



Research article

Measuring consumer' willingness to pay for food safety certification labels of packaged rice

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Abstract: Food safety is vital for public health, influencing a country's economic development and international reputation. In recent years, Taiwan has encountered several food quality problems, with consequent public questioning and mistrust of food safety. If consumers are unaware of the quality of a product, their perception and demands can be influenced by the credibility of the food safety certification labels. This study uses the contingent valuation method (CVM) to analyze the factors influencing consumer willingness to pay (WTP) for food safety certification labels of packaged rice. Questionnaires are randomly adopted and assigned to 434 participants. The results indicate that product factors should be presented clearly on their packaging and advertisements. Consumers focus on certification labels for food safety perception. Gender, education level, place of purchase, certification cognition, and health cognition are all found to affect willingness to pay. These significant results indicate that women were more willing to pay than men; people were willing to pay a higher amount for purchases of packaged rice at supermarkets or hypermarkets; health cognition was estimated to be negative and significant, showing that health cognition negatively affected WTP, perhaps because participants did not sufficiently trust the foundation's assurance that the rice was safe. In the valuation of WTP for food safety certification, each person was willing to pay on average NT\$1131.07 annually to reduce the risk of food safety problems.

Keywords: food safety; health cognition; willingness to pay; contingent valuation method, certification label

1. Introduction

Food safety has been a substantial concern in agribusiness and the food industry, and serious food safety scares have eroded public confidence [1]. The mad cow disease scandal involving beef infected with bovine spongiform encephalopathy in the United Kingdom and the melamine contamination of baby formula in China, for example, has raised the interest of our well-informed global society in all matters pertaining to food safety [2,3]. Media reports have caused consumer panic and further contributed to the decline in public confidence [4]. Food safety is, therefore, an increasingly crucial issue not only for public health but also for countries' economic development and international reputation.

Food safety refers to the prevention of illnesses resulting from the consumption of contaminated food [5] and is related to the hygiene standards of food that reach consumers [6]. It is a crucial element of consumer perceptions and decisions. Without seeing quality certifications, consumers may have difficulty evaluating product characteristics [7]. To reduce consumer uncertainty and safeguard public health, governments usually establish food safety laws or regulations or implement relevant policies [8]. Food safety certification labels are one such policy tool, which functions to differentiate a product from competitors by highlighting its attractiveness or guaranteeing consumers a certain level of quality [9]. Altmann [9] affirmed that certification labels can enhance product value and attractiveness and indicate to consumers a certain level of quality. Pancer et al. [10] contended that certification labels can increase product credibility. Brach et al. [11] stated that certification labels provide brand-like information cues that reduce the perceived risk of products.

Food safety certification labels reduce consumers' screening efforts and information costs and simplify decision-making [12,13]. When food safety information is available, the average price that consumers are willing to pay for safe food increases [1]. However, in a previous study, we found that consumers do not easily recognize food safety certification labels and do not adequately understand them [14]. Regardless, the presence of these labels on food products can reduce consumer perceptions of risk [15], and consumers are willing to pay a premium price for such products [6,11,16]. Consumer willingness to pay (WTP) for food safety certification labels has been explored in investigations of the relationship between these labels and consumer attributes, including gender, age, income, and education [17,18]. Wang et al. [17] studied consumer WTP for labels on pork products and found that higher income and level of education were associated with higher WTP. Liu et al. [18] studied consumer WTP for eco-labeled rice and reported that WTP did not increase with consumer knowledge.

In recent years, with the change of consumption habits, people buying bulk rice have turned to buy packaged rice. Packaged rice has become the primary rice product on the market for nuclear families in Taiwan. We investigated consumer cognition of and WTP for food safety certification labels on packaged rice. Because food safety, product quality, and certification labels have a nonmarket value, they cannot be evaluated directly through changes in market prices and manufacturer incomes. Thus, we used the contingent valuation method (CVM) to evaluate consumer WTP. In addition, based on the research cost, the limitation of the study only targeted major large cities in Taiwan as the subject of the questionnaire and did not extend to every city in Taiwan.

