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Consumer Attitudes towards Genetically Modified Foods in Emerging Markets: The Impact of Labeling in Taiwan

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Abstract

In 2001, Taiwan enacted a law for genetically modified food (GM foods) labeling. Beginning January 1st 2003, food containing more than 5% of GM ingredients must be labeled. Taiwan imports most of its soybeans from the United States. In order to assess the effects of the new policy, a telephone survey was conducted in 2002. A total of 257 interviews were completed.

A typology of consumers' attitudes towards GM foods is constructed from the use of a multiple correspondence analysis and a classification method. Four profiles are identified: proponents, 52%, moderate opponents, 32.5%, extreme opponents, 12.5%, and those with no opinion, 5.5%.

Key Words: genetically modified food, consumer attitudes, Taiwan, telephone survey.

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Introduction

In 2001, the Bureau of Food Sanitation in Taiwan enacted a new law for genetically modified (GM) food labeling. Under this new regulation, food containing more than 5% of GM ingredients must be labeled. In 2002, Taiwan imported $414.6 million of soybeans from the United States, the world-leading country in research, development and sales of genetically modified organisms (GMOs).[1] As noted, 66% of the estimated acreage of GM crops worldwide was grown in the U.S. in 2002 and the National Agricultural Statistics Service reported an adoption rate of 75% for GM soybeans.[2]

Across the world, countries have implemented different labeling policies regarding GM foods. Contrary to the European Union (EU), Japan or Australia where the labeling of GM foods is mandatory, the U.S. has adopted a voluntary labeling. These differences are causing problems for agricultural producers and exporters who have to adjust to different labeling standards. In fact, any new regulation regarding the GM technology can potentially harm their interests.

Prior to the new GMO labeling regulation, Taiwanese were eating many GM foods (especially soybean-based), but they did not know it. With mandatory labeling, consumers can make their own decisions on the acceptance of GM foods. The assessment of the consumer's attitudes towards GM foods is important to agricultural traders, manufacturers, and policy makers. The future of GMOs will be influenced by how they are perceived by the public. Indeed, since the initial commercialization of GM soybeans and corn in 1996, public attitudes and perception have proved to be important factors affecting the consumer's acceptance of these products, the willingness to pay or unwillingness to sell GM products in the marketplace.

The objective of this study are to investigate the consumer's acceptance of GM foods in Taiwan and to assess the effects of the new labeling policy on trade and the implications for the GM grain producers. We attempt to show that various attitudes towards GMOs can be found within the Taiwanese population, and to present the associated distributional information useful for the biotechnology and food industry in terms of market evaluation. For these purposes, a telephone survey was conducted in Taiwan in 2002. This comprehensive survey dealt with both stated preferences for GM vs. non-GM foods as well as behavioral intentions, since behavioral intention reflects a person's decision to perform the behavior (Fishbein and Ajzen, 1975). For the remainder of the paper, we will first discuss the survey design and descriptive statistics, and then the methodology and results of classifying the Taiwanese consumers.

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[1] U.S. Department of Agriculture, Foreign Agricultural Service: http://www.fas.usda.gov/ustrade.
[2] USDA Economics and Statistics System: http://jan.mannlib.cornell.edu/

The Survey

The questionnaire, on which the survey was based, focused on consumers' attitudes and behavioral intentions towards GM foods. It included various questions dealing with the willingness to consume GM foods in terms of favorable (e.g., if it was more nutritious) or adverse (e.g., if it posed a risk of causing allergic reactions for some people) arguments, the knowledge of the respondents regarding biotechnology in general and GMOs in particular, and the regulation of GM foods. The survey focused on three specific products, namely, vegetable oil, tofu and salmon, and asked respondents to make choices between GM and non-GM products under different price scenarios.[3] Information also was collected on respondents' socio-economic characteristics. The data were collected in 2002 through a national telephone survey from randomly selected households in Taiwan. A random digit dialing was used to select the households (generation of random telephone numbers avoiding undercoverage of unlisted numbers). Respondents were limited to food shoppers in the household aged 20 and over. A total of 257 interviews were completed with a response rate of 29.3% using the response rate computation method adopted by the American Association for Public Opinion Research (AAPOR), the most conservative calculation.[4]

In order to validate the representativeness of the sample, two variables were considered: age and gender. The age distribution of the sample compared to the Taiwanese Census of population aged 20 and over (in 2000) is given in Table 1.

Table 1: Age Distribution, Sample and Population

Age (Years)	Taiwan Census of Population (2000)	Total Sample
20-24	12.9%	6.4%
25-29	11.4%	7.6%
30-34	12.0%	12.4%
35-39	12.4%	13.5%
40-44	11.7%	21.5%
45-49	10.4%	13.9%
50-54	6.9%	6.4%
55-59	5.2%	6.0%
60-64	4.9%	3.2%
65 and over	12.2%	9.2%

Sources: http://www.dgbas.gov.tw/census~n/home-e.htm and primary data.

[3] The survey covered two types of salmon, namely non-GM salmon, GM-fed salmon (salmon raised with GM soybean meals).

[4] Number of completed interviews divided by the number of interviews plus the number of non-interviews (refusal and break-off plus non-contacts plus others) plus all cases of unknown.

Except for a slight imbalance for the age classes 20-24 and 40-44 years, there is no significant difference between the sample and the population. As for gender, men represent 44% of the sample compared to 51% in the population. Since the survey targets are food shoppers, the higher representation of female shoppers is expected and the break down is deemed satisfying. Overall, the sample is therefore fairly representative of the target population.

