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Consumer confidence and consumers' preferences for infant formulas in China



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Abstract

A series of safety incidents related to domestically-produced infant formulas (DIFs) almost destroyed Chinese consumer confidence in domestic dairy products. Understanding consumer confidence and its effect on consumption behavior is important to restore consumer confidence and enhance the competitiveness of domestic dairy industry. This article first measures Chinese consumer confidence in DIFs safety using a two-dimension scale (optimism and pessimism) and then investigates its effect on consumers' preferences for DIFs through a choice experiment. Involving 450 consumers residing in Beijing, Tianjin and Shijiazhuang, the experiment elicited information on their preferences for DIFs with six attributes (organic raw milk, farm-to-table traceability, region of origin, quality certification, animal welfare, and price). Our analysis yields four findings. First, Chinese consumers still lack confidence in DIFs safety. Second, quality certification is the most preferred product characteristic, followed by organic raw milk and farm-to-table traceability. Third, serving as a signal of high quality, price exerts a positive impact on choices of DIFs for pessimistic consumers. Finally, consumer preferences for farm-to-table traceability and region of origin are significantly influenced by consumer confidence.

Keywords: consumer confidence, food safety, infant formula, choice experiment, willingness to pay, China

1. Introduction

The melamine-contaminated milk incident struck China in September, 2008, triggering widespread panic among Chinese consumers. In that incident, infant formulas

produced by 22 major domestic dairy companies were identified to be tainted by melamine, a chemical that can cause kidney stones in infants and impose risks of renal failure and even death on them. It was revealed later that approximately 300 000 children became sick and at least six infants died from consuming melamine-contaminated formulas, which almost completely destroyed Chinese consumer confidence in domestically-produced infant formulas (DIFs) (Qiao *et al.* 2010). A survey conducted in 2009 showed that 85% of Chinese consumers are worried about the safety of milk powder (Zhou and Zhuo 2010). The lack of confidence, in turn, led numerous Chinese consumers to turn to imported infant formulas for quality assurance, despite their much higher prices (Xiu and Klein 2010). Not surprisingly, financial losses incurred in China's

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domestic dairy industry were devastating — the total direct loss incurred during the three months immediately following the melamine-contaminated milk incident was estimated to exceed three billion USD (Wang 2009).

To raise safety and quality standards of DIFs and to regain consumer confidence, the Chinese government carried out a series of active measures to enhance regulations in the domestic dairy industry after the 2008 incident. Food safety laws were strengthened, maximum tolerance levels for melamine content in dairy products were officially set, inspections on milk collection stations were made stricter and more frequent, and the construction of a dairy-product traceability system was accelerated (Xiu and Klein 2010; Zhang *et al.* 2012). Meanwhile, a few dairy manufacturers, such as Yili and Mengniu, have started to promote organic milk brands to address consumers' food safety and health concerns (Yue *et al.* 2015). However, even though these measures have significantly improved the safety levels of China's domestic dairy products, especially those of infant milk powders (DAC and MoA 2017), they have largely failed to attract Chinese consumers back. In 2017 alone, China imported 296 000 tons of infant formulas (<http://www.ifooday.cn/news/case/20180420/93299.html>), more than seven times the corresponding figure in 2008 (<http://news.china.com/domesticgd/10000159/20160609/22839188.html>). Direct purchases of infant formulas from overseas, either through bulk buying or through individual purchases made by underground shoppers, also became popular (Sharma and Zhang 2014), accounting for nearly 20% of China's infant-formula market share in recent years. For example, in 2015, the total spending on direct overseas purchases was 2.36 billion USD, which amounts to 19% of the infant formula market size in that year (<http://www.chyxx.com/industry/201606/422972.html>). The rising market share of imported infant formulas has caused substantial profit losses in domestic dairy firms, seriously threatening their survival. Given that the quality of DIFs has been substantially improved, how to regain consumer confidence remains the key to reviving China's domestic dairy industry.

While considerable efforts have been devoted to searching for solutions to problems that plague China's dairy sector, including establishing quality management systems (e.g., Wang *et al.* 2008), promoting the use of organic

pasture (e.g., Yin *et al.* 2016), constructing traceability systems (e.g., Bai *et al.* 2013), and improving the cow breeding environment (e.g., Wang *et al.* 2016), etc., two questions related to consumer confidence have not been adequately answered. First, what is Chinese consumers' current level of confidence in DIFs safety, nearly a decade after the 2008 incident? Second, how does Chinese consumer confidence level impact their preferences for DIFs with safety and quality attributes, such as traceability, origin of raw milk, and quality certification, etc.? Given the important role consumer confidence plays in determining their consumption behavior (Bennett and Harrell 1975; Ludvigson 2004; Lymperopoulos *et al.* 2010; Simintiras *et al.* 2014), especially when it comes to food products with potential safety concerns (Böcker and Hanf 2000; Berg 2004; Berg *et al.* 2005; Qiao *et al.* 2010; Barnett *et al.* 2016), answers to these questions can certainly help formulate food safety policies to restore consumer confidence and help develop supply-chain management strategies to enhance the competitiveness of China's domestic dairy industry.

