Food Control 27 (2012) 21–28

Contents lists available at SciVerse ScienceDirect

Food Control

journal homepage: www.elsevier.com/locate/foodcont

Consumers' willingness to pay for traceable pork, milk, and cooking oil in Nanjing, China

Caiping Zhang [a], Junfei Bai [b,*], Thomas I. Wahl [c,1]

[a] School of Economics, Central University of Finance and Economics, 39 South College Road, Haidian District, Beijing 100081, China
[b] Center for Chinese Agricultural Policy, Chinese Academy of Sciences, Institute of Geographical Sciences and National Resources Research, Jia 11, Anwai Datun Road, Chaoyang District, Beijing 100101, China
[c] Department of Agribusiness and Applied Economics, North Dakota State University, Fargo, ND 58108-6050, USA

ARTICLE INFO

Article history:
Received 27 September 2011
Received in revised form
5 February 2012
Accepted 1 March 2012

Keywords:
Food safety
Food traceability
Information effects
Willingness-to-pay

ABSTRACT

We analyzed consumers' willingness to pay (WTP) for traceable pork, milk and cooking oil, and its determinants using data from Nanjing, China, with particular focus on the effects of consumer knowledge. The major findings suggest that Nanjing consumers are willing to pay a significant positive price premium for food traceability despite variations across products. Meanwhile, consumers' WTP for food traceability was positively affected by consumer knowledge about food traceability and awareness of food quality- and safety-related certifications. A number of demographics such as income and age also have statistically significant impacts on the WTP.

© 2012 Elsevier Ltd. All rights reserved.

1. Introduction

The 2008 melamine milk incident and a number of other food safety accidents that have increased worldwide concern over China's food safety have resulted in a growing desire in China to regain consumer confidence in the safety of the food supply. Establishing food traceability systems is one of the top policy tools to attain this goal. Traceability is usually defined as the ability of firms or supervising agencies to trace the origin of a product as it moves through the supply chain. With these systems, firms are able to strengthen their capacity to manage the flow of inputs and outputs to improve distribution efficiency, product differentiation, and food quality and safety (Golan et al., 2004). Since the discovery of bovine spongiform encephalopathy (BSE) and other food safety related scares, food traceability has attracted increasing attention in the EU, Australia, and Japan. In the United States and Canada, many food producers have also been motivated to make enormous efforts to track the flow of food, although these systems are not government regulated (Golan et al., 2004).

In recent years, China's private food sectors have also made efforts to improve the traceability of their products, but mainly in private and export-oriented food industries (Calvin, Gale, Hu, & Lohmar, 2006). Nationwide food traceability systems were not legally required until China's New Food Safety Law went into effect on June 1, 2009. The new law targets the entire national food safety monitoring system. Under the law, food producers, processers, packers, and retailers are required to implement testing and record keeping systems for all inputs and outputs and to archive the records for at least two years (*Articles 36 though 41*). Food manufacturers and distributors are also required to establish a regime to be able to immediately stop the production of food that does not meet food safety standards, to promptly recall food already in the market place, and to issue a notification to related participants (*Article 53*). For violations, the new law stipulates associated punishments, including warning, fines ranging from 2000 to 20,000 Yuan, and license suspension, according to the degree of seriousness (*Article 87*).

The system shares several key features with the European Regulation 178/2002, which was developed as a framework of food traceability system in 2002, and then became mandatory in January 2005 (Charlier & Valceschini, 2008). The first feature is characterized as "accurate and targeted withdrawals", that is, all inputs at all stages of production, processing and distribution should be able to accurately targeted and traced back. The second feature is characterized as "one step forward and one step backward". This requires that all producers, processors, packers and retailers are able to trace their incoming and outgoing food, feed, or any other substance one

* Corresponding author. Tel.: +86 10 64888979; fax: +86 10 64856533.
E-mail addresses: cpzhang77@gmail.com (C. Zhang), jfbai.ccap@igsnrr.ac.cn, jfbai007@gmail.com (J. Bai), tom.wahl@ndsu.edu (T.I. Wahl).
[1] Tel.: +1 701 231 9481.

0956-7135/$ – see front matter © 2012 Elsevier Ltd. All rights reserved.
doi:10.1016/j.foodcont.2012.03.001

step backward and one step forward rather than to trace the origin of a product as it moves through the entire production and supply chain. Finally, both the European Regulation 178/2002 and the related articles in China's new Food Safety Law highlight traceability as a device of risk management in food safety rather than as a quality measurement.

However, in deciding to adopt the traceability system or not, firms in food supply chains have to compare potential benefits and costs. Theoretically speaking, in a completely competitive market, cost increases as a result of adopting traceability can be largely passed along to consumers with little change in quantity demanded because of relatively lower food demand price elasticity compared to most industrial products. However, in practice, firms who truly adopt the food traceability system could face two opposite situations. On one hand, they may earn more by attracting more consumers to buy their traceable products at a higher price level (Golan et al., 2004). In contrast, they may suffer from the embarrassment of being driven out by "Bad Money" according to the Gresham's law.[2]

Given China's unreliable food safety monitoring system and the complicated existing food distribution system—one with over 200 million small farms, hundreds of thousands of small food processors and fragmented supply chains, the likelihood that firms cannot pass along cost to consumer is high. Therefore, it is critical for firms to know how much consumers are willing to pay for traceable food products or if these firms are able to gain extra benefits from its adoption. These potential benefits must be balanced against the anticipated costs to employ the tracking system.

For policymakers, it will also be beneficial to recognize consumers' responses to the tracking system. On the one hand, knowing consumers' preferences for traceable foods is an important component for government to assess possible welfare distribution due to the implementation of the system, and to evaluate the economic effects of the policy, especially on small farmers and market participants. On the other hand, by knowing consumers' opinion of the system, governments can design better policy instruments if they plan to fund (fully or partially) the increased cost from the mandatory tracking system.

