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Product attributes and consumer attitudes affecting the preferences for infant milk formula in China – a latent class approach

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Abstract

A series of food safety incidents has led to low levels of trust in the safety of domestically produced Chinese infant milk formula. Concerned parents in China increasingly source 'foreign-produced' brands and use a range of authenticity cues as assurance of the safety and authenticity of infant formula products. However, the effectiveness of authenticity cues in providing assurance to Chinese consumers has not been evaluated. The aim of this study is to analyse the importance of various authenticity cues for infant milk product choices. Latent class models were used to analyse responses to an online choice experiment with 350 consumers of European infant formula in three Chinese cities: Beijing, Guangzhou and Chengdu. The model included respondents' preferences for different labels, authenticity cues and price along with perceptions, attitudes, and socio-demographic characteristics. We identified two consumer segments, with one preferring lower priced infant formula and the second choosing higher priced products. All authenticity cues, including price, appear to serve as indicators of food quality and safety, and all were found to be highly important information sources for the respondents when making purchase decisions. In general, Chinese consumers are prepared to pay a premium for authenticity assurance. Chinese policy makers and the infant formula industry should continue to improve quality control systems to increase consumers' trust in food value chains. These control systems should comprise the whole food supply chain, from production to marketing, and should focus on building trust and communicating credibility.

Keywords:

Food integrity; authenticity; China; consumers; Infant milk formula; latent class choice modelling

1. Introduction

Consumer confidence in the safety of infant formula is important for the economic success of the milk-processing industry (Qian et al. 2011). The Chinese market is substantial, so exporters of infant formula to China have an interest in assuring Chinese consumers of the safety of their products. Infant food, which includes infant formula, is the second most important EU agri-food export to China by value, and the category is expected to grow (EC, 2015). The demand for dairy products rose sharply between 1996 and 2006; from 8 kg to 25 kg per person (Lu & Zong, 2008), which included fresh milk and milk powder (Fuller et al., 2006), as approximately 53% of Chinese babies are 'bottle-fed' (Gong & Jackson, 2012). The demand for infant formula is expected to increase in the future (Euromonitor, 2014), following the relaxation of the one-child policy in 2013, accompanied by a rising dependence on infant formula as more women participate in the workforce (Gong and Jackson, 2012),

However, the presence of melamine in milk and infant formula was identified in 2008. Melamine was deliberately added so that quality tests would indicate a higher than actual protein content (Wu et al., 2012). The discovery led to a rapid loss of trust in the safety and integrity of domestically produced infant formula. The fraudulent practice was revealed when, due to the toxic effects of melamine, 16 infants in Gansu Province of China, who had consumed milk powder produced by the Sanlu Group, were diagnosed with kidney stones (Zhou & Wang, 2011). The entire Chinese dairy industry was consequently the focus of Government inspection, which identified melamine contamination in milk powder from 20% of all producers (Wu et al., 2012). An estimated 300,000 victims were reported in China, with 860 children hospitalized and six infants dying from kidney stones or other kidney damage caused by melamine poisoning (Zhou & Wang, 2011). At present, the issue of consumer preferences for information regarding food fraud integrity has not been adequately addressed in the consumer behaviour literature. Chinese consumers are of particular interest given the impacts of the melamine case. The lack of information about consumer preferences for consumer protection in this regard, including within China, means that it is timely to conduct research into this topic, and to consider the wider implications for food fraud and consumer perceptions of food safety in China. The topic of this paper is therefore extremely timely, and will make an important contribution to the field of Chinese consumer behaviour and food fraud mitigation practices (Kendall et al., 2018).

The discovery of melamine contaminated infant formula had severe consequences for the Chinese milk industry. Foreign markets became largely inaccessible to Chinese dairy companies (Qian et al., 2011) and the domestic sale of dairy products in China decreased by 50% immediately following the incident, subsequently recovering to 70% of the 2008 sales in June 2009 (Zhou and Wang, 2011). Production in suspected dairy processing firms was shut down, and dairy farmers were unable to sell their milk until the State Council's "Plan for Rectifying and Revitalizing China's Dairy Industry" was announced in November, when milk stations were gradually inspected and brought back into production (Jia et al., 2012). The Chinese government reacted by imposing high penalties on the people and companies involved (Yiu & Klein, 2010). The Chinese public reacted by increasing their demands for improved and enforced food safety standards (Bánáti, 2011; Kim, 2013; Qiao et al., 2010). Despite mitigation actions taken by industry and government, further incidents of melamine-contaminated milk powder were reported in the years following the initial discovery (Huang and Blanchard, 2011; Le and Hornby, 2010; Xiu and Klein, 2010). These incidents have further reduced trust in the safety and integrity of domestically produced dairy products, and continued to undermine consumer confidence in the safety of the domestic food supply chain (Kendall et al., 2018; Knight et al., 2008; Lui et al., 2014; Walley et al., 2014; Wang et al., 2008; Xu & Wu, 2010). Concerned Chinese parents have sought alternative sources of infant formula, leading to an increase in demand and price of imported brands (Quio et al, 2012).

