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Abstract:

Consumers are facing a trade-off between the benefits of an increase in the length of the shelf life of food, such as low food costs, and the potential health damages caused by food preservatives. However, few studies in the current literature place emphasis on food preservatives, neither from a scientific perspective nor from an economic perspective. This causes a lot of controversies about government regulations.

By constructing a theoretical framework and using a survey of 293 customers from 25 supermarkets in Beijing, this paper studies the consumer attitude towards food preservatives and attempts to fill the gap in the current literature. The main findings include that food price, and consumers' age and income are important for the willingness to pay (WTP) for "preservative-free food" in Beijing. In particular, food price and consumer incomes are positively correlated with the WTP and there might be an inverted U-shaped relationship between age and WTP. This study indicates that consumers in Beijing are willing to pay a very high premium for preservative-free food —62% for preservative-free Mooncakes compared to conventional ones.

Key words: Preservative-Free Food; Willingness to Pay; Double-Bounded Dichotomous Choice; Mooncakes; Beijing

JEL: I12, Q18

Consumer Willingness to Pay for Preservative-Free Food: The Case of Beijing

Introduction

Food preservatives are increasingly used as additives for slowing down food spoilage and prolonging the shelf life of food. In general, there are two types of food preservatives: (1) anti-microbial preservatives inhibiting the growth of bacteria or fungi and (2) antioxidants inhibiting the oxidation of food constituents. However, some modern synthetic preservatives have become controversial because they have been shown to cause health problems[1]. For instance, the study by McCann et al. (2007) shows that sodium benzoate preservatives may increase hyperactivity in children in general population. The statistical robustness of this result has been checked by the European Food Safety Authority (EFSA) (2008). However, the studies on some other preservatives are still inconclusive. For instance, animal experiments indicate that formaldehyde can cause nasal tumors (EHC 1989), while no evidences support that it is carcinogenic by the oral route for humans when the dose in food is low (EFSA 2006). Unfortunately, there are few studies on other food preservatives. As we know, it is very difficult to conduct such kind of studies on humans because it may take a very long time to trace the samples and many factors can affect the accuracy of the conclusions. Because of little information about the health consequences of food

[1] Hereafter, the term "preservatives" refers to synthetic food preservatives.

preservatives, it is very difficult for governments to regulate them properly, which also causes a lot of uncertainties regarding health consequences of food preservatives for consumers.

After a number of recent crises associated with food additives in China, food safety, in particular the issue of food preservatives is increasingly attracting attention around the world. Food preservatives, on the one hand, can inhibit the growth of bacteria or fungi and prolong the food shelf life, and hence decrease the food supply costs, thus enabling consumers to enjoy cheaper food. On the other hand, consumers may suffer from some potential health damages from them. Thus, consumers are facing a trade-off between the length of food shelf life (or lower food costs) and the potential health damages from food preservatives, in particular from synthetic preservatives. Due to the same reason, governments cannot regulate preservatives properly. Given the complexity of the issue, the most important thing might be to get information on the consumer attitude towards food preservatives, which might serve as a benchmark for government regulations on food preservatives.

The cost-benefit approach is prevailingly used for the evaluation of food safety; even though in practice, it is a big problem to precisely define the costs and benefits. Generally, the consumer willingness to pay (WTP) is widely accepted as a measure of the benefits for consumers (Golan and Kuckler 1999). A large number of studies have been conducted on consumer willingness to pay for food safety in different countries

and for different products. The current literature mainly focuses on general organic food (Groff et al. 1993; Thompson 1998; Huang 1996; Roitner-Schobesberger et al. 2008; Wier M. et al. 2008), or in particular on pesticide-free food (Huang 1993; Huang et al. 1999; Florax et al. 2005; Huang and Xu 2007), and some on non-genetically-modified (GM) food (Li et al. 2002; Moon and Balasubramanian 2003; Qiu et al. 2007). However, to the best of our knowledge, only few studies have been conducted specifically on the consumer attitude towards food preservatives, even though this topic is extremely important for policy-making. This paper attempts to fill the gap in the current literature and studies the consumer attitude towards food preservatives in Beijing.

As aforementioned, food preservatives are widely used in processed food, particularly in canned food or pastries, for prolonging their shelf life and therefore lowering food supply costs. In this study, we randomly surveyed 293 customers from 25 supermarkets in Beijing and choose a Chinese traditional pastry, the Mooncake, as an example to study consumer willingness to pay for preservative-free food. The Mooncakes are traditionally consumed during the Mid-Autumn Festival (August 15 of the Chinese lunar calendar). The Mid-Autumn is very important for family reunions and the Mooncakes are offered between friends and family members. The main reasons for choosing Mooncakes as a target product in this study include: (1) Mooncakes are known to every Chinese as they are consumed almost by everyone; (2)

it is easy to standardize, so that it is easy for consumers to answer the questionnaires; and (3) there are no big differences between Mooncakes and other pastries in terms of chemical components and in particular in terms of the effects of preservatives.

