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Determinants of Consumer Attitudes and Purchasing Behaviors on Genetically Modified Foods in Taiwan

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Abstract

Consumers have been concerned about the introduction of genetically modified (GM) foods into Taiwan. This study examines the public's attitude toward GM foods in Taiwan using data obtained in a nationwide telephone interview in January 2004. Logit regression was used to measure the relative importance of consumers' socio-demographic characteristics, personal beliefs, and awareness of genetically modified foods which may impact their purchasing behavior, as well as consumers' willingness to pay a premium for non-GM foods. Results show that the perceived risk of GM foods and technology, previous knowledge about genetic engineering, and higher education levels were significant determinants of consumers' willingness to purchase non-GM foods versus GM foods. Moreover, on average, Taiwanese consumers were willing to spend 19% more to avoid purchasing GM foods.

Keywords: Genetically Modified foods, Taiwanese consumers, willingness to pay.

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Introduction

The increased marketing of genetically modified (GM) foods raised considerable concerns about this new technology, which calls for a better understanding on the public's attitude toward GM foods in Taiwan. Consumers' attitudes toward risk, GM labeling, shopping frequency, knowledge about genetic engineering, religion, vegetarianism, and basic socio-demographic indicators shape their opinions about GM foods. The objective of this paper is two-fold: firstly to examine the significance of various factors that may influence consumers' attitudes and purchasing intentions about genetically modified vegetable oil, tofu, and salmon; secondly to estimate determinants of consumers' willingness-to-pay premium for non-GM foods. Finally, based on empirical results, recommendations will be made to come up with GM foods regulations better adjusted to the needs of Taiwanese consumers, as well as marketing strategies.

Data

Data used were drawn from a telephone survey administered by The Research Center for Humanities and Social Sciences (RCHSS) in Taiwan (Chiang 2012) during the period January 2 to 29, 2004. This survey was conducted by random sampling telephone interviews across Taiwan. In total, there are 1002 valid observations in the data set.

The telephone interview contained 337 questions that were divided into three sections. The first section focuses on consumers' purchasing behaviors, habits and attitudes toward GM products. The second section collects consumers' WTP on vegetable oil (made from non-GM soybeans vs. GM soybeans), tofu (made from non-GM soybeans vs. GM soybeans), and salmon (fed with non-GM soy powder vs. GM soy powder), which covers the main usages of GM soybeans and corn in Taiwan. Because many WTP questions have the same price range, we calculate the percentage difference between non-GM and GM foods to capture consumers' choice under different price scenarios. In the third section, basic household socio-demographic data were collected.

Overall, the data represent consumers who are mostly female, married, middle-aged, less educated, and with relatively low income. Thus, we weighted the dataset to keep it balanced. Notably, the data in Table 1 shows that more people think GM foods are risky (65.5%) and should be labeled (95.2%).

Table 1. Variable Definition and Sample Means of Taiwanese Consumer Characteristics

Variable	Definition and Coding	Mean	Std.
Female	= 1 if female; 0 otherwise	0.779	0.416
Married[1]	= 1 if married; 0 otherwise	0.916	0.278
Young age	= 1 if < 30 years old; 0 otherwise	0.254	0.436
Middle age	= 1 if 30 to 50 years old; 0 otherwise	0.652	0.477
Base group	= > 60 years old		
Medium education	= 1 if some college but no bachelor's degree; 0 otherwise	0.160	0.367
High education	= 1 if 4 years college degree and above; 0 otherwise	0.133	0.34
Base group	= high school diploma or less		