However, the food safety certification mark is more complicated in Taiwan, which makes consumers unable to effectively face the diversified certification information to choose. This is an important problem faced by consumers when purchasing. As far as the industry is concerned, this

study was based on the premise of food safety risks in different contexts to investigate consumer cognition of and WTP for food safety certification labels on packaged rice. If the design and presentation of a clear and uniform label can be used, it is bound to effectively enhance consumers' purchasing awareness and gain a deeper understanding of product characteristics. In addition, through the type of packaged rice, manufacturers can diversify product planning and highlight product characteristics. If consumers can effectively increase their awareness of food safety certification, it will indirectly affect the stability of the purchased products.

2. Materials and methods

The CVM, originally proposed by Ciriacy-Wantrup in 1947, is used for the valuation of nonmarket goods and services. Under this method, individual WTP for nonmarket goods is determined [19]. It has been widely applied for evaluating nonmarket goods, resources, and concepts, including ecological conservation, environmental resource protection, cultural asset preservation, landscapes, and food [20].

The CVM entails building a hypothetical scenario to evaluate consumer WTP for typically invaluable goods through questionnaires. It assumes that consumer evaluation of prices of goods and services is rational and dependent on perception or preference. The CVM comprises the open- and closed-ended models; the closed-ended model can be further divided into a single-bounded model or a double-bounded model. Compared with the single-bounded dichotomous choice model, the double-bounded model is more efficient [19,21]. Respondents are assumed to have successively answered two questions (bids) about WTP. The amount presented in the second question depends on the respondents' response to the first bid (A_i). If they answer "yes" to the first WTP query, the second bid (A_i^y) will be higher than the first bid ($A_i < A_i^y$); if they answer "no," the second bid will be lower than the first bid ($A_i^n < A_i$) [22]. Four responses are possible in the double-bounded model:

Both answers are "yes" (p^{YY}):

$$\begin{aligned} p^{YY}(A_i, A_i^y) &= \Pr \{A_i \leq \text{MaxWTP} \text{ and } A_i^y \leq \text{MaxWTP}\} \\ &= \Pr \{A_i \leq \text{MaxWTP} | A_i^y \leq \text{MaxWTP}\} \cdot \Pr \{A_i^y \leq \text{MaxWTP}\} \\ &= \Pr \{A_i^y \leq \text{MaxWTP}\} = 1 - Gc(A_i^y) \end{aligned} \quad (1)$$

Both answers are "no" (p^{NN}):

$$\begin{aligned} p^{NN}(A_i, A_i^n) &= \Pr \{A_i > \text{MaxWTP} \text{ and } A_i^n > \text{MaxWTP}\} = \Pr \{A_i^n > \text{MaxWTP} > 0\} \\ &= Gc(A_i^n) \end{aligned} \quad (2)$$

A "yes" followed by a "no" (p^{YN}):

$$p^{YN}(A_i, A_i^y) = \{A_i \leq \text{MaxWTP} < A_i^y\} = Gc(A_i^y) - Gc(A_i) \quad (3)$$

A "no" followed by a "yes" (p^{NY}):

$$p^{NY}(A_i, A_i^n) = \{A_i^n \leq \text{MaxWTP} < A_i\} = Gc(A_i) - Gc(A_i^n) \quad (4)$$

In these four equations, p^{YY} , p^{NN} , p^{YN} , and p^{NY} represent the probabilities of each situation; MaxWTP represents the respondents' true maximum WTP, p^{YY} represents the probability that respondents are willing to pay both the first and second bids, p^{NN} represents the probability that respondents are unwilling to pay both the first and second bids, p^{YN} represents the probability that respondents are willing to pay the first bid but are unwilling to pay the second bid, p^{NY} represents the probability that respondents are unwilling to pay the first bid, but are willing to pay the second bid, and $Gc(\cdot)$ represents the cumulative probability distribution.

In Eqs. (3) and (4), the second bids are the upper and lower bounds, respectively, of the respondent's true maximum WTP. In Eqs. (1) and (2), the second bid represents the respondent's lower and upper WTP bounds, respectively. Given N respondents under the conditions of A_i , A_i^y , and A_i^n , the log-likelihood function of the i th respondent is as follows:

$$\ln L^D(\theta) = \sum_{i=1}^N \{d_i^{YY} \cdot \ln \pi^{YY}(A_i, A_i^y) + d_i^{NN} \cdot \ln \pi^{NN}(A_i, A_i^n) + d_i^{YN} \cdot \ln \pi^{YN}(A_i, A_i^y) + d_i^{NY} \cdot \ln \pi^{NY}(A_i, A_i^n)\} \quad (5)$$