As there is a price premium for imported infant formula, Chinese consumers are attractive targets for fraudsters wishing to capitalize on demand. Food fraud is the act of deliberately deceiving consumers

for economic gain, and its existence is a manifestation of a failure to guarantee the quality, safety and authenticity of food to consumers (Spink & Moyer, 2011). Consumers' trust in the quality and safety of infant milk formula is important to economic success of the processing industry in China and abroad. This is because the integrity and safety of foods is an important determinant of consumer acceptance of specific products, (Liu et al, 2013), their perceptions of food safety in general (de Jong et al, 2008), and the regulatory system designed to promote consumer protection from food risks (Lam et al, 2013). Food authenticity as a social construct and rather culturally contingent is an often institutionalised attribution, which is usually made in reference to other entities such as places and organizations (Peterson, 2005). Geographic specificity, or the place of origin of the food, is a prominent authenticity cue (Johnston & Baumann, 2007). Deliberate mislabelling, in which the vendor makes incorrect claims about the food, such as about the geographical origin or the production method, is a type of food fraud that does not necessarily impact the quality or safety of the food, and may be unobservable, but deceives the customer with regard to authenticity (Spink & Moyer, 2011). Selling Chinese infant formula as imported infant formula, and thereby deceiving the customer about the geographic origin of the product, is therefore a case of authenticity related fraud.

Given that Chinese consumers are aware of attempts to defraud purchasers of infant formula, consumers themselves may develop strategies to avoid being defrauded, which means searching for authenticity signs, or cues, that indicate whether the product is authentic or otherwise. Distrust in information sources has also been demonstrated to influence food consumption decisions, such that consumers may seek alternatives to the foods which are the focus of the information source (see, *inter alia*, Frewer et al, 1996; Lobb, 2005; Lui et al, 2014). Studies on Chinese consumers have reported similar results, with evidence that Chinese consumers seek assurances of the authenticity of a product's stated origin (Agnoli et al, 2014; Wang et al, 2017; Walley et al, 2014; Li et al, 2016). There have been several studies examining the effects of authenticity cues on Chinese consumer choices with regard to European wine (Agnoli et al, 2014), beer (Wang et al, 2017), and food in general (Li et al, 2016; Walley et al, 2014), but there has been limited research into the effects of consumer confidence in authenticity cues with regard to European infant formula. This research gap is particularly relevant to non-Chinese exporters of infant formula into China because of the size of the market, the evidence that infant formula is a target of fraud, and the particular interest given by Chinese consumers to this product category.

The aim of this study is to use consumer choice experiments to analyse the relative importance of different product attributes in consumer product choices, and the willingness to pay for these authenticity attributes while taking the perception of food risk and authenticity and socio-demographic variables into account. Latent class models are used to analyse the relative importance of product origin, labels, authenticity cues and price in the purchasing choices made by Chinese consumers. The willingness to pay (WTP) for these extrinsic product quality cues is then calculated. Furthermore, differences due to the socio-economic characteristics of the respondents and potential regional differences are assessed in terms of their contribution to consumer decision-making. The results show how trust of Chinese consumers in infant formula can be increased and which specific authenticity assurance systems and product attributes are helping Chinese consumers in food product choices. This information can be used by the industry and policy makers to address the continuing domestic distrust in domestic food supply chains within China.

2. Factors affecting consumers' choices

2.1 Creating consumer trust with authenticity cues

Product manufacturers provide assurances, such as labels, to verify the product's authenticity, as well as to facilitate product differentiation within the market. Labels intended to ensure authenticity are commonly those that signify that the product has been inspected by an independent third party certifier, which can provide additional and trustworthy information on food quality and safety, and play an important role in consumers' buying decisions in China (Bai et al., 2013; Wang et al., 2008;

Yin et al., 2010). Chinese consumers have been reported to perceive that third party inspection makes it more difficult for fraudsters to insert contaminants (Chen, et al, 2014), including in relation to milk products (Yin et al, 2016). The use of labels to indicate third party certification would be unnecessary if consumers were to buy directly from a trusted supplier, but this is unlikely to be the case when Chinese consumers are buying European products, as most suppliers sell their products through local retail outlets.

Examples of authenticity labels that indicate third party inspection include protected designation of origin (PDO) labels and protected organic certification labels. The PDO label is based on EU Regulation 1151/2012 “Quality Schemes for Agricultural Products and Foodstuffs”, and aims to differentiate PDO labelled products against those that do not meet the PDO specification. The strength of the PDO label is that Europeans conduct the inspections that are required for certification, and so capitalises on the inherent trust held by Chinese consumers in European products (Li et al. 2016).

A third party certification label that is independent of Europe is the Chinese organic label (Huber & Schmid, 2017), which certifies that organic food is produced using legally defined methods and is systematically and independently inspected for compliance with regulations at the point of production. There is evidence that some Chinese consumers utilise organic certification as a food safety and quality cue (see, inter alia, Chen, et al, 2014; Sirieix et al, 2011), which has also been reported in relation to milk products (Wu et al, 2014; Yin et al, 2016).

Comparing Chinese consumer preferences for European certified products and Chinese certified products is likely to deliver insights into the relative degree to which the attribute of “being European” and the attribute of “external certification” convey authenticity to Chinese consumers. The attribute of food products “being European” is purported to convey confidence to Chinese consumers (Li et al, 2016; Walley et al, 2014), and there is a reported lack of trust in the domestic infant formula supply chains (Quio et al, 2012). It is therefore of interest if Chinese consumers are more sensitive to European PDO or Chinese organic label.