Labeling and Gross Measure of Consumer Acceptance of GM Foods

As elsewhere in the world, consumers are becoming more particular about what is in their food and how it is produced. However, consumer knowledge about products often amounts to its visualization in the aisles of food stores and to the information given by commercials, when, to quote Oddveig Storstad (2001), "the manner in which the product is produced is also necessary […] to be able to make a choice that is in line with his own wishes". This information asymmetry between the seller and the customer may prevent the consumer from making completely rational and optimal decisions. In the case of GMOs, consumers can not simply differentiate the products without labeling. Labeling is one way to correct this information asymmetry by providing the consumer with needed information. It is a solution adopted by many governments. However, by implementing GM labeling programs, a number of ethical and economic issues arise. Very often, the question amounts to: should labels be voluntary or mandatory?

The results of this survey show that 83% of the surveyed Taiwanese population is in favor of mandatory labeling. An earlier survey conducted in September 2000 by the Health Department in Taiwan had found that 73% of all respondents said that the forthcoming labeling system should be mandatory (Chuang, 2002). This result is in accordance with studies conducted in other countries. In a recent study conducted in the U.S., Ganiere et al. (2004) found that 89% of the interviewees were in favor of a mandatory labeling. In fact, most surveys indicate that a high proportion (82-93%) of American consumers wants GM foods labeled. For example, Hallman and Metcalfe (1995), in their survey of New Jersey residents, showed that 84% of those polled wanted mandatory labeling of genetically engineered fruits and vegetables. Similar results were found in the European Union (EU) where 94.6% of Europeans want to have the right to choose when it comes to GM foods, possible only under mandatory labeling (Eurobarometer 52.2, 2001).

One may ask why such a consensus of opinion for mandatory labeling? To use a marketing term, ingesting food is incredibly "involving". This may be due to the fact that the food, very literally, becomes internalized in the body, which is a very strong act in biological and symbolic terms. This concept is known in anthropology as the "incorporation principle"; simply stated, it amounts to: "you are what you eat". If I eat healthy, I will be healthy. A consequence of this belief is that the eater feels it essential to have control over incorporation. But nowadays, consumers face what

Fischler (1990) called UFO, Unidentified Food Object. As it is often said, “we don't know anymore what we are eating”. The industrialization of the food system means that food production and processing take place beyond the view of the lay consumer, involving techniques that they are only vaguely aware of or simply do not understand. Thus, many of the food items routinely purchased may be perceived as having unknown features or unknown ingredients, with a consequent loss of the consumer's confidence. Facing this uncertainty, one of the usual solutions is to "reidentify" the food (through cooking for example); hence, the obsession of labels or the guaranty of origin.

Nonetheless, consumers do not want to spend much time seeking and analyzing information. Some evidence even suggests that customers do not pay attention to labels. For example, Noussair et al. (2002) show that sales do not decrease when the label reveals that the product contains GMOs. Using experimental economics, they concluded that the absence of reaction to the labeling was due to the fact that most customers do not notice the labeling, and thus do not realize that the product they are purchasing contains GMOs. Finally, customers want simple and clear information, easily accessible; if they know the information is available, they consider the one providing them with it has nothing to conceal. Labels would therefore be a mean of reinsurance. In our survey, we found 70% of respondents read (often or sometimes) the label of nutrition information on the food package. Only 14% of respondents indicated that they never read the label.

Furthermore, the case of GM foods is somewhat different since most of the producers perceive the GM labeling as negative. As reminded by Rousu and Huffman (2001), there are four reasons why one could oppose GM foods: ethical reasons, environmental concerns, health concerns and trading worries. For consumers in particular, it seems the GM technology refers to conceptions people have about agriculture, technological innovation and risk (Sylvander and Leusie, 2002). Ethics does not seem to have a big role; in our survey (79% of the respondents considered ethical or religious concerns as somewhat or extremely unimportant when they decide whether or not to consume GM foods). The safety of GM foods is, overall, a major concern. The impacts of this major technological innovation are not yet fully known. Consumers support labeling since labels may reduce the information acquisition costs to them (Rousu and Huffman, 2001).

We found that 40% of the surveyed sample perceives a health-related risk associated with the consumption of GM foods. The desire for labeling is then bolstered by this perceived risk. Florkowski et al. (1998), in a study on risk perception and new food production technologies, found that the highest additive risk perception was associated with the habit of reading labels on foods and meat products. From this result, it can be deduced that the risk perception for GMOs induces a claim for mandatory labeling.

As a result of concerns over the safety and environmental impacts of GM crops, many governments have decided to implement mandatory labeling; Taiwan is one of them, following Japan and the EU.

Multiple Correspondence Analysis

Consumers have clearly different behaviors and attitudes towards the GM technology. These attitudes can be grouped within distinct profiles. Thus, from the questions assessing the attitudes of the respondents, two individuals can be assumed having the same attitude if they answered the same way to the questions. Moreover, two individuals can be thought belonging to the same profile if their answers only diverged slightly. Lastly, each profile can be described through the people belonging to it. If all the people are women aged over sixty years, it can be thought as being one of the dominant features of this profile. Therefore we can explore and identify the structure of association amongst the set of categorical variables related to the consumer attitude.