where d_i^{YY} , d_i^{NN} , d_i^{YN} , and d_i^{NY} correspond to the probabilities of (1), (2), (3), and (4), respectively, for the respondent's WTP. Therefore, the maximum likelihood estimator for the double-bounded model ($\hat{\theta}^D$) is the solution to the equation $\partial \ln L^D(\hat{\theta}^D) / \partial \theta = 0$. The asymptotic variance-covariance matrix for $\hat{\theta}^D$ is as follows:

$$V^D(\hat{\theta}^D) = \left[-E \frac{\partial^2 \ln L^D(\hat{\theta}^D)}{\partial \theta \partial \theta'} \right] \equiv I^D(\hat{\theta}^D)^{-1} \quad (6)$$

where $I^D(\hat{\theta}^D)^{-1}$ is an information matrix. The statistical efficiency of the double-bounded model is higher than that of the single-bounded model [19].

Before distributing the formal questionnaire, we conducted a pretest, the primary purpose of which was to determine the respondents' WTP intervals, which served as a basis for the questionnaire. We asked the respondents, through an open-ended CVM, how much money they were willing to donate for a year under two circumstances. First, we imagined a food safety foundation responsible for supervising and participating in tracking and inspection. This foundation would have a trust for fundraising and would reduce the risk of food safety problems by ensuring the reliability of the inspection bodies. Second, the foundation would create a quick response (QR) code that, when scanned with a mobile QR code reader, would automatically direct consumers to product information and provide confirmation of the foundation's participation in the food safety inspection. The QR code would constitute a new tool for food safety certification. The WTP intervals are shown in Table 1.

Table 1. Pretest results: Frequency distribution of respondents' WTP.

Amount of WTP(NT\$/year/person)	Number of people
0	6
100	4
200*	1
500*	3
1,000	16
1,200*	1
2,000*	3
3,000	2
5,000	1
10,000	3
12,000	1
total	41

¹ Result removed 10% of extreme values. * denotes an amount selected in the questionnaire.

We introduced four price options [22]. The amounts in the pretest questionnaire were arranged from low to high, and 10% of the extreme values were removed. Hence, the amounts of 20%, 40%, 60%, and 80% were selected as the first bids. If the response to the first bid was “yes,” the amount of the first bid was increased by half that amount to serve as the second bid. Conversely, if the response to the first bid was “no,” the first bid was halved to serve as the second bid. The amounts are presented in Table 2.

As Table 2 shows, in the formal questionnaire, the inquiry prices were designed to present one of four price options: A, B, C, and D. The questionnaires were randomly administered to the participants.

Table 2. Initial WTP amounts.

Group	Amount of WTP (NT\$*/year/person)
A	200 (100/400)
B	500 (250/1,000)
C	1,200 (600/2400)
D	2,000 (1,000/4,000)

¹ Only the second bid amounts are enclosed in parentheses. The second bid amount was determined from that of the first bid; if the first bid response was “no,” the first bid was reduced for the second bid (before the slash); if it was “yes,” the first bid amount was increased for the second bid (after the slash). * Unit prices were in New Taiwan Dollars (NT\$), and the exchange rate was US\$1 = NT\$30.

3. Results and discussion

3.1. Demographics

Using the questionnaires, we conducted face-to-face interviews with primary food shoppers in Tainan City, Taiwan. To ensure the quality of the data collected and to explain the objectives of the survey, we recruited five trained investigators. The participants were willing to complete the survey under assurance of anonymity and confidentiality. All participants were approached at the entrances

of traditional markets, supermarkets, and hypermarkets. After the investigators provided a brief introduction, the participants were asked whether they were the primary food shopper for their household. The questionnaires were distributed to 452 participants, of whom 28 refused further participation; therefore, the actual sample size was 434.

As Table 3 shows, 30.9% of the participants were men and 69.1% were women, and 58.7% were aged between 40 and 59 years. Married and single participants comprised 67.7% and 32.3% of the total, respectively. In total, 66.8% of the participants had a monthly income of between NT\$20,000 and NT\$80,000. Three hundred twenty consumers (73.8%) expressed willingness to go to the supermarket to buy rice, and among respondents, rice expenditure was reported to account for less than 5% of total food expenditure (306 participants, 70.5%).

Table 3. Participants' demographic characteristics.