In balancing benefits and costs, firms (even policymakers) have to also consider how consumers' knowledge about the potential benefits, costs, and creditability of the tracking system will affect their preferences. This is especially important in China given the food tracking system is quite new for most consumers. Many theoretical and empirical studies have suggested the importance of information on buyers' opinions and valuing of the products as they search. For instance, Akerlof (1970) explained that asymmetric information is the reason that causes a good car to be undervalued as "Lemons" by buyers. In terms of food traceability, Lee, Han, Nayga Jr., and Lim (2011) found that Korean food shoppers' willingness to pay for imported beef with traceability can be significantly reduced with negative and two-sided information about traceability.

The current paper aims to measure consumers' willingness-to-pay (WTP) for traceable food products and to investigate associated determinants, with particular focus on the effects of consumer knowledge. Three products, including fresh pork, fresh milk, and vegetable cooking oil (hereafter referred to as cooking oil), are analyzed. The data were collected by a recently conducted consumer survey in Nanjing, the capital of Jiangsu province, using a dichotomous choice questioning format.

We chose pork, milk and cooking oil for several reasons. First, most food safety incidents disclosed recently have been in these sectors, which has caused a growing desire to improve food safety in these industries. Second, these three food products are consumed daily in Chinese households, so, there is little heterogeneity for respondents in understanding the products.[3] Third, unlike grain or vegetables, milk and cooking oil industries have become remarkably concentrated in China in recent years (Zhang & Kong, 2009), which has reduced the threshold for firms to implement the tracking systems.

Given China's great regional differences, it is recognized that using data only from one city limits our ability to make direct generalizations in nationwide from the study results. Despite this limitation, studying Nanjing still can provide important evidence for both firms and policymakers in understanding Chinese urban consumers' preferences of food traceability. Here are several reasons. First, Nanjing, located in the lower Yangtzre River drainage basin and Yangtze River Delta economic zone, has long been a national center of education, economic, transport networks, and tourism, consumers' preference in Nanjing has an important influence on the Eastern Region of China, including the entire province of Jiangsu, and parts of Anhui, Zhejiang, and Shandong provinces. Second, as a city located between the North and the South of China, food dietary culture in Nanjing includes nearly all the Northern and Southern elements. This ensures that we have enough sampled respondents who regularly consume these three investigated food products. Third, although it is not the largest city in terms of population, Nanjing is not small. According to the latest population census in China, Nanjing has over eight million residents in 2010. Finally, by narrowing our study scope into one single city we are able to maintain a carefully collected and focused data set to evaluate.

The rest of the paper is organized as follows. First, we review previous studies. Second, we describe the data and survey. Third, we present empirical methods and model specification. Fourth, we discuss the empirical results. And finally, we summarize major findings.

2. Previous studies

Consumers' willingness to pay for food traceability has been given increasing attention because of the worldwide concern about food safety. The research results, however, vary across studies and regions. For example, Loureiro and Umberger (2007) analyzed consumers' relative preferences for meat attributes in labeled ribeye beef steaks by using choice experiments. Their results indicate that both traceability and country-of-origin are less valued than certification of USDA food safety inspection. Similary, Verbeke, Ward, and Avermaete (2002) found that Belgian consumers expressed more interest in food safety and quality standards than in traceability and origin cues. On the contrary, Lee et al. (2011) indicated that consumers in Korean are generally willing to pay a 39 percent premium for the traceable imported beef over similar beef without traceability. Ubilava and Foster (2009) also find that consumers in Georgia treat product traceability as a substitute of quality certification.

[2] The Gresham's law says that "bad money drives out good." More exactly, if coins containing metal of different value have the same value as legal tender, the coins composed of the cheaper metal will be used for payment, while those made of more expensive metal will be hoarded or exported and thus tend to disappear from circulation. This phenomena is mainly resulted from the existence of asymmetric information between buyer and seller (Akerlof, 1970).

[3] Pork is considered as staple in the Chinese diet and recent relative price increases are not likely to greatly affect their perceptions of the safety of pork. Further food safety incidents are more likely to have a greater effect of their willingness to pay for traceability.

Several studies found that consumers' WTP for traceable food products is often affected by the associated information and attributes. For example, Dickinson and Bailey (2002) analyzed the existence of a market for meat traceability in the US using laboratory auction markets. Their findings suggest that consumers would pay a higher premium for valuable attributes (such as transparency and assurance) attached to traceability than that paid for traceability alone. Hobbs, Bailey, Dickinson, and Haghiri (2005) examined the economic incentives for implementing traceability systems in the meat and livestock sector in Canada, and found that without quality verification traceability is of limited valued to individual consumers.

Therefore, the study suggested that bundling traceability with quality assurances can deliver more value of traceable food products. Lee et al. (2011) examined the information effects on Korean food shoppers' WTP for imported beef with traceability. Their results indicated that positive information has insignificant effects while negative and two-sided information about traceability can significantly reduce WTP. Studies by Hobbs (2003) in Saskatchewan and Ontario showed that the average price premium paid by Canadian consumers for traceability of a beef sandwich was less than 10 percent, but the studies also indicated that providing information of traceability and the higher credibility of information sources could increase consumers' WTP for traceability.

Research on consumer responses to food traceability in China is quite limited despite well publicized and periodic food safety incidents in various food sectors in recent years. Ehmke, Lusk, and Tyner (2008) used data from conjoint experiments to measure consumer preferences for country-of-origin (COO) information in China. They found that Chinese consumers did not give COO information as much credit as organic production information. Ortega, Wang, Wu, and Olynk (2011) measured Chinese consumer preferences for selected food safety attributes in pork through choice experiment models, and concluded that Chinese consumers are willing to pay more for a government certification program than a traceability system, but consumers give significantly higher credit to a food traceability system than a product-specific information label. Wang, Zhang, Mu, Fu, and Zhang (2009) surveyed consumers in Beijing and found that the age of consumers, educational level, the perception safety and the average price, are the main determinants of consumers' WTP for the traceable products. Song, Liu, Wang, and Nanseki (2008) also suggested that most Chinese consumers lack knowledge of food traceability systems, but over 90 percent indicated that they considered that the system was very necessary. Yang and Wu (2009) surveyed consumers in Chengdu and found an approximate 10 percent price premium for traceable agricultural commodities.

