CHINESE CONSUMERS' DEMAND FOR FOOD SAFETY ATTRIBUTES: A PUSH FOR GOVERNMENT AND INDUSTRY REGULATIONS

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The diet of urban Chinese consumers has changed drastically over the past twenty years, due in part to rising incomes and changing lifestyles. Food consumption has shifted away from grains and toward higher-quality calories from animal proteins and aquaculture products. Dairy demand in urban China has shown remarkable growth in the past decade, driven by mutually reinforcing factors, including rising incomes, government promotion of dairy products, changing urban lifestyles, and the development of more sophisticated marketing channels (Fuller et al. 2006). China's dairy production has surged from just over 10 million metric tons in 2001 to an expected production level of nearly 48 million metric tons by 2013 (Woolsey, Zhang, and Zhang 2010). Most notable has been the rise in demand for ultra-high temperature (UHT) pasteurized fluid milk among urban consumers in recent years, with a 50% sales increase in 2009 alone (Fuller et al. 2006; Wang, Mao, and Gale 2008; Woolsey, Zhang, and Zhang 2010).

Chinese milk production systems are extremely heterogeneous across farms, ranging from farmers in remote villages with one or two dairy cows, often operating unsupervised, to state-of-the-art dairy facilities with hundreds of cows (Fuller et al. 2006). In recent years, the dairy processing industry in China has been composed of a few firms marketing nationwide, most notably the Yili, Mengniu, and Bright Dairies and over 700 smaller companies that cater to regional markets (Fuller et al. 2006; Wang, Mao, and Gale 2008; Xiu and Klein 2010). Such a fragmented food sector, coupled with loose regulations, has caused serious food safety problems.

China's increasing demand for milk products is raising awareness regarding milk production, the effectiveness of government certification, and the integrity of China's leading dairy firms. Concerns over food safety in Chinese domestic markets emerged and received global attention starting in 2003, following a string of incidents involving food poisonings and fraudulent products (Wang, Mao, and Gale 2008). Adulteration of dairy products in China has sickened thousands of people and caused infant deaths. Recent findings of tainted dairy products include hundreds of tons of contaminated milk powder in several provinces in 2010 (Woolsey, Zhang, and Zhang 2010). These Chinese milk-related food safety incidents have affected trade flows from China. At the height of the milk scare, over a dozen countries banned Chinese dairy imports, fearing that lethal melamine-tainted milk had made its way into their domestic markets (Tran 2008).

Recent studies show food safety concerns at an all-time high for Chinese consumers (Ortega et al. 2011). The Chinese government has approved a series of tougher food safety laws and regulations, which include an array of national standards, certification systems, and requirements for use of quality

UHT Milk Attributes	Alternative 1	Alternative 2	Alternative 3
Price	RMB2.0/unit	RMB1.5/unit	
Shelf-life	>3 months	<3 months	I would not purchase UHT Milk
Government certification	No	Yes	
Private certification	Yes	No	
Brand	Local	National	
I would purchase:	☐	☐	☐

Figure 1. Sample choice set

and safety management systems (Ramzy 2009; Wang, Mao, and Gale 2008). Consequently, UHT milk in China is known to carry multiple labels and logos indicating that the product has met various safety-related certifications, such as "Green Food," "HACCP" (approved by the Hazard Analysis and Critical Control Points system), "China Top Brand," etc. (Bai et al. 2007; Wang, Mao, and Gale 2008). On June 1, 2009, China's new Food Safety Law went into effect, replacing the Food Sanitation Law (Xiu and Klein 2010). Although touted as a tough approach to alleviating food safety issues, it is unclear whether these government efforts have improved food safety effectively.

While previous consumer research has identified the primary determinants of food safety in China, little focus has been given to estimating the economic value that consumers place on various verification entities and product safety attributes (Wang, Mao, and Gale 2008; Zhang et al. 2010). It is important for Chinese public health officials and product marketers to understand consumer awareness of food safety issues and their preferences for safety and quality attributes (Wang, Mao, and Gale 2008). As one of China's fastest growing food markets, UHT milk serves as an outlet for dairy companies to develop brand equity and regain consumers' trust.

The goal of this study is to provide an economic assessment of Chinese consumer preferences for food safety verification attributes in UHT milk. Specifically, we use a choice experiment approach to evaluate Chinese consumers' willingness to pay (WTP) for select food safety attributes, incorporating consumer preference heterogeneity in a random parameters logit (RPL), and we estimate aggregate welfare effects of certain food safety policies.