The five questions used as active variables for this analysis are the following; they were aimed at assessing the attitudes of the respondents towards GM foods:

1. How risky would you say GM foods are in terms of risk to human health?
2. How willing are you to consume foods produced with GM ingredients?
3. How willing would you be to consume GM foods if it reduced the amount of pesticide applied to crops?
4. How willing would you be to purchase GM foods if it was more nutritious than similar food that isn't genetically modified?
5. How willing would you be to purchase GM foods if it posed a risk of causing allergic reactions for some people?

For each of these questions, respondents were proposed the following six categorical modalities:

1. Extremely unwilling / risky
2. Somewhat unwilling / risky
3. Neither willing nor unwilling / risky nor safe
4. Somewhat willing / safe
5. Extremely willing / safe
6. Don't know (not spontaneously proposed to the interviewees)

Considering the complexity to analyze ten two-way cross-tabulations, a technique of data analysis is required, an exploratory technique intended to reveal features in the data.[5] Multiple correspondence analysis (MCA) is one such method to analyze

[5] In the general case of Q categorical variables, there are Q(Q-1)/2 possible two-way cross-tabulations of pairs of variables; in our case, with Q= 5 variables, we have 10 pairs of categorical modalities.

the associations amongst categorical variables, with the purpose of visualizing the most salient relationships in the data.

MCA is a multivariate extension of correspondence analysis (CA). It permits an analysis of the interrelationships between three or more variables. It is a technique for displaying the rows and columns of a data matrix as points in dual low-dimensional vector spaces (Greenacre, 1984). Each respondent is characterized by the modalities chosen in the survey. For example, in the question, "How risky would you say GM foods are in terms of risk to human health?", a respondent is characterized by the categorical modality he or she chose, such as "somewhat risky" or "extremely safe". Respondents can therefore be represented in a multidimensional space. Since we cannot observe points in a space with more than three dimensions, it becomes necessary to reduce the dimensionality of the points. The points are projected on a lower-dimensional subspace which is chosen to capture as much of the dispersion of the profiles as possible. A new orthogonal set of axes (the factor axes or factors) is found, so as to maximize the inertia of the projected points onto the new axes.[6] These axes define a two by two factor plane. Each factor represents a salient feature related to the consumer acceptance of GM foods. By studying the modalities significantly associated with the main factor axes, one can explain the main oppositions within the population and thus discriminate the people. The main variables eliciting the consumer acceptance of GM foods can then be extracted from the analysis.

Empirical Results of MCA

The principal objective of our analysis is to differentiate the respondents according to their attitude towards GM foods with respect to a range of different arguments. As we already mentioned, our analysis concentrates solely on shoppers in the household, as we consider that their attitudes are the closest to the reality, thereby decreasing the hypothetical bias of the study.

Note that, as in any factorial method, it is possible to include what are known as the "illustrative" variables. These are not used in the construction of factor planes, but can help in the interpretation of the factors or later in the description of the classes. In our case, we included: the socio-demographic variables, the questions dealing with the knowledge about GM foods and biotechnology, some questions about the regulation of GM foods (especially labeling), and also the questions asking for choices between GM and non-GM foods.

[6] The inertia is the square of a distance weighted by the mass of the point. The inertia of a cloud of points is the sum of the inertias of all the points, or the weighted sum of squared distances from the points to their respective centroids. The total inertia is the same in both row and column cloud of points.

Factor Planes

Typically, in the MCA, analyses of factor planes are guided by the centroid principle: category coordinates are the center of gravity (or centroid) of respondent coordinates occurring in that category. Stated differently, respondents are relatively close to categories they are in and relatively far from categories they are not in. In the MCA, the weighted Euclidean distance is used to measure the distances between points. In practice, the weighting scheme is such that categorical modalities occurring less frequently contribute more to the creation of the factor axes, while those occurring more contribute less. Hence, modalities of higher weight tend to be close to the center of gravity (the origin of the axes represent the center of gravity) while modalities of lower weight are plotted further. Note that computations are partially based on the difference between the observed and expected proportions calculated from the product of marginal proportions, thus if 10% of the sample chose modality one of the first variable and 10% chose modality three of the second variable, it is expected that 1% of the sample chose conjointly modality one of the first variable and modality three of the second variable. The variable category points are plotted in Figures 1 and 2, typical graphs produced in MCA (see for example, Greenacre and Blasius, 1994) – all modalities from the five questions chosen as active variables are represented in the graph.

Different regions of consumer acceptance are revealed in Figure 1. In the upper left quadrant, the variable categories associated with the most extreme level of acceptance: extremely safe, extremely willing to consume GM foods, etc. Thus, respondents in this area of the map are associated with these categories. A region of extreme rejection exists on the right of the origin. Moving up in the figure, a region of non-opinions with modalities "I don't know" is identified. In the lower center of the map, a cluster of moderate variable categories is shown. Hence, the MCA has clearly identified four distinct regions relating to consumer acceptance of GM foods.