While the above studies have contributed to an understanding of Chinese consumer responses to food traceability, they are either largely of a descriptive nature or ignore the potential variation of consumers' WTP due to the heterogonous properties of food products. Meanwhile, studies of Chinese consumers' WTP for traceability rarely paid attention to the importance of consumer understanding about traceability and its associated features. In particular, the Chinese government has put a great deal of effort into facilitating food quality- and safety-related certification systems over the last several decades in response to growing food safety concerns. How consumers' awareness of these certifications systems could affect their attitudes toward traceable food products has seldom been studied. Therefore, the implications of the results for policy and market decision makers are limited.

The current study differs from previous studies in China and complements this literature body in three major aspects. First, we focus on three specific food products, i.e., pork, milk and cooking oil, to capture potential heterogeneity of consumers' preferences for different food products. Second, in order to capture the potential effect of consumers' understanding of traceability on their WTP a food traceability information treatment was included in the survey. Third, consumer knowledge about food quality and safety related certification are examined and incorporated as an important factor in determining the WTP for food traceability.

3. Survey and data

The data used in this study were collected by a consumer survey using a single-bounded dichotomous choice contingent valuation method (CVM) to elicit WTP through dichotomous choice (Hanemann, Loomis, & Kanninen, 1991; Kanninen, 1993). CVM has been used extensively in previous studies to evaluate environmental attributes and investigate market perspectives for non-marketed products (Dickinson & Bailey, 2005; McCluskey, Grimsrud, Ouchi, & Wahl, 2005; Shogren, Fox, Hayes, & Roosen, 1999). The survey was conducted in Nanjing, China in October 2009. The survey instruments are as follows:

We first selected households by a stratified and random sampling approach from among households included in the Urban Household Income and Expenditure (UHIE) survey conducted by China's National Bureau of Statistics. The UHIE is a national survey which provides the primary official information on urban consumers' income and expenditures. The data from the UHIE survey has been widely used by scholars for food consumption and expenditure research (Huang & Gale, 2009; Yu & Abler, 2009). In 2009, the UHIE survey in Nanjing consisted of 753 households randomly selected from city districts.

Then, the data specifically for this study were collected by interviewing the person who is mainly in charge of the food shopping for the household. The interview was conducted in-person and inside the home. In total, 260 households were selected from six districts in Nanjing, accounting for about one third of the total household samples included in the UHIE survey in the city. Of these, six households were not able to be surveyed due to availability, and seven did not complete the survey, resulting in 247 usable observations for this analysis.

To determine the effects of consumer knowledge about food traceability on consumers' WTP, we randomly split respondents into two groups, a treatment group and a control group. An informational sheet on food traceability and the associated features was provided to the subjects in treatment group, but not to consumers in control group. The informational statement provided to the treatment group was:

"*Food traceability usually means the ability for firms or supervising agencies to trace the origin of a product and the flow of inputs and outputs through all stages of production, processing and distribution. The traceability system has several key features, including (1) be able to target, isolate and recall contaminated food products; (2) be able to trace back to resources that caused the problem; (3) consumer could access information about food origin, processors, and distributors by cell phone or internet when this information is of interest to them. But, building up and maintaining this system would increase cost and thus would cause higher prices of food products.*"

The definition of food traceability and its first two features in above statement were obtained from Golan et al. (2004) with slight revision to fit the *Articles* related to traceability in China's new Food Safety Law. Clearly, these two features highlighted the objective of "accurate and targeted withdrawals" of the Law. The third feature in the statement was created by us, with an intention of providing credibility of information to consumers. An implicit assumption here is that consumers are more likely to believe that the product is traceable if they could have access to the tracking information of the product by themselves rather than just by listening to and relying on producers' or retailers' statements.

Then, respondents, whether being provided with the informational sheet or not, were asked three single-bounded dichotomous choice willingness-to-pay questions for traceable fresh pork, fluid milk and cooking oil, respectively. The question for traceable fresh pork, as an example, was asked as "*If there is traceable fresh pork available in the market, are you willing to buy the traceable one if it has price that is ______ higher than the fresh pork that does not claim to be traceable*?" The premium for each willingness-to-pay question for each individual respondent was randomly assigned at one of the following levels: 5%, 10%, 15%, 20%, 25% and 30%. Notice that we assume that traceability will not be perceived as reducing the value of these products, thus, the lower bounds on the WTP are determined *a priori* as no premium. Since traceable pork, milk and cooking oil are rarely seen or hardly identified in domestic markets, price premium ranges in our survey were chosen by interviewing several influential meat and milk processors in domestic China on the degree to which total cost could be increased due to adopting an effective traceability system. Distribution of respondents by assigned price premium, and informational treatments for this analysis are reported in Table 1.

Following the WTP question, we collected demographic information for the respondents and their households. Table 2 reports summary statistics for demographic variables that are used in this analysis. Of the 247 respondents, nearly 70 percent are female because they commonly play a major role in family's food shopping. The average education level is 11 years, with over half (53 percent) holding a high school (or equivalent) diploma, 25 percent completing junior high school, and 17 percent with a college or advanced degree. Average monthly per capita income is 1940 yuan, which is slightly lower than the level of 2009 for Nanjing (2056 yuan) reported in the *Statistical Yearbook of Jiangsu* (2010), but the difference is statistically insignificant. Distribution of respondents in terms of per capita monthly disposable income is 46 percent falling in the low income group, 32 percent in the middle income group and 22 percent in the high income group (Table 2). The average age of respondents is 49, which is expected given that we asked the enumerators to interview the person who is the primary food shopper in the family. About 20% of respondents reported the existence of children aged eight years old or below in their family.