As income increases rapidly in China, consumers pay more and more attention to food quality, and food safety is one of its most important dimensions (Yu and Abler 2009). Since it is one of the most developed places in China, a study in Beijing can reflect future consumer attitudes towards food preservative in all of China. Furthermore, recent crises associated with food additives in China, such as the incident of melamine in the baby milk powder and the oil-soluble yellow in fried chicken, have raised public concerns about food safety. The People's Congress of China just passed the "Food Safety Act" in February of 2009. However, the question of how to regulate food preservatives is still unresolved due to the aforementioned difficulties. Hence, this study may provide some policy implications for government regulations on food preservatives in China and other countries.

The structure of this paper is organized as follows: First, we construct a theoretical framework able to explain the willingness to pay for food safety; second, we empirically study the determinants of willingness to pay for "preservative-free food" in China and test the theoretical hypotheses; and finally, we draw conclusions and provide policy implications.

Theoretical Framework

In this section we attempt to develop a theory about consumer willingness to pay for food safety. In order to simplify the study, we assume that there are only two types of Mooncakes in a market: the conventional Mooncakes (containing preservatives) and the preservative-free ones. If a consumer only consumes preservative-free Mooncakes, following the concept of health capital proposed by Grossman (1972) and the framework of Yu and Abler (2010), the indirect utility function is $V(p_F, h, m, Z)$, which depends on the price of the preservative-free Mooncake p_F, the health capital stock h, the current income m, and a vector of some other exogenous variables Z.

The preservative-free Mooncakes are more perishable and usually have a shorter shelf life. Thus, they also feature higher production, supply and storage costs either for producers or for consumers, so that the food costs for consumers should be higher in this market[2]. If Mooncakes contain preservatives, the price of a Mooncake for consumers will decrease to $p_F - t$.

We assume that the market is competitive and in equilibrium and the information about food preservatives is symmetric. t is a mark-up in production costs from the perspective of producers without using preservatives. However, t is also the consumer willingness to pay for preservative-free Mooncakes from the perspective of consumers. It is furthermore known that the preservatives can potentially harm

[2] In some extreme cases, consumers do not even have a chance to buy certain food items without containing preservatives in markets as they can perish on their way from producers to the markets.

consumer health. Therefore, the health stock of the consumer may decrease from h to $h-d$ if he chooses to consume the conventional Mooncakes. If a consumer only consumes the Mooncakes containing the preservatives, the indirect utility function will be $V(p_F - t, h-d, m, Z)$. The market equilibrium shows that

$$V(p_F - t, h-d, m, Z) = V(p_F, h, m, Z) \qquad \text{Equation (1)}$$

By taking the first-order approximation of $V(p_F - t, h-d, m, Z)$, we get

$$V(p_F - t, h-d, m, Z) \approx V(p_F, h, m, Z) - \frac{\partial V}{\partial p_F} t - \frac{\partial V}{\partial h} d \qquad \text{Equation (2)}$$

Combining (1) and (2) yields

$$t = -\frac{\partial V / \partial h}{\partial V / \partial p_F} d \qquad \text{Equation (3)}$$

By Roy's identity,

$$t = \frac{d}{x_n} \frac{\partial V / \partial h}{\partial V / \partial m} \qquad \text{Equation (4)}$$

where x_n is the Marshallian demand for the preservative-free Mooncakes. We assume that the demand elasticity of Mooncakes is very small because it is usually consumed by everyone in China. That is, regardless of the type of Mooncakes (whether preservative-free Mooncakes or not), the total consumption is given as x_n. The health damage from consuming one unit conventional Mooncake is defined as $k = \frac{d}{x_n}$. Rewriting equation (4) yields

$$t = k\frac{\partial V / \partial h}{\partial V / \partial m} \qquad \text{Equation (5)}$$

where $\partial V / \partial h$ denotes the marginal utility of health and $\partial V / \partial m$ is defined as the marginal utility of money. Drawing on equation (5), we can state two hypotheses:

(1) Consumers' willingness to pay for food safety is positively correlated with the marginal utility of health, while the marginal utility of health might be correlated with age as health can affect the length of people's lives (Grossman 1972). The youth have longer life expectations than the elder, but the elder might care more about their health, so that the relationship between the marginal utility and age is unclear and might be nonlinear. The current empirical literature on organic food finds that there is a negative correlation between age and WTP (Groff et al. 1993; Thompson 1998) but the second-order relationship has not been well examined. Furthermore, Halliday (2007) finds that there are a large number of heterogeneities and a certain degree of state-dependence for the evolution of health over the life cycle and hence proposes that the relationship between age and health might not be linear. Therefore, the empirical part of this paper will test if there is a non-linear relationship between WTP and age.

(2) Consumer willingness to pay for food safety is negatively correlated with the marginal utility of money. The rich usually have smaller $\partial V / \partial m$, so that we arrive at the second testable hypothesis: Consumer willingness to pay would increase as

income increases. Most current empirical studies on organic food support this proposition. A good review can be found in Thompson (1998).