Figure 2 highlights some particularities regarding the consumer acceptance of GM foods. The curves linking, on the one hand, the modalities regarding pesticide-related and nutritional issues and, on the other hand, the modalities regarding the willingness to consume GM foods, are shifted. "Extremely / "somewhat unwilling to consume GM foods even if it reduced the amount of pesticide applied to crops" and "extremely / somewhat unwilling to purchase GM foods even if it was more nutritious than similar food that isn't GM" are much closer to the center of gravity than are "extremely / somewhat unwilling to consume GM foods". Based on the centroid principle, people are more willing to consume GM foods when food items are associated to a benefit, like a decrease of the amount of pesticide used or an increase of nutritional value. Figure 2 shows that the modality "extremely unwilling to purchase GM foods if it posed a risk of causing allergic reactions for some people" is very close to the center of gravity and is, furthermore, the only modality of this variable "allergy" located in the right part of the map. It stresses the fact that the

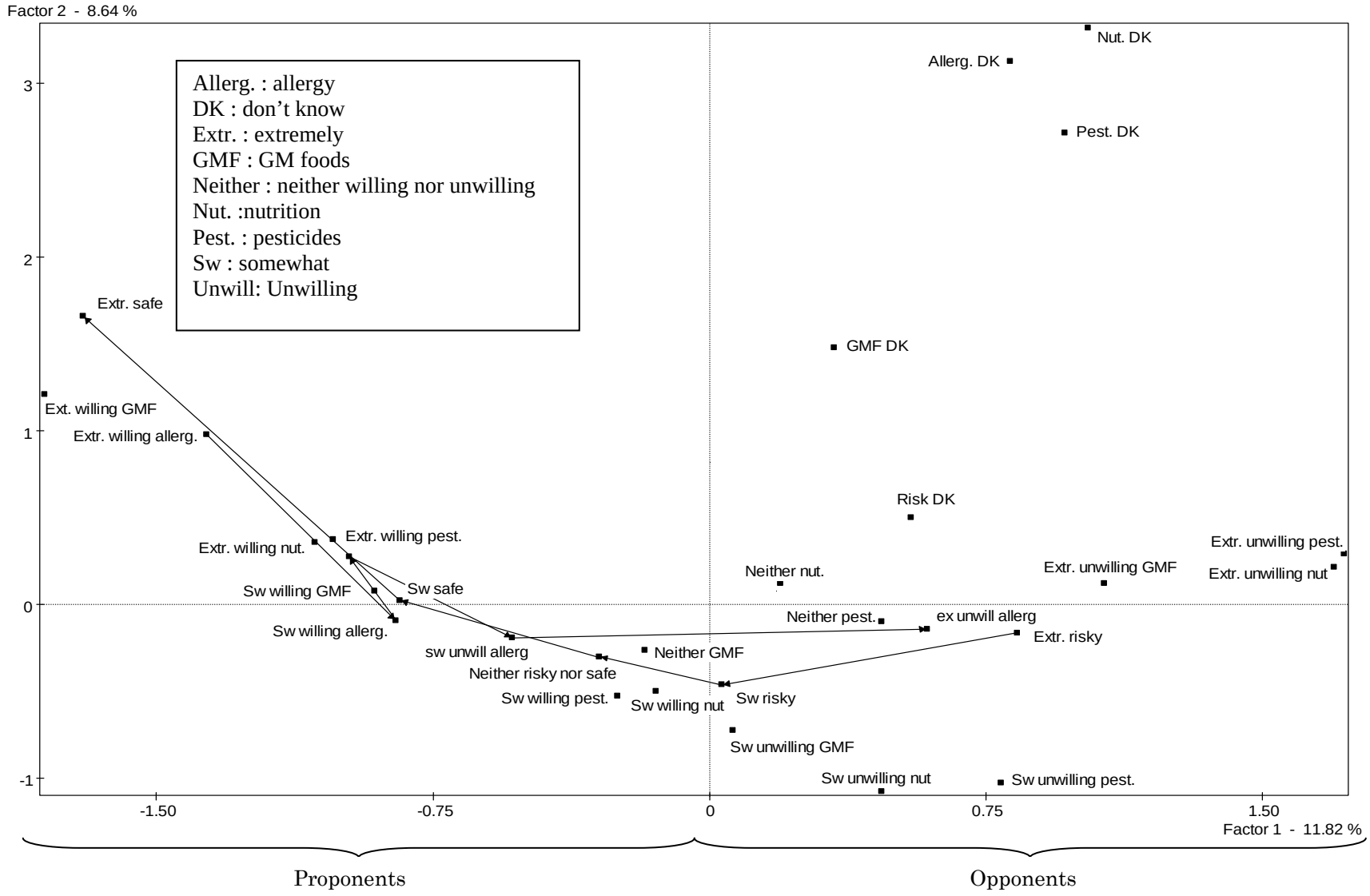

Figure 1: Two-Dimensional Display of the Active Variables Using Factors 1 and 2
Factor 1: Opposition between Proponents and Opponents
Factor 2: Opposition between Moderate Modalities and "Don't Know" Categories
Source: Primary Data

