Demand for milk quantity and safety in urban China: evidence from Beijing and Harbin*

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Urban households account for most of the milk consumption in China, but their consumption is hampered by safety concerns. Using survey data collected in Beijing and Harbin in 2010, this paper simultaneously analyses urban households' milk consumption using a multiple linear model and their willingness-to-pay for milk safety using an ordered choice model. The results of this study show that as income increases, urban households consume more milk and are willing to pay a higher premium for milk safety. Modern food marketing channels play a positive role in stimulating milk consumption and building consumers' confidence in milk safety. The growth in the elderly population influences milk consumption positively, but their demand for milk safety is negatively affected by higher price. The combined analysis of households' demand for milk quantity and safety may be useful to the Chinese government in promoting the development of the domestic milk industry and to dairy firms in exploring the milk market in China.

Key words: China, food safety, milk consumption, ordered choice model, willingness-to-pay.

1. Introduction

Milk consumption in urban China accounts for over 90 per cent of milk consumption of the entire country (Dong 2006). It has experienced rapid growth since 1990s, with per capita consumption of fluid milk in urban China increasing from 4.62 kg in 1995 to 18.83 kg in 2004 (Ministry of Agriculture of China (MOA) 2012). Several mutually reinforcing factors contributed to this rapid growth of milk consumption, including rising incomes, changing urban lifestyles, the development of more sophisticated marketing channels and government promotion of the domestic dairy industry (Fuller *et al.*

2006). However, the growth of milk consumption has stagnated since 2005, and per capita fluid milk consumption of urban households even declined to 13.98 kg in 2010, mainly because of food safety problems (Liu and Li 2011; MOA 2012). Food safety concerns in Chinese domestic markets emerged at the beginning of the 21st century, escalated and fuelled by a string of incidents involving food poisoning, illegal use of harmful dyes or additives in food products, and sale of fraudulent or expired food products (Wang *et al*. 2008). The Sanlu melamine-tainted milk scandal in 2008 led to a significant decline of 14.42 per cent in per capita fluid milk consumption by urban households (MOA 2012) and evoked widespread public concern about milk safety. On the supply side, after the milk scandal, both dairy participation and herd size of dairy farmers declined (Jia *et al*. 2012), and the dairy production structure changed substantially (Mo *et al*. 2012).

At present, per capita milk consumption in China is still much lower than in developed countries. This implies that China has a huge market potential for milk consumption, which provides good opportunities for the development of domestic dairy firms as well as for the expansion of international dairy trade. However, milk safety problems remain unresolved, causing Chinese consumers to be more cautious about their milk purchasing decisions than ever and hampering market development. Therefore, the further development of the domestic dairy industry, market expansion in China by multinational dairy firms and the effectiveness of government promotion of the development of milk industry all depend largely on a deeper and more comprehensive understanding of consumers' demand for milk quantity and safety.

Previous researchers (e.g. Heien and Wessells 1988; Cornick *et al*. 1994) used survey data and econometric models to study the milk consumption behaviour of urban households. Fuller *et al*. (2007) used a double-hurdle model to analyse determinants influencing urban households' consumption of four dairy products (fresh milk, yogurt, ice cream and powdered milk) in Beijing, Shanghai and Guangzhou. Bai *et al*. (2008) adopted a Tobit model to analyse the influences of socio-demographic characteristics of urban consumers on their fluid milk consumption in Qingdao. These studies indicated that income, milk price and marketing channels significantly influenced milk consumption of urban households. In addition, Yen *et al*. (2004) and Zheng and Henneberry (2009) used urban household survey data from the China National Bureau of Statistics and the Almost Ideal Demand System (AIDS) model to study the demand of urban households for food (including milk) in China and in Jiangsu Province, respectively. These studies analysed milk consumption and its determinants, but paid little attention to consumers' demand for milk safety.

Studies on milk safety (e.g. Bernard and Bernard 2009) focused on estimating consumers' willingness-to-pay (WTP) for milk safety. Wang *et al*. (2008) investigated consumers' WTP for HACCP-certified milk in Beijing and found that after receiving information on HACCP nearly all respondents were willing to pay a modest premium for HACCP-certified milk. Zhang

et al. (2010) analysed how consumers in Beijing determined milk safety and found that brand and purchase venue were ranked as the two most important safety indicators. Using UHT milk as an example, Ortega *et al.* (2011) evaluated urban consumers' WTP for food safety attributes and found that they considered government certification most significant, followed by national brand and nongovernment certification. In sum, the previous studies on milk consumption and milk safety have been performed independently, and studies that combine analysis of milk quantity and milk safety are still lacking.

