Consumer Attitudes, Knowledge, Experiences, and Socio-Demographic Characteristics on Willingness to Pay for Irradiated Pork

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Food processors are interested in increasing the safety of their food products not only to provide a safer product but by reducing losses associated with foodborne illness. Recalling food products can have dire direct and indirect financial consequences for food processors and retailers alike. Irradiating food products provides one means of addressing the food-safety issue by significantly reducing the presence of foodborne bacteria and diseases. The USDA's Food and Safety and Inspection Service has approved the use of irradiation to control bacteria in frozen and refrigerated meat and seafood products. However, the food industry is hesitant to adopt irradiation technology despite its benefits because of perceived consumer resistance to irradiated products (Misra et al. 1995).

Over the past decades, a number of studies have focused on consumer acceptability of irradiated food products. In 1992, Senauer reported that 71% of consumers surveyed list irradiated foods as either a serious or moderate hazard. Consumer acceptability of irradiated food products ranges from a low of 15% (Gaynor, Jensen, and Jaenicke 2002) to as high as 50% (Frenzen et al. 2001). Malone (1990) found that only one-third of the consumers in the United States were willing to purchase beef, pork, chicken, and fish irradiated to control microbial pathogens. He suggested that the success of the food-irradiation process is dependent on consumer acceptability. Fox, Hayes, and Shogren (2002) reported that a favorable description of irradiation increased respondents' willingness-to-pay for a pork sandwich irradiated to control *Trichinella*.

The objective of this study is to determine the likelihood that various socio-demographic and attitudinal factors may affect whether consumers are willing to buy and how much they are willing to pay for irradiated pork products. In addition, the study evaluates consumers' level of knowledge about the food-irradiation process and their level of concern with the food-irradiation process as well as with other food-safety procedures.

Empirical Model

The approach taken in this study recognizes explicitly the importance of consumer perceptions and attitudes as they relate to behavioral intent in the decision-making process. Specifically, it is assumed that consumers formulate their perception or attitudes from available information, knowledge, experiences, and given environmental factors, which may include personal characteristics and social and cultural background. Previous studies suggest that information acquisition, and consequently behavior, is affected by various demographic factors such as age and gender, education, and region and urbanization (Hinson, Harrison, and Andrews 1998.; Nayga 1986; Steger and Witte 1989).

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Thus these factors are hypothesized to be important determinants that influence consumers' decisions to buy irradiated pork products, if available, and the amount of a premium that they are willing to pay.

In order to analyze the interdependent relationships of behavioral intent—i.e., purchase intent and willingness to pay—in the consumer decision-making process, a two-equation structural model is formulated and specified as follows:

(1) $LTB = f(Z_1, SE) + \varepsilon_1$,

(2) $WTP = g(LTB, Z_2, SE) + \varepsilon_2$,

where LTB represents the likelihood of a consumer's intention to buy irradiated pork; WTP denotes a consumer's willingness to pay for irradiated pork products; Z_is are sets of independent variables measuring consumers' beliefs, knowledge, experiences, and attitudes toward irradiation technology; SE represents socioeconomic and demographic characteristics; and ε_is are vectors of random errors.

Specifically, the Z_i variables are assumed to include issues related to food safety and respondents' knowledge about irradiation technology and other technology such as using genetically modified (GM) organisms in food production. Consumers' attitudes toward the application of food irradiation and GMO are also considered relevant variables. In addition, the Z_i variables also include how much confidence consumers have in the sources of their information acquisition, such as the U.S. Food and Drug Administration (FDA) or American Medical Association (AMA). The SE variable is specified to include some of the variables representing age, race and gender, education, marital status, household composition, and income.

Survey Design and Methodology

In May 2003, the University of Georgia's Center for Survey Research interviewed 303 primary food shoppers from a randomly generated sample of Georgians using a computer-assisted telephone-interview (CATI) system. The questionnaire began with measuring respondents level of knowledge of the irradiation process, their attitudes toward food irradiation, and its effectiveness in increasing food safety.