Variable	N	%	Variable	N	%		
Gender	Male	134	30.9	Education level	Junior high School	7	1.6
	Female	300	69.1		Senior high school	69	15.9
Age	<20	5	1.2		College or university	252	58.1
	20–29	77	17.7		Graduate school	106	24.4
	30–39	74	17.1	Monthly income (NT\$**)	Below 20,000	23	5.3
	40–49	139	32.0		20,000–40,000	92	21.2
50–59	116	26.7	40,000–60,000		125	28.8	
60 or over	23	5.3	60,000–80,000		73	16.8	
Marital status	Married	140	32.3	80,000–100,000	60	13.8	
	Single	294	67.7	Above 100,000	61	14.1	
Place of Purchase*	Traditional market	47	10.8	Proportion of rice expenditure to total food expenditure	Less than 5%	306	70.5
	Supermarket	320	73.8		6%–10%	100	23.0
	Rice merchant	53	12.2		11%–20%	18	4.2
	Other*	14	3.2		Over 21%	10	2.3
Total					434	100	

Note: * Included farmers' alliance and organic and online shops. **Unit prices were in New Taiwan Dollars (NT\$), and the exchange rate was US\$1 = NT\$30.

3.2. Food Safety Cognition

Table 4 presents the results of the analysis of the participants' food safety cognition. In total, 50% of participants scored 5 points on certification cognition, which refers to awareness that a food safety certification is a standard of food safety assurance; 90% scored 3–5 points on health cognition, which refers to the need for health information about a product, which is associated with a positive evaluation of the product; and 47% scored 4 points on brand cognition, which is associated with trust of food manufacturers, businesses, and brands.

Table 4. Food safety cognition analysis.

Variable (all scored from 1 to 5)	Definition		N	%
Certification cognition	Awareness that food safety certification is a standard of food safety assurance.	1	0	0
		2	0	0
		3	16	3.69
		4	170	39.17
		5	248	57.14
Health cognition	Requirement for health information about a product, which is associated with a positive evaluation of the product.	1	0	0
		2	7	1.62
		3	35	8.06
		4	227	52.30
		5	165	38.02
Brand cognition	Food safety knowledge connected to trust of manufacturers, businesses, and brands.	1	2	0.46
		2	23	5.30
		3	130	29.95
		4	204	47.01
		5	75	17.28

3.3. Estimation Results

According to the pretest questionnaire results, base prices were set against which to evaluate respondents' WTP. Respondents were asked, "Would you be willing to pay if the foundation has a trust for fundraising to reduce the risk of food safety problems and ensure the reliability of inspection bodies and creates a QR code that, when scanned with a mobile QR code reader, directs consumers to product information and provides immediate confirmation of the foundation's participation in food safety inspection?" The price options were (in NT\$) 200 (100/400), 500 (250/1,000), 1,200 (600/2,400), and 2,000 (1,000/4,000).

After consideration of factors affecting WTP, this study focuses on variables such as socioeconomic background (income, gender, and education level), place of purchase (b1, b2, b3, b4), and food safety cognitive factors (certification cognition, health cognition, and brand cognition). In particular, this study did not include marital status variables in the model evaluation. The main reason is due to the decline in the marriage rate, the marriage status variable had an insignificant influence on the discussion of agricultural products [23,24]. Based on the theoretical model, an empirical model of the WTP for food safety certification was established, as represented by the following formula:

$\ln WTP = f(\text{Income, Gender, Edu, } b_1, b_2, b_3, b_4, \text{ Certification cognition, Health cognition, Brand cognition}).$

The WTP assessed in the present study represented hypothetical rather than actual WTP for food safety certification. The socioeconomic variables comprised $\ln(\text{income})$ —a logarithm of the income of the respondent, gender, and education level. Place of purchase comprised $b_1, b_2,$ and b_3 , dummy variables representing place of purchase (at supermarkets, traditional markets, and hypermarkets = 1, at other places = 0), and b_4 , a variable representing the proportion of rice expenditure to total food expenditure. From the empirical model, three Weibull distributions were generated for maximum

likelihood estimation.

The estimation results from the Weibull distributions are presented in Table 5 and described as follows. Significance was set at 5%. Gender was estimated to be positive and significant at 10% and 5% for women and men, respectively; the foregoing means that gender positively affected the amount of WTP, and women were more willing to pay than men. Place of purchase b1 and b3 were estimated to be positive and significant, indicating that buying packaged rice at supermarkets or hypermarkets had a positive effect on WTP, meaning that participants were willing to pay a higher amount for purchases of packaged rice at supermarkets or hypermarkets. Health cognition was estimated to be negative and significant, showing that health cognition negatively affected WTP, perhaps because participants did not sufficiently trust the foundation's assurance that the rice was safe. Scale values were set at 1% significance. The log-likelihood ratio was greater than 15.987, indicating that the model had high explanatory power.