A better understanding of milk consumption behaviour is important not only for the Chinese government to design effective policies for the milk industry but also for domestic and foreign dairy firms to occupy the China milk market. The primary goal of this study is to provide a combined analysis of factors that influence urban consumers' demand for milk quantity and safety. The remainder of this paper is organised as follows. Section 2 presents the data, models and variables used. Section 3 discusses the regression results. The paper concludes with a summary of the main findings and a brief discussion of future research.

2. Methodology

2.1. Data

The survey data used in this study were collected in urban areas of Beijing and Harbin in October 2010 using the stratified random sampling method. The specific sampling procedures are as follows. First, typical urban districts of the two cities were determined. Five urban districts (Dongcheng, Xicheng, Haidian, Chaoyang and Fengtai) in Beijing and four districts (Nangang, Daoli, Daowai and Xiangfang) in Harbin were selected. Secondly, in each district, two communities were randomly selected. Finally, in each community, about 20 households were randomly chosen from the households that were included in the Urban Household Income and Expenditure Survey conducted by National Bureau of Statistics of China. The urban households that had purchased and consumed milk were further interviewed, and others were excluded from the sample. The survey was designed to collect information on milk consumption and WTP for milk safety of urban households. The person most familiar with food shopping and milk consumption in each household was interviewed. In total, the sample consisted of 360 urban households, 200 from Beijing and 160 from Harbin.

Two variables, that is, household size and per capita annual disposable income, which are important indicators of household characteristics, are used to verify the representativeness of the sample. In 2010, the average urban household size was 2.80 persons in Beijing and 2.70 persons in Harbin, and the per capita annual disposable incomes of urban households

in the two cities were 29 073 RMB and 17 557 RMB, respectively. The sample means of household size in Beijing and Harbin were 2.88 persons and 2.76 persons, respectively, slightly greater than the population means. The sample means of per capita annual disposable income were 27,574 RMB in Beijing and 16 605 RMB in Harbin, slightly lower than the population level. However, the results of single sample *t*-tests of household size and per capita annual disposable income indicate that the differences of these variables between the sample and the population are not statistically significant, see Table 1. Therefore, the sample is well representative of the population.

2.2. Models and variables

A multiple linear model and an ordered choice model are used, respectively, to analyse determinants of urban consumers' demand for milk quantity and safety. The same explanatory variables were included in the two econometric models in order to conduct a combined analysis of their impacts on the demands for milk quantity and safety.

The multiple linear model is specified in semi-logarithmic form as Equation (1), where $\mathbf{x}_i$ is a vector of explanatory variables, $\boldsymbol{\beta}$ is a vector of coefficients and μ_i is an error term. The explained variable is the demand for milk quantity, which is measured by per capita milk consumption of urban households ($QUANTITY$).

$$\log(QUANTITY_i) = \mathbf{x}_i'\boldsymbol{\beta} + \mu_i \tag{1}$$

The ordered choice model has been widely applied to estimate equations with ordinal level dependent variables (McKelvey and Zavoina 1975; Train 2009). In the ordered choice model specified in this study, the explained

Table 1 Sample representative test

	Beijing				Harbin			
	Population mean	Sample mean	SD	*P* value†	Population mean	Sample mean	SD	*P* value†
Household size (persons)	2.80‡	2.88	0.98	0.25	2.70§	2.76	0.56	0.20
Per capita annual disposable income (RMB)	29,073‡	27,574	14,554	0.15	17,557§	16,605	9614	0.21

†Single sample *t*-tests were conducted to verify the representativeness of the sample. The null hypothesis is that sample mean is equal to population mean.
‡Data are from *Beijing Statistical Yearbook 2011* (Beijing Municipal Bureau of Statistics 2012).
§Data are from *Harbin Statistical Yearbook 2011* (Harbin Municipal Bureau of Statistics 2012).

variable is the demand for milk safety, measured by urban residents' WTP for milk safety (*SAFETY*). In China, safe food usually refers to hazard-free food, green food and organic food, all three of which are legally defined by the Chinese government (Liu *et al.* 2013). There are differences in the certification standards adopted to define hazard-free food, green food and organic food. The safety ranking of these three kinds of food gradually increases from hazard-free food, green food to organic food. Green food certification was chosen for this study to represent food safety, because in China green food is more widely recognised by domestic consumers (Liu *et al.* 2013) and the green food sector is more mature compared with hazard-free food and organic food sectors (Lin *et al.* 2009). Green food is certified by the China Green Food Development Center (CGFDC) which was established by MOA in 1992. The green food standard in China is based on the Codex Alimentarius Commission's standard and with reference to standards of developed countries, and meets the corresponding international standards in general.