Table 1-*Continued*

Variable	Definition and Coding	Mean	Std.
Medium income	= 1 if income $30,000 to $50,000; 0 otherwise (in USD)	0.168	0.375
High income	= 1 if income more than $50,000; 0 otherwise (in USD)	0.072	0.259
Base group	= income less than $30,000		
Knowledge[2]	= 1 if very/somewhat knowledgeable about GM foods; 0 otherwise	0.292	0.455
Shopper	= 1 if shops more than once a week; 0 otherwise	0.928	0.259
Religion	= 1 if belongs to a religious group; 0 otherwise	0.505	0.5
Vegetarian	= 1 if is vegetarian; 0 otherwise	0.045	0.207
Label[3]	= 1 if GM food should be labeled; 0 otherwise	0.952	0.213
Risk	= 1 if associate GM foods with high/ moderate risk; 0 otherwise	0.655	0.476
Price	= price difference between GM and non- GM foods	0.593	0.291

Note. [1] married=1 if married or have at least one year of marriage. [2] The survey examined consumers' knowledge by the question "How do you perceive your knowledge about the GMO?" Answers are "Very knowledgeable", "Somewhat knowledgeable", "Heard of but do not know", "Unheard of and do not know", "No reply". The question design has subjective issues. [3] label =1 if consider GM labelling very important, or somewhat important

Methodology

This research applied a logit model to estimate the degrees of influence of identified factors on respondents' purchasing choice and willingness to pay for GM foods (vegetable oil, tofu or salmon). The response to the survey questions about WTP is a binary choice between yes and no, following Li, Zepeda, and Gould's methodology (2007).

$$(1) \qquad Y = \gamma + \alpha k + \beta p + \varepsilon$$

$$\text{Where } y = \begin{cases} 1 \text{ if the respondent chooses to buy GM foods} \\ 0 \text{ otherwise} \end{cases}$$

Also, k is a vector of the 14 explanatory variables listed in the Table 1, and p is a price vector defined as the price difference between GM and non-GM foods (base group) in the empirical model in order to capture the price effect; ε is the random error assuming logistic normality (Bukenya and Wright 2007). By maximum likelihood estimation of the logit model, we can determine which factors have a significant impact on consumers choosing GM foods.

With respect to the price variable, we assume non-GM foods to be the base group: GM food products were more expensive than their non-GM counterparts. Therefore, the prices of non-GM food products were specified as discounts to the prices of GM food products, using Chern and Rickertsen's methodology (2002). The discounts ranged from -50% to 100%, while responses to questions about WTP on vegetable oil clustered mainly between 0 – 30%, 0 – 100% for tofu, and 0 – 50% for salmon. So 30% price difference was assigned for vegetable oil-related questions, 100% for tofu questions, and 50% for salmon questions in the logit model in order to avoid the multicollinearity problem.

The WTP premium is calculated by definition as the expected premium for non-GM foods: how much more are consumers willing to pay for non-GM foods to avoid consuming GM foods (Wang et al. 2007).

Results and Discussion

Estimated Logit Regression Results

The results are presented in the Table 2, including the log-likelihood coefficient, the pseudo R^2, the model's prediction success, and the estimated WTP premium. Although the R^2 value is low, it is the norm with logistic regression (Hosmer Jr. and Lemeshow 2004). There is no multicollinearity problem of explanatory variables (the condition number is 23.55).

Table 2. Estimated Logit Regression Results of Taiwanese Consumers' Willingness to Purchase Three GM Foods.

Logit Model		Dependent Variable = Assessment of the willingness to purchase GM foods (vegetable oil, tofu or salmon)
Variable	**Coefficient**	**SE**
Female	0.058	0.040
Young age	-0.092	0.071
Middle age	-0.080	0.065
Married	0.008	0.070
Medium education	-0.018	0.048
High education	-0.157 **	0.063
Religion	0.000	0.033
Medium income	-0.004	0.048
High income	0.103	0.067
Shopper	0.006	0.066
Knowledge	-0.178 ***	0.040
Risk	-0.274 ***	0.036
Label	0.087	0.075
Vegetarian	-0.082	0.090
Price	-0.001	0.054
Constant	-0.488	0.619
Observations	736	
Pseudo R-squared	0.1145	
Model Prediction		
(dependent variable = 1)	67%	
(dependent variable = 0)	72%	
Log likelihood	-398.252	
WTP premium	23.78	
Sample size	736	