Method

In the present context, UHT milk can be viewed as a collection of its food safety informational attributes, from which consumers derive utility. Choice experiments allow for the evaluation of tradeoffs among attributes by replicating real-life purchasing situations and allowing evaluation of multiple attributes (Lusk, Roosen, and Fox 2003). We selected five two-level attributes in the choice experiment: price, shelf-life, government certification, third-party (private) certification, and brand, based on a food safety pilot study and a milk-specific survey (see Wang, Mao, and Gale 2008). A D-optimal fractional factorial experimental design with sixteen choice scenarios was used to estimate the necessary effects. Each survey respondent was presented with the same sixteen choice sets featuring two 200–250 mL hypothetical UHT milk products and a no-purchase option to better simulate a milk purchasing decision. A sample choice set is provided in figure 1.

The survey, including the choice experiment, was administered in seven major Chinese cities: Beijing, Chengdu, Hohhot, Nanjing, Shanghai, Wuhan, and Xi'an (figure 2). Students from China Agricultural University were trained as enumerators and then employed to administer the survey in-person between June and August 2009. In an attempt to better simulate a milk purchasing situation, experimental subjects were selected at random in supermarkets and convenience stores, where actual milk purchasing decisions take place (Lusk and Fox 2003). Approximately sixty completed consumer surveys were obtained at each of the seven cities, yielding a statistical sample of 6,720 observations (7 cities × 60 observations × 16 choice sets).
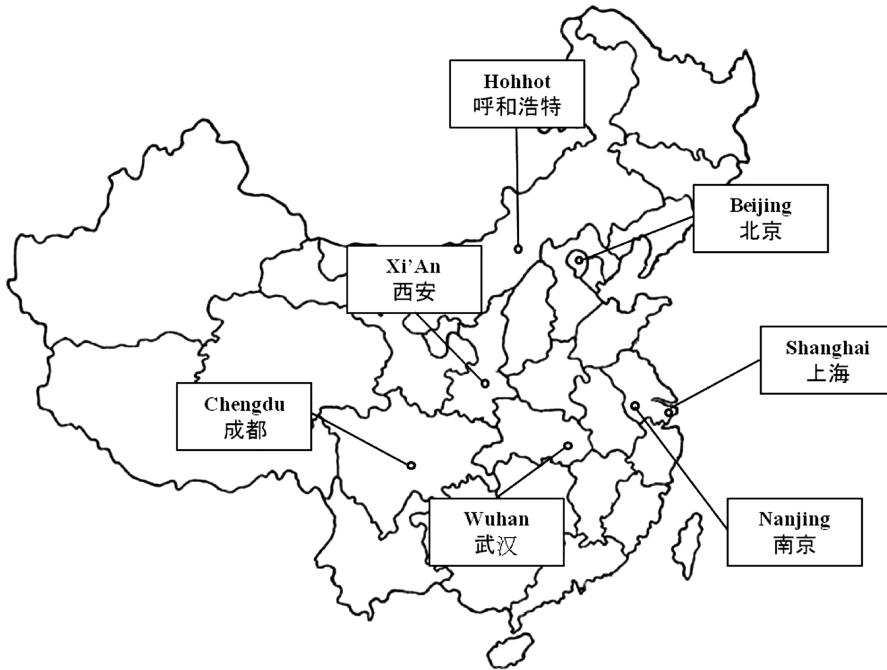
Figure 2. Survey locations in mainland China

Data

Currently, a lack of reliable demographic data creates challenges for assessing the representativeness of any sample of urban Chinese consumers. Expert advice from economists was sought on a city-specific level to facilitate a representative sample of this demographic. The average respondent was 34 years old, with a monthly household income of approximately 5,000 renminbi (RMB) and a college degree, and drinks about five packages (200–250 mL) of UHT milk per week. Approximately 39% of observations were obtained from convenience stores, 44% from domestic supermarkets, and 17% from international supermarkets. Because our study focuses solely on urban consumers, results should not be taken as representative of all Chinese consumers.