A pilot survey was conducted in Beijing and Harbin prior to October 2010 when the final survey was conducted. In the pilot survey, we directly asked respondents about their WTP for milk with green food certification. We found that it was difficult for respondents to assign a figure to express their WTP. Therefore, to appropriately simplify the survey and to gain relatively reliable data on respondents' WTP, WTP for milk safety was classified into four categories, that is, a premium of 0 RMB/L, 0.5 RMB/L, 1.0 RMB and more than 1.0 RMB/L for the milk with green food certification compared with conventional milk, based on the results of the pilot survey. The value of *SAFETY* is assigned 0, 1, 2 and 3 correspondingly.

It is assumed that *SAFETY** is an unobservable latent variable of *SAFETY*. The relationship between *SAFETY* and *SAFETY** is shown as Equation (2), in which $c_1 < c_2 < c_3$ are the unknown threshold parameters. *SAFETY** is determined by Equation (3), where $\mathbf{x}_i$ is a vector of explanatory variables, γ is a vector of coefficients and ε_i is an error term. γ and $\mathbf{c}$ can be estimated by maximising the logarithmic likelihood function of Equation (4). $1(SAFETY_i = j)$ is an indicator function, where $1(SAFETY_i = j) = 1$ when $SAFETY_i = j$, otherwise $1(SAFETY_i = j) = 0$. After obtaining the estimates $\hat{\gamma}$ and $\hat{c}$, the marginal effects of explanatory variables on the probability $\text{Prob}(SAFETY = j | \bar{\mathbf{x}})$ could be calculated using Equation (5) when $\mathbf{x}$ equals $\bar{x}$.

$$SAFETY_i = \begin{cases} 0 & SAFETY_i^* \leq c_1 \\ 1 & c_1 < SAFETY_i^* \leq c_2 \\ 2 & c_2 < SAFETY_i^* \leq c_3 \\ 3 & c_3 < SAFETY_i^* \end{cases} \tag{2}$$

$$SAFETY_i^* = \mathbf{x_i'}\gamma + \varepsilon_i \tag{3}$$

$$L(\gamma, \mathbf{c}) = \sum_{i=1}^{n} \sum_{j=0}^{3} \log(\Pr ob(SAFETY_i = j | \mathbf{x_i})) \cdot 1(SAFETY_i = j) \quad (4)$$

$$\partial \Pr ob(SAFETY = 0 | \mathbf{x}) / \partial x_k = -\hat{\gamma}_k f(\hat{c}_1 - \mathbf{x}' \hat{\gamma})$$

$$\partial \Pr ob(SAFETY = 1 | \mathbf{x}) / \partial x_k = \hat{\gamma}_k f(\hat{c}_1 - \mathbf{x}' \hat{\gamma}) - \beta_k f(\hat{c}_2 - \mathbf{x}' \hat{\gamma})$$

$$\partial \Pr ob(SAFETY = 2 | \mathbf{x}) / \partial x_k = \hat{\gamma}_k f(\hat{c}_2 - \mathbf{x}' \hat{\gamma}) - \beta_k f(\hat{c}_3 - \mathbf{x}' \hat{\gamma})$$

$$\partial \Pr ob(SAFETY = 3 | \mathbf{x}) / \partial x_k = \hat{\gamma}_k f(\hat{c}_3 - \mathbf{x}' \hat{\gamma})$$

(5)

The explanatory variables selected and included in the above two models are income level (*INCOME*), milk price (*PRICE*), location of purchase (*SUPERMARKET*), proportion of children in the household (*CHILD*), proportion of the elderly in the household (*ELDERLY*), the experience of organic milk purchase (*ORGANIC*), proportion of milk expenditure in the household food budget (*EXPENDITURE*) and a city dummy variable (*CITY*). The definition and descriptive statistics of the variables used in this study are presented in Table 2. Two variables need further illustration. One is *SUPERMARKET*. Supermarkets play an important role in the development of China's dairy sector, not only improving dairy product distribution, but also creating opportunities for consumers (Hu *et al.* 2006). Fuller *et al.* (2007) found that supermarkets positively influenced milk consumption of urban households. Similar to Fuller *et al.*, a dummy variable was included to consider the effect of supermarkets on urban households' demand for milk quantity and safety. The other variable is *ORGANIC*. As mentioned above, organic food is certified with higher standards compared with green food. To a certain extent, the purchasing experience of organic food can be used to measure respondents' awareness of food safety, which is an important factor of milk demand especially for milk safety.

