High (@ 0.00)				
Prediction Success	68%				

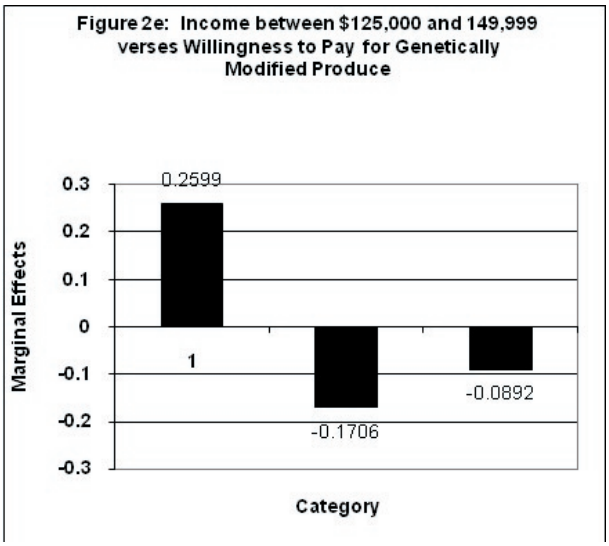
* = 0.10, ** = 0.05, *** = 0.01

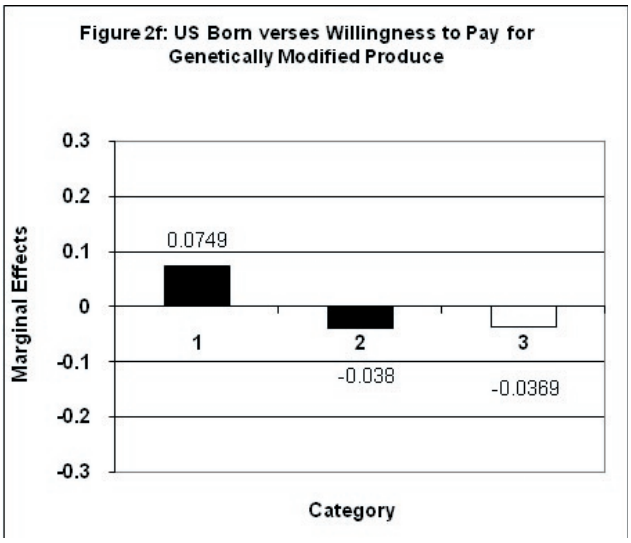












Note: Highlighted bars indicate the significant marginal effects (at one-percent, five-percent, and ten-percent significance levels) of demographics variables.

Figure 2. Impact of Marginal Effects of Consumers Demographics Variables on Willingness to Buy Genetically Modified Produce.

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