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Fluid milk consumption in urban Qingdao, China*

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This study relates the social-demographic characteristics of urban Chinese consumers to their consumption of fluid milk. A Tobit model is estimated drawing on individual consumer survey data collected in urban Qingdao in China in 2005. The major results of this study indicate that fluid milk consumption in urban Qingdao is much higher compared to China's national level. The effect of increased income on milk consumption is positive, as expected. The expansion of modern food retailers also appears to play a positive role by facilitating consumers' fluid milk consumption and influencing their food shopping patterns. The young and old consume significantly more fluid milk than the middle-aged. Health consciousness of the elderly and the openness of youth to new foods appear to be fuelling these consumption patterns. If the findings of this study apply to other urban regions in China, then as urbanisation continues so also will the trend of increasing fluid milk consumption in China.

Key words: China, fluid milk consumption, market participation, Qingdao.

1. Introduction

Consumption of dairy products, particularly fluid milk, has experienced record growth over the last decade in China, especially in urban areas (Fuller *et al*. 2006). Per capita annual consumption of fluid milk in urban China has increased to 18.8 kg in 2004, up from 6 kg in 1995 (*China Statistical Yearbooks* 1995–2005) and from far less 20 years ago (USDA 2006). Although these statistics reveal a sharp increase in growth rate, they conceal the fact that urban Chinese consumers are consuming even more fluid milk. Fuller *et al*. (2004) found that in 2002 annual per capita fluid milk consumption in three metropolitan cities, Beijing, Shanghai and Guangzhou, reached 56, 51 and 27 kg, respectively, which are all well above the national level of 15 kg for the same year. The data used in the present study also show that per capita consumption of fluid milk in 2005 in Qingdao, a medium size city in population, was 67 kg, or nearly three times the national level.

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Investigating fluid milk consumption and its determinants in an urban Chinese city provides insights that might apply to other Chinese cities likely to be on a similar path of economic development and social and cultural transformation. The findings, if generalisable, may have trade and policy implications as Chinese consumers change their dietary habits towards dairy products (Rutherford 1999). Two developed countries, Japan and South Korea have higher milk consumption compared to other Asian countries except India (Dong 2006). Their milk consumption growth prior to 1990 was mainly driven by strong economic growth, population growth, urbanisation and the westernisation of their diet (Beghin 2006; Dong 2006). While these macro factors are also expected to similarly affect China (Dong 2006), there is little known about the spatial or social-demographic aspects of changes in consumption in China.

Much of the previous literature on China's milk consumption is descriptive in nature (Wang and Fan 1999; Zhou *et al*. 2002); or is measured at national and aggregated levels (Hsu *et al*. 2001; Gould 2002; Ma *et al*. 2004; Dong 2006), or has examined only a few socio-demographic aspects of milk consumption due to data limitations (Guo *et al*. 2000; Ma and Rae 2004; Wang *et al*. 2004; Yen *et al*. 2004). In aggregate, these studies have contributed to some understanding of China's milk consumption patterns. However, their aggregated, coarse or national focus overlooks important regional and socio-demographic differences in milk consumption.

Only one study (Fuller *et al*. 2004) has examined milk consumption in particular urban regions of China. They examined consumers' market participation and demand for four milk products in Beijing, Shanghai and Guangzhou, but drew on a relatively small sample in 2001 of 314 households. This current study furthers the work of Fuller *et al*. through an analysis of a larger and more recent data set collected in Qingdao, China, in 2005. A major difference from Fuller *et al*. and most previous studies is that this present study examines the individual respondent's consumption for fluid milk instead of the household consumption or average consumer's consumption derived from household purchases. This allows a more accurate description of the consumers' fluid milk consumption behaviour and its relationship to their individual demographic, social and economic characteristics.

The primary objective of this study is to identify and examine the factors that affect Qingdao urban consumers' consumption behaviour for fluid milk (cow's milk only). Since milk traditionally has not been part of the Chinese diet in southern areas (Fuller *et al*. 2006) such as Qingdao, a left-censored Tobit model is applied in this study to deal with the expected zero-consumption observations. This approach makes it feasible to simultaneously examine the change in both market participation and demand characteristics for fluid milk.

The rest of this paper is organised as follows. In Section 2, the methodology, data and variables used in the analysis are presented. Estimation results are discussed in Section 3. In the last section, we summarise the main findings of this study and conclude with a brief discussion of further research.