However, a label is reasonably easy to mimic, or even copy, so it may be that Chinese consumers seek authenticity cues that are more difficult to replicate. Three authenticity cues that are commonly used to make replication more difficult are hologram stickers, security packaging, and quick response (QR) codes. The hologram sticker is put on the product by the producing company, and shows a brand specific design that is difficult to imitate, thus making fraudulent products easier to identify. Security packaging means that packages are locked with a special fixture that breaks when the package is opened. Such fixtures serve as a sign to the consumers that the product has not been tampered with since it left the manufacturer. The QR code can be scanned by the consumer *via* a mobile phone and links to a website with information on the product authenticity. This enables inclusion of information about the product and the producer, as well as information about further authenticity cues, that may be included on the packaging. For policy makers and the food industry it is of interest to understand consumers’ value different possible authenticity cues on packaging, and if the related third party inspections increase the degree of confidence in the food chain of infant formula., independently of whether the products are imported or produced domestically.

2.2 Consumers’ characteristics affecting product choices

Consumer segmentation in China is affected by demographics such as age, gender, educational level, economic conditions and regional differences (e.g. Xu & Wu, 2010). Individual consumers may have different perceptions associated with different food safety risks (Houghton et al., 2008; Van Kleef et al, 2006), which potentially influences their purchase decisions. Therefore, data on a range of socio-demographic variables were included in the experimental design, along with data on risk perception, the perception of authenticity and the perception of organic products:

- *Household income*. Gale and Huang (2007) found that consumers with higher incomes pay higher prices for milk and most other products in China.

- *Age*. Different studies have found a relationship between age and consumers' food safety perceptions (e.g. de Jonge et al., 2004, Kennedy et al., 2008), with older consumers reporting more risk adverse attitudes.
- *Education*. Zhou and Wang (2011) Qiao et al (2012) and Kennedy et al. (2008) each found that less educated respondents expressed more concern than more educated respondents about melamine contamination of milk products.
- *Region*. Qiao et al. (2010) found that consumers in four districts of Inner Mongolia, where the two largest dairy companies in China are located, sharply reduced consumption of milk powder after the contamination announcement, but that demand recovered strongly by the end of 2008. Consumers in these regions expressed confidence in the effectiveness of actions taken by the domestic dairy industry but they were less satisfied by the actions taken by companies located in other parts of the country. Lu (2009) found that some major dairy companies, such as Mengnui and Yili, lost 80% of their sales in the first 10 days after disclosure of the melamine contamination, but the demand surged for milk products from Beijing-based Sanyuan Company whose products were unaffected. Moreover, buying decisions can differ between regions because of regional disparities in regulatory standards (Tam & Yang, 2005). For instance, more stringent regulations for food producers and manufacturers were noted by consumers in higher tier cities and less rigorous regulatory mechanisms were employed in lower tier cities and in rural areas, which were considered to be dumping grounds for lower quality food products. These regional disparities were recognised by consumers to be due to economic constraints at the provincial government level (Tam & Yang, 2005).
- *Gender*. Several studies have found differences in risk perception between women and men (e.g. Baker, 2003; Laufer & Gillespie; 2004; Slovic, 1999), with women perceiving higher food safety risks.
- *Risk Perception*. Risk perception and purchasing behaviour were, ceteris paribus, found to be inversely correlated (Yeung & Morris, 2001).
- *Authenticity perception*. Many consumers consider authentic local food to be a more sustainable choice than conventional food and value the perceived safety benefits, ethical associations and improved taste of authentic local food (Autio et al. 2013).
- *Perception of organic food*. Żakowska-Biemans (2011) identified a high degree of trust in the authenticity and safety of organic food, with 96% of respondents agreeing that it is more trustworthy and safer than conventional food. Yin et al. (2010), in their study of Chinese consumers, reported similar results, although they also suggest a perceived need for improvement of the inspection system of organic food in China.
- *Experience with counterfeit products*. Tang et al. (2014) reported that experience with counterfeit products affected risk perception and preferences with regard to several factors including different food quality and safety cues.

3. Methodological approach

3.1 Survey instrument

The survey consisted of a choice experiment and supplementary questions including questions on the socio-economic characteristics of the respondents; attitudes towards authenticity; perceptions of food risk and of organic certification; and whether respondents were aware of having purchased a counterfeit product in the past. This single-source approach, in which the same consumers first conducted a choice experiment and then completed the supplementary questions, was adopted so that causal links between stated choices and the determinants of the choices could be identified and so that the responding consumers could be segmented.

Choice experimentation is often designed and presented to consumers as a simulation of a purchasing experience (Hair et al, 2006), in which consumers are asked to choose ("purchase") one

product option out of a range of differing product options in each choice set. Choice experiments are based on Random Utility Theory, which proposes that goods are not the direct objects of utility but that utility is derived from the properties or characteristics of the goods instead (Lancaster, 1966). The key principle of choice experiments is systematic variation of a set of independent variables across the product options presented in each choice set, which affects the dependent variable (Aaker et al., 2006). McFadden (2001) established a theory-based econometric model for discrete responses in which utilities are specified as a linear function of observed attributes of the alternatives. The model's function includes the measured attributes of the product options and the coefficients that reflect the choice of the decision-makers (McFadden, 2001).