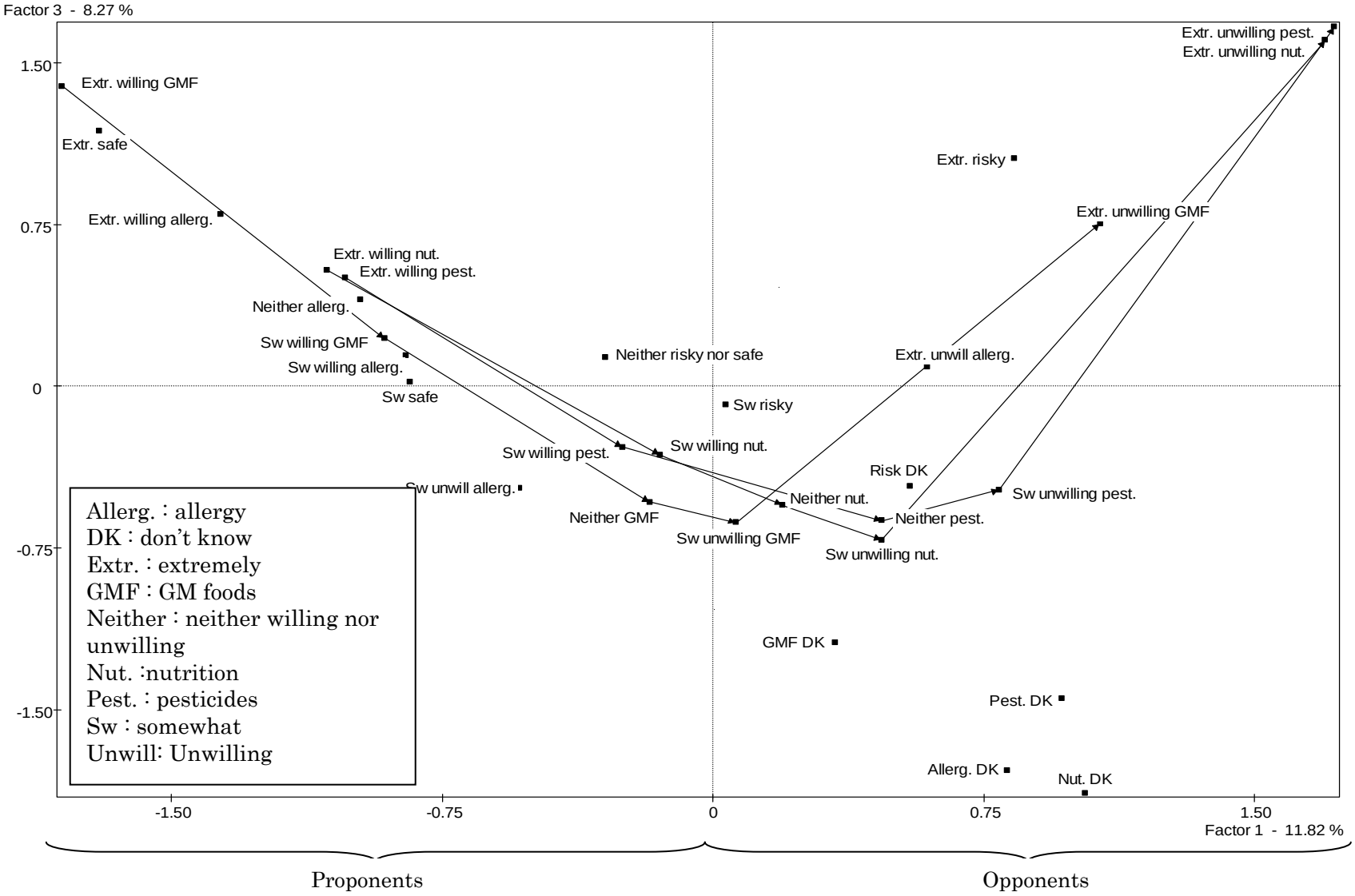

Figure 2: Two-Dimensional Display of the Active Variables Using Factors 1 and 3
Factor 1: Opposition between Proponents and Opponents
Factor 3: Opposition between Extreme Modalities and "Don't Know" Categories
Source: Primary Data

surveyed population agrees on the rejection of GM foods if it posed a risk of causing allergic reactions for some people. Finally, the consumer acceptance of GM foods is higher when the modification is associated with a perceived benefit; the contrary is also true when a health-related risk is perceived. The graphic representation of factors 1, 2 and 3 are further explained by factors axes created by the MCA.

Factor Axes

As factor axes can be considered as summary variables, their interpretation reveals the salient patterns related to the notion of acceptance. The first three axes together account for one third of the total inertia, which is acceptable for a MCA. It suggests that the consumer acceptance of GM foods is a complex matter. The analysis is limited to these three axes since they appear to be the most relevant. In the MCA, the fact that each variable presents different modalities means, when many variables are considered, the percentage of inertia of each factor would be small. The three main factors are detailed below.

It is important to determine whether or not a modality is significantly associated to a factor (variables) or a class (individuals). That is, whether there is a discrepancy of appearance between the modalities in the factor/ class. The test-value (TV) method is used. The difference is deemed significant, with a level of confidence equal to 95%, if the absolute value of the estimated TV is equal or greater than 1.96. As indicated by the absolute value, TV can be positive or negative. The interpretation of the sign varies whether we consider a factor[7] or a class[8] (to be discussed later):

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[7] The test statistics for testing the null hypothesis that the projection of the modality j on the factor axis α is not different than on the other factor axis is the so-called Test-Value (TV) expressed as

$$TV = \hat{\Phi}_{\alpha j}\sqrt{\frac{n-n_j}{(n-1)n_j}}$$

where $\hat{\Phi}_{\alpha j}$ is abscissa of category j on the factor axis α; n_j is number of individuals who chose the modality j; n is total number of individuals. TV has a standard normal distribution. For a significance level ($\alpha = 5\%$), the critical value of the test statistics is $Z_{1-\alpha/2} = 1.96$. See Lebart et al. (1984) for more details.