2. Methodology, data and variables

2.1 Tobit model, marginal effects and elasticities

The Tobit model has been widely applied to estimate demand equations with censored observations (Adesina and Zinnah 1993; Cornick *et al*. 1994; Howard 1995; Castronova and Hagstrom 2004). The approach makes it possible to measure the decision of participation and to examine the levels of consumption in one model. The observed consumption of fluid milk by individual i can be specified as

$$y_i = \begin{Bmatrix} y_i^* = \mathbf{x}_i\boldsymbol{\beta} + \varepsilon_i^* \\ 0 \end{Bmatrix} \quad \text{if} \quad \begin{Bmatrix} y_i^* > 0 \\ y_i^* \le 0 \end{Bmatrix} \tag{1}$$

where y_i^* is an unobservable latent variable that can be modelled as a linear function of a vector of explanatory variables $\mathbf{x}_i$ and error term ε_i^*, which is usually assumed to have a normal distribution $\varepsilon_i^* \sim$ idd $N(0, \sigma^2)$. The likelihood function associated with a sample outcome $(y_1, \ldots, y_n)$ is then given by

$$L(\boldsymbol{\beta}, \sigma; \mathbf{y}) = \prod_{(i:y_i=0)} F\left(\frac{-\mathbf{x}_i\boldsymbol{\beta}}{\sigma}\right) \prod_{(i:y_i>0)} \sigma^{-1} f\left(\frac{y_i - \mathbf{x}_i\boldsymbol{\beta}}{\sigma}\right) \tag{2}$$

where F and f are the distribution and density function, respectively, of the standard normal variable, $\prod_{(i:y_i=0)}$ represents the product over those i for which $y_i^* \le 0$, and $\prod_{(i:y_i>0)}$ represents the product over those i for which $y_i^* > 0$. The maximum likelihood (ML) estimates of parameters β and σ can be obtained by maximising the log of Equation (2). Amemiya (1973, 1984) demonstrated that the usual consistency and asymptotic normality properties of ML estimators hold for this model.

From Equation (1), the expected value of the unconditional purchases can be given by $E(y) = \mathbf{x}\beta F(z) + \sigma f(z)$, where $z = \mathbf{x}\beta/\sigma$, and the expected value of purchases conditional on a positive level of consumption is $\mathrm{E}(y \mid y^* > 0) = \mathbf{x}\beta + \sigma(f(z)/F(z))$. Therefore, the relationship between the unconditional case and the conditional case can be derived as $E(y) = F(z)E(y \mid y^* > 0)$. By taking the derivative of this equation with respect to x_k, McDonald and Moffitt (1980) and Maddala (1983) showed how the total change in the unconditional purchases in terms of an independent variable x_k can be disaggregated into two parts: the change in conditional purchases weighted by the probability of purchasing, and the change in the probability of purchasing weighted by the conditional expected value of purchases. Algebraically,

$$\frac{\partial E(y)}{\partial x_k} = F(z)\left(\frac{\partial E(y \mid y^* > 0)}{\partial x_k}\right) + E(y \mid y^* > 0)\left(\frac{\partial F(z)}{\partial x_k}\right) \tag{3}$$

where $\partial E(y \mid y^* > 0)/\partial x_k$ is the change in conditional purchases (or conditional marginal effect), identifying how the daily consumption for fluid milk changes due to a specific independent variable x_k for those with non-zero consumption; $\partial F(z)/\partial x_k$ is the change in the probability of purchasing (or marginal effect of probability of purchasing), explaining how those consumers with zero-consumption start consuming fluid milk due to x_k; $F(z)$ and $E(y \mid y^* > 0)$ represent the probability of purchasing and the conditional expected value of purchases, respectively.

Multiplying both sides of Equation (3) by $x_k/E(y)$ and simplifying, the elasticities can be expressed as,

$$\frac{\partial E(y)}{\partial x_k}\frac{x_k}{E(y)} = \frac{\partial E(y \mid y^* > 0)}{\partial x_k}\frac{x_k}{E(y \mid y^* > 0)} + \frac{\partial F(z)}{\partial x_k}\frac{x_k}{F(z)} \qquad (4)$$

$$\text{i.e.} \quad \xi_{\text{uncond}} = \xi_{\text{cond}} + \delta_{pp}$$

where

$$\xi_{\text{uncond}} = \frac{\partial E(y)}{\partial x_k}\frac{x_k}{E(y)}, \quad \xi_{\text{cond}} = \frac{\partial E(y \mid y^* > 0)}{\partial x_k}\frac{x_k}{E(y \mid y^* > 0)}$$

$$\text{and } \delta_{pp} = \frac{\partial F_{\text{norm}}(z)}{\partial x_k}\frac{x_k}{F_{\text{norm}}(z)}$$

are the unconditional elasticity, the conditional elasticity and the elasticity of the probability of purchasing, respectively.