Furthermore, Mooncakes are assumed to be homogenous in this model, which might not be realistic. However, when Mooncakes are heterogeneous in price and quality, one can infer that consumer WTP for preservative-free Mooncake would be higher if her base price for a piece of Mooncake is higher. That is, the WTP could be positively correlated with the base price. Therefore, the price information should be incorporated in the empirical part.

In the next part of this paper, we will use survey data on the willingness to pay for preservative-free Mooncakes of 293 consumers in Beijing to test the above hypotheses and provide the policy implications.

Econometric Model

The benefit of food safety is a non-market value. It is difficult to get the information with respect to the revealed preferences of consumers, though some studies use experimental auctions to reveal consumer WTP (Alfnes and Rickertsen 2003; Froehlich et al. 2009). However, the complexity of auction designs and consumer heterogeneity may bias the results.

Instead, the stated-preference methods are often proposed. Bockstael and Freeman (2005) provide a good review of the development, status quo and

controversies regarding the stated preference methods. Among the stated preference methods, the contingent valuation method (CVM) is the most important and also the most popular one. Carson and Hanemann (2005) summarize the development and status quo of the CVM. Golan and Kuckler (1999), and Antle (2001) are good reviews for both the theoretical and empirical studies of consumer WTP for food safety.

The CVM has many different elicitation formats, and different formats would influence the results greatly. Researchers have gradually developed two types of methods to elicit consumer WTP: (1) the Continuous Method, in practice including the payment card (PC) approach and the open-ended (OE) approach; (2) the Discrete Method, in practice mainly including the dichotomous choice (DC) approach. Ready, Buzby and Hu (1996) point out that a continuous format usually generates a lower estimated WTP than a dichotomous choice format due to more yes-saying among DC respondents. The discrete method is more popular in practice. In 1993, the National Oceanic and Atmospheric Administration (NOAA) panel gave a number of important guiding principles regarding the application of the CVM, and recommended the dichotomous choice approach for eliciting the WTP for non-market goods (Arrow et al., 1993) since this format has a better simulation of the market price and can reduce the strategic bias, thus providing more reliable and accurate valuations of the WTP.

The DC approach also has different elicitation formats. Single-bounded dichotomous choice (SBDC) and double-bounded dichotomous choice (DBDC) are

the most important ways. The estimation methods of SBDC and DBDC are completed by Hanemann et al., in 1984 and 1991, respectively.

Based on the principle of utility maximization, consumers would, as the theory predicts, choose different levels of food safety. According to McFadden's (1974) random utility model (RUM),the economic principle of the CVM can be described as follows: Other things being equal, when the level of food safety rises from a relatively low level Q_o (containing preservatives) to a higher level Q_1 (preservative-free food), consumers can reach a higher level of utility due to an increase in their health stock, that is

$$V_1(Q_1, p_F, m, Z, \varepsilon_1) > V_0(Q_0, p_F, m, Z, \varepsilon_0),$$

where ε_o and ε_1 are the random error terms. The CVM uses the survey method to reveal consumer preferences, and we can derive the equilibrium utility at different levels of food safety combing the above theoretical framework, so that

$$V_1(Q_1, p_F + t, m, Z, \varepsilon_1) = V_0(Q_0, p_F, m, Z, \varepsilon_0).$$

We can then use statistical methods to derive t, which represents the consumer willingness to pay.

This paper uses the DBDC approach as the specific elicitation format, and the following part will introduce its principles and the mathematical derivation. The DBDC approach was first proposed by Hanemann (1985) and then developed by Hanemann et al. (1991). It involves asking the respondents to engage in two rounds of

bidding: Participants respond to a first dollar amount and then face a second question involving another dollar amount, whether it is higher or lower depends on the response to the first question (Hanemann et al., 1991).

In this paper, respondents are faced with the following questions: "If the price of the Mooncake without preservatives is B_i *yuan* per unit higher than the conventional Mooncake, are you willing to pay?" followed by: "What about B_i^u (or B_i^d)?" B_i is the initial bid, B_i^u is the second bid if the response to the first bid was "yes" and B_i^d is the second bid if the response was "no". Thus, the respondent's answers will be four possible combinations :(yes, yes), (no, no), (yes, no) and (no, yes). Hanemann et al. (1991) first constructed the log-likelihood function of the DBDC approach and verified that the DBDC approach is shown to be asymptotically more efficient than the conventional SBDC approach, although the analysis of the data is more complex.