To examine consumers' awareness of food safety regulations and its impacts on their WTP for traceable foods, we showed respondents the trademarked logos of six domestic certification programs along with 11 possible verbal descriptions, and asked respondents to match each logo with its description. The question design for the pair-up is given in Fig. 1. The number of correct answers from the pair-up quiz is an indicator of consumers' awareness of food safety and quality related certification programs. From Table 2 we can see the average number of correct answers was less than one (0.93), suggesting a surprisingly low knowledge or awareness of food quality or safety related certifications that Nanjing consumers have.

Two points related to the pair-up design are worth to highlight. First, notice that Chinese characters in several logos were hidden in order to observe respondent's real knowledge about the certification, so the respondent had to identify the logo solely by recognizing the symbol. Respondents were told during the survey that this was done to avoid any possibility of treating the symbol differently from what it actually represents. Second, we provided 11 options (including "Don't know") instead of six in option list. This was specifically designed to reduce the likelihood of pairing up by guessing and obtain more reliable answers. The correct answers are provided in the footnote of Fig. 1.

Table 2
Definitions and summary statistics for demographic variables.

Variable	Coding and description	Mean	Std. Dev
Certification knowledge	Number of pair-up correction (0 thr. 6)	0.93	0.85
Gender	1 = male; 0 = female	0.31	0.46
Education	Respondent's education in years	10.66	2.58
Income	per capita income (1,000yuan)	1.95	1.04
Low income[a]	1: income ≤ 1.5; 0: otherwise	0.46	0.50
Middle income	1: 1.5 < income < 2.5; 0: otherwise	0.32	0.47
High income	1: income > 2.5; 0: otherwise	0.22	0.42
Age	Respondent's age in years	49.48	13.74
Age ≤ 35[a]	1: yes; 0: no	0.20	0.40
35 < Age ≤ 45	1: yes; 0: no	0.21	0.41
45 < Age ≤ 55	1: yes; 0: no	0.23	0.42
55 < Age ≤ 65	1: yes; 0: no	0.22	0.41
Age > 65	1: yes; 0: no	0.13	0.34
Child	Existence of child (≤8 years old). 1:yes; 0: no	0.21	0.40

[a] Reference bases in regression.

Table 1
Distribution of respondents by bid and information assignments.[a]

Product	Informational statement	Bid (premium)						Total
		5%	10%	15%	20%	25%	30%	
Pork[b]	No	29	18	17	13	16	25	118
	Yes	23	14	20	25	25	19	126
	Total	52	32	37	38	41	43	244
Milk	No	16	21	23	17	24	19	120
	Yes	25	21	24	19	18	20	127
	Total	41	42	47	36	42	39	247
Cooking oil	No	25	17	29	19	13	17	120
	Yes	24	17	29	20	18	19	127
	Total	49	34	58	39	31	36	247

[a] Each level of premium and whether to provide traceability information were randomly assigned to respondents.
[b] Three respondents in our sample were Hui people who have a taboo against consuming any pork or products with pork as an ingredient, so we did not ask them the willingness-to-pay question for pork.

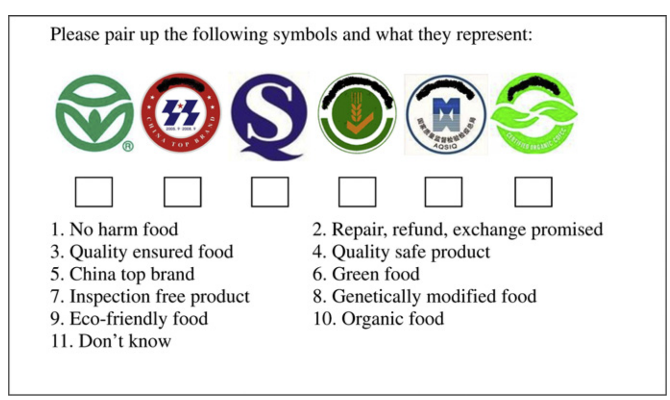

Fig. 1. Pair-up of food quality and safety related symbols. Description: This figure presents a key question design for collecting consumer knowledge about food safety and quality related certifications in our survey. Note: Logos from left to right are (6) Green food, (5) China top brand, (4) Quality safe product, (1) No harm food, (7) Inspection free product, and (10) Organic food, respectively. While Green food, No harm food, and organic food are certified by the authorized agents under the Ministry of Agriculture of P.R. China, the rest of these logos are certified by the authorized agents under the General Administration of Quality Supervision, Inspection, and Quarantine of P.R. China.

4. Model specification and estimation

Consumers' responses to the single-bounded dichotomous choice CVM questions can be analyzed by using binary choice models. Assume that the ith consumer has a latent willingness-to-pay for the jth traceable food product, WTP^*_{ij}, which can be expressed as a linear function as:

$$\mathrm{WTP}^*_{ij} = \alpha_j + \rho_j B_{ij} + \gamma_j I_{ij} + \beta'_j z_i + \varepsilon_{ij} \quad i = 1,\ldots,n; j = 1,2,3 \tag{1}$$

where B_{ij} is the price premium that the ith consumer faces for the jth traceable product, j = 1, 2, 3 denotes traceable pork, milk and cooking oil, respectively, I_{ij} is a dummy variable, taking on the value of one if the consumer was provided with the informational sheet of food traceability (i.e. the treatment group), and zero otherwise, z_i is a vector of explanatory variables, and ε_{ij} is an independently and identically distributed error. The unobserved WTP^*_{ij} in the survey has relationships with the actually observed binary responses (D_{ij}) as,

$$D_{ij} = \begin{cases} 1 & B_{ij} \le \mathrm{WTP}^*_{ij} \\ 0 & 0 \le \mathrm{WTP}^*_{ij} < B_{ij} \end{cases} \tag{2}$$

where $D_{ij} = 0$ means that the ith respondent is not willing to purchase the jth traceable product at the premium offered (or, selected the "NO" answer to the WTP question), and $D_{ij} = 1$ means the respondent has a WTP that is greater than or equal to the price of traceable food, or greater than the price of the corresponding non-traceable food product plus the offered premium (or, selected the "Yes" answer to the WTP question). Under these assumptions, the probability of $D_{ij} = k, \quad k \in \{0,1\}$ for the ith consumer can be expressed as,

$$\Pr(D_{ij} = k | B_{ij}, I_{ij}, z_i) = \begin{Bmatrix} F\left(\alpha_j + \rho_j B_{ij} + \gamma_j I_{ij} + \beta'_j z_i\right) \\ 1 - F\left(\alpha_j + \rho_j B_{ij} + \gamma_j I_{ij} + \beta'_j z_i\right) \end{Bmatrix} \quad \text{for} \quad k = \begin{cases} 1 \\ 0 \end{cases} \tag{3}$$