Notes. *** p<0.01, ** p<0.05, * p<0.1

Dependent variable for the logit model is purchasing GM foods that takes on a value of one if the participant opted to purchase, and zero otherwise. Logit estimates are partial derivatives computed at sample means or the discrete change of dummy variables from zero to one

The coefficient of high education is significant at the 5% level. It indicates the purchase of GM foods will be 15.7% less if one has a four-year college degree or above. The perceived risk levels

associated with GM foods and previous knowledge about genetic engineering both have negative effects on purchasing GM foods, which are both significant at the 1% level. It shows that consumers will decrease their purchase by 27.4% if they perceive GM foods as risky; similarly, consumers will decrease purchase by 17.8% if they are more knowledgeable about GM foods.

Since the WTP premium is affected by the price differences designed in the survey when calculated in terms of price, we calculate it in percentage terms: how much more in percentage terms are consumers willing to pay a premium for non-GM foods. The results shows the WTP are 19% for non-GM vegetable oil, 20% for non-GM tofu, and 18% for non-GM salmon, respectively. The average WTP premium is 19%.

Determinants of Differences in Willingness to Pay for Non-GM Foods

In this section, determinants of differences in WTP across individual consumer characteristics are examined. The dependent variable for this regression is the WTP premium, and the estimation results are presented in the Table 3.

Table 3. Determinants of WTP Premium for Non-GM Foods

WTP Premium	**Coefficient**		**SE**
Female	-0.026		0.043
Young age	0.121	*	0.066
Middle age	0.141	**	0.057
Married	0.000		0.051
Medium Education	0.072		0.049
High Education	0.065		0.049
Religion	0.067	*	0.037
Medium income	-0.113	**	0.047
High income	0.012		0.066
Shopper	0.073		0.053
Knowledge	0.016		0.035
Risk	0.185	***	0.028
Label	0.146	**	0.058
Vegetarian	0.029		0.068
Price	0.014		0.060
Constant	-0.200	**	0.095
Observations	430		
R-squared	0.117		
Sample size	430		

Note. *** p<0.01, ** p<0.05, * p<0.1

The results indicate that age plays an important role in the WTP premium for non-GM foods; younger age consumers are willing to pay premiums of 12.1% more for non-GM foods, and people of middle age are willing to pay premiums of 14.1% more for non-GM foods. Religion, risk, and labelling also play important roles in WTP premium decisions. On the contrary, medium- income consumers are not willing to pay premiums to purchase non-GM foods. Other coefficients are not significant; however, most coefficients present positive signs, indicating

consumers in the sample are more willing to pay premiums to purchase non-GM foods in avoidance of GM foods.

Although the explanatory variables are the same in both analyses (Tables 2 and 3), their significance level are different. It indicates that variables that significantly influence GM food purchasing decisions are not always the ones that lead to consumers' WTP premiums for non-GM foods in avoidance of GM foods; for example, the variables education and knowledge were not significant. This is very important because purchasing decisions are the first step in the consumers' food choices, and the next step is their WTP premiums to back up their purchasing decisions.

Implications

This research has important implications for policy makers, producers, and marketers of GM foods. Positive publicity of GM foods and their functions within a country's food chain should be reinforced (Xu and Wu 2010). Since the survey indicates that only 29.2% of the sampled consumers are somewhat or very knowledgeable about GM foods, most of the individuals are rather "uninformed" about GM technology, which may lead to GM avoidance behaviors.

Manufactures could refine their labeling strategy in order to capture market margins since consumers, on average, are willing to spend 19% more to purchase non-GM foods (Chern and Rickertsen 2002). Moreover, consumers' attitudes and purchasing behaviors relative to GM foods in Taiwan might have changed since the study period, and food manufactures need to keep update with consumers' tastes and preferences. Thus, more recent surveys should be conducted to keep the analyses up to date.

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