More precisely, an individual n will choose alternative i from a set of j product options only if this option has the highest perceived utility U_{ni} . The probability P_{ni} that an individual will choose option i from a choice set J is:

$$P_{ni} = P(U_{ni} > P(U_{nj}) \text{ for all } j \neq i) \quad (1)$$

Hereby, utility U_{ni} is split into two components, a systematic component V_{ni} that summarises all measurable choice determinants (Louviere et al., 2000) and a random component ε_{ni} that captures unobserved variation:

$$U_{ni} = V_{ni} + \varepsilon_{ni}. \quad (2)$$

In this study, the presented attributes included the products' geographical origin (whether a product was produced and packaged in China, imported in bulk and repackaged, or was imported in its "on the shelf" packaging); two labels (PDO and the Chinese national organic label); three authenticity cues (hologram sticker, security packaging, QR code); and the product price (see Table 1). All attributes, and attribute levels varied in the choice experiment, are presented in Table 1.

Table 1. About here

The choice experiment was designed as an unlabelled experiment, and so did not contain any option-specific description (such as a specific brand name). Instead, the options were listed as "option 1", "option 2" and "option 3", and the single attributes of interest were distributed across the three options following a d-efficient experimental design. In contrast to orthogonal designs that attempt to minimize the correlation in the data, d-efficient designs aim to generate parameter estimates with the smallest standard errors. The design was generated in the software package Ngene 1.0 (Choice metrics, 2017).

The choice experiment included six choice sets; each with three different options that were varied collections of product attributes. In addition, a "no choice" option was provided, i.e. the option when none of the three presented alternatives was eligible for selection from the consumers' point of view. Each participating consumer received a written explanation of the background and meaning of each of the product attributes tested in the choice experiment. A base price was initially selected, based on observations during a field visit to Beijing in September 2014 of shelf prices of infant milk formula products on offer in Chinese stores: namely CNY 235 for a standard 900g container. Three different price attribute levels with 20% increments, namely 100%, 120% and 140% of the average price of infant formula were selected to be included in the experiment because of the high variation in the observed prices between the various products on offer. However, these levels were found during pre-testing to be insufficient to identify willingness-to-pay thresholds, so were increased in the choice sets that were offered to participants so that price attribute levels were 100%, 130% and 160% of the average observed price. Price levels were presented in the Chinese currency (CNY) per 900g. An example of one choice set is presented in Figure 1.

Figure 1. About here**3.2 Sample**

An initial pilot survey was conducted in September 2015 in Switzerland (n=8) to evaluate the comprehensibility and time required for completion. A revised survey was piloted in three Chinese cities; Beijing, Guangzhou and Chengdu, by the social research agency Millward Brown in October 2015 (n=51). These cities are located in the North, South and West of China respectively. Beijing and Guangzhou are first tier cities, which represent the most economically developed regions in China with the most affluent consumers. Chengdu is a second tier city. Such cities are typically capital cities of a province and are considered to be developing economically, with consumer trends following those of the first tier cities. These cities were chosen as their populations differ with regard to socio-economic factors, and thus represent a wide range of consumers in higher socio-economic groups. Respondents in higher socio-economic groups are the target group of this research because they are potential purchasers of imported infant formula, which carries a significant price premium. This deliberate sampling of respondents from higher socio-economic groups should be kept in mind when interpreting the results of this study.

The final survey was conducted in Beijing, Guangzhou and Chengdu by Millward Brown in November 2015 (n=350). Survey participants were equally distributed across the three cities and had been living for at least 3 years in the city in which they were sampled. The sample was approximately evenly divided according to gender and was stratified so that 50% of the respondents were aged between 18 and 35; and 50% of the respondents were aged between 36 and 55. The minimum household income for eligibility to participate in the survey was 8,000 RMB in Chengdu and in 10,000 RMB in Beijing and Guangzhou. Participation eligibility was also dependent on the respondent having purchased infant formula within the three months prior to sampling (Table 2).

The research team provided guidelines to Millward Brown to ensure that sample selection was conducted according to the appropriate, rigorous scientific standards. The following guidelines were applied to select potential survey participants. In total, 50% of the respondents were aged between 18 and 35, and the remainder were aged between 36 and 55. The sample was evenly divided according to gender (50% of the respondents were male, 50% were female). Citizens of the three cities Beijing, Guangzhou and Chengdu were selected for the quantitative survey. Potential participants were required to have been living for at least 3 years in the city in which they were sampled. These cities were chosen as their populations differ with regard to socio-economic factors and thus represent a wide range of consumers in higher socio-economic groups: the target group of this survey. Survey participants were equally distributed across the three cities. Participants who were employed or had a family member who was employed in advertising/promotion, market research/marketing/consulting, radio/TV/newspaper/magazine, public relations, manufacturers/wholesale/retail of food and drink were excluded from the survey. To screen potential survey participants with regard to whether they were buyers of (or intended to buy) infant milk formula, participants were shown a list of different products and asked to nominate which of the products they had purchased in the previous six months or intended to purchase within the following three months. If infant milk formula was selected, the respondent was selected to participate in the survey.

Table 2. About here**3.3 Econometric modelling of heterogeneous consumers' choices using LCA**

Latent class analysis (LCA) allows the measurement of heterogeneity in consumers' preferences by using observed variables to sort individuals into a number of latent classes; in this case, each composed of a homogeneous group of consumers (Boxall & Adamowicz, 2002).