When asked about their intention to purchase irradiated foods, respondents were first told that the food-irradiation process kills insects, parasites, and bacteria such as *Salmonella*, *E. Coli* and Staph and also extends the shelf life of the food by preserving freshness. The respondents were then asked if they would be very likely, somewhat likely, not too likely or not at all likely to buy irradiated pork products. If a respondent answered "very likely" or "somewhat likely," the respondent was considered likely to buy irradiated foods and the dependent variable of LTB is assigned a value of 1; otherwise, the variable was set at 0. With respect to willingness to pay for irradiated pork products, each respondent was asked how much, on average, was spent on pork products per month. The respondents were then asked if they would be willing to pay an additional amount (randomly selected 5%, 10%, 25%, 75%, to 100%) for pork products with bacteria levels greatly reduced by irradiation.

Due to some refusals and missing information, the sample used for this analysis consists 212 observations with complete information. The variables constructed from the survey data and sample characteristics are presented in Table 1. Overall, respondents tended to be

Table 1. Variable Definition and Sample Characteristics.

Variable	Definition	Mean (std. dev.)
Likely to Buy (LTB) Irradiated Pork Products	= 1 if respondent indicated at least somewhat likely to buy irradiated pork if it was treated with approved doses and properly labeled, 0 otherwise.	.5849 (.4939)
Willingness to Pay (WTP)	Amount of price premium $/lb that respondent is willing to pay for irradiated pork.	6.6248 (14.6108)
ADCH	= 1 if additive/chemicals are a food safety concern, 0 otherwise.	.1887 (.3922)
Know Irradiation	= 1 if at least know something about the food irradiation process, 0 otherwise.	.2123 (.4099)
Irradiation Necessary	= 1 if irradiation is considered at least somewhat necessary for pork, 0 otherwise.	.7736 (.4195)
Support Irradiation	= 1 if respondent indicated at least somewhat support the use of food irradiation, 0 otherwise.	.5566 (.4980)
Know GM Foods	= 1 if respondent is at least somewhat informed about genetically modified (GM) foods or organisms, 0 otherwise.	.4057 (.4922)
Consume GM Foods	= 1 if respondent is at least somewhat willing to consume food produced with GM ingredients, 0 otherwise.	.8019 (.3995)
FDA	= 1 if confidence in the safety of irradiated food increased because it is endorsed by the U.S. Food and Drug Administration (FDA), 0 otherwise.	.5236 (.5006)
USDA	= 1 if confidence in the safety of irradiated food increased because it is endorsed by the U.S. Department of Agriculture (USDA), 0 otherwise.	.5187 (.5008)
AMA	= 1 if confidence in the safety of irradiated food increased because it is endorsed by the American Medical Association (AMA), 0 otherwise.	.5802 (.4947)
WHO	= 1 if confidence in the safety of irradiated food increased because it is endorsed by the World Health Organization (WHO), 0 otherwise.	.3962 (.4903)
Primary Shopper	= 1 if the respondent is responsible for the household's grocery shopping, 0 otherwise.	.5613 (.4974)
Urban Household	= 1 if household resides in urban area, 0 otherwise.	.6698 (.4714)
White	= 1 if the race of household is white, 0 otherwise.	.7406 (.4394)
Female	= 1 if respondent is female, 0 otherwise.	.6398 (.4821)
Children < 18 Years	= 1 if there are children under 18 years of age living in the household, 0 otherwise.	.4245 (.4954)
Household Size	Number of persons in the household	3.0047 (1.4685)
Married	= 1 if married, 0 otherwise.	.6651 (.4731)
Age	Age of the respondent in years.	45.3868 (15.3469)
High School Education	= 1 if respondent attended or graduated from high school, 0 otherwise.	.3066 (.4622)
Household Income	Annual income class before taxes, ranking from 1 being under $15,000 to 9 being $75,000 and over.	6.3066 (2.6690)

demographically upscale, with older, better-educated, and higher-income consumers slightly over-represented. The average household size was about 3 persons. Females, urban residents, and people of European origin represent 64%, 67%, and 74% of survey respondents, respectively. The results show that about 58% of Georgia consumers surveyed were at least somewhat likely to buy irradiated pork products and they were willing to pay an additional amount averaging about $6.62 per month for irradiated pork.