2.2 Data

In Qingdao in the summer of 2005 personal interviews with 638 participants were conducted. The city of Qingdao is one of 14 coastal cities that were first opened to foreign markets in 1984. Qingdao is on the southern tip of the Shangdong Peninsula along the Yellow Sea and is currently divided into seven urban districts. In 2003, its total population was 2.24 million. Annual per capita disposable income in 2005 was 12 920 Yuan, about 2000 Yuan higher than both the national level (10 493 Yuan) and the Shandong provincial level (10 744 Yuan), but lower than that of main metropolitan cities such as Beijing (17 653 Yuan) and Shanghai (18 645 Yuan) in the same period.

The interviews were conducted in three food shopping locations (one hypermarket, one supermarket and one convenience store), located in three of the seven urban districts. These locations were chosen to ensure a sample representative of a cross-section of the Qingdao population and to survey consumers at the same time and place where actual purchasing decisions were made in an effort to better elicit their true preferences. To avoid potential selection bias from individual sampling, respondents were selected with the criterion that the interviewer was to solicit every third adult consumer

(18 years and older) who came into the survey area. To improve data quality, contracts were signed with the selected food stores, and 200–400 Yuan per day was paid to each store for their cooperation. As a reward for participating in the survey, every respondent was given a gift card (worth US $1.80) redeemable at the participating store. Four graduate students were hired and trained to conduct this survey in Chinese.

Although the samples were almost evenly distributed across the three locations, restricting the survey to one hypermarket, one supermarket and one convenience store may have caused sample selection bias. For example, those residents who heavily rely on outdoor markets for food groceries might be less likely to be surveyed. Also, those who more frequently visit supermarkets and hypermarkets for food shopping may have a higher probability of being fluid milk consumers. Therefore, restricting the survey to these three stores might cause an upwards bias in milk consumption if these three locations are not representative of the buying patterns of Qingdao consumers. Surveying at these shopping locations, however, does have practical advantages and is a more accessible and cost efficient way to collect data compared with other methods. For example, comparing our sample with the survey pool of the National Bureau of Statistical of China (NBSC), our sampling approach better represents the population, since NBSC survey data is often based on interviews of the elderly.

The sample statistics indicate that our selected sample is representative of most of the characteristics of the population in the study area (see the last two columns in Table 1). The average family size and monthly per capita disposable income in the sample have no significant differences from their corresponding population levels. Although women (66.9 per cent) and unemployed respondents (6.7 per cent) are over-represented in the sample, we believe that these sample characteristics are expected and acceptable. The higher share of female respondents is expected since women typically play a larger role in family food shopping in China. The unemployment rate in the sample is lower than the *official registered unemployment rate*. However, the sample may be representative of the true unemployment rate because there is 'unregistered' urban unemployment (Wolf 2004).

Table 1 also shows that the survey sample was distributed widely among various consumers. The majority of surveyed respondents were in their late 1930s or early 1940s, with an average age of 38 years. Nearly three-quarters of respondents had a high school education level or higher and were the primary food shoppers in their households. Full-time employed respondents accounted for half the sample size; 8 per cent were part-time employed and 19 per cent were retired. The monthly household disposable income for more than 60 per cent of the sample ranged between 2000 and 5000 Yuan ($250 and $625). Forty-three per cent had children under 18 years old.

The summary statistics for fluid milk consumption in the sample show that about 90 per cent of respondents consumed fluid milk in 2005, with an average daily consumption of 185 mL/person. The average price for fluid milk

Table 1 Sample statistics and representative tests

	Mean	SD	Population mean	*P*-value*
Age (years)	37.95	13.51		
Female % of total (binary; female = 1)	0.669	0.471	0.495†	< 0.001
Education level (binary; yes = 1)				
Primary school or illiteracy	0.041	0.198		
Middle school	0.246	0.431		
High school or equivalent	0.370	0.483		
2-year college or equivalent	0.218	0.413		
4-year college	0.121	0.326		
Advanced or professional degree	0.005	0.068		
Employment status (binary; yes = 1)				
Full time	0.495	0.500		
Part time	0.083	0.276		
Unemployed	0.067	0.251	0.030‡	< 0.001
Homemaker	0.088	0.283		
Retired	0.190	0.392		
Student	0.077	0.266		
Monthly household disposable income (1000 Yuan)				
< 1000	0.039	0.194		
1001–2000	0.177	0.382		
2001–3000	0.265	0.442		
3001–4000	0.218	0.413		
4001–5000	0.143	0.350		
5001–10 000	0.132	0.338		
> 10 000	0.027	0.161		
Monthly per capita disposable income (1000 Yuan)	1.076	0.554	1.077‡	0.959
Children under 18 years exist in household (binary; yes = 1)	0.431	0.496		
Household size (persons)	3.237	1.074	3.191†	0.283
Observations	638			