3. Results

3.1. Milk consumption and WTP for milk safety

The sample mean of per capita milk consumption was 78 kg in Beijing and 56 kg in Harbin, 5.6 times and 4.0 times the national level (13.98 kg). In 2010, per capita fluid milk consumption was 109 kg, 97 kg and 68 kg in Australia, the United States and the European Union, respectively (Food and Agricultural Policy Research Institute (FAPRI) 2011). Apparently, the milk consumption of urban households interviewed, particularly in Beijing, has already approached that in developed countries. However, the consumption levels of other dairy products such as butter and cheese in China were much lower than in developed countries. In 2010, per capita

Table 2 Definition and descriptive statistics of variables

Variables	Definition and unit	Sample mean	SD
Explained variable in milk quantity demand model			
QUANTITY	Per capita annual milk consumption of urban households (kg)	68.56	31.52
Explained variable in milk safety demand model			
SAFETY	Premium that urban households were willing to pay for green certified milk (0: 0 RMB/L; 1: 0.5RMB/L; 2: 1.0 RMB/L; 3: over 1.0 RMB/L)	0.70	0.67
Explanatory variables			
INCOME	Per capita annual disposable income of urban households (RMB)	22,699	13,717
PRICE	Average price of various milk purchased by urban households (RMB/L)	10.20	4.62
SUPERMARKET	Milk is mainly purchased in supermarket or not (0: NO; 1: YES)	0.84	0.37
CHILD	Proportion of children (under 18 years old) in urban households	0.0960	0.1489
ELDERLY	Proportion of the elderly (over 60 years old) in urban households	0.1214	0.2737
ORGANIC	The purchasing experience of organic milk by major shopper in urban households (−1: has purchased organic milk before but not now; 0: never purchase; 1: sometimes purchase; 2: only purchase organic milk)	0.31	0.60
EXPENDITURE	Proportion of milk expenditure in total food expenditure of urban households	0.0900	0.0534
CITY	An urban household is in Beijing or Harbin (0: Harbin; 1: Beijing)	0.56	0.50

consumption of butter and cheese were only 0.1 kg and 0.23 kg in China (FAPRI 2011).

It is necessary to point out that the milk consumption of urban households obtained in this study is much greater than the official data from MOA. According to MOA, in 2010, per capita fluid milk consumption was 22 kg in urban Beijing, ranking it fifth among all domestic metropolitan cities, and 15 kg in urban Harbin (MOA 2012). Our estimates of per capita milk consumption were higher, because the urban households that did not consume milk were not sampled in our survey but they were sampled in the MOA statistics, and the milk in our survey included both fluid milk and

yogurt, which were treated separately by MOA. However, the estimates of per capita fluid milk consumption in this study are similar to Fuller *et al.* (2007) and Bai *et al.* (2008). Fuller *et al.* found that in 2002 per capita fluid milk consumption in urban Beijing, Shanghai and Guangzhou reached 57 kg, 51 kg and 27 kg respectively. Bai *et al.* found that per capita consumption of fluid milk in urban Qingdao in 2005 was 67 kg.

Regarding milk safety, about 90 per cent of the respondents paid attention to green food certification, but only 58 per cent were willing to pay a premium for green certified milk. To be specific, 47 per cent and 11 per cent were willing to pay a premium of 0.5 RMB/L and of 1.0 RMB/L for green certified milk, respectively, and only one respondent was willing to pay a premium of over 1.0 RMB/L. The sample mean of milk price was 10.20 RMB/L (see Table 2). The above three premiums were 5 per cent, 10 per cent and over 10 per cent of the average milk price, respectively. Obviously, there was limited space for raising the premium for milk safety. In addition, the average milk consumption of the respondents' willing to pay a premium of 1.0 RMB/L was 84.75 kg, significantly greater than that of other respondents. The average milk consumption of the respondents' willing to pay a premium of 0.5 RMB/L (68.43 kg) was not statistically different from that of the respondents' unwilling to pay any premium (64.37 kg).

3.2. Regression results

The multiple linear model for milk consumption and the ordered choice model for milk safety were estimated using EViews version 7.0. Estimation results are presented in Table 3. For the milk consumption model, the statistical significance of the model was examined by using an F test of the null hypothesis that all slope coefficients are zero. The F statistic of 75.40 indicates rejection of this hypothesis. The robust t-values further indicate that all explanatory variables except *ORGANIC* are significantly different from zero. The adjusted R^2 is 0.62, implying that more than 60 per cent of the variation in milk consumption is explained.