In LCA an individual i belongs to class q with probability w_{iq} (Sarrias and Daziano, 2015):

$$\beta_i = \beta_q \text{ with probability } w_{iq} \text{ for } q = 1, \dots, Q, \quad (3)$$

where $\sum_q w_{iq}=1$ and $w_{iq} > 0$. The most widely used formulation for w_{iq} , i.e. the class assignment probability which is unknown to the researcher, is the semi-parametric multinomial logit format (Greene and Hensher, 2003, Shen, 2009):

$$w_{iq} = \frac{\exp(h_i \gamma_q)}{\sum_{q=1}^Q \exp(h_i \gamma_q)}; q = 1, \dots, Q, \quad \gamma_1 = 0, \quad (4)$$

where h_i denotes a set of socio-economic characteristics that determine assignment to classes. The parameter of the first class are normalized to zero for identification of the model.

In the basic latent class model, i.e. if no additional independent variables are considered in the class assignment, every observation (individual) has the same probability of belonging to each latent class prior to observing the responses to the manifest variables (Linzer & Lewis, 2007). In the extended version used in this study, these prior probabilities vary by individuals as a function of the socio-demographic characteristics of the respondents (see section 2.2).

The socio-demographic characteristics included in the extended latent class model were: gender (nominal scaled, dummy coded, male as the base category); age (in years); household income (ordinal scaled in four income classes with the lowest (8000-9999 CNY) as the base category); education (ordinal scaled in five education classes with the lowest [senior high school] as the base category); and region (nominal scaled, 3 dummy variables with Beijing as the base category). The coefficients that were estimated for the second class (class 2) in the latent class model (shown in Table 4) were estimated in relation to the respective base categories.

In addition to the product attributes and socio-demographic variables, attitudinal variables were included in the latent class model. Sets of statements were formulated to elicit information with regard to food safety and risk, attitudes towards authenticity and perceptions of organic products, with responses on a seven point Likert scale. The means of the responses to these scale variables were used as three (dummy coded) variables: labelled 'risk perception', 'authenticity', and 'organic perception', and included in the latent class model. Consumers' experiences with counterfeited food products (binary scaled, dummy coded variable) was also included in the model, with the base category being a negative response to the question: "Have you ever bought baby milk formula and found that it is counterfeit?".

The number of classes has to be determined by the researcher, and is typically chosen on the basis of information criteria scores where the lowest score is considered best. Train (2003) suggests either the Akaike Information Criterion (AIC) or the Bayesian Information Criterion (BIC) to assist the determination of the number of classes. We use the BIC criteria for choosing the number of latent classes, which is the most conservative criteria in that it penalizes the most for additional parameters (Morey and Thacher, 2012). The latent class models were estimated using the package gnm1 (Sarrias & Daziano, 2015) of the R Development Core Team.

To provide economic information from the LCA results, willingness-to-pay (WTP) can be calculated for each of the product attributes, including the country of origin, labels and authenticity cues. This is done by dividing the parameter estimate of each product attribute by the estimated price coefficient. The WTP for each of the product attributes provides information for the infant milk industries on valuable strategies of product declaration.

4. Results

4.1 Descriptive statistics

Table 3 summarises the judgements of Chinese consumers on seven questions related to risk perception, on three questions related to food authenticity and two questions related to organic products.

The results show that Chinese consumers are highly concerned about most of the food safety and quality problems presented in this study. Consumers are marginally less worried with regard to genetically modified and mis-described food and drinks. The results furthermore show that Chinese consumers believe that food authenticity is a highly relevant issue, which will become more important in the future. As compared to the other two authenticity statements, consumers are marginally less confident that they will only buy authentic food in the future. In general, consumers perceive organic food as being very safe and trustworthy.

Table 3: About here

Responses to the different statements were compared between men and women using a Mann Whitney U test. On average, women were more concerned about food safety risk compared to men. This is true for all statements, with the exception of risks related to residues, counterfeit or adulterated infant milk formula, where gender differences were not observed. For all statements related to the authenticity of infant milk formula, women showed significantly higher agreement scores compared to men. Furthermore, women perceived organic products as being safer and more trustworthy than did men.

To test for significant correlations between age and education and the average risk scores, authenticity scores and organic perception scores, Pearson correlations were applied. The analysis shows that age is significantly, positively correlated to average risk perception (cor: 0.07, p-value: <0.001), average authenticity perception (cor: 0.13; p-value:<0.001) and the perception of organic food (cor: 0.21, p-value:<0.001). The correlations, however, are rather small. For education, the Pearson correlations show that more highly educated people perceived less risk (cor: -0.10, p-value:<0.001), perceived authenticity as less important (cor: -0.13, p-value: <0.001), and perceived organic food as being not necessarily more trustworthy or safer (cor: -0.15, p-value: <0.001) when compared to less educated persons. Again, the correlations are rather small.

Kruskal Wallis tests showed that differences in the perceived risk, authenticity and perception of organic products between participants from Beijing, Guangzhou and Chengdu could be identified. . Subsequent Whitney U tests revealed that participants from Chengdu held significantly higher risk perception and authenticity scores than participants from Guangzhou, followed by participants from Beijing. With regard to the perception of organic food, no differences were found between Chengdu and Beijing. Participants from both Chengdu and Beijing, perceived organic food as being significantly more trustworthy and safer than participants from Guangzhou.