The present study attempts to answer these questions, at least partially, by analyzing data from a consumer survey that incorporates a choice experiment involving 450 residents in the cities of Beijing, Tianjin, and Shijiazhuang. These three cities are major economic centers of China's Jing-Jin-Ji Economic Circle (Beijing and Tianjin are two municipalities of China; Shijiazhuang is the capital city of Hebei Province of China) whose large population and high birth rate predict a high demand for infant formulas¹. Shijiazhuang is also "ground zero" of the melamine contamination incident in 2008, which renders it (and the two nearby major cities) a suitable area to study consumer confidence in DIFs safety. Besides its focus placed on a relevant study area², our study makes two additional contributions to the literature. First, unlike previous studies that assess Chinese consumer confidence using single-item measures (e.g., Lu 2000; Qiao *et al.* 2010), our study employs multi-item measures. More specifically, we follow De Jonge (2008) and measure two different yet related dimensions of consumer confidence in DIFs safety with a seven-item scale: optimism (four items) and pessimism (three items). Optimism measures the extent to which consumers are satisfied with DIFs safety, while pessimism measures the extent to which

¹ According to National Bureau of Statistics of China in 2016, the populations of Beijing, Tianjin, and Hebei are 21.73 million, 15.62 million and 74.70 million, which accounts for 8% of the total population of China. The birth rate of Beijing, Tianjin, and Hebei are 9.32, 7.37, and 12.42‰. Among them, the birth rate of Hebei is basically the same as the national rate, 12.95‰.

² We selected the sample to be representative of the very subset of Chinese consumers whose confidence was most seriously affected — note that the melamine-contaminated infant formula incident first occurred in Shijiazhuang City in 2008, and the other two cities are geographically close to Shijiazhuang. Moreover, precisely because consumers residing in these three cities are relatively wealthy, they are more likely to be representative of those consumers who can afford imported infant formulas (which are much more expensive than domestically produced ones) — in other words, our sample is indeed relevant given the purpose of our study.

consumers are worried and suspicious about DIFs safety. Compared to single-item measures, our multi-item measures provide a more comprehensive assessment of consumer confidence, thereby providing a more solid foundation for further analysis of how consumer confidence affects their purchase decisions.

Second, our study is among the first few that apply choice experiment to estimate Chinese consumers' willingness-to-pay (WTP) for DIFs. While choice experiments have been used to study Chinese consumers' choices for other food products, such as beef (Ortega *et al.* 2016), pork (Ortega *et al.* 2011; Wu *et al.* 2015), milk products (Wang *et al.* 2008; Ortega *et al.* 2012; Bai *et al.* 2013), etc., there are only a handful of studies that examine Chinese parents' choices of infant formulas using choice experiments (Wu *et al.* 2014; Quan *et al.* 2017; Yin *et al.* 2017). Also, while most of these studies investigate separately consumers' preferences for traceability or organic certification of infant formulas, our experiment investigates their preferences for a combination of six attributes of DIFs — organic raw milk, origin of raw milk, farm-to-table traceability, quality certification, animal welfare, and price — as well as the resulting WTP for DIFs. A mixed logit model was also developed to capture preference heterogeneity in the effects of consumer confidence in DIFs safety.

Our analysis yields four important findings. First, nearly a decade after the melamine-contaminated milk incident, Chinese consumers still lack confidence in DIFs safety. Second, quality certification is the most preferred product characteristic, followed by organic raw milk and farm-to-table traceability. Third, serving as a signal of high quality, price exerts a positive impact on the choice of DIFs for consumers who lack confidence in DIFs safety. Finally, consumers' preferences are significantly influenced by their confidence level, especially for farm-to-table traceability and region of origin. These findings highlight the need to improve quality management, to establish traceability systems, and to promote the use of organic pasture, in the process of restoring consumer confidence in DIFs and stimulating DIFs consumption.

The rest of this paper is organized as follows. The next section describes the data. Section 3 introduces our choice experiment and the related analytical framework. Section 4 presents and discusses our empirical results. The last section draws conclusions and points out a number of directions for further research.

2. Data

2.1. Survey and sample

The data used in this study were collected through a survey conducted in July 2016 in the cities of Beijing, Tianjin and Shijiazhuang, which are located in the Jing-Jin-Ji Economic Circle, one of the largest urban agglomerations in China. Beijing and Tianjin are the most developed cities in China, where urban households' per capita disposable incomes reached 62 406 and 40 278 CNY in 2017, respectively; Shijiazhuang is the capital city of Hebei Province with a per capita income of approximately 32 929 CNY in 2017³. With relatively high income levels, urban residents in this area are major consumers of imported infant formulas⁴. Moreover, since the melamine-contaminated infant formula incident occurred in Shijiazhuang in 2008, consumer confidence in this city (and the two major cities nearby as well) was most seriously undermined, which renders consumers residing in these three cities the most relevant populations to study. Therefore, examining consumer confidence in and preferences for DIFs in this area is helpful for domestic dairy enterprises to develop effective market strategies when competing with foreign enterprises.