To implement the empirical model, the typical application is to apply Heckman's (1979) two-step sample-selection procedure in which Equation (1) is to be estimated by the probit procedure and Equation

Table 2. Estimated Probit Results of Purchasing Irradiated Pork Products.

Variable	Estimated coefficient	Standard error	Marginal effect[a]
Constant	-1.4655*	0.7831	
ADCH	-1.0623***	0.3075	-.4046***
Know Irradiation	-0.3055	0.3034	-0.1176
Irradiation Necessary	.7742***	0.3052	.2989***
Support Irradiation	1.3099***	0.2729	.4727***
Know GM Foods	0.3469	0.2539	0.1285
FDA	0.299	0.3808	0.1124
USDA	.5822*	0.3542	.2172*
AMA	1.0925***	0.3597	.4032***
WHO	-1.3403***	0.3608	-.4886***
Primary Shopper	.5912**	0.2875	.2222**
Urban Household	-0.1929	0.2586	-0.068
White	0.2769	0.278	-0.1061
Female	-0.3108	0.2757	-0.1148
Children < 18 Years	-0.4917	0.3725	-0.1856
Household Size	0.0855	0.1231	0.0322
Married	.6038**	0.2761	.2306**
Age	-0.008	0.0091	-0.003
High School Education	-0.07	0.2607	-0.0264
Household Income	-0.0381	0.0472	-0.0143
-2 x Log-likelihood ratio		115.447***	
Efron's pseudo R^2		0.442	
Sample size		212	

*, **, and *** indicate the estimated coefficients are statistically significant at the 10%, 5%, and 1% significance level, respectively.
[a] Marginal effect is defined as the change in the probability given a change in the explanatory variable. For binary variables, the marginal effect is calculated as the difference in probability for a discrete change of the value of the binary variable from 0 to 1.

(2) is to be estimated by ordinary least squares (OLS) procedure based on a subsample of positive observations with the inclusion of inverse Mills ratio obtained from Equation (1) as an additional regressor. In this study, the dependent variables of likely to buy (LTB) and willingness to pay (WTP) are constructed based on the survey data collected. The survey question that related to WTP was not structured sequentially following the question of LTB, and the observation of zero amount on WTP is considered a valid answer. Hence it is necessary to use the entire sample for WTP instead of a subsample of positive willingness to pay.

The problem of estimating Equation (2) with OLS based on the observed data is the correlation between the endogenous binary variable (LTB) and the error term, $_2$. A solution to the inconsistent estimates of OLS is to use the two-stage least-squares procedure (Greene 1995). Huang (1993) also used the two-stage estimation procedure to investigate interrelationships among consumers' risk perceptions, attitudes, and willingness to pay for residue-free produce. In this case, Equation (1), as before, is estimated by probit and the predicted probabilities are used as the instrumental variable for LTB in Equation (2) in the second stage of the estimation process. The joint parameter estimation of Equations (1) and (2) was carried out by

Table 3. Estimated Regression Results of Willingness to Pay for Irradiated Pork Products.

Variable	Estimated coefficient	Standard error
Constant	-18.1800***	5.7564
LTB	8.1116*	4.2725
Know Irradiation	-1.5118	2.3018
Support Irradiation	2.7849	2.8218
Consume GM Foods	2.5384	2.4062
Primary Shopper	1.4564	2.1217
Urban Household	3.2526*	1.9964
White	1.9024	2.318
Female	1.7335	2.1665
Children < 18 Years	-5.3558*	2.935
Household Size	2.6001***	0.9618
Married	1.7453	2.2195
Age	0.102	0.0694
High School Education	0.1693	2.0924
Household Income	-0.015	0.3869
-2 x Log-likelihood ratio	66.180***	
Adjusted R^2	0.156	
Sample size	212	

*, **, and *** indicate the estimated coefficients are statistically significant at the 10%, 5%, and 1% significance level, respectively.

LIMDEP program (Greene 1995).