In this analysis z_i, the explanatory variables in the empirical model, are specified to include the respondent's gender, education, age dummies, income, family size, and the respondent's knowledge of food safety certifications as well. Then, the log-likelihood function can be derived as:

$$\ln L = \sum_i \left\{ I_{D_{ij}=1} \ln[F(\bullet)] + I_{D_{ij}=0} \ln[1 - F(\bullet)] \right\} \tag{4}$$

where, $F(\bullet) = F(\alpha_j + \rho_j B_{ij} + \gamma_j I_{ij} + \beta'_j z_i)$. In the empirical model, ε is assumed to be distributed logistically with mean zero and$\mathrm{var}(\varepsilon) = \pi^2/3$, leading to the binary logit model. α, β, ρ and γ are parameters to be estimated.

Based on the estimated parameters, the mean sample WTP for traceable food can be estimated at the mean of the independent variables, denoted as $WTP = -(\tilde{\alpha} + \tilde{\gamma} I + \tilde{\beta}' \bar{z})/\tilde{\rho},\ I \in \{0,1\}$. $I = 0$ means that the WTP is calculated for control group, i.e. the group without information being provided. The effect of each explanatory variable of interest on the consumer's WTP can be estimated at each level of the explanatory variable while assuming other variables at means.

5. Empirical analysis

The distribution of response for traceable pork, milk and cooking oil is reported in Table 3. For people who were not provided with the informational statement of food traceability, 70 percent were willing to purchase traceable pork, 60 percent for milk, and 63 percent for cooking oil. In the treatment group, these numbers became 86 percent, 78 percent and 77 percent, respectively. Percentages of the subjects who would pay for traceability are segregated by the offered price premium. Overall, the percentages of respondents who were willing to purchase traceable foods decreased as the offered bid increases, though there were some exceptions. A possible explanation for the exceptions is that we did not control other important influencing factors (such as income, age) in Table 3 as we will do in the econometric analysis. This is consistent across the studied products and between the control and the treatment groups.

Table 3
Percentage of subjects willing to purchase traceable food (%).

Variable & levels	No information (control group)			Information provided (treatment group)		
	Pork	Milk	Oil	Pork	Milk	Oil
Overall	69.5	60.0	62.5	85.7	78.0	77.2
Bid Premium						
5%	79.3	56.3	72.0	87.0	92.0	87.5
10%	72.2	71.4	64.7	100.0	76.2	82.4
15%	58.8	65.2	55.2	80.0	79.2	79.3
20%	76.9	64.7	52.6	92.0	84.2	70.0
25%	62.5	58.3	76.9	80.0	83.3	72.2
30%	64.0	42.1	58.8	78.9	50.0	68.4
Number of pair-up correction						
0	47.2	40.0	45.5	76.7	67.4	69.8
1	86.7	70.0	70.0	89.5	81.6	81.6
2 &up	88.6	82.9	82.9	91.1	84.8	80.4
Gender						
Female	71.1	58.4	67.5	88.0	78.5	78.5
Male	66.7	62.8	53.5	79.4	76.5	73.5
Education						
Primary	75.0	50.0	37.5	75.0	75.0	75.0
Junior high	40.0	40.7	51.9	75.8	67.6	73.5
High sch. or equivalent	75.8	63.6	65.2	86.2	75.4	72.3
College or advanced	84.2	78.9	79.0	100.0	100.0	95.8
Per capita income						
Income $\le$ 1.5k	50.0	43.1	47.1	80.3	67.7	71.0
1.5k $<$ income $\le$ 2.5k	90.2	78.6	76.2	83.8	83.8	75.7
Income $>$ 2.5k	74.1	63.0	70.4	100.0	92.9	92.9
Age						
Age $\le$ 35	91.7	79.2	83.3	96.2	92.3	96.2
36 $<$ age $\le$ 45	80.0	65.0	70.0	87.1	75.0	78.1
46 $<$ age $\le$ 55	53.6	44.8	55.2	82.8	58.6	55.2
56 $<$ age $\le$ 65	60.0	60.0	60.0	83.3	91.7	83.3
Age $>$ 65	68.8	52.9	41.2	75.0	75.0	75.0

The percentages of respondents who would pay a premium for food traceability are likely related to consumer's knowledge of safety certifications and a number of demographics. The results suggest that more correct pairing of safety certification symbols the more consumers are willing to purchase traceable products. Females are observed to have a higher likelihood than males of purchasing traceable pork and traceable cooking oils, but there seems to be no remarkable difference for purchasing traceable milk. Also, both respondents' education and per capita income levels show likely positive relationships with the percentage of respondents who would purchase traceable products. On the contrary, respondents' age probably has negative effects on consumers' preferences for traceability. Households with more family members have a higher proportion stating that they are willing to purchase traceable pork, milk and cooking oils than those families with fewer members. These comparisons are consistent between the control and treatment groups (Table 3).