Conducted by trained enumerators, our survey targeted consumers who are infant formula buyers, whom were all recruited in maternal stores or at children's playgrounds. Before the main survey was conducted, a pilot survey was carried out to interview 30 respondents randomly selected in Beijing, to provide a basis for improving the questionnaire design, especially for setting up attributes and their associated levels in the choice experiment. In the main survey, we sampled 450 respondents randomly from urban areas of the three cities, using a stratified multistage sampling approach. Five districts from each city were first randomly selected; in each chosen district, 30 consumers were then selected according to a simple random rule at maternal stores or children's playgrounds. Our questionnaire centers on three areas of variations: respondents' socio-demographic characteristics, questions on consumer confidence in DIFs safety, and choice-experiment questions on DIFs with six attributes including price, region of origin, organic raw milk, animal welfare, farm-to-table traceability, and quality certification.

Table 1 summarizes respondents' socio-demographic characteristics. The majority (75.78%) of the respondents

³ Source: Municipal Bureaus of Statistics of Beijing, Tianjin, and Shijiazhuang; <http://tjj.beijing.gov.cn/> (accessed on May 28, 2018), http://calendar.hexun.com/area/dqzb_120000_D0240001.shtml (accessed on May 28, 2018), and <http://www.sjz.gov.cn/col/1493102274678/2018/03/30/1523169496094.html> (accessed on July 23, 2019).

⁴ In 2016, imported infant formula brands occupy 80–90% of the market share in the developed cities of China. Source: <http://www.chyxx.com/industry/201708/546443.html> (accessed on June 7, 2018).

are female, who are usually the mother or the primary caregiver (e.g., grandmother or aunt) of young children in the household. About one half (50.89%) of the respondents are relatively young, aged between 31 and 45 years. They are also highly educated: about two-thirds (63.33%) hold a college or university degree. The total household monthly income of most of the respondents (62.22%) ranges from 5 000 to 20 000 CNY, which is quite high compared to the national average. Consistent with results of previous surveys (e.g., Qian *et al.* 2014), the proportion of consumers who never purchased DIFs is high (53.78%), reflecting Chinese consumers' lingering concern about DIFs safety.

2.2. Measuring consumer confidence

To measure Chinese consumer confidence in DIFs safety, we developed an appropriate scale through principle component analysis (PCA) and validated it by confirmatory factor analysis (CFA). A set of 20 items (more precisely, statements to be assessed by the respondents) designed to measure consumer confidence in food safety was adopted from the study of De Jonge (2008), with adjustments to suit the context of DIFs (see Appendix A for details). These items cover consumers' perception of DIFs safety, emotion, and affection related to consumption, as well as their positive and negative attitudes toward DIFs safety. All items were rated on a 5-point Likert scale ranging from strongly disagree (1) to strongly agree (5).

To test for reliability of the two-dimension scale, the data were randomly split into two separate samples, Sample A and Sample B. The PCA with varimax rotation was first conducted to explore the underlying dimensional structure

of 20 items based on Sample A. By removing items with communalities below 0.40, a two-dimension scale with 9 items was identified. To examine whether this scale has a good fit with another independent sample, a more rigorous CFA was applied to Sample B using maximum likelihood fitting. After removing two items that departed significantly from what were expected based on their item loadings, a valid two-dimension scale with 7 items was finally chosen to measure consumer confidence in DIFs safety. Following De Jonge (2008), we labeled the two dimensions as optimism (4 items) and pessimism (3 items). The detailed process of scale development is described in the Appendix A.

To illustrate the data structure of all measuring items, we present the percentage of respondents choosing the maximum and minimum of all items in Table 2. It shows that consumers are in general more pessimistic about DIFs safety. The percentages of consumers who agree with the statements associated with optimism are all lower than those of consumers who agree with the statements associated with pessimism.

Table 3 provides the mean scores of these two dimensions of consumer confidence, as well as the corresponding items. The mean score of optimism is lower than that of pessimism — a formal test indicates a significant difference between them ($t=10.26$, $P\text{-value}<0.0001$). This suggests that Chinese consumers still lack confidence in DIFs safety by the time of survey in 2016. Further comparing the mean scores of all items reveals that Chinese consumers' lack of confidence stems largely from their dissatisfaction with DIFs safety and fear caused by previous DIFs safety incidents.