Following Watson and Ryan (2007), let t_1 be the base bid of the initial dichotomous choice question (DC1) and t_2 be the follow up bid of the second dichotomous choice question (DC2). The above possible responses are:

1) When respondent's answer is "yes-yes", $WTP \geq t_2$
2) When respondent's answer is "no-no", $WTP < t_2$
3) When respondent's answer is "yes-no", $t_1 \leq WTP < t_2$
4) When respondent's answer is "no-yes", $t_1 > WTP \geq t_2$

Following this:

$$WTP_{ij} = \beta' x_{ij} + \varepsilon_{ij} \qquad \text{Equation (6)}$$

where WTP_{ij} is the WTP of individual j, and $i = 1,2$ represents DC1 and DC2, respectively; x_{ij} ($i = 1,2$) is a vector of explanatory variables, including the bids (B), consumers' demographic characteristics (such as income, age, gender, education, etc.) and supermarkets' characteristics (e.g. the size of the supermarket) and β is the corresponding vector of coefficients. The error term, ε_{ij}, incorporates both the individual and the question specific error.

According to equation (6), for instance, the probability of respondent j answering "yes" to DC1 and "no" to DC2 is expressed as:

$$\Pr(\text{yes-no}) = \Pr(WTP \geq t_1, WTP < t_2).$$

That is,

$$\Pr(\text{yes-no}) = \Pr(\beta' x_{1j} + \varepsilon_{1j} \geq t_1, \beta' x_{2j} + \varepsilon_{2j} < t_2).$$

Then, incorporating all response combinations in the likelihood function yields

$$\begin{aligned} L_j(\beta' x_{ij} | t) = {} & \Pr(\beta' x_{1j} + \varepsilon_{1j} \geq t_1, \beta' x_{2j} + \varepsilon_{2j} < t_2)^{YN} \\ & \times \Pr(\beta' x_{1j} + \varepsilon_{1j} > t_1, \beta' x_{2j} + \varepsilon_{2j} \geq t_2)^{YY} \\ & \times \Pr(\beta' x_{1j} + \varepsilon_{1j} < t_1, \beta' x_{2j} + \varepsilon_{2j} < t_2)^{NN} \\ & \times \Pr(\beta' x_{1j} + \varepsilon_{1j} < t_1, \beta' x_{2j} + \varepsilon_{2j} \geq t_2)^{NY} \end{aligned} \qquad \text{Equation (7)}$$

Assuming the error terms ε_{1j} and ε_{2j} are normally distributed with zero means and variances σ_1^2 and σ_2^2, respectively, and the correlation coefficient between DC1 and

DC2 is expressed by ρ. Equation (7) can be estimated using the bivariate probit model (Cameron and Quiggan, 1994)[3].

Furthermore, as the estimators for the constant α^* and the coefficients β_M^*, β_S^* and β_B^* are in hand, we can calculate the mean WTP:

$$E(WTP) = -\frac{\alpha^* + \beta_M^{*\prime} E(M) + \beta_S^{*\prime} E(S)}{\beta_B^*} \cdot \frac{n_1}{n}, \qquad \text{Equation (8)}$$

where β_M^*, β_S^* and β_B^* are the estimated coefficients for the consumers' demographic characteristics, the supermarkets' characteristics and the bids, respectively. $E(\bullet)$ represents the mean of the corresponding variables. n is the whole sample and n_1 is the amount of respondents whose answer is "yes".

Data Description

We conducted a survey of consumer willingness to pay for "preservative-free Mooncakes" in 25 supermarkets in Beijing in October 2006. Using face-to-face interviews, this survey covered the main areas of Beijing.

[Insert Table 1 & Figure 1]

Based on the results of a pilot pre-survey and the study of Cooper (1993), the survey finally adopted three sets of bids (0.5, 1.0, 1.6), (1.0, 1.6, 2.5) and (1.6, 2.5, 3.5) in order to identify the bivariate probit econometric model. Each set includes 100 questionnaires, and the survey eventually yielded 293 effective samples from 25

[3] A restricted version of the bivariate probit model is the interval data model (Hanemann et al., 1991).

supermarkets. For the purpose of comparison, we also include an open-ended bid and a question regarding Mooncake's base price in the questionnaire, as has also been done in some previous studies. Part of the questionnaire is shown in Figure 2.

[Insert Figure 2]

The frequency of different combinations of answers is shown in Figure 1. It indicates that the number of people answering "yes-yes" is a little bit high and accounts for a share of 65.31%, perhaps resulting from (1) the yes-saying bias and (2) the starting point bias as Ready, Buzby and Hu suggested (1996).

Table 1 shows the descriptive statistics of the main variables. First, the mean of the open-ended bids is 4.96 yuan, higher than the starting bid of our DC bids design. This indicates that the higher proportion of yes-yes answers is caused by the so-called starting point bias. Additionally, it indicates that consumers are more concerned about food preservatives than we thought. The mean price of the Mooncakes the consumers purchased is 9.36 yuan per piece. The average premium for the WTP for preservative-free Mooncake is 53%, which is a relatively large number.

Furthermore, the number of the respondents with a college education or above amounts to around half of the sample. Consequently, there may exist some bias in the sample, even though China's overall educational level is increasing. However, Beijing is a cultural center in China, which might be another reason for a higher proportion of highly educated people. In our sample, about 58.8% of the respondents are women,

which might be explained by the fact that women usually play a more important role in food shopping. The average age of the respondents is 34.87 years, and it might imply that the sample might be biased towards the youth.