*Ho: sample mean = population mean.
†2003 data are used as more recent population data were not available. The household size is from the 2004 *Qingdao Statistical Yearbook*, and the share of females in the household is calculated from data in the 2004 *Shandong Statistical Yearbook*. We assume that these data have no significant differences between 2003 and 2005.
‡Data are from the *Qingdao 2005 Economic and Social Development Annual Report* released by the Qingdao Bureau of Statistics.

self-reported by consumers was 1.52 Yuan/250 mL. Within the group of non-zero consumption respondents, 70 per cent said that they had increased expenditures on fluid milk consumption over the past three years, while 27 per cent reported no significant change, and 3 per cent reduced their expenditure in the same period. The most common explanations for zero consumption were the unpleasant taste of fluid milk (75 per cent) and milk allergies (12 per cent).

2.3 Variables used the empirical analysis

The dependent variable is individual respondent's daily consumption of fluid milk rather than family purchase or per capita consumption derived from

family purchases. The fluid milk in this study consists of all cow's milk in liquid available in the Qingdao market, including ultra-high-temperature (UHT) milk and non-UHT. As illustrated in the data description section, 10.5 per cent of surveyed respondents did not consume fluid milk during the year of the survey. Consequently, the recorded outcomes for the respondent variable can be viewed as a *mixed, discrete-continuous* random variable.

The explanatory variables used in this study are presented in Table 2. The respondent's gender (GENDER) is an indicator variable, taking on the value of one if the respondent is a male. YOUNG and SENIOR are two indicator variables, representing those respondents whose ages are under 30 years and over 50 years, respectively. Compared to those with middle age (between 30 and 50 years), both young and senior consumers are expected to consume more fluid milk. This is mainly because younger consumers are generally more open to new or different food products while senior consumers generally become more health conscious and are more susceptible to various health problems, some of which are caused by lack of calcium. As a result, they believe that drinking fluid milk strengthens their bones. The respondent's education level (EDU) in years is included in the model as a continuous variable. SHOPPER is a dummy variable which takes on the value of one if the respondent is the main food shopper in the household. According to Fuller *et al*. (2004), the point-of-purchase milk advertisements have a significantly positive effect on milk product sales in China. Thus, the estimate for SHOPPER is expected to be positive because they encounter more in-store milk advertisements than other members of the family.

INCOME is included in the model to capture the effects of per capita disposable income on consumer's market participation and consumption of fluid milk. All previous studies, either descriptively or empirically have found that income is a positive influence on consumers' fluid milk consumption (e.g. Zhou *et al*. 2002; Fuller *et al*. 2004). Bai and Wahl (2005) demonstrated that the consumption of fluid milk increases as income increases but at a decreasing rate. A quadratic term of income, INCOME2, is thus also included in the model. In addition, an indicator variable (REFR) is included to represent how a refrigerator in a household influences the respondent's demand for fluid milk. Since the fluid milk in this study is all cow's milk in liquid form available in the market rather than UHT only, a refrigerator is expected to have a positive effect on milk consumption for the obvious reason that a refrigerator can lengthen the storage and shelf life of fluid milk.

This model also includes RISK, which is a dummy variable that equals one if the respondent previously bought spoiled or adulterated milk or heard of any event involving spoiled or adulterated milk. According to media reports, some well-publicised cases of dairy quality problems have shaken consumers' confidence in the safety of fluid milk. This was used as important evidence in the USDA GAIN Annual Report (2005) on China dairy products in 2005 to explain their lower forecast of growth in fluid milk use in China in 2006. By