To estimate the influences of consumer confidence on their preferences for DIFs, factor scores of optimism and

Table 1 Sample characteristics

Variable	Description	Number of observations	Percent (%)
Gender	Male	109	24.22
	Female	341	75.78
Age	18–30	168	37.33
	31–45	229	50.89
	46–60	35	7.78
	61–75	18	4.00
Education	Less than junior high school	9	2.00
	Junior high school	32	7.11
	High school	75	16.67
	College/University	285	63.33
	Graduate school	49	10.89
Household income (CNY mon ⁻¹)	≤4 999	91	20.22
	5 000–9 999	144	32.00
	10 000–19 999	136	30.22
	≥20 000	79	17.56
Decision maker of infant formula purchase?	No	104	23.11
	Yes	346	76.89
Do you have any experience in purchasing domestically-produced infant formulas (DIFs)	No	242	53.78
	Yes	208	46.22

Table 2 Descriptive statistics of measuring items of consumer confidence (%)

Statement ¹⁾	Strongly disagree	Disagree	Not sure	Agree	Strongly agree
Optimism					
I am confident that DIFs are safe	1.56	19.11	44.89	31.11	3.33
DIFs are in general safe	5.56	24.89	40.67	25.33	3.33
I am optimistic about DIFs safety	2.44	9.56	42.44	40.67	4.89
I am satisfied with DIFs safety	6.00	24.67	45.11	20.67	3.56
Pessimism					
I panic as a result of DIFs incidents that occur	2.22	8.89	35.33	44.00	9.56
Problems related to DIFs that occur make me angry	1.78	8.67	31.78	37.56	20.22
It scares me that there are problems with managing the safety of DIFs	1.56	8.22	30.00	44.67	15.56

¹⁾ DIFs, domestically-produced infant formulas.

Table 3 Mean scores of dimensions in consumer confidence

Statement ¹⁾	Mean	SD
Optimism		
I am confident that DIFs are safe	3.10	0.69
DIFs are in general safe	3.16	0.82
I am optimistic about DIFs safety	3.36	0.82
I am satisfied with DIFs safety	2.96	0.93
I am satisfied with DIFs safety	2.91	0.91
Pessimism		
I panic as a result of DIFs incidents that occur	3.60	0.74
I panic as a result of DIFs incidents that occur	3.50	0.87
Problems related to DIFs that occur make me angry	3.66	0.95
It scares me that there are problems with managing the safety of DIFs	3.65	0.89

¹⁾ DIFs, domestically-produced infant formulas.

pessimism were estimated and used as two explanatory variables in the analysis below. While principal component method is used to explore the underlying dimensional structure of measuring items, refined procedures are usually applied to estimate factor scores (Distefano *et al.* 2009). The least-squares regression approach, as one of refined procedures to predict factor scores, was used in our estimation. Factor scores of optimism and pessimism, as the predictor variables, are weighted by regression coefficients, which are obtained by multiplying the inverse of the observed variable correlation matrix by the matrix of factor loadings (Distefano *et al.* 2009). Finally, the computed factor scores of optimism and pessimism are standardized to have mean zero and unit standard deviation.

3. Choice experiment

3.1. Product attributes

A choice experiment was conducted to analyze consumers' preference and their WTP for safety and quality attributes of DIFs. Based on results of a series of pilot tests, six attributes were chosen: price, region of origin, organic raw milk, animal welfare, farm-to-table traceability, and quality certification.

Region of raw milk origin This attribute involves four best-known raw milk source regions in China: Hebei Province (*OriginHB*), Heilongjiang Province (*OriginHLJ*), Inner

Mongolia Autonomous Region (*OriginING*), and Xinjiang Uygur Autonomous Region (*OriginXJ*). Previous research suggests that the region of product origin has a direct effect on consumers' preference for the product under discussion, especially for those residing in the region of product origin (Van der Lans *et al.* 2001). However, existing studies on Chinese consumers' preference for infant formulas have not paid sufficient attention to the origin of raw milk; rather, most of them are focused on country of origin (Wu *et al.* 2014; Quan *et al.* 2017; Yin *et al.* 2017). Our study fills this gap by investigating consumer demand for DIFs originated from different regions in China.

Organic raw milk After the 2008 scandal, organic milk products became increasingly catering to the rising demand for safe DIFs in China. It is thus important to understand Chinese consumers' valuation of products of organic raw milk and whether they rely on this attribute to screen out unsafe DIFs when lacking confidence. This attribute (*Organic*) assumes two values: organic or nonorganic.

Farm-to-table traceability Traceability systems have long been developed to enhance food safety and consumer confidence in developed countries (Loureiro and Umberger 2007). Driven by serious consumer concerns over DIFs safety, several Chinese dairy firms, such as Mengniu and Yili, have established their own traceability systems. In our experiment, the traceability attribute (*Traceability*), which assumes two values (yes or no), allows us to examine

consumers' valuation of traceability information related to the production process of DIFs.

Access to quality certification Information asymmetry prevents consumers from being fully informed about the safety of the food item they intend to purchase. Thus, they seek to obtain more information for quality detection, such as certification by third-party agencies (Wang *et al.* 2008)⁵. The quality-certification attribute (with two values: yes or no) thus allows us to assess the extent to which consumers are concerned about quality detection and certification.

Animal welfare Animal welfare is defined as cows being treated well, eating well, and living healthily and happily on dairy farms. We include this attribute to explore whether it is viewed as a signal for safer and healthier DIFs by Chinese consumers. Since animal welfare is a relatively new concept to Chinese consumers, we explained its meaning to the respondents before implementing our choice experiment. This attribute assumes three levels, i.e., low (*AWLow*), medium (*AWMedium*) or high (*AWHigh*), for the living conditions of cows and how they are treated.