This survey chooses monthly income as the indicator of family welfare status. In our sample, 53.1% of all families have an income of less than 3000 yuan, whereas only 7.1% have an income above 8000 yuan. Furthermore, 32.3% of the families have children under the age of 12, while 62.9% have old people above 65 years.

Huang (1993) points out that consumers' risk perception and risk attitude may affect the WTP for food safety, even though it was not supported in the empirical ground. This survey uses the question "Have you heard of any incidents of unqualified Mooncakes?" to elicit consumer risk perceptions and finds that about half of the respondents heard of some incidents of unqualified Mooncakes. This study uses a five-point scale problem of "concern about food safety" as a proxy for the consumer risk attitude towards food preservatives as well as food safety. We assume that consumers' concern increases along with their risk-aversion. The survey shows that the average level of consumer concern about food safety is very high. On average it amounts to 1.82 points. The highest degree of concern receives 1.0 points in this survey.

In addition, the consumption quantity and the shopping place may affect consumers' attitude towards food safety. It is very difficult to get information about

the specific consumption quantity. Our questionnaire uses the propensity of Mooncake consumption (eat a lot / eat some / eat almost none) to approximate consumption quantity. The current literature shows that the size of the supermarket matters for consumer WTP for food safety (Zeng et al. 2008). We use a dummy variable (small / large) to represent the size of the supermarkets. The large supermarkets in our sample are Carrefour and Wal-Mart, while the rest are small ones. In this survey, 43% of the respondents are from the large supermarkets.

Estimation and Discussion

- Econometric Models

Based on the theoretical framework above and the data, our econometric model is specified as follows:

$$y_1 = \alpha_0 + \alpha_1 \text{Bid1} + \alpha_2 \text{Price} + \alpha_3 \text{Income} + \alpha_4 \text{Age} + \alpha_5 \text{Edu} + \alpha_6 \text{Elder} + \alpha_7 \text{Child} + \alpha_8 \text{Gender} + \alpha_9 \text{Quant} + \alpha_{10} \text{Percept} + \alpha_{11} \text{Concern} + \alpha_{12} \text{Size} + \varepsilon_1 ,$$

$$y_1 = \begin{cases} 1 & \text{if } t_1 > \text{Bid1} \\ 0 & \text{if } t_1 < \text{Bid1} \end{cases}; \qquad \text{Equation (9.1)}$$

$$y_2 = \beta_0 + \beta_1 \text{Bid2} + \beta_2 \text{Price} + \beta_3 \text{Income} + \beta_4 \text{Age} + \beta_5 \text{Edu} + \beta_6 \text{Elder} + \beta_7 \text{Child} + \beta_8 \text{Gender} + \beta_9 \text{Quant} + \beta_{10} \text{Percept} + \beta_{11} \text{Concern} + \beta_{12} \text{Size} + \varepsilon_2 ,$$

$$y_2 = \begin{cases} 1 & \text{if } t_2 > \text{Bid2} \\ 0 & \text{if } t_2 < \text{Bid2} \end{cases}; \qquad \text{Equation (9.2)}$$

where α_i and β_i ($i = 0,1\cdots 12$) are the coefficients for equation (9.1) and (9.2) and ε_1 and ε_2 are error terms with normal distributions $N(0,\sigma_1^2)$ and $N(0,\sigma_2^2)$, respectively. The correlation coefficient between ε_1 and ε_2 is ρ. Equation (9) is a typical bivariate probit model. However, in order to be consistent with the theory of consumer behavior, the coefficients in equation (9.1) and equation (9.2) should be equivalent. Therefore, we need to add some constraints and let $\alpha_k = \beta_k$ ($k = 0,1,\cdots 12$) in the estimation.

For the purposes of comparison and robustness check, we also include a Tobit model to estimate open-ended bids, even though there are many ways to estimate open-ended CVM (Yu and Abler 2010). The Model is specified as

$$WTP_{open-ended} = \gamma_0 + \gamma_2 \mathrm{Price} + \gamma_3 \mathrm{Income} + \gamma_4 \mathrm{Age} + \gamma_5 \mathrm{Edu} + \gamma_6 \mathrm{Elder} + \gamma_7 \mathrm{Child} + \gamma_8 \mathrm{Gender} + \gamma_9 \mathrm{Quant} + \gamma_{10} \mathrm{Percept} + \gamma_{11} \mathrm{Concern} + \gamma_{12} \mathrm{Size} + \varepsilon_3 \quad . \quad \text{Equation (10)}$$

where γ_i ($i = 0,1\cdots 12$) are the coefficients regarding the open-ended bids and ε_3 is an error term with a normal distribution $N(0,\sigma_3^2)$.