Econometric Methods

The random utility model (RUM) is used to analyze consumer preferences. Choice experiments are based on the assumption that individual n obtains utility U_{nit} from selecting alternative i from a finite set of J alternatives contained in choice set C in situation t. In the RUM, utility is composed of a deterministic component V_{nit}, which depends on the attributes of an alternative, and a stochastic component ε_{nit}, as

$$(1) \qquad U_{nit} = V_{nit} + \varepsilon_{nit}.$$

Therefore, individual n will choose alternative i if $U_{nit} > U_{njt} \forall j \neq i$. Consequently, the probability of individual n choosing alternative i is given by

$$(2) \qquad P_{nit} = Prob(V_{nit} + \varepsilon_{nit} > V_{njt} + \varepsilon_{njt}; \quad \forall j \in C, \forall j \neq i).$$

Given the underlying distribution of the error term, the closed form of the logit choice probability can be expressed as:

$$(3) \qquad P_{nit} = \frac{\exp(V_{nit})}{\Sigma_j \exp(V_{njt})}.$$

This study examines a random effects specification by implementing an RPL model. Unlike the traditional logit model, where consumers are assumed to be homogeneous, heterogeneity in consumer preferences for food safety informational attributes is measured using RPL. The RPL relaxes the limitations of the

traditional logit by allowing random taste variation within a sample according to a specified distribution (McFadden and Train 2000). Under RPL, the deterministic component of utility V_{nit} in the RUM takes the form of

$$(4) \qquad V_{nit} = \beta' x_{nit}$$

where β is a vector of random parameters, which has its own mean and variance, representing individual preferences, and x_{nit} is the vector of attributes found in the ith alternative. Following Train (2003), the probability that individual n chooses alternative i from the choice set C in situation t is given by

$$(5) \qquad P_{nit} = \int \frac{\exp(V_{nit})}{\sum_j \exp(V_{njt})} f(\beta) d\beta$$

where we can specify the distribution of the random parameter $f(.)$. If the parameters are fixed at β_c (nonrandom), the distribution collapses, i.e., $f(\beta_c) \to \infty$ and $f(\beta) = 0$ otherwise.

Estimation

The random parameters model specification was estimated using NLOGIT version 4.0. We hypothesize that the product-specific parameters are random and follow normal distributions; for modeling purposes we treat price and the constant terms as fixed (Ubilava and Foster 2009). The estimated model coefficients are not conveniently interpretable in economic terms given the noncardinal nature of utility. Therefore, consumer WTP estimates were calculated as:

$$(6) \qquad WTP = -2\beta_k/\beta_p$$

where β_k is the estimated parameter of the kth attribute, and β_p is the estimated price coefficient. In this analysis, the WTP estimates

are multiplied by 2 due to our use of effects coding (Lusk, Roosen, and Fox 2003). Ninety-five percent confidence intervals were created using the parametric bootstrapping procedure suggested by Krinsky and Robb (1986). More specifically, 1,000 observations were drawn from a multivariate normal distribution parameterized by using the coefficients and variance terms estimated by the RPL model.

Results

Willingness to Pay

All standard deviation coefficients from the RPL model results were statistically significant at the 0.01 level, indicating preference heterogeneity (complete RPL results are available from the authors upon request). WTP estimates, presented in table 1, indicate that consumers are willing to pay the most for government certification (RMB3.55), followed by the product's brand (RMB2.07) and private certification (RMB1.72); then there is a negative WTP for UHT milk with a shelf-life longer than three months (RMB −0.64). (We note the importance of interpreting this WTP value relative to UHT milk with a shelf-life less than three months.) The WTP results regarding the certification attributes are expected given the current situation in China. Chinese consumers' confidence in private entities is generally weaker than in government, as many of the food safety incidents were caused by profit-driven firm behavior (Ortega et al. 2011). In particular, differences in WTP between government and private certification were found statistically significant using a complete combinatorial method proposed by Poe, Giraud, and Loomis (2005). Product brand information received the second highest WTP. A study conducted in 2005 found that when

Table 1. Mean Estimates of Random Parameters Logit Model and Derived Willingness to Pay (WTP) for Food Safety Attributes

Attribute	Mean Coefficient Estimates* (standard errors)	Derived Mean WTP	95% CI
Shelf-life	−0.174 (0.030)	−0.64	[−0.98, −0.40]
Government certification	0.967 (0.045)	3.55	[2.67, 5.07]
Private certification	0.462 (0.027)	1.72	[1.23, 2.51]
Brand	0.554 (0.035)	2.07	[1.48, 2.97]
Price	−0.545 (0.087)	N/A	N/A

Notes: WTP calculations are based on equation (5).
*All estimates have statistical significance at the 0.01 level.