Price There are substantial variations in the price of DIFs due to different weight specifications, ranging from 400 to 900 g, on the market. To avoid confusion, we chose "900 g of DIFs for children aged 6–12 months" as the representative product in the choice experiment. This attribute (*Price*) assumes four levels based on actual market prices of infant formulas: 150, 250, 350, and 450 CNY (for 900 g)⁶.

The attribute and level settings discussed above lead to a total of $4^2 \times 3 \times 2^3 = 384$ virtual product profiles. It is unrealistic to ask a respondent to compare and select among a total of 147 456 ($=4^2 \times 3 \times 2^3$)² choice tasks. In general, comparing as many as 15–20 profiles will fatigue the consumer (Allenby and Rossi 1998). Therefore, we employed a fractional factorial orthogonal design to generate 10 versions of questionnaire using SPSS 22. Each version includes 12 tasks and each task includes two product profiles and a neither option.

3.2. Econometric models

A mixed logit model is adopted to analyze data from the choice experiment, for the following reasons. First, the mixed logit models allow for heterogeneity in preferences which are unrelated to observed characteristics (Hole and Kolstad 2012). An attractive feature of the mixed logit model is that it need not assume independence of irrelevant alternatives; thus, it reflects a more realistic substitution pattern than do standard logit models (Train 2003). Second,

it has been shown that any discrete choice random utility model can be approximated by an appropriately specified mixed logit model (McFadden and Train 2000).

Specifically, consumers are assumed to choose an attribute portfolio of DIFs within their budget constraint. The utility of consumer *i* choosing product *j* among *J* alternatives of DIFs products is modeled as

$$U_{ij} = \mathbf{X}'_{ij}\beta_i + \xi_{ij} + \epsilon_{ij} \quad (1)$$

Where, \mathbf{X}_{ij} is the vector of the six product attributes discussed above, ξ_{ijt} captures unobserved product characteristics, and ϵ_{ij} is an independently and identically distributed (i.i.d.) disturbance term. To capture potential heterogeneity in consumers' responses to DIFs attributes due to different levels of consumer confidence, we further specify the set of random coefficients β_i to include a fixed component ($\bar{\beta}$) and a variable component that varies with consumers' levels of optimism (*Opti_i*), pessimism (*Pessi_i*), as well as other characteristics (δ_i), including socio-demographic and unobserved characteristics

$$\beta_i = \bar{\beta} + \lambda_1 \text{Opti}_i + \lambda_2 \text{Pessi}_i + \kappa \delta_i \quad (2)$$

Where, the parameters λ_1 and λ_2 measure, respectively, how consumers' preferences vary with different levels of optimism and pessimism; δ_i is assumed to follow a standard multivariate normal distribution with κ being a scaling vector. Under utility maximization, a consumer chooses alternative *j* if and only if his or her utility associated with it is greater than that associated with any other alternatives. The probability of consumer *i* choosing alternative *j* is then the integral of standard logit probabilities over the parameters' densities (Train 2003):

$$\text{Prob}_{ij} = \int \frac{\exp(\mathbf{X}'_{ij}\beta_i)}{\sum_{r=1}^J \exp(\mathbf{X}'_{ir}\beta_i)} f(\delta_i) d\delta_i \quad (3)$$

The associated log likelihood is given by:

$$L = \sum_{i=1}^I \sum_{j=1}^J d_{ij} \ln \text{Prob}_{ij} \quad (4)$$

Where, $d_{ij} = 1$ if consumer *i* chooses alternative *j* and zero otherwise; Prob_{ij} is defined in eq. (3). The simulated maximum likelihood estimation method (Train 2003) with 500 Halton draws was applied to estimate the parameters in eqs. (3)–(4).

Finally, to explore how consumers' WTP for DIFs may vary with their confidence level, we estimate the mixed logit model directly in the WTP space, with interaction terms between product attributes and the two confidence measures. Compared to the conventional approach of estimating WTP (e.g., Ortega *et al.* 2011; Wu *et al.* 2014), the model specified in the WTP space has two advantages. First, it allows the preferences for price to be heterogeneous and may thus produce more realistic WTP estimates

⁵ A recent study conducted in the Jing-Jin-Ji area finds that informing consumers about product quality can increase their willingness to pay for genetically modified foods (Chen *et al.* 2017).

⁶ 1 CNY = 0.1573 USD at the time of survey in 2016.

(Sonnier *et al.* 2007). Second, it estimates consumers' WTP directly. In so doing, it avoids the rather arbitrary choice of the WTP distribution that arises from dividing the coefficients of the non-monetary attributes by the coefficient of price, which could lead to unusual distributions of WTP values (Hole and Kolstad 2012).