- Model comparison

Table 2 reports the estimation results of four models: Two constrained bivariate Probit models, one unconstrained bivariate Probit model, and one Tobit model. The chi-square tests for all three models are statistically significant at the 1% level, which indicates that the models fit the data very well.

Model 1 is the estimation results of the constrained bivariate Probit model of Equation (9.1) and (9.2). Model 2, which includes the variable of age-squared, is intended to test the nonlinearity between WTP and age. The results of Model 1 and Model 2 are quite close. The Likelihood ratio test for the two models is

$\chi_1^2 = 5.57$ (p=0.062),

which is marginally significant and slightly favors Model 2. In particular, Model 1 indicates that WTP and age are negatively correlated. This is consistent with the current literature (Groff et al. 1993; Thompson 1998). However, Model 2 shows that the coefficients of both age and age-squared are statistically significant, which indicates that there may exist an inverted U-shape relationship between WTP and age, with the turning point being at the age of 32. It is consistent with some recent literature that the relationship between age and health might be nonlinear (Halliday 2008).

Model 3 is the estimation results of the unconstrained bivariate Probit model of Equations (9.1) and (9.2). The Likelihood Ratio test for the constraints yields

$\chi_{13}^2 = 15.88$ (p=0.256),

which cannot reject the difference between the two models, so that the constraints are valid. Furthermore, the estimated results of the unconstrained model, particularly the Bid 2 equation, are quite close the results of the constrained model.

Model 4 yields the Tobit estimation results of the open-ended model. Compared with Model1, the signs of the estimated parameters are the same except for the coefficients of Child and Quant. However, the coefficients of Child and Quant are not statistically significant in any of the models.

Comparing the results of the four models in Table 2, we conclude that the empirical results are quite consistent and robust.

In the next section, we will discuss in detail the empirical results, specifically those based on the constrained Model 1.

[Insert Table 2]

- Discussion of Results

As shown in Model 1, the coefficients of Bid, Price, Income, Age, Percept and Size are statistically significant.

First, price and income are positively correlated with the WTP, which is consistent with economic theory. As consumers are willing buy a higher priced Mooncake or consumers have higher incomes, their WTP should be higher.

Second, the bidding values and the WTP are negatively correlated. The negative sign of the coefficient of Bid also matches the economic theory: As the bidding value increases, the probability to accept it will of course decrease.

As aforementioned, Model 1 shows that age and WTP are negatively correlated, but Model 2 also shows that relationship between age and WTP might be

characterized by an inverted U-shape. Even though both results are supported by some current literature, we believe that the relationship might be nonlinear (Halliday 2008).

The level of consumer risk perception regarding food safety (Percept) has a significantly positive impact on WTP, which differs from the results of Huang (1993). Compared with the consumers who have not heard of incidents of unqualified Mooncakes, those who have heard of such incidents, are willing to pay a higher price for preservative-free Mooncakes. From the perspective of insurance, consumers would like to pay more to avoid the risks, as the risk level increases.

Compared to those in small supermarkets, consumers shopping in large supermarkets have a higher probability of being willing to pay for preservative-free Mooncakes. The reason might be that large supermarkets, such as Carrefour and Wal-Mart, usually have a better reputation regarding quality control and quality guarantee. In addition, the quality might be higher and the information regarding preservative-free might be much more trustworthy. Therefore, consumers in large supermarkets should have a higher probability of being willing to pay for preservative-free Mooncakes.

The results also show that the coefficients of Edu, Elder, Child, Gender, Quant, and Concern are not statistically significant. Hence, these variables have no significant links with the WTP in this empirical ground.

- Calculation of WTP

One of the main purposes of food safety research is to calculate the value of WTP, and it can provide a benchmark for assessing food safety policies. According to the method for calculating the mean WTP shown in equation (8), we can put the estimated coefficients and the corresponding mean values of all the variables into equation (8), and can thus obtain the result that the mean WTP for preservative-free Mooncake is 5.80 yuan per unit in Model 1[4]. Even though the unconstrained Model 3 also yield the mean WTP values, they are not efficient since the variances are much greater than in the constrained models.

Our survey also shows that the average price consumers pay for a piece of Mooncake is 9.36 yuan, so that the premium rate is about 62%. This is relatively a very high value for the WTP for preservative-free Mooncakes. Using Krinsky and Robb Monte Carlo simulation (Jeanty 2007), we obtain a 95% confidence interval for the WTP which is 5.31～6.46 Yuan.

As aforementioned, in order to check the robustness of the estimation results of the DBDC format, we also added a question regarding the willingness to pay for preservative-free Mooncakes with an open-ended format in the questionnaire of this study, as has also been done in previous studies. Even though there are many ways to deal with open-ended bids (Yu and Abler, 2010), we calculated the mean of the WTP

[4] The mean WTP in Model 2 is 5.72 Yuan per unit, which is quite close to the corresponding result of Model 1.

in the open-ended format from the raw data. The WTP for the preservative-free Mooncakes according to the open-ended bids is 4.96 Yuan[5], which is slightly lower than the above result from the DBDC format but is still consistent with the current literature. Ready, Buzby and Hu (1996) point out that a continuous format usually generates a lower estimated WTP than a dichotomous choice format due to more yes-saying among DC respondents.