Table 2. Welfare Effects and Market Impacts

	Welfare change from gaining the option to purchase third-party certified UHT milk	Welfare change from losing the option to purchase government-certified UHT milk
RMB/choice occasion	2.03 [1.56; 2.77]	−3.24 [−4.39; −2.51]
Individual (RMB/person/year)	607.58 [465.74; 830.25]	−970.08 [−1,314.56; −750.56]
Aggregate (million RMB/year)	16,237.55 [12,446.89; 22,188.46]	−25,925.49 [−35,131.60; −20,058.62]

Note: Numbers in brackets represent 95% confidence intervals. Authors' calculations are from survey data, model parameters, and National Bureau of Statistics of China population data.

consumers were asked about their preferences for milk company brands, respondents overwhelmingly chose the two largest dairies in China: Yili and Mengniu (Wang, Mao, and Gale 2008). The negative WTP value for a longer shelf-life product indicates that consumers do not positively value longer-shelf-life UHT milk.

Welfare Evaluation and Market Impacts

Although WTP is a valid welfare measure, Lusk, Norwood, and Pruitt (2006) point out that it is not appropriate in situations where a consumer may not make a purchase when shopping or in situations involving choice uncertainty. Following Small and Rosen (1981) and Morey (1999), Lusk, Norwood, and Pruitt show that the expected maximum utility from making a choice from a particular choice set is given by

$$(7) \qquad CV = \ln(\Sigma_j e^{V_j}) + \gamma$$

where γ is Euler's constant. Therefore, the change in welfare that occurs from moving from situation A to B is given by

$$(8) \qquad \frac{1}{Marginal\ Utility\ of\ Income}(CV^B - CV^A).$$

In China, the government currently oversees food safety certification, and consumers do not have the option to purchase UHT milk that has been independently certified. The welfare change that would result from giving consumers the option to purchase UHT milk that has been privately certified can be estimated using equations (7) and (8). Specifically, this value represents the maximum amount consumers would pay, per choice occasion, to have third-party certified UHT milk in their choice set. Similarly, we can measure the change in welfare that consumers would experience if

government-certified milk were removed from their choice set.

To compute aggregate welfare changes, we estimate the average number of choice occasions an individual faces in a year. We note that the average participant in our study reported consuming five packages of UHT milk per week and that when faced with a decision between government-certified milk and no purchase (the current choice situation for consumers in China), 87.1% of consumers chose to purchase UHT milk. This implies that approximately 300 choices per year would rationalize UHT milk consumption levels for the average consumer given the simulated purchasing scenarios. Results from the welfare analysis are presented in table 2. Given our RPL model results, we estimate an individual welfare gain of RMB608 per person per year from giving consumers the option to purchase third-party certified UHT milk. We can extrapolate this measure and estimate aggregate welfare changes. Assuming that half of the population of the cities of interest purchase UHT milk, we estimate an aggregate welfare gain of RMB16,238 million annually. (This assumption is not unreasonable given that in 2002, 30% of urban food retail took place in supermarkets, where most UHT milk is sold, and was growing at a rate of 30–40% per year; see Hu et al. 2004). Similarly we predict an aggregate welfare loss of RMB25,926 million annually from consumers losing the option to purchase government-certified UHT milk.

Implications and Conclusions

This study evaluates Chinese consumers' WTP for selected food safety and quality attributes. While UHT milk is known for having a longer shelf-life than pasteurized milk, the UHT milk market in China is segmented into shorter shelf-life and longer shelf-life milk given the various packaging used in the Chinese milk sector. Our study finds that consumers prefer

the shorter shelf-life UHT milk relative to the longer shelf-life product.

Our research has found that with respect to UHT milk, consumers have the highest value for government certification, followed by a national brand. This result updates research conducted prior to the melamine incidents which indicated that consumers did not prefer certification programs over other milk-safety attributes (Zhang et al. 2010). The recent milk-safety incidents that affected various nationally recognized brands in China have sparked consumer interest in government certification efforts, especially as they pertain to the monitoring and supervision of branded firms and products. In 2000, the Chinese government established an "inspection exemption" program to reduce the burden and costs of monitoring dairy and milk processing companies (Zhang et al. 2010). As was evident in the wake of the milk-safety incidents, which affected mostly companies under the inspection exemption program, stricter government supervision of national milk companies will provide the most value to urban consumers. Our study also found that a third-party nongovernment certification program is positively valued by consumers, and if implemented would increase aggregate consumer welfare and potentially eliminate some of the inefficiencies that arise from a government monopoly on food safety and quality assurance.

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