More specifically, rewriting eq. (1) as a function of price, $price_i$, and all the other product attributes, \bar{X}_{ij} .

$$U_{ij} = \beta_i^{price} price_i + \bar{X}_{ij} \bar{\beta}_i + \xi_{ij} + \varepsilon_{ij} \quad (5)$$

Where, β_i^{price} and $\bar{\beta}_i$ are individual-specific parameters respectively for price and for all the other product characteristics. This results in a mixed logit model specified in the *preference* space (Train and Weeks 2005), in which the WTP for non-monetary attributes is given by. One can further rewrite eq. (5) as

$$U_{ij} = \beta_i^{price} [price_i + \gamma \bar{X}_{ij}] + \xi_{ij} + \varepsilon_{ij} \quad (6)$$

to yield a model specified in the WTP space (Train and Weeks 2005). Eq. (6) can be estimated by maximum simulated likelihood methods.

4. Results and discussion

4.1. Estimation results of the mixed logit model

Table 4 reports results of estimating the mixed logit model (eq. 3) with two specifications. Serving as the benchmark specification, model 1 includes only the random coefficients of the six product attributes. Model 2 further allows consumers' preference to vary across their optimism and pessimism levels. In order to capture potential heterogeneity in consumer preferences for DIFs, coefficients of product attributes are assumed to follow a normal distribution in both models. In model 2, part-worth utilities estimated for product attributes are evaluated as the main effects, assuming away heterogeneity generated by consumer confidence. Standard deviations of parameter distributions that are significantly different from zero indicate heterogeneity in the estimates of the parameters around their respective means (Hensher *et al.* 2005). In contrast to coefficients of the product attributes, coefficients of the interaction terms are assumed to be nonrandom; thus, only their means (as opposed to their standard deviations) are reported. Judging by both the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC), model 2 has better goodness-of-fit than model 1, suggesting that the inclusion of interaction terms helps improve the fit of the model.

Estimation of models 1–2 yields four important findings. First, in both models, the estimated coefficients of all product attributes but price are highly significant (at the 1% level) and have expected signs, suggesting that the presence of any of these attributes is likely to increase consumers' utility derived from DIFs consumption. Although not being significant in

model 1, the coefficient of price has the expected negative sign (the estimated impact of price in model 2, which involved interaction terms, will be discussed below). That the impact of price is less significant than the impacts of other attributes suggests that non-price attributes play a much more important role than price in affecting Chinese consumers' DIFs consumption decision.

Second, among the six attributes of interest, quality certification is the most important determinant of consumers' preference for DIFs, followed by organic raw milk and farm-to-table traceability. Since different attributes assume different levels/values, we follow Kallas *et al.* (2014) and assess the relative importance of these attributes using the differences between coefficients of these levels as the basis of evaluation. First, weights were calculated for each attribute. For attributes that have more than two levels/values (i.e., region of origin and animal welfare), the differences between the largest and smallest coefficients on them were calculated as their weights. For attributes that have only two levels/values (i.e., organic, traceability, and quality certification), the coefficients are directly treated as their weights. Then, the ratio of the coefficient of each attribute to the weighted sum of these differences (across attributes) is calculated as the measure of each attribute's relative importance, which yields the following ranking of relative importance: quality certification (35.95%), organic raw milk (26.81%), traceability (15.76%), region of origin (12.01%), and animal welfare (9.47%).

Third, consumers' sensitivity to price is significantly affected by their confidence level. More importantly, price seems to serve as a signal of quality, exerting a positive impact on DIFs choices among consumers who are pessimistic about DIFs safety. It has long been documented that when the quality of a product is uncertain to the consumers, the price of this product plays a positive role in their perception of product quality (Erickson and Johansson 1985). The context of urban China further reinforces the positive impact of price among pessimistic consumers. Due to the long-term effects of "one-child" policy in the past, a typical urban Chinese couple would try their best to ensure good health of their only child. Thus, parents lacking confidence in DIFs safety would be willing to pay a high price to ensure that the DIFs consumed by their children are of high quality. In fact, despite their rising prices in recent years, imported infant formulas remain very popular for Chinese consumers, who view these high prices as signals of high product quality.

Finally, there is significant heterogeneity in consumers' preferences for the remaining DIFs attributes. The impacts of farm-to-table traceability and region of raw milk origin vary significantly across consumer confidence levels. Pessimistic consumers are more likely to choose products with available