The premium of WTP for preservative-free food is very high, even higher than we thought, as we set low bidding values in the DBDC questionnaires. Given a very high WTP for preservative-free Mooncakes and a very high level of concern about the health consequences of food preservatives as well, governments should start to take some measures to regulate synthesized food preservatives in order to protect consumers' welfare.

Conclusion

Due to a lack of research on the health consequences of food preservatives both from scientific and economic perspectives, consumers are facing a dilemma, namely the trade-off between the benefits of an increase in food shelf life, such as lower food prices, and the potential health damages from food preservatives. This study sheds

[5] Including both zero and non-zero bids.

light on the consumer attitude towards food preservatives and attempts to fill the gaps in the current literature.

As income increases, consumers are usually willing to pay more attention to food quality rather than food quantity, and food safety is one of the most important dimensions in food quality (Yu and Abler 2009). Given the uncertainty regarding the health consequences of food preservatives, consumers should pay a premium for preservative-free food in order to reduce the uncertainty from the perspective of insurance.

Consumer willingness to pay is used in this study to measure the consumer benefit from consuming preservative-free Mooncakes. This study finds that income and price are positively correlated with the WTP, and there might be an inverted-U-shaped relationship between age and the WTP. The theoretical framework highly matches the empirical results of our study using a survey of 293 customers in 25 supermarkets in Beijing City. In general, this study also provides a good framework for understanding the concept of consumer willingness to pay for food safety.

This study also indicates that consumers in Beijing are willing to pay 62% more for a piece of preservative-free Mooncake, which represents a high level of consumer benefit from consuming preservative-free Mooncakes and a high level of concern about food preservatives as well. The result provides a good policy benchmark for government regulations on food preservatives. Since it is one of the most developed

places in the country, a study in Beijing can also reflect the future consumer attitude towards food preservatives in all of China and a number of other countries.

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Table 1 Descriptive Statistics of the Variables

Variables	Description	Mean	Std. Dev.
Price	Consumers' real purchase price for Mooncakes	9.36	9.40
Bid-Open	Open-ended bid	4.96	7.75
Bid1	The initial bid	1.73	0.61
Wtp1	Respondent's answer to the initial question:1=yes ;0=no	0.80	0.40
Bid2	The follow-up bid	2.27	0.92
Wtp2	Respondent's answer to the second question:1=yes; 0=no	0.68	0.47
Income	The average monthly family income (Yuan): 1～8 represents eight levels from low to high (~500; 500-1000; 1000-2000; 2000-3000;3000-4000;4000-5000;5000-8000;8000~), respectively	4.68	1.70
Age	Age	34.87	15.07
Age2	Age squared	1442.39	1281.24
Edu	Respondent's education: 1～6 represents six levels from low to high (Illiterate; Elementary School; Middle School; High School; College; College above), respectively	4.29	0.96
Elder	Existence of family member above 65: 1=yes; 0=no	0.63	0.48
Child	Existence of family member less than 12: 1=yes; 0=no	0.32	0.47
Gender	Gender: Male=1; Female=0	0.42	0.49
Quant	The propensity of Mooncake consumption 1＝Eat a lot，2＝Eat some; 3＝almost not eat	1.58	0.78
Percept	Have you heard of incidents of unqualified Mooncakes? 1=yes,0=no	0.50	0.50
Concern	Respondent's concern about food safety，1＝Very much，2＝Relatively，3＝Average，4＝almost not，5＝Not at all	1.82	0.92
Size	Large-scale supermarket，1＝yes，0＝no	0.43	0.50

Note: (1) The sample size is 293.

(2) The large-scale supermarkets are Carrefour and Wal-Mart.