Results

The estimation results of Equation (1) on the likelihood of a Georgia consumer buying irradiated pork products are presented in Table 2. Two goodness-of-fit measures are also reported. One is the log-likelihood ratio. The log-likelihood ratio test statistic indicates that the estimated probit model is statistically significant at less-than-1% significance level. The computed Efron's pseudo R^2 of .442 also indicates a good fit for the data to model.

The estimated coefficient on ADCH is negative as expected and significantly different from zero at the less-than-1% significance level. The result suggests that respondents who are concerned about food-safety issues related to additives and chemicals are less likely to buy irradiated pork products than are those who are not concerned with additives and chemicals. The estimated marginal effect suggests the probability of those concerned respondents buying irradiated pork is about 40% smaller than their counterparts, *ceteris paribus*.

The estimated coefficients for Irradiation Necessary and Support Irradiation are both positive and highly significant at the less-than-1% significance level.

The estimated coefficients for FDA, USDA, and AMA are all positive and statistically significantly different from zero except for FDA. This result suggests that respondents are more likely to buy irradiated pork products if the process is endorsed by the USDA or medical associations like the AMA. The estimated coefficient for WHO is statistically significant but negative, which is contrary to expectations. The result indicates that a respondent is not likely to buy irradiated pork if the process is endorsed by the WHO. This finding appears to suggest that perhaps respondents feel more confident with endorsements made by U.S. government and institutions than by international organization.

Among the socio-demographic characteristics, only two variables are found to have statistical significant impacts on the likelihood of purchasing irradiated pork products. The estimated coefficient for primary food shopper and marital status suggest that the probability of purchasing irradiated pork products is increased by an estimated 22% and 23% if the respondent is the primary shopper of the household or married, respectively. The result shows that white households and larger households are more likely to purchase irradiated pork than are their counterparts. However, the estimated coefficients are not statistically significant.

The estimation results of Equation (2) on the Georgians' willingness to pay extra for irradiated pork products is presented in Table 3. In general, most of the estimated coefficients for the explanatory variables are not statistically significant. However, the overall goodness-of-fit statistics indicate that the model performed satisfactorily. The log-likelihood ratio test shows that the estimated model is statistically significant at less-than-1% significance level. Although the adjusted R^2 of 0.156 appears low, it is considered satisfactory and acceptable for the model given that the data are cross-sectional in nature and collected from the survey.

As is to be expected, one of the important variables that affects a respondent's willingness to pay for irradiated pork is the likelihood of purchasing irradiated

pork products. Thus, if the respondents are willing or likely to buy irradiated pork products, they would be willing to spend an additional $8.11 per month for irradiated pork. Although the results show that respondents who support the irradiation process and are willing to consume GM foods are positive, suggesting they would be willing to pay an additional amount for irradiated pork, the estimated coefficients are not statistically significantly different from zero.

With respect to the demographic variables, the results suggest that urban households and larger households are willing to pay an extra amount of $3.25 and $2.60 per month, respectively, for irradiated pork products. As expected, households with children under 18 years of age are not willing to pay extra. The result suggests that those respondents who have young children at home would be spending $5.36 per month less than their counterparts for irradiated pork. The result supports the hypothesis advanced in the literature that families with children would be less inclined to accept irradiated foods because of the perceived risk and hazards associated with the technology. Hinson, Harrison, and Andrews also reported similar findings that, compared to households without children, households with children appeared less willing to pay any price premium for irradiated foods.

Implications and Conclusions

The results suggest that the probability of a consumer's purchasing irradiated pork products is influenced by their perceptions of the necessity for irradiating these products as well as by their support for the products. Consumers concerned with additives and chemicals were significantly less likely to purchase irradiated pork. Two demographic variables, primary food shoppers and married respondents, were found to have exerted positive and significant impacts on the probabilities of purchasing irradiated pork products among Georgia consumers. The influence of the demographic variables is important in that for the food irradiation process to gain wide-spread acceptability and become successful in the marketplace, consumers will have to be convinced that the process is safe, wholesome, and beneficial.

The second component of the model found that the