Survey participants were asked whether they had previously bought a product and found that it is counterfeit. In total, 24% of all survey participants had previously bought infant milk formula and later discovered that it was counterfeit. Even if the judgements of the different food risks presented are very similar across survey participants, Wilcoxon rank-sum test results show that consumers who had previously bought counterfeit infant milk formula were significantly more worried about most of the presented food risks. This is true for the statement about the worries regarding inferior quality and residues in food and drink, and worries about adulterated or deteriorated food and drink. Interestingly, participant who had not previously bought counterfeit infant milk formula were significantly more worried about counterfeit or miss-described products. No differences were

observed between participants in relation to the statement about genetically modified food and drink. With regard to the questions on food authenticity, the results indicate that, for all three statements, that respondents who had previously bought a counterfeit product perceive food authenticity as significantly more important when compared to persons who had not bought a counterfeit product previously. Respondents who had bought a counterfeit product previously furthermore perceived organic products as safer and more trustworthy when compared to respondents who had not bought a counterfeit product previously.

4.2 Consumer segmentation by latent class analysis and willingness to pay

Socio-economic and attribute variables were varied across latent classes of the regression model to detect differing segments and, based on the BIC criteria, two latent classes were chosen for our model¹. The estimated coefficients for the different product attributes and the respondents' characteristics are shown in Table 4. The estimated scores for the socio-demographic, attitudinal, and experience characteristics in class 2 are related to those in class 1, which serves as baseline and thus includes no scores. The estimates for country of origin, labels and authenticity cues show the expected positive marginal utility. In contrast, the price effect differs between classes, with one class showing a negative price effect and the other a positive price effect. The respondents' risk perception, the perception of organic products and the respondents' city, i.e. the city where the respondent lives, were found to be useful in predicting class membership. In contrast, household income, the respondents' education level, gender, age and the perception of the importance of food authenticity were not useful for predicting class membership.

Respondents belonging to segment 1 (Latent Class 1) took the PDO and Chinese organic label into account when making product choices. Even if the coefficient for the PDO label is higher than the coefficient for the organic label, a z-test does not show significant differences suggesting that Chinese consumers do not have a clear preference for one or the other label. In addition, all of the authenticity cues were important for decision-making, with the security code being rated as the most important of the authenticity cues. In contrast, the product's country of origin did not influence segment 1 respondent's decisions. Respondents in this segment preferred lower priced over higher priced infant formula products.

Respondents in segment 2 (Latent Class 2) were found to be significantly and positively influenced by information about the product's origin, the PDO and organic label and all of authenticity cues presented in this study. When compared to the other authenticity cues, the hologram sticker was found to be of lowest importance for their product choices, with the QR code being of highest importance. Respondents in this segment preferred infant formula with declared information on the country of origin, and preferred higher priced over lower priced products. Respondents in this segment reported having had experiences with counterfeit products more often, perceived food risks as more problematic, and had a higher preference for organic products than segment 1. Furthermore, these respondents were less likely to be from Chengdu as compared to Beijing (the baseline region in our model).

Table 4: About here

In Table 5, the willingness to pay (WTP) estimates for the different product attributes are presented. It shows that WTP differs considerably between product attributes and between consumer

¹ BIC value for model with two latent classes: 4771; BIC value for model with three latent classes: 4823

segments. For instance, the first consumer segment was willing to pay additional 105 CNY for 900 g PDO labelled infant milk formula, while the additional WTP within the second consumer segment was only 69 CNY for the PDO labelled product.

Table 5: About here

5. Discussion

For reasons of brevity, we refer to the participants of the study as ‘consumers’, but the sampling method in which participants were deliberately sampled from a relatively high socio economic group should be considered when interpreting these results. The choice experiments show that infant formula associated with a PDO label have a significantly higher probability of being chosen by Chinese consumers compared to infant formula without this label. A system of convincingly guaranteeing the origin of infant formula, such as a PDO label, could therefore be an important tool for European exporters to influence consumer decision-making. It should be kept in mind that all respondents in this study had been informed of the background and meaning of the PDO label, so we add the proviso that this finding applies *when* consumers are informed about the meaning of the label. Even though consumers perceive organic products to be very safe and trustworthy, the Chinese organic label was found to have less influence than the PDO label on consumer choice of infant formula. A possible explanation for this result could be that any Chinese certification reflects a lack of trust on the part of Chinese consumers in domestic food supply chains. For instance, Liu et al. (2014) and Knight et al. (2008) showed that consumers have a deeply rooted lack of trust in the domestic Chinese food chain, which was aggravated by the perceived lack of governance and regulation of the Chinese food industry: a position reinforced by multiple food scandals (Liu et al., 2014; Ortega et al., 2011; Feng et al., 2009; Zhang et al., 2012). Our results suggest that this mistrust in the infant formula food chain does not extend to foreign markets, and that Chinese consumers have greater levels of trust in the European supply chain and its regulations, including the PDO label.