Table 4 Estimation results of the mixed logit model

Variable ¹⁾	Model 1				Model 2			
	Coef.	SE	Deviation	SE	Coef.	SE	Deviation	SE
Product attributes								
<i>Price</i>	-0.0028	0.0018	-0.005	0.0059	-0.0033*	0.0017	-0.0048	0.0059
<i>Organic</i>	0.3868***	0.0459	0.3892***	0.0739	0.3885***	0.0463	0.3815***	0.0745
<i>Traceability</i>	0.2274***	0.0385	0.1476	0.1270	0.2365***	0.0387	0.1332	0.1441
<i>Quality</i>	0.5188***	0.0554	0.6843***	0.0672	0.5142***	0.0556	0.6915***	0.0684
<i>OriginHLJ</i>	0.0192	0.0615	-0.3098**	0.1225	0.0217	0.0625	0.2894**	0.1305
<i>OriginIMG</i>	0.4008***	0.0581	0.4961***	0.0814	0.4199***	0.0580	0.4666***	0.0826
<i>OriginXJ</i>	0.1926***	0.0559	-0.0868	0.1937	0.2119***	0.0556	-0.0361	0.3064
<i>AWMedium</i>	0.1817***	0.0561	0.0100	0.1007	0.1811***	0.0568	0.0045	0.0997
<i>AWHigh</i>	0.3183***	0.0494	-0.0611	0.1734	0.3230***	0.0496	0.0353	0.1567
Interactions with consumer confidence dimensions								
<i>Opti×Price</i>					-0.0005***	0.0002		
<i>Pessi×Price</i>					0.0004*	0.0002		
<i>Opti×Organic</i>					0.0383	0.0442		
<i>Pessi×Organic</i>					0.0666	0.0475		
<i>Opti×Traceability</i>					-0.0396	0.0380		
<i>Pessi×Traceability</i>					0.0897**	0.0409		
<i>Opti×Quality</i>					-0.0356	0.0538		
<i>Pessi×Quality</i>					-0.0075	0.0575		
<i>Opti×OriginHLJ</i>					-0.0142	0.0590		
<i>Pessi×OriginHLJ</i>					-0.0458	0.0638		
<i>Opti×OriginIMG</i>					-0.2314***	0.0578		
<i>Pessi×OriginIMG</i>					0.0200	0.0617		
<i>Opti×OriginXJ</i>					-0.1562***	0.0543		
<i>Pessi×OriginXJ</i>					-0.0182	0.0591		
<i>Opti×AWMedium</i>					0.0089	0.0562		
<i>Pessi×AWMedium</i>					-0.0016	0.0606		
<i>Opti×AWHigh</i>					-0.0519	0.0491		
<i>Pessi×AWHigh</i>					0.0467	0.0532		
Observations	49 168				49 168			
Log Likelihood	-8 250				-8 166			
AIC	16 536				16 404			
BIC	16 661				16 655			

¹⁾ HLJ, Heilongjiang; IMG, Inner Mongolia Autonomous Region; XJ, Xinjiang Uygur Autonomous Region; *AWMedium* and *AWHigh*, the levels of animal welfare are medium and high, respectively; *Opti*, optimistic; *Pessi*, pessimistic; AIC, Akaike Information Criterion; BIC, Bayesian Information Criterion. *Hebei* and *AWLow* are used as the benchmarks of origin dummies and animal welfare dummies, respectively. ***, $P < 0.01$; **, $P < 0.05$; *, $P < 0.1$.

traceability systems. And optimistic consumers are found to prefer Hebei to Inner Mongolia and Xinjiang as the origin of raw milk.

4.2. WTP estimates and influence of consumer confidence levels

Table 5 reports results of estimating eq. (5), which indicate that consumers are willing to pay the most for quality certification (245.7 CNY), followed by raw milk produced in Inner Mongolia (178.4 CNY), organic raw milk (175.6 CNY) and traceability (119.0 CNY). As suggested by the significance of the deviation parameters, there is significant heterogeneity in consumers' WTP for organic raw milk, traceability, quality certification and Inner Mongolia as the

region of raw milk origin. Estimated coefficients of the nonrandom interaction terms suggest that consumers' WTP for traceability and that for animal welfare are significantly influenced by their confidence levels. Consistent with results discussed above, optimistic consumers are willing to pay a discount for traceability. Pessimistic consumers are willing to pay a premium for animal welfare, which may be viewed as a signal of safer and healthier DIFs by these consumers.

5. Conclusion

Measuring consumer confidence in DIFs safety by a two-dimension scale, optimism and pessimism, our study finds that Chinese consumers residing in urban Northern China still lack confidence in DIFs safety nearly a decade after

Table 5 Estimated WTP for key product attributes (CNY 900 g⁻¹)

Variable ¹⁾	Mean effect		Deviation	
	Coef.	SE	Coef.	SE
<i>Organic</i>	175.6 ^{***}	49.4	-113.0 [*]	62.3
<i>Opti</i> × <i>Organic</i>	-15.2	21.6		
<i>Pessi</i> × <i>Organic</i>	1.9	21.6		
<i>Traceability</i>	119.0 ^{***}	39.8	66.7 [*]	38.1
<i>Opti</i> × <i>Traceability</i>	-39.1 [*]	21.2		
<i>Pessi</i> × <i>Traceability</i>	31.4	20.7		
<i>Quality</i>	245.7 ^{***}	77.8	-205.8 ^{***}	77.5
<i>Opti</i> × <i>Quality</i>	-48.1	31.6		
<i>Pessi</i> × <i>Quality</i>	12.6	25.6		
<i>OriginHLJ</i>	-9.7	28.1	-46.0	42.1
<i>Opti</i> × <i>OriginHLJ</i>	32.2	31.0		
<i>Pessi</i> × <i>OriginHLJ</i>	-21.3	29.2		
<i>OriginIMG</i>	178.4 ^{***}	55.6	-88.9 [*]	46.5
<i>Opti</i> × <i>OriginIMG</i>	-41.4	32.2		
<i>Pessi</i> × <i>OriginIMG</i>	-7.6	21.1		
<i>OriginXJ</i>	87.8 ^{**}	36.2	-12.8	27.8
<i>Opti</i> × <i>OriginXJ</i>	-16.5	32.3		
<i>Pessi</i> × <i>OriginXJ</i>	-7.6	23.4		
<i>AWMedium</i>	101.4 ^{**}	45.0	8.2	23.3
<i>Opti</i> × <i>AWMedium</i>	-23.0	27.9		
<i>Pessi</i> × <i>AWMedium</i>	39.0	25.9		
<i>AWHigh</i>	122.1 ^{**}	53.0	17.3	21.5
<i>Opti</i> × <i>AWHigh</i>	-35.5	27.5		
<i>Pessi</i> × <i>AWHigh</i>	48.7 [*]	27.6		