[8] For testing the association between modality and class, the Test-Value (TV) is given as:

$$TV = \frac{\overline{X_k} - \overline{X}}{S_{\overline{X_k}}}$$

where $\overline{X_k}$ is the mean of the modality X in the class k; $\overline{X}$ is the mean of the modality X in the sample; $S_{\overline{X_k}}$ is the standard deviation of the modality X in the class k.

The null hypothesis (H_0) is that there is no significant difference between $\overline{X_k}$ and $\overline{X}$. For example, we can use this test to examine if the proportion of men in the class 1 is significantly different from the proportion in the sample, that is, if the modality "male" is characteristic of the class 1. Again the TV has a standard normal distribution.

1. When modalities are used to characterize a factor, the sign coincides with the coordinate of the modality in the factor. Thus, if a modality has a negative coordinate, then TV is negative.
2. When modalities are used to characterize a class, the positive sign means that the modality is over-represented in the class whereas the negative sign highlights an under-representation.

First Factor: 12%

The first factor axis accounts for 11.8% of the inertia.[9] It emphasizes the consumer acceptance of GM foods through the attitude of the respondents. There is an ordering along the axis: individuals with an extreme acceptance of GM foods are plotted on the left side, then the moderate opinions come and, at last, the rejection of GM foods on the right side. Hence this first axis represents the acceptance.

Comparing the two extremities of the axis, one side contains all the extreme modalities in favor of GMOs ("extremely") and the other side, all the extreme modalities in disfavor of GM foods. It means that when one supports GM foods, one tends to accept all the positions, the contrary is also true. By studying the modalities (from the illustrative variables) significantly associated to the first factor, it is possible to characterize the attitudes of rejection and acceptance of GM foods.

As expected, proponents of GM foods tend to choose GM products. They support the implementation of mandatory labeling (TV = -3.42) and the creation of a non-GM food logo (TV= -4.61), but only if the associated extra-costs are not too important. Furthermore, they are characterized by a higher level of education and knowledge. Indeed, the proportion of people who attended graduate school is higher than in the total sample (TV= -2.72). They consider themselves as somewhat informed about GMOs (TV= -2.42) and often look at the panel of nutritional information on food packages (TV= -3.73). It therefore shows a higher involvement in food issues.[10] However, they do not seem to have a level of science literacy much higher than the rest of the sample. Indeed, if they tend to know a person's genes cannot be altered by eating GM foods, they believe more than the average that non-GM organisms do

[9] The inertia along the axis is equal to the weighted sum of squared distances to the origin of the displayed row profiles or, equivalently, the corresponding weighted sum for the displayed column profiles, the weight being the masses of the respective points.

[10] According to Sherif's theory (Sherif and Cantril, 1947), the position adopted by an individual towards a social object is based on his degree of involvement towards it. From that angle, the involvement concept is based on three different "latitudes": a latitude of acceptance, a latitude of reject, a latitude of non-involvement. An individual highly involved, who has a well-established opinion on a subject, will accept, according to that theory, not a lot of positions and will reject a lot. On the opposite, an individual non-involved should find acceptable a larger range of positions or have no opinion on the subject. To complete this idea, according to Burnkrant (1978), the involvement is materialized by the intensity of the information inquiry, which is attributable to a keen need of being informed.

not contain genes. The results also show that younger people (20-29 years) are over-represented in this profile (TV= -2.69), which likely is linked to the higher percentage of singles (TV= -3.42).

People opposed to GM foods tend to choose non-GM products. However, contrary to the previous profile, they are not involved in food issues. Indeed, the proportion of respondents who never look at the panel of nutritional information is greater than the rest of the sample (TV= 3.62). Moreover, they are likely to have no opinion on the questions asked (they "don't know"). These respondents have a lower level of education insofar as illiterates are over-represented (TV= 4.26). Lastly, they are older than the average population (people over 60 are over-represented, TV= 3.21, which can be linked to the higher proportion of widows).

Second Factor: 8.6%

This second factor represents 8.6% of the total inertia. In Figure 2, one side of the axis shows moderate modalities such as "somewhat willing" and, on the other side, "don't know" categories. This factor therefore contrasts the "moderate" respondents with those who answers "don't know"; two different attitudes present in the surveyed population. In summary, the "moderate respondents" are more likely to buy non-GM products than their GM counterparts. These people are also more informed and educated than the average population.

The respondents choosing the modalities "don't know" are characterized by a non-involvement in food issues (a specific labeling is extremely unimportant, TV= 2.53, and they are likely never to read the panel of nutritional information on food packages, TV= 4.13). They have a lower level of education and are also older.

Third Factor: 8.3%

The third factor represents 8.3% of the total inertia. Extreme modalities and "don't know" categories contribute the most to this axis. Because of the opposition along the axis of these modalities, this factor is determined by the opposition between the "extreme" respondents and those who "don't know".

Respondents with no opinion are somewhat opposed to GM foods, as compared to "don't know", the active modalities significantly associated (TV≥ 1.96) with the axis are: "somewhat unwilling to consume foods produced with GM ingredients" and "somewhat unwilling to consume foods if it was more nutritious than similar food that isn't GM".

People with no opinion sometimes look at the panel of nutritional information (TV= -2.33) and consider the specific labeling of GM foods to be somewhat important (TV= -2.17). However, ethics are somewhat unimportant (TV= -2.10) when they decide

whether or not to consume GM foods. These features are associated with manual workers (operator / fabricator / laborer). Men are predominant in this profile (TV= -3.18).