To empirically measure consumers' willingness-to-pay for traceable foods and to identify and isolate the effects of influential

Table 4
Estimation results from single-bounded logistic model regressions.[a]

	Pork	Milk	Cooking oil
Bid (Premium)	−0.036*	−0.042**	−0.032*
	(0.02)	(0.02)	(0.02)
Information	1.078***	0.969***	0.754**
	(0.38)	(0.33)	(0.32)
Certification knowledge	0.431**	0.370**	0.281**
	(0.18)	(0.15)	(0.14)
Gender	−0.517	−0.040	−0.563
	(0.40)	(0.37)	(0.35)
Education	0.379	0.481**	0.306
	(0.27)	(0.24)	(0.23)
Middle income	1.414***	1.193***	0.835**
	(0.45)	(0.39)	(0.37)
High income	1.549***	0.913**	1.034**
	(0.55)	(0.44)	(0.45)
36–45 years old	−0.639	−0.497	−0.808
	(0.83)	(0.61)	(0.66)
46–55 years old	−1.497*	−1.116*	−1.563**
	(0.78)	(0.58)	(0.62)
56–65 years old	−1.570**	−0.136	−0.892
	(0.76)	(0.60)	(0.62)
66 years old or up	−1.105	−0.770	−1.386*
	(0.88)	(0.69)	(0.71)
Child	0.356	0.401	0.182
	(0.59)	(0.52)	(0.50)
_cons	0.566	−0.635	0.584
	(1.07)	(0.91)	(0.89)
N	244	247	247
Log-likelihood	−98.52	−121.23	−126.48

[a] Standard errors in parentheses; $^{*}p < .1$, $^{**}p < .05$, $^{***}p < .01$.

factors on WTP, a single-bounded logistic model is estimated for each selected product. The estimated results are reported in Table 4.[4] Since the magnitude of the coefficient of a logistic model is not directly interpretable, the marginal effects of each explanatory variable on the WTP are estimated and presented in Table 5. The marginal effects can be interpreted as the percentage changes in the probability that consumers are willing to purchase traceable food products due to a unit change of the explanatory variable of interest given others being constants. In the case of dummy explanatory variables, the marginal effect estimates the probability changes resulting from a discrete change from 0 to 1. To obtain the significance of the marginal effects, we apply a bootstrap method with 200 subsamples and 300 iterations to simulate confidence intervals of the estimated marginal effects (e.g. Mittelhammer, Judge, & Miller, 2000).

As expected, the estimates of the bid variable are significantly negative for all three products, meaning that as the price premium offered for food traceability increased, the respondent was less likely to be willing to purchase traceable pork, milk and cooking oil (Table 4). The estimated marginal effects are −0.006, −0.010 and −0.007, respectively, suggesting that a 10 percent increase of the offered price premium would decrease the probability of a consumer to be willing to purchase traceable pork, milk and cooking oil by 6 percent, 10 percent and 7 percent, respectively (Table 5).

Providing information about the major features of food traceability significantly increases consumers' likelihood to purchase traceable foods. The marginal effects for pork, milk and cooking oil are 0.133, 0.183 and 0.142, respectively, meaning that the respondents provided with the features of food traceability have about 13 percent, 18 percent, and 14 percent higher probabilities to be willing to purchase traceable pork, milk and cooking oil, respectively, compared to consumers provided with no information (Table 5). This result suggests that consumer campaigns to increase their knowledge of food traceability could significantly increase consumers' willingness to purchase traceable food products.

In addition, consumers' WTP for traceable food products are significantly and positively related to consumers' awareness of the existing food quality- and safety-related certification. This is consistent across all three studied food products (Table 4). The results suggest how food safety regulations could affect consumers' choices in food market where asymmetric information commonly exists. Clearly, the more information consumers have about certification and traceability, the more credence they give these systems. This finding has important policy implications. The Chinese government has made enormous efforts in regulating and supervising food safety, particularly in facilitating certification for high quality and safe food products or ingredients to inform consumers that a food product or a process is in conformity with corresponding standards. Low consumers' awareness, however, discounts the effectiveness of these certifications. Therefore, consumer publicity campaigns are as important as implementing regulations in order to improve the food safety in China.

The estimated results also indicate that consumers' WTP for food traceability is significantly affected by respondent's socio-economic characteristics and demographics (Table 4). For example, in the control group, compared to consumers with a low per capita income, middle income and high income respondents have 17 percent to 25 percent higher probabilities to be willing to purchase traceable foods. The probabilities in the treatment group are consistently lower (Table 5). Besides, young consumers (35 years old or below) are more likely to purchase traceable food products than other age groups. Considering the potential effects of the well-publicized melamine-contaminated baby formula incident in China, we also include child dummy in the model. However, the estimated results do not show a significant influence on consumer's preference of traceable products. This may be because our survey was conducted about one year after the event occurred.

The mean WTPs are estimated for both groups with and without the information treatment (referred to as treatment WTP and control WTP, respectively). For traceable pork, milk and cooking oil, the estimated control WTP is 16.7 percent, 21.7 percent and 19.8 percent, respectively, suggesting that Nanjing consumers are willing to pay a remarkably higher price for traceable food products than for non-traceable products (Fig. 2). Compared with the control WTP, the treatment WTP is consistently higher, being 20.7 percent for pork, 26.5 percent for milk, and 24.4 percent for cooking oil. The large differences between the treatment and control WTPs suggest that Chinese consumers know very little about traceability. This is consistent with our expectation and to the finding reached by Song et al. (2008). The results suggest the importance of information of food traceability for improving market demand for traceable products. These numbers are crucial for policymakers and firms to conduct cost and benefit analysis before launching any food traceability related policy or starting any consumer campaign programs for the policy.

To better understand the estimated WTP for food traceability, one should be aware of the differences of WTPs between the treatment and control groups rely on the information provided in the treatment group. In this case, the provided informational statement, to some extent, treats traceability as a "silver bullet" that could solve most food safety problems. In practice, food safety

[4] For comparison, a two-stage feasible generalized least square (FGLS) model is also fitted (Greene, 2003; pp. 227–235). However, as the estimated results have no significant difference from the logit model results, we present the logit results alone. The FGLS results are available upon request.