Table 2 Variables

Variable	Definition, unit and coding	Sample mean	SD	Expected sign
Dependent variable	Individual respondent daily consumption (L)	0.185	0.110	
Independent variables				
GENDER	Respondent's gender (male = 1)	0.331	0.471	±
YOUNG	Under 30 years (yes = 1)	0.332	0.471	+
MIDAGE*	30–49 years (yes = 1)	0.433	0.496	
SENIOR	50 years and older (yes = 1)	0.235	0.424	+
EDU	Respondent's education level	3.146	1.064	+
SHOPPER	If respondent is the main person in household for food shopping (yes = 1)	0.572	0.495	+
INCOME	Per capita monthly disposable income (1000 Yuan)	1.076	0.554	+
INCOME2	Square of INCOME	1.464	1.576	+
REFR	If own refrigerator in household (yes = 1)	0.915	0.279	+
RISK	Has the respondent ever bought spoiled milk or heard of such events (yes = 1)	0.091	0.288	−
PRICE	Self-reported price for most often purchases of fluid milk (Yuan/250 mL)	1.515	0.315	−
SUPERMKT	Visit supermarkets or hypermarkets at least once a week for food shopping (yes = 1)	0.528	0.500	+
DISTANCE	Distance from home to most often food shopping place (km)	0.561	0.688	−

*Used as the baseline category in regression.

including this variable, we could statistically test the effect of these reported cases on consumers' confidence.

The model includes PRICE, which is an individual self-reported purchasing price for milk. For those who do not consume fluid milk, the self-reported prices are the prices they faced when they purchased for others. Four respondents who could not report milk prices were excluded from our dataset. Self-reported prices raise the issue of possible endogeneity problems since richer consumers may tend to buy high price milk believing its positive correlation to product quality and safety. To address this possibility, a two-stage regression was estimated using RISK as an instrumental variable. Since there was no significant difference for the variables of interest compared to the model reported in this paper, the results from the two-stage regressions are not reported.

The rise of supermarkets in urban China is regarded as an important factor in boosting milk sales, since they have made milk readily available to urban consumers (Hu *et al*. 2004; Beghin 2006). To confirm this qualitative result, the dummy variable SUPMKT, which equals one if the respondent visits a supermarket or hypermarket at least once a week, is included in the model and a positive sign expected. Finally, DISTANCE is a continuous variable, representing the distance between respondent's home and his or her food shopping place, such as an outdoor market or supermarket which is visited most often. Fuller *et al*. (2004) found the distance from the household to the nearest McDonald's restaurant was negatively related to market participation and consumption of ice cream. The estimate sign for DISTANCE is thus also expected to be negative.

3. Empirical results

The log version of the likelihood function in Equation (2) is used to obtain parameter estimates for fluid milk consumption. The square root of the dependent variable is used to correct for heteroscedasticity since it provides the best fit. The estimated results from the ML estimator are presented in Table 3. The statistical significance of the model is examined by using a likelihood ratio test of the null hypothesis that all slope estimates are zeros. The statistic, $LR\ \chi^2(12) = 86.89$, indicates that we can reject the null hypothesis. The skewness and kurtosis tests for normality in terms of the unconditional and the conditional errors produce $\text{Prob}_{\text{uncond}} > \chi^2 = 0.809$ and $\text{Prob}_{\text{cond}} > \chi^2 = 0.129$, respectively. Therefore, we fail to reject the null hypotheses of that the underlying distributions are normally distributed, implying that the ML estimator is consistent.

Estimated results show that all coefficients except for EDU have the expected signs, and all but two are significant at $\alpha = 0.10$ level, implying that most of our hypotheses about the independent variables' influences on fluid milk consumption are empirically demonstrated. Characteristics such as being male, the family's primary food shopper, owning a refrigerator, and visiting

Table 3 ML estimates of daily consumption for fluid milk

	Coefficient	SE	Coefficient/SE
INTERCEPT	0.145***	0.041	3.57
GENDER	0.036**	0.017	2.06
YOUNG	0.039***	0.012	3.34
SENIOR	0.040***	0.012	3.30
EDU	–0.005	0.005	–1.07
SHOPPER	0.029*	0.017	1.70
INCOME	0.086***	0.030	2.90
INCOME2	–0.023**	0.010	–2.26
REFR	0.032*	0.017	1.91
PRICE	–0.056***	0.015	–3.81
RISK	–0.015	0.016	–0.93
SUPMKT	0.049***	0.009	5.21
DISTANCE	–0.016**	0.007	–2.34
Log-likelihood:	354.370		
LR χ^2 (12) test:	86.890		
Prob > χ^2:	0.000		
McFadden's R^2	0.120		
Number of observations:	638		

Notes: ***significant at 1% level, **significant at 5% level, *significant at 10% level.

modern retailers such as supermarkets and hypermarkets more frequently, are positively related to an individual's market participation and demand for fluid milk. Income is positively related to fluid milk consumption, but the negative sign for the coefficient of