As for extreme modalities, we find here some of the features mentioned previously. Thus, younger and senior are over-represented, so are women.

Hierarchical Classification Method

The MCA is used to construct principal components, which best summarized the individual's characteristics within the population. To search for a typology of the attitudes related to the consumer acceptance of GM foods, an ascending hierarchical classification method is carried out on the individuals described by the factors discussed previously (Ward's minimum variance method). Then, the individuals are grouped into clusters according to their proximity, i.e., their similar characteristics.

The hierarchical classification method (Ward, 1963) led to the construction of four clusters expressing 32.1% of the total inertia, that is, one third of the total information. Respondents are assigned a class depending on the answers they chose in the survey.

Class 1: Proponents (52% of the Sample)

This first class extracted from the hierarchical classification is composed of proponents of the GM technology - 52% of the sample. These respondents are willing to buy GM foods: over 51% of them are somewhat or extremely willing to consume foods made with GM ingredients ("somewhat": TV= 7.84 and "extremely": TV=3.25). They are supportive of a mandatory labeling (90.2% with TV= 3.10) and think it is necessary to design a specific logo for non-GM food (87.2%, TV= 4.43).

Their desire to be informed and to choose between GM and non-GM products supports a higher level of interest and / or knowledge about the topic. Indeed, 40.6% of them (TV=2.10) are somewhat informed about GM foods and 76% often or sometimes look at the panel of nutritional information on the food package (TV= 2.66 for often, not significant for sometimes). As a consequence, they appear to be involved in food issues. However, involvement and interest are no guarantee for a higher level of science literacy as they do not answer the questions assessing the knowledge better than the rest of the sample.

Insofar as this class includes more than half of the respondents, it is difficult to describe it through the personal characteristics. However, respondents are younger than the average (Table 2) and young people are over-represented in this class (20-29 years, with TV= 2.73). They also appear wealthier than the rest of the population with an average annual household income of NT $909,587.

Class 2: Moderate Opponents (30% of the Sample)

The second class brings together 30% of the respondents: moderate opponents to GMOs, since two types of modalities dominate in this profile: "somewhat unwilling" and "neither willing nor unwilling". Their moderation can be explained by a decision-making process. Indeed, according to the theory of involvement, the involvement is materialized by the intensity of the information inquiry. Moreover, involved people tend to reject a lot of positions. Given that they are more likely than others to look at the panel of nutritional information ("sometimes", TV= 2.39), we assume they are somewhat involved. Nonetheless, the absence of any "radical" position indicate they are in a decision-making process.

Table 2: Socio-Demographic Characteristics by Class

Class	Statistics	Age (years)	Income (in NT $)
1	Mean	41.2	909,587
	Standard deviation	13.2	736,903
2	Mean	42.8	754,375
	Standard deviation	10.6	691,290
3	Mean	59.5	412,857
	Standard deviation	18.3	378,317
4	Mean	46.8	686,296
	Standard deviation	14.8	484,245
Total Sample	Mean	43.4	820,822
	Standard deviation	13.6	694,391

Source: Primary data.

When considering the socio-demographic variables that might serve to better characterize this class, emphasis should be made on the over-representation of men (53.9%, TV= 1.97; Table 3). They are predominantly middle aged with 35.9% of 30-39 years and 25% of 40-49 years (not significant). As expected, given their age, 91% are married.

Table 3: Gender Characteristics.

Gender	Total Sample	Census of Population	Class 1	Class 2	Class 3	Class 4
Men	44%	49%	44%	54%	36%	22%
Women	56%	51%	56%	46%	64%	78%

Sources: http://www.dgbas.gov.tw/census~n/home-e.htm and primary data.

Class 3: Don't Know (5.5% of the Sample)

This cluster of "non-expression" includes those with lack of interest in the survey and those who refuse to become involved. This class is essentially composed of respondents older than the average population (59.5 years, see Table 2) with a lower level of education. Most of these respondents are retired (14.3%) or do not have an "occupation" (50%; students, housewives). They have a relatively low income (NT $412,857).

Class 4: Extreme Opponents (12.5% of the Sample)

This fourth class gathers 12.5% of the sample: extreme opponents to GM foods (they are "extremely unwilling"). As a whole, they reject the technology overall: they do not feel safe eating GM foods (TV= 2.25), they prefer natural foods (TV= 3.24), they are extremely unwilling to consume foods produced with GM ingredients (96.9%, TV= 9.07). Nonetheless, their real motivations are difficult to comprehend as these modalities were proposed in the questionnaire. Their attitude does not seem motivated by an extended level of information since 31.25% (TV= 2.45) of them never read the panel of nutritional information. Moreover, they do not seem to have a clear idea of what genes are insofar as they do not know whether yes or no "non-GM soybeans contain genes" (over 71%, TV= 2.93). Given they have no opinion regarding the labeling of GM ingredients, one could assume they are not involved in the issue.

It is interesting to consider the coexistence of extreme modalities and "don't know" as part of the modalities characterizing this fourth class. Finally, they "don't know" and are opposed. It is likely that this opposition is the consequence of a more general opposition or distrust, as it has been shown to be an important factor determining the acceptance of the technology (Ganiere et al., 2004). Respondents in this class are mainly women (78%, Table 3) above 54 years, a fraction of the population that has been shown to be extremely risk-averse.