Table 2 Estimation Result of the Bivariate Probit Model

Variables	Constrained Bivariate Probit Model				Unconstrained Bivariate Probit Model				Open-Ended Model	
	Model1		Model2		Model 3				Model 4	
	Bid 1 & 2		Bid 1 & 2		Bid 1		Bid 2		All Bids	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Bid（1&2）	-0.4045	0.0469***	-0.4137	0.0478***	-0.1718	0.1572	-0.2190	0.1089**	-	-
Price	0.0598	0.0157***	0.0600	0.0157***	0.0574	0.0189***	0.0594	0.0161***	0.3047	0.0512***
Income	0.1262	0.0500**	0.1127	0.0504**	0.1870	0.0639***	0.1138	0.0510**	0.6730	0.2999**
Age	-0.0149	0.0053***	0.0507	0.0286*	-0.0203	0.0063***	-0.0115	0.0055**	-0.0716	0.0343**
Age2	-	-	-0.0008	0.0003**	-	-	-	-	-	-
Edu	-0.0371	0.0876	-0.0508	0.0880	-0.0186	0.1095	-0.0608	0.0898	-0.0439	0.5322
Elder	-0.1482	0.1619	-0.1146	0.1631	-0.2724	0.1967	-0.0993	0.1670	-2.0259	0.9874**
Size	0.2913	0.1588*	0.3283	0.1604**	0.2805	0.1895	0.3334	0.1627**	0.8179	0.9722
Child	0.1000	0.1664	0.0138	0.1707	0.2822	0.2057	0.0194	0.1713	-0.4586	1.0349
Gender	0.1652	0.1622	0.1651	0.1631	0.1009	0.1930	0.1217	0.1676	0.4050	1.0123
Percept	0.4026	0.1576**	0.3762	0.1587**	0.6413	0.1977***	0.2936	0.1647*	0.7384	0.9807
Concern	-0.0595	0.0816	-0.0455	0.0823	-0.1121	0.0922	-0.0225	0.0846	-0.4582	0.5354
Quant	-0.0383	0.1018	-0.0495	0.1024	-0.1112	0.1241	-0.0087	0.1048	0.2116	0.6290
Intercept	0.9581	0.4973	-0.0468	0.6577	0.7675	0.6222	0.4337	0.5700	2.0332	3.0197
ρ	0. 9996	23. 6071	0. 9988	0. 0765	0.9441	0.0554				
Mean WTP	5.80		5.72		12.63		8.40		4.96	
95%C.I.	(5.31,	6.46)	(5.25,	6.38)	(-53.92,	70.40)	(6.78,	21.11)		
Log Likelihood	-260.26		-257.48		-241.65				-886.37	
Num. of Obs.	293		293		293				283	

Note: (***), (**) and (*) denote significance at the 1%, 5% and 10% levels, respectively.

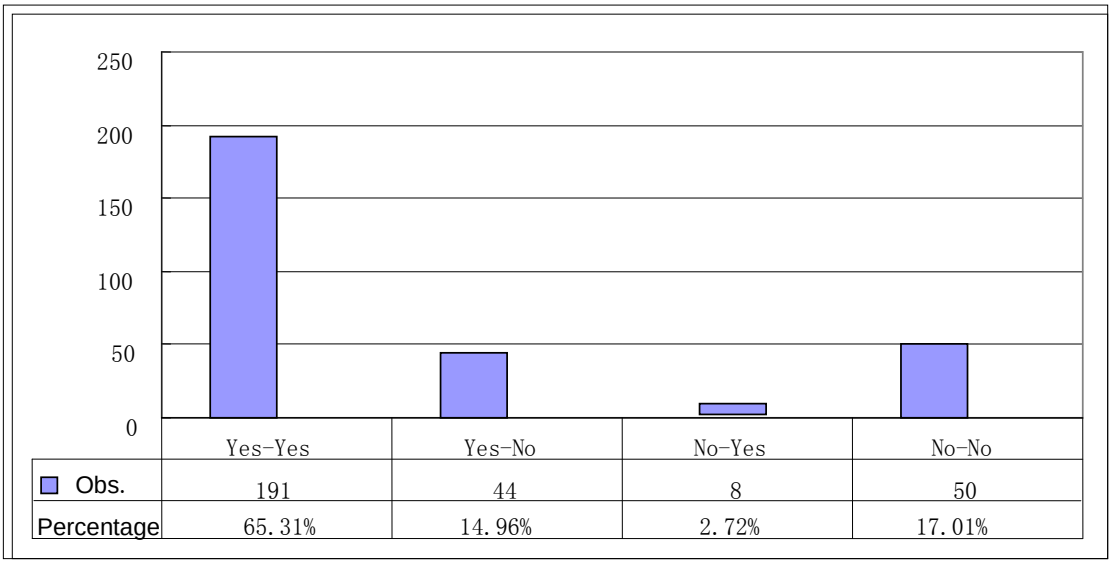

Figure 1 Distribution of WTP Combinations

……..…

Most Mooncakes' shelf life is not so long, and preservatives can inhibit growth of bacteria or fungi, and prolong the shelf life. However, most preservatives, particularly the synthesized preservatives, might cause some health damages. If there are preservative-free Mooncakes in the market,

1, would you like to pay a higher price for preservative-free Mooncakes?

(1) Yes (2) No

2, The price of a normal Mooncake you purchased is _____yuan/unit. If the price for preservative-free Mooncakes are **2.5** yuan higher the normal one, would you like to buy them?

(1) Yes -----→go to question (3) (2) No-------→Go to question (4)

3, Then, if the price for a preservative-free Mooncake is **3.5** yuan higher than the normal one, would you like to buy them?

(1) Yes (2) No

4, Then, if the price for a preservative-free Mooncake is **1.6** yuan higher, would you like to buy them?

(1) Yes (2) No

5, If possible, please give a specific number of the willingness to pay more for a preservative-free Mooncake._____ yuan/unit.

……..…

Figure 2 Part of the Questionnaire