The Chinese national organic label was introduced in the survey to allow comparison between European and Chinese third party certification, but there is not yet an established record keeping and/or traceability system implemented to guarantee the integrity of organic food across the supply chain. A lack of trust in the governance of food supply chains, including the food safety inspectorate, suggests that more transparency may be required on how food quality and safety is guaranteed throughout the whole food supply chain. This finding is in agreement with the results of Yin et al. (2010), who suggested that there was a need to establish and perfect the supervision system of organic food in China. This result suggests that the Chinese organic label will have less influence on consumer choice than the PDO label, a challenge for future research might be to compare the influence of the PDO label to an organic label from another country, instead of the Chinese organic label that was used in this study. The finding that the respondents in segment 1 do not take the product’s origin into account when making product choices and prefer cheaper over more expensive products, yet take PDO and organic labels into account in their decision-making, suggests that it is the external validation represented by the certification process that conveys trust rather than the attribute to which the certificate attests.

All of the authenticity cues that were assessed in the experimental design, namely security packaging, hologram sticker and QR codes, were found to be highly important as information sources for Chinese consumers when making purchase choices for infant formula. This result suggests that authenticity cues on packaging will convey a similar degree of confidence as labels indicating third party inspection. This was especially the case for consumers who reported having previously bought a counterfeit product, and who gave a higher value to authenticity cues than consumers who had not experienced a counterfeit product previously. Furthermore, the choice experiments indicate that all

of these three authenticity cues have a positive effect on consumer choices for infant formula, but that hologram stickers are, *ceteris paribus*, less likely than the other authenticity cues to have a positive effect on the consumer decisions regarding a product. However, authenticity cues will only be effective if the consumer knows which cues to look for. At the same time, informing consumers means also informing the fraudsters, who would then know which cues to replicate. It may be that consumers perceive authenticity cues as being primarily intended to be used by inspectors, but that their presence gives the consumer a sign that somebody is taking care that the products are authentic.

For most product choices, price negatively affects the buying decision, meaning that an increase in prices reduces the demand for the product. However, the results in this study showed that two consumer segments exist. While one consumer segment prefers lower priced over higher priced products, the other consumer segment reacts positively to price increases, which indicates that this segment prefers more expensive infant formula products, regardless of other product attributes. This result suggests that price serves as a quality cue for some consumers, and supports the findings of Rao and Akshay (2005), and Ritson and Petrovici (2005), that higher prices can be used as a signal for higher food quality. This finding aligns with those of Ortega et al. (2011), who found that Chinese consumers are willing to pay a high premium to assure that their food is safe, and of Qiao et al. (2012) and Gong (2003), who reported that the purchase of expensive products reflects the Chinese people's belief that cheap products are inferior. Consumers who use price as a quality cue also prefer products for which information on the country of origin is available. These consumers are likely to have previously bought counterfeit infant formula products and are more averse to food risks. In addition, consumers in this group perceive organic food as being significantly safer and more trustworthy than do consumers who prefer less expensive products. This segment is likely to live in a city and have higher household incomes, i.e. from Beijing rather than from Chengdu, which suggests that household income influences the preference for more expensive infant formula. There were no significant differences between consumer segments on the basis of age, gender, education or the perception of food authenticity.

The results of this study are subject to three limitations and should be interpreted with these limitations in mind. Firstly, the sample was not selected to represent a cross section of the Chinese population, but instead to represent the population segment with a relatively high socio-economic status who can afford to buy European products. Secondly, the same order of attributes was used for all choice sets, and thus were presented in the same place on the survey. Eye tracking has shown that this will tend to favour some positions more than others (see e.g. Orquin and Mueller Loose, 2013). Thirdly, our results are derived from hypothetical settings with controlled variables, so no definite guidance can be given to the infant milk industry on which authenticity cues should preferably be used by the infant formula industry. However, the results provide give insight into the relative importance of these single product attributes under controlled conditions, and suggest the added value of these authenticity cues in a real purchase situation.

6. Conclusions

The research presented here suggests that, eight years after the initial discovery of melamine in Chinese dairy products, and independent of most socio-demographic factors, Chinese consumers' choices for infant formula are still driven by mistrust in the safety of domestic supply chains. The results of our study show, that infant formula is chosen based on product cues such as labels and authenticity cues and, if household income is high enough, consumers use price as a quality cue and prefer more expensive products. Relying on price as a quality cue however, increases the risk of counterfeit infant formula, as high premiums can be placed on the product without changing the quality control system. This situation can provide incentives for counterfeit products or repackaging.

On the other hand, the positive willingness to pay for each of the product authenticity cues suggests that consumers will expect some guarantees that the more expensive products that they prefer are indeed of higher quality and safety. This last finding provides important information for the infant milk food industries on valuable strategies of product declaration.

The responsiveness of Chinese consumers to certified products is very high and the establishment of a quality control system has the potential to increase Chinese consumers' trust in food value chains and the demand for infant formula from the domestic Chinese market. Although the case selected, infant formula, may be a specific focus of consumer concern because the consequences of this particular food fraud have been extremely serious in the past, and have affected a particularly vulnerable and dependent group within the population, the authors believe that the results can be extrapolated to other products in regard to both safety and quality attributes. This control system should comprise the whole food supply chain, from production to marketing, and should in particular focus on communicating authenticity.

Another key finding from this study was that awareness of food risk and food authenticity, and the perceived importance of different authenticity cues were different between regions. Knowledge of regional differences is therefore of fundamental importance if appropriate policy and private actor measures are to be developed. The study found that experience with counterfeit products is important in consumer choices, but effective measures should reduce the frequency of contact with counterfeit products, and thereby increase trust in the effectiveness of policy or private sector measures. Until then, the demand for foreign products in the Chinese infant formula market will remain strong. Manufacturers would be well advised to continue to communicate the authenticity of their products by means of authenticity cues, such as holograms and QR codes, and also to continue to ensure that their products cannot be tampered with between production and the point of sale.