A Comparison with the U.S.

The result of this classification is somewhat similar to the four classes described by Ganiere et al. (2004) from a survey conducted in the U.S. (Table 4). First, it appears that Taiwanese are more opposed to GM foods than Americans, 42.5% vs. 34.4% in the U.S. However, despite these distributional differences and some specificities inherent to the populations such as the occurrence of the modality "I don't know", the same features can be observed in both populations. Thus, it illustrates that there is no population exactly in favor or disfavor of GM foods, just complex combinations of attitudes regarding biotechnology.

Table 4: Consumer Profile in Taiwan and the U.S.

Class	% of Sample	
	Taiwan (N=257)	U.S. (N=256)
Proponents	52%	4.7%
Non-Opponents	*	60.9%
Moderate Opponents	30%	22.7%
Extreme Opponents	12.5%	11.7%
Don't Know	5.5%	*

N : Sample Size
* : Does not Apply
Sources: Ganiere et al. (2004) and primary data.

Discussion

Several variables affect the consumer's attitude towards GM foods. First, we find the acceptance of GMOs decreases as age increases. The hypothesis of a simple age group effect has some validity since all sociological studies on risk-taking and risk perception reveal that younger people tend to underestimate levels of risk and to expose themselves to more risks.

Another important finding was the relative importance of people with no opinion. The frequency of "don't know" was very high in this survey, much higher than in the survey conducted in the U.S. at the same time (Ganiere et al., 2004). For the active variables used in this study, there were 2.3% to 26.5% of "don't know" in the Taiwanese survey while 1.6% to 14.5% in the U.S. survey. These differences would not be due to a design effect.

In our survey, women were more opposed than men to GM foods. This result may be due to a higher perceived risk as it has been shown in many other opinion polls. Knowledge also is an important determinant of the consumer acceptance of GM foods: the more informed people think they are, the more likely they are to be supportive. However, education was not found to be significantly associated with a higher level of information or level of acceptance. Illiteracy was found to be significantly associated with an extreme opposition but the older age of these respondents is likely to be the main factor. It appears that providing consumers with information is likely to increase the consumer acceptance of GM foods. Indeed, Rousu et al. (2002) showed that an independent, third-party source that provides verifiable information on GM foods would have a favourable impact on consumer's demand. Nevertheless, information can only influence consumer's attitude to the extent that they have not made their decision. This idea has been widely examined with the recurrent failures of nutritional information campaigns. Hence, a verifiable third-party information might increase the demand by the "moderate opponents" and the "non-involved".

Our study clearly indicates a strong support for the labeling of GM foods by Taiwanese (83%), a result in accordance with the 73% found by the Health Department in Taiwan in 2000 and comparable with the range 82-93% found in the U.S. Thus by implementing mandatory labeling, the Taiwanese government enhances public confidence. Nonetheless, Taiwan appears to be much more divided regarding the use of the technology: 40% consider GM foods risky for human health and 49% are unwilling to consume foods produced with GM ingredients. The success of GMOs will be influenced by how they are perceived by members of the society. A MCA and a hierarchical classification were used conjointly to obtain a clearer insight to consumer attitudes towards the technology. Four distinct attitudes towards GM foods were identified from the behavioral intentions reported in this survey. It shows that only a minority of the surveyed population (12.5%) composed of older respondents, the extreme opponents, are radically opposed to GM foods. The rest of the sample is constituted of proponents (52%), usually younger respondents willing to consume GM foods, other respondents still in a decision-making process, moderate opponents (32.5%) and some others who have no opinion on the issue (5.5%).

Conclusion

The results of this survey show that, just like in the U.S. (Ganiere et al., 2004), the majority, 87%, of the surveyed Taiwanese consumers are not opposed to GM foods, although our statistical analysis only identified 52% as proponents, a percentage lower than the one found with American consumers. The implementation of the mandatory labeling is not likely to impact dramatically the purchase behavior of the consumers because only 13% of Taiwanese are extreme opponents and 5% have no opinion. As consumers have been shown not to pay attention to the labels (Noussair et al., 2002), we conclude that most Taiwanese consumers will continue to purchase the same categories of food items even if they contain GM ingredients. Furthermore, it also emerge from our analysis that the willingness to consume GM foods increases when the GM food items are associated with benefits for the consumer such as a decrease of the amount of pesticide applied to crops or increased nutritional values. The food industry should highlight the benefits brought by the added GM ingredients.

The typology presented in this paper appears to be more complex than the usual acceptance / rejection opposition since we find two distinct profiles of opponents and since a fraction of the surveyed population is not involved in the issue. This distinction is important as the percentage of people extremely opposed to GM foods amounts to only 13%, and not to 45%, if we included the moderate opponents. This classification should lead the biotech and food industries, and policy makers to relevant decisions regarding the use of the technology and the potential outcomes in light of these consumer attitudes. Clearly, the threat for American exporters and

producers is that Taiwan, a substantial export market, could turn its back on GM importations, once they become aware of the presence of GMOs in their food. Nonetheless, our results highlight that the implementation of mandatory labelling is not expected to have significant impact on the consumer's purchasing behavior. As a consequence, it is not likely that the trading relationship between Taiwan and the U.S. will be affected unless new evidences regarding potential human and environmental hazards are identified. Finally the general claim for mandatory labelling of GM foods would be part of a more global desire to be informed.

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