Table 5
Marginal effects with respect to explanatory variables.

Variables	No information			Information		
	Pork	Milk	Oil	Pork	Milk	Oil
Bid (Premium)	−0.006***	−0.010***	−0.007***	−0.003***	−0.006***	−0.005***
Information provided[a]				0.133***	0.183***	0.142***
Certification knowledge	0.074***	0.085***	0.062***	0.035***	0.053***	0.043***
Gender[a]	−0.094**	−0.009	−0.128**	−0.045**	−0.006	−0.092**
Education	0.065**	0.110***	0.068***	0.030**	0.069***	0.047**
Middle income[a]	0.210***	0.250***	0.174***	0.096***	0.150***	0.117***
High income[a]	0.208***	0.190***	0.203***	0.092***	0.111***	0.133***
36–45 years old[a]	−0.121	−0.118	−0.189**	−0.060*	−0.078	−0.142***
46–55 years old[a]	−0.305***	−0.266***	−0.366***	−0.169***	−0.191***	−0.297***
56–65 years old[a]	−0.323***	−0.032	−0.209***	−0.183***	−0.020	−0.158***
66 years old or up[a]	−0.228**	−0.186**	−0.331***	−0.124**	−0.131**	−0.275***
Child	0.058	0.088	0.040	0.026	0.053	0.027

*$p < .1$, **$p < .05$, ***$p < .01$.
[a] denotes that dy/dx is for discrete change of dummy variable from 0 to 1.

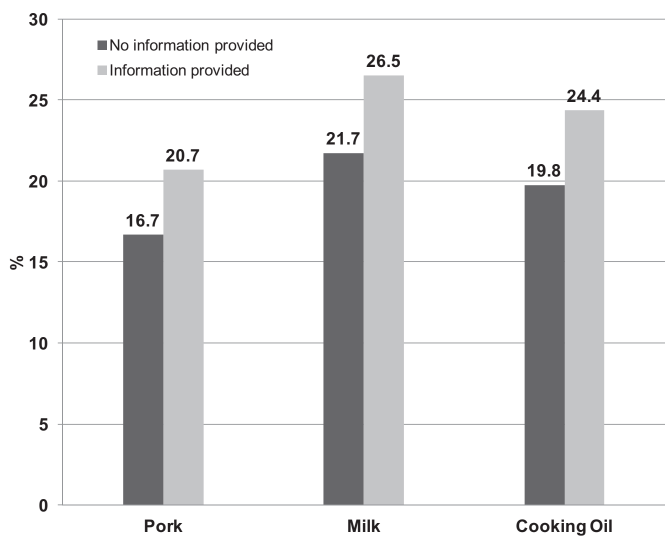

Fig. 2. The estimated mean WTPs in percentage changes for food traceability. Description: This figure presents the estimated mean willingness-to-pay in percentage changes for traceable pork, milk and edible oil for both informational treatment and control groups.

supervision is split among many government agencies and none of food safety regulators can take full responsibility. Therefore, in understanding the differences of WTP between two groups one should focus on the importance of information of food traceability on consumers WTP rather than the magnitude of the gap.

6. Conclusions

In this study, we analyzed Nanjing consumers' willingness-to-pay for *ad hoc* traceable pork, milk and cooking oil, and identified the associated influencing factors. A single-bounded dichotomous-choice contingent valuation method was used for these purposes. The major findings are summarized as follows:

First, Nanjing consumers are willing to pay a significant positive price premium for food traceability despite some differences across food products. In the current study, the highest mean WTP is for traceable milk, which is 21.7 percent higher than regular milk prices, followed by cooking oil (19.8 percent) and pork (16.7 percent). Compared to the estimates by several food processors, these estimated WTPs suggest that most food industries in China could largely offset the expected cost of adopting a relatively effective food traceability system. Even so, it's worthwhile to note that an effective supervision system which provides certification services for traceable foods and conformity of traceability is required for firms to have incentive to establish the system. Otherwise, firms who produce real traceable foods can be driven out by "bad" firms who claim traceability for their actually untraceable foods.

Second, consumers' WTP for food traceability is significantly affected by their knowledge of traceability as well as the certification systems. In the current study, we found that the more respondents are aware of the features of food traceability and the more they know about China's food certifications, the more they are willing to pay for traceable products. This result suggests that consumer campaign programs accompanied with the implementation of food traceability systems would be remarkably helpful to improve market demand for traceable food products.

Third, consumers' WTP for traceable foods was found to be significantly related to a number of individual and household demographics. Age, income, and household size all significantly affect consumers' WTP for food traceability. It is imaginable that there would be more consumers willing to purchase traceable foods as rising income could strengthen the preferences for safer food products in China.

Finally, the mean WTP estimated using contingent valuation methods has been criticized as having the potential of overstatement due to hypothetic bias (List & Gallet, 2001; Neill, Cummings, Ganderton, Harrison, & McGuckin, 1994). Cummings and Taylor (1999), Blamey, Bennett, and Morrison (1999), Lusk (2003) and Tonsor and Shupp (2011) suggested that a "cheap talk" and dissonance minimization could reduce such bias. In this study, we did not consider possible overstatement because neither the "cheap talk" nor the dissonance minimization could indicate the degree to which they could mitigate the overstatement of WTP using the CV method. If we assume that there are certain hypothetic biases, the mean WTP in the current study could be estimated upwards, but it would not overstate the effects of information and features of food traceability on consumers' WTP.

Acknowledgment

The authors wish to acknowledge financial support from the National Natural Science Foundation of China (70903062; 71003114), the Agricultural Food Research Initiative of the National Institute of Food and Agriculture/USDA (#2010-65400-20489), the Emerging Markets Program Agreement (#2010-27) Commodity Credit Corporation/USDA, and the third stage of project "211", Central University of Finance and Economics.

References

Akerlof, G. A. (1970). The market for "Lemons": quality uncertainty and the market mechanism. *The Quarterly Journal of Economics, 84*(3), 488–500.