Table 5. Estimation results of the evaluation function.

Variables	Coefficient Estimates (<i>t</i> -Values)
Constant	9.73 (6.47)***
ln(Income)	-0.19 (1.53)
Gender	-0.36 (2.36)**
Education	0.07 (0.71)
b1	0.39 (2.23)**
b2	0.08 (0.29)
b3	0.4 (1.97)**
b4	0.12 (1.13)
Certification cognition	0.21 (1.51)
Health cognition	-0.35 (2.02)**
Brand cognition	-0.04 (0.34)
Scale	0.84 (17.1)***
Log likelihood	-391.54
Log-likelihood ratio	20.43**

Note: *,**,*** were significant at 10%, 5%, and 1%, respectively. Log-likelihood ratio = $(-2) \times (\text{restricted log-likelihood} - \text{log likelihood})$; $\chi^2(10,0.9) = 15.987$.

Table 6 shows the participants' WTP for food safety certification as estimated through the Weibull distribution. Per year per person, the mean mid-WTP was NT\$1,311.07, the lower bound was NT\$863.04, and the upper bound was NT\$2,010.03.

Table 6. WTP for food safety certification.

WTP Item	Mean of Mid-WTP (NT\$/year/person)	Lower Bound (NT\$/year/person)	Upper Bound (NT\$/year/person)
Food safety certification labels	1,311.07	863.04	2,010.03

*Unit prices were in New Taiwan Dollars (NT\$), and the exchange rate was US\$1 = NT\$30.

4. Conclusions

In this study, we assessed consumer food safety cognition and WTP for food safety certification. After a questionnaire survey, the CVM was used to estimate the effect of personal variables on participants' WTP. To evaluate the WTP for food safety certification, income, gender, education level, buying behavior, and cognitive factors were used as model input variables. Being female, purchasing rice at supermarkets and hypermarkets, and health cognition resulted in higher WTP in the model, indicating that consumer trust in food safety certification can be rebuilt. Consumers are concerned with the health effects, place of origin, and brand, among other factors, of the food products they purchase. This information should be clearly presented on product packaging and advertisements for maximal accessibility.

The description of the food safety certification is one of the important factors in establishing food safety, but the establishment of consumers' perception of food labeling is an important basis for food safety. This study shows that if consumers have correct health perceptions, the more they attach importance to food safety labels. The results of this study mainly found that Taiwan's food safety certification label is relatively complex, and consumers cannot effectively face the diverse certification information to choose. Therefore, as the Taiwan Agriculture Council has put forward the concept of production and sales history in recent years, it allows products to start from manufacturing. The integration of production, packaging, sales, and other places, combined with the simple and clear indication of the certification mark, will inevitably enhance the stability and awareness of consumers when choosing to buy. In addition, food safety education is another important result of this research. This research believes that if the certification mark can be simplified and clarified, it is bound to be introduced into the scope of school education so that students can understand the importance of food safety and certification during the learning process. In the long term, the recognition of the mark will definitely effectively increase the awareness of food safety and certification marks, and indirectly will positively affect the clarity of the products to be purchased.

Therefore, in the process of implementing food safety certification, the government should not only reduce the complexity of the labels but also establish a credible certification system so that consumers can easily recognize the labels. In addition, the foundation of food and agriculture education must be strengthened at the same time, and the understanding of food and the concept of health must be established. Only with the correct food and agriculture education can we effectively accumulate knowledge about food nutrition and indirectly be able to clearly distinguish the content of food safety certification. The food safety certification must not only allow consumers to improve

the safety of the products they choose through food labels, but also in-depth basic education and learning, so that food safety label policies can effectively alleviate food safety problems.

Acknowledgments

We would like to thank the constructive feedback provided by the reviewers.

Conflict of interest

The authors declare no conflict of interest.

Funding

This research was funded by Ministry of Science and Technology, Taiwan, R.O.C.: MOST 106-2410-H-309 -006 -MY2 and was funded by Business School of Yulin Normal University, China: MOST G2021SK02.

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