¹⁾ *Opti*, optimistic; *Pessi*, pessimistic; *HLJ*, Heilongjiang; *IMG*, Inner Mongolia Autonomous Region; *XJ*, Xinjiang Uygur Autonomous Region; *AWMedium* and *AWHigh*, the levels of animal welfare are medium and high, respectively; *Hebei* and *AWLow* are used as the benchmarks of origin dummies and animal welfare dummies, respectively. ^{***}, $P < 0.01$; ^{**}, $P < 0.05$; ^{*}, $P < 0.1$.

the melamine-contaminated milk incident in 2008. Unlike previous studies that investigate Chinese consumers' preferences for traceability or organic certification of infant formula separately (Wu *et al.* 2014; Quan *et al.* 2017; Yin *et al.* 2017), our study exploits a choice experiment with six safety and quality attributes and investigates the effect of consumer confidence on consumers' preferences for DIFs. We discover that among the six attributes being examined, quality certification is the most preferred one, followed by organic raw milk and farm-to-table traceability.

Estimation results of mixed logit models suggest that consumers' preferences for DIFs vary across the levels of optimism and pessimism in DIFs safety. First, price exerts a positive impact on choices of DIFs for consumers who are pessimistic about DIFs safety. Secondly, consumers' preferences and WTPs for farm-to-table traceability are significantly influenced by their confidence level. Farm-to-table traceability is only preferred by consumers who are pessimistic about DIFs safety, but not by optimistic consumers. Also, optimistic consumers prefer DIFs produced in Hebei, and pessimistic consumers are willing to pay a premium for animal welfare. These results highlight the need to include consumer confidence as a key psychological factor in attempts to understand how consumers make DIFs

choices, which may also help formulate food-safety policies and supply-chain management strategies.

From a policy perspective, these findings suggest that quality certification, which is viewed as the most important product attribute by the consumers, should be made as a mandatory characteristic of DIFs products. In addition, accelerating the establishment of an effective farm-to-table traceability system helps to enhance Chinese consumer confidence in DIFs. Policy actions on improving consumers' perception of DIFs safety may also be needed. Public institutions should provide more information on the production process of dairy products, quality inspection, and measures taken to improve DIFs safety, especially information regarding traceability system, organic practices and animal welfare.

From a supply-chain management perspective, developing traceability systems could help domestic dairy companies capture significant premiums from the consumers, especially in the current context that Chinese consumers still lack confidence. Chinese dairy suppliers should also devote efforts to developing organic pastures and improving domestic raw milk source, which appear to be attractive to Chinese consumers. In addition, ensuring animal welfare may also help dairy companies convince consumers of the high safety level of DIFs.

Before closing, a note on the limitations of this study is in order. First, the measures of consumer confidence constructed in our study could be endogenous. For example, those consumers who had purchased low-quality DIFs before our survey may be pessimistic about DIFs; and it is their unsatisfactory purchase experience (an omitted variable in our model), rather than their pessimism *per se*, that drives down their willingness to consume DIFs. However, the comparison of the theoretical direction of bias and our estimation results suggests that endogeneity may not be a serious concern here. Note that the most likely case is that our consumer-confidence measures are picking up the influences of some omitted factors (say, unsatisfactory purchase experience discussed above); these omitted factors are likely to be positively correlated with pessimism and negatively correlated with optimism. Note also that, in theory, pessimism has a negative impact on consumers' willingness to purchase and optimism has a positive impact on their willingness to purchase. Thus, if there are indeed some omitted factors at work, the estimated impact of pessimism should be biased downward (i.e., more negative) and that of "optimism" upward (i.e., more positive). But our results indicate the opposite: the estimates involving optimism are mostly negative while those involving pessimism are mostly positive — in other words, these estimates are conservative estimates if endogeneity does exist. Moreover, in our study, although all product attributes

are orthogonal to each other by experimental design, their interactions with the two dimensions of consumer confidence may not be so. Therefore, future studies may exploit exogenous interventions to solicit information on consumer confidence. Second, to ensure a tractable size of the attribute space, this study only includes six attributes in the choice experiment. Some other potentially important factors, such as information on nutrition contents, are not included in the model. Future studies taking into account these factors may be fruitful.

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Appendix associated with this paper can be available on <http://www.ChinaAgriSci.com/V2/En/appendix.htm>

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