Blamey, R. K., Bennett, J. W., & Morrison, M. D. (1999). Yea-saying in contingent valuation surveys. *Land Economics, 75*(1), 126–141.

Calvin, L., Gale, F., Hu, D., & Lohmar, B. (2006). Food safety improvements underway in China. *Amber Waves*, 16–21.

Charlier, C., & Valceschini, E. (2008). Coordination for traceability in the food chain. A critical appraisal of European regulation. *European Journal of Law and Economics, 25*(1), 1–15.

Cummings, R. G., & Taylor, L. O. (1999). Unbiased value estimates for environmental goods: a cheap talk design for the contingent valuation method. *American Economic Review, 89*, 649–665.

Dickinson, D. L., & Bailey, D. (2002). Meat traceability: are US consumers willing to pay for it? *Journal of Agricultural and Resource Economics, 27*(2), 348–364.

Dickinson, D. L., & Bailey, D. (2005). Experimental evidence on willingness to pay for red meat traceability in the United States, Canada, the United Kingdom, and Japan. *Journal of Agricultural and Applied Economics, 37*(3), 537–548.

Ehmke, M. D., Lusk, J. L., & Tyner, W. (2008). Measuring the relative importance of preferences for country of origin in China, France, Niger, and the United States. *Agricultural Economics, 38*(3), 277–285.

Golan, E., Krissof, B., Kuchler, F., Calvin, L., Nelson, K., & Price, G. (2004). *Traceability in the U.S. food supply: Economic theory and industry studies*. Agricultural Economic Report. Washington DC: U.S. Department of Agriculture, ERS.

Greene, W. H. (2003). *Econometric analysis* (5th ed.). New Jersey: Pearson Eduction, Inc.. 227–235.

Hanemann, M., Loomis, J., & Kanninen, B. (1991). Statistical efficiency of double-bounded dichotomous choice contingent valuation. *American Journal of Agricultural Economics, 73*, 1255–1263.

Hobbs, J. E. (2003). Traceability in meat supply chains. *Current Agricultural, Food, and Resource Issues, 4*, 36–49.

Hobbs, J. E., Bailey, D. V., Dickinson, D. L., & Haghiri, M. (2005). Traceability in the Canadian red meat sector: do consumers care? *Canadian Journal of Agricultural Economics, 53*(1), 47–65.

Huang, K. S., & Gale, F. (2009). Food demand in China: income, quality, and nutrient effects. *China Agricultural Economic Review, 1*(4), 395–409.

Kanninen, B. J. (1993). Optimal experimental design for double-bounded dichotomous choice contingent valuation. *Land Economics, 69*, 138–146.

Lee, J. Y., Han, D. B., Nayga, R. M., Jr., & Lim, S. S. (2011). Valuing traceability of imported beef in Korea: an experimental auction approach. *The Australian Journal of Agricultural and Resource Economics, 55*, 360–373.

List, J. A., & Gallet, C. A. (2001). What experimental protocol influence disparities between actual and hypothetical stated values? *Environmental and Resource Economics, 20*, 241–254.

Loureiro, M. L., & Umberger, W. J. (2007). A choice experiment model for beef. What US consumer responses tell us about relative preferences for food safety, country-of-origin labeling and traceability. *Food Policy, 32*(4), 496–514.

Lusk, J. L. (2003). Effects of cheap talk on consumer willingness-to-pay for golden rice. *Agricultural and Resource Economics Review, 85*(4), 840–856.

McCluskey, J. J., Grimsrud, K. M., Ouchi, H., & Wahl, T. I. (2005). Bovine spongiform encephalopathy in Japan: consumers' food safety perceptions and willingness to pay for tested beef. *The Australian Journal of Agricultural and Resource Economics, 49*, 197–209.

Mittelhammer, R. C., Judge, G. G., & Miller, D. (2000). *Econometric foundations*. New York: Cambridge University Press.

Neill, H. R., Cummings, R. G., Ganderton, P. T., Harrison, G. W., & McGuckin, T. (1994). Hypothetical surveys and real economic commitments. *Land Economics, 70*, 145–154.

Ortega, D. L., Wang, H. H., Wu, L., & Olynk, N. J. (2011). Modeling heterogeneity in consumer preferences for select food safety attributes in China. *Food Policy, 36*(2), 318–324.

Shogren, J. F., Fox, J. A., Hayes, D. J., & Roosen, J. (1999). Observed choices for food safety in retail, survey, and auction markets. *American Journal of Agricultural Economics, 81*(5), 1192–1199.

Song, M., Liu, L. J., Wang, Z., & Nanseki, T. (2008). Consumers' attitudes to food traceability system in China-evidences from the pork market in Beijing. *Journal of the Faculty of Agriculture Kyushu University, 53*(2), 569–574.

Tonsor, G. T., & Shupp, R. S. (2011). Cheap talk Scripts and Online choice experiments: looking beyond the mean. *American Journal of Agricultural Economics, 93*(4), 1015–1031.

Ubilava, D., & Foster, K. (2009). Quality certification vs. product traceability: consumer preferences for informational attributes of pork in Georgia. *Food Policy, 34*(3), 305–310.

Verbeke, W., Ward, R. W., & Avermaete, T. (2002). Evaluation of publicity measures relating to the EU beef labelling system in Belgium. *Food Policy, 27*(4), 339–353.

Wang, F., Zhang, J., Mu, W. S., Fu, Z. T., & Zhang, X. S. (2009). Consumers' perception toward quality and safety of fishery products, Beijing, China. *Food Control, 20*(10), 918–922.

Yang, B., & Wu, X. (2009). Consumers' willingness to pay for traceability agricultural commodities. *Rural Economy, 8*, 57–59.

Yu, X., & Abler, D. G. (2009). The demand for food quality in rural China. *American Journal of Agricultural Economics, 91*(1), 57–69.

Zhang, L., & Kong, X. (2009). *China's dairy industry development report*. Beijing: China Economy Press.