In the milk safety model, the LR-value is 72.76, and thus the null hypothesis that all slope coefficients are zero is rejected. The z-values indicate that five explanatory variables, *INCOME*, *SUPERMARKET*, *ELDERLY*, *EXPENDITURE* and *ORGANIC*, significantly influence WTP for milk safety. Table 4 presents the marginal effects of these variables computed by using Equation (5). The estimates of the three thresholds (c_1, c_2, c_3) are all statistically significant. The correct prediction ratio of the model is 54 per cent, implying that WTPs for milk safety of over half of urban households interviewed are correctly predicted.

In the milk consumption model, the estimated coefficient on *INCOME* is positive and significant at the 1 per cent level. The income elasticity is 0.45. The estimated coefficient on *PRICE* is negative and significant at the 1 per cent level. The price elasticity is −0.57, implying that milk consumption is

Table 3 Regression results for milk demand of urban households

	Milk quantity demand model		Milk safety demand model	
	Coefficient	t-statistics	Coefficient	z-statistics
Log (*INCOME*)	0.450***	12.39	0.663***	2.75
Log (*PRICE*)	−0.566***	−11.68	0.109	0.39
SUPERMARKET	0.101*	1.85	−0.842**	−2.55
CHILD	0.546***	4.63	0.898	1.18
OLD	0.121*	1.92	−0.823*	−1.87
ORGANIC	0.033	1.40	0.985***	5.17
EXPENDITURE	4.243***	10.11	−7.542***	−3.25
CITY	0.082*	1.95	0.270	0.89
INTERCEPT	0.352	1.03	—	—
Threshold 1 (c_1)	—	—	5.419***	2.34
Threshold 2 (c_2)	—	—	8.162***	3.49
Threshold 3 (c_3)	—	—	12.160***	4.75
	F statistic	75.40	LR statistic	72.76
	Adjusted R^2	0.624	Pseudo R^2	0.103
			Correct prediction ratio	54.44 per cent
	Sample size	360	Sample size	360

***Significant at the 1% level; **Significant at the 5% level; *Significant at the 10% level.

inelastic. Milk consumption is also affected by *SUPERMARKET*. The urban residents who usually bought milk in supermarkets consumed about 10 per cent more than other urban residents, suggesting that the development of modern marketing channels (e.g., supermarkets) played a positive role in increasing urban households' potential for milk consumption. The estimated coefficients for *CHILD* and *ELDERLY* are both positively significant, reflecting that children and the elderly consumed more milk than other urban residents. This is mainly because the health problems of children and the elderly are receiving much more attention and it is generally believed that drinking milk is helpful for these groups to assimilate nutrients (e.g. calcium). *EXPENDITURE* also significantly influenced milk consumption. The proportion of milk expenditure in total food expenditure reflected urban residents' awareness of the importance of milk in the diet. The more that people believe the nutritional value of milk to be, the more milk they tend to consume.

Table 4 The marginal effects of explanatory variables on milk safety

	Log (*INCOME*)	*SUPERMARKET*	*OLD*	*ORGANIC*	*EXPENDITURE*
$\partial \Pr{ob}(SAFETY = 0)/\partial \bar{x}$†	−0.1655	0.2102	0.2054	−0.2461	1.8836
$\partial \Pr{ob}(SAFETY = 1)/\partial \bar{x}$	0.1299	−0.1650	−0.1613	0.1932	−1.4787
$\partial \Pr{ob}(SAFETY = 2)/\partial \bar{x}$	0.0348	−0.0443	−0.0433	0.0518	−0.3966
$\partial \Pr{ob}(SAFETY = 3)/\partial \bar{x}$	0.0007	−0.0009	−0.0009	0.0011	−0.0083

†$\bar{x}$ is the vector of the sample means of explanatory variables.