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Figure 1. Example of a choice set

	Option 1	Option 2	Option 3
Geographical origin	Produced and packed in China	Produced in Europe, packed in China	Produced and packed in Europe
Protected Designation of Origin (PDO) label			No PDO label
The Chinese national organic label	No organic label		No organic label
Hologram sticker	No hologram sticker
Security packaging	No security packaging
QR (quick response) code			No QR code
Price	250 CNY/ 900g	400 CNY/ 900g	325 CNY/ 900g
Your choice:	☐	☐	☐

☐ None of these options

Table 1. Product attributes and attribute levels

Product attribute	Attribute levels
Price	1=250 CNY/900g; 2= 325 CNY/900g; 3= 400 CNY/900g
Origin	1= produced and packed in China; 2= produced in Europe, packed in China; 3=produced and packed in Europe
PDO (Protected designation of origin)	0= no; 1= yes
ORG (organic)	0= no; 1= yes
Hologram sticker	0= no; 1= yes
Security packaging	0= no; 1= yes
QR code	0= no; 1= yes

Table 2. Sample statistics

Socio-demographic information		No of observations (n=350)	Percentage
Gender	Male	162	46.3
	Female	188	53.7
Age	Years	Mean: 35; Min/Max: 18-55	
Household income	8000-9999 CNY	18	5.1
	10000-14999 CNY	115	32.9
	15000-19999 CNY	118	33.7
	≥20000 CNY	99	28.3
Education	Senior high school	5	1.4
	Technical school	5	1.4
	2-3 years of College	35	10.0
	University	273	78.0
	Graduate degree or above	32	9.1
Region	Beijing	122	34.9
	Guangzhou	124	35.4
	Chengdu	104	29.7

Table 3. Perception of Chinese infant milk formula consumers on risk, authenticity and organic foods

Survey questions	mean	sd
For me and my family, I am worried about (1=completely disagree and 7= completely agree with the statement)		
Counterfeit food & drink	6.063	1.215
Deteriorated food & drink (for example, mould and bacteria)	6.014	1.189
Inferior quality food & drink	6.063	1.179
Adulterated food & drink (for example: tainted food & drink, food & drink that has been diluted or had chemicals added)	6.054	1.178
Food & drink containing residues of pesticides or veterinary drugs	6.051	1.148
Food & drink that has been mis-described	5.691	1.182
Genetically Modified food & drink	5.754	1.277
Average across all food risk related questions	5.956	1.000
The next question is about your attitudes and intentions towards authenticity. Please tell me the extent to which you agree/disagree with the following statements: (1=completely disagree to 7= completely agree with the statement)		
I think that signals or guarantees of authenticity for food will become more important in the future.	6.103	0.869
I will encourage my family and friends to look for information about the authenticity and safety of food and drinks in the future.	6.100	0.878
I only buy food that I am confident is authentic.	5.757	0.992
Average across all authenticity related questions	5.987	0.771
In your opinion how safe are organic foods? (1 = unsafe to 7 = completely safe)	5.814	0.899
In your opinion how trustworthy are organic foods? (1 = completely untrustworthy to 7 = completely trust worthy)	5.814	0.870
Average across the two organic questions	5.814	0.831

Table 4: Results of the latent class analysis

	Latent Class 1			Latent Class 2		
	coef	sd	z-val	coef	sd	z-val
Origin	0.124	0.221	0.560	0.296***	0.051	5.760
PDO	0.998***	0.264	3.774	0.334***	0.068	4.903
ORG	0.686***	0.258	2.656	0.313***	0.063	4.986
Hologram	0.598**	0.265	2.258	0.115*	0.065	1.781
Security	1.119***	0.270	4.148	0.259***	0.067	3.849
QR code	0.549**	0.274	2.001	0.368***	0.085	4.332
Price	-0.010***	0.002	-4.282	0.005***	0.001	4.999
Income				0.142	0.104	1.369
Education				0.241	0.150	1.614
Female				0.130	0.168	0.775
Age				0.009	0.013	0.672
Counterfeit				0.728**	0.286	2.547
Risk perception				0.163*	0.086	1.896
Authenticity				-0.026	0.127	-0.205
Organic perception				0.978***	0.100	9.795
Guangzhou				0.001	0.219	0.005
Chengdu				-0.457**	0.219	-2.087
LC2				-6.931***	1.494	-4.640
LogLikelihood	-2289.9					
No of observations	2100					

*, **, *** denote significance at the 10%, 5%, and 1% significance level respectively

Table 5. Willingness-to-pay estimates

	Latent Class 1	Latent Class 2
Country of origin	12.95	60.99
PDO label	104.56	68.94
Chinese organic label	71.82	64.53
Hologram sticker	62.66	23.79
Security packaging	117.23	53.45
Quick response code	57.49	75.94

Highlights:

- Chinese consumers mistrust domestic food supply chains for infant formula.
- Chinese consumers will pay a premium for authenticity cues and European products.
- Authenticity cues give assurance: especially when associated with 3rd party controls.

ACCEPTED MANUSCRIPT