In the milk safety model, *INCOME* significantly influenced urban residents' WTP for milk safety. As income increases, urban residents can afford and are more willing to pay a premium for milk safety. If the income of urban households increases by 1 per cent, the probability of paying a premium for milk safety will increase by 0.1655. Specifically, the probability of paying a premium of 0.5 RMB/L, 1.0 RMB/L and over 1.0 RMB/L will increase by 0.1299, 0.0348 and 0.0007 times, respectively. *SUPERMARKET* also affected urban residents' WTP for milk safety. Urban residents who purchased milk mainly in supermarkets were less likely to pay a premium for milk safety. This is because they trusted the quality of milk in supermarkets and believed that it was unnecessary to pay a higher price for higher quality. *ELDERLY* is found to negatively influence urban residents' WTP for milk safety. The elderly have lower incomes after retiring, but they are experienced shoppers and have abundant time for shopping. Therefore, they utilised their shopping experience and retirement time to investigate and ascertain milk safety, rather than simply paying a higher price. *ORGANIC* had a positive impact on milk safety. Certification guarantees the quality of organic milk. Although the price of organic milk was higher than conventional milk, the marginal utility of organic milk to urban residents was even greater. Thus, they were reluctant to pay a premium for milk safety. In addition, *EXPENDITURE* had a relatively small impact on urban residents' demand for milk safety.

There is a noticeable similarity among the impacts of explanatory variables on urban residents' demand for milk safety, that is, their marginal effects decrease as the premium increases. Take *INCOME* as an example. When income increases by 1 per cent, the probability that urban residents are willing to pay a premium of 0.5 RMB/L for milk safety will increase by 0.1299, and the increase in the probability of paying a premium decreases to 0.0348 for a premium of 1.0 RMB/L and to only 0.0007 for a premium of over 1.0 RMB/L.

Several meaningful findings could be obtained when a combined analysis is conducted on the impacts of explanatory variables on urban residents' demand for milk quantity and safety. First, as income rises, urban households will not only consume more milk but also demand more safety. This implies that the high-quality milk will account for a larger proportion in milk consumption. Second, the expansion and maturation of modern marketing channels may reduce the price of goods and the information asymmetry of food safety, which is helpful for increasing urban residents' demand for milk quantity and quality simultaneously. Third, as the proportion of elderly increases, milk consumption will increase, but it is not possible to attract the elderly to purchase high-quality milk at higher prices.

4. Discussion and conclusions

This study analyses urban households' demand for milk quantity and safety, by using survey data collected in 2010. The per capita annual consumption of fluid milk of urban households in Beijing and Harbin was 78 kg and 56 kg,

respectively, which already approached the level in developed countries. Most urban consumers paid certain attention to milk safety problems, but only about half of them were willing to pay a premium for milk safety. A positive relationship has been found between urban households' demand for milk quantity and milk safety. The respondents who were willing to pay a higher premium for milk safety tended to consume more milk.

Our research has found that income positively influences urban consumers' demand for milk quantity and milk safety. As income increases, urban consumers will not only consume more milk but also are willing to pay a higher premium for milk safety. Thus, it can be inferred that the proportion of high-quality milk will gradually increase and more high-quality and safety milk needs to be supplied. However, the national milk quality standard has been degraded since 2010 from the previous standard of 2.95 g protein per 100 g and 0.5 million bacterial per ml to the present standard of 2.80 g protein per 100 g and 2 million bacterial per ml. The degradation of milk quality standards may be helpful in the short term to solve the urgent problems that domestic dairy firms are facing, but it will be harmful in the long term for the future development of the domestic dairy industry. A larger share of the fluid milk market will be occupied by foreign dairy firms, which is already the case for the milk powder market.

Our study also found that the establishment and expansion of modern food marketing channels plays an important role in stimulating milk consumption as well as in building urban consumers' confidence in milk safety. In addition, the population structure significantly influences milk consumption. The United Nations predicts that the proportion of the elderly over 60 years of age in China will reach 33.9 per cent by 2050 (UNPD 2010), and this will be a factor in milk consumption. However, the high-quality milk consumption of the elderly, whose incomes are mainly from their pensions, will be inhibited by the higher price of this milk. Therefore, it is beneficial to understand the evolution of population structure and milk consumption characteristics of urban residents of different ages for dairy firms to formulate their development strategies and for the government to design and implement effective supportive policies for the dairy industry.

There are several limitations of this study to note. First, the survey data used in this study did not include the urban households that did not consume milk, and thus the milk consumption of urban households estimated tends to be overestimated. Furthermore, two independent econometric models with the same explanatory variables are used for analysing urban households' demand for milk quantity and safety, which inherently interact with each other. A systematic model simultaneously considering quantity demand and safety demand should be developed and adopted to better explain urban households' demand for milk. Finally, the conclusions in this study are implicitly based on the assumption that the correlations between independent variables and demand for milk quantity as well as milk safety, at least partly, measured the causalities between them. A formal

theoretical model capturing the causalities between them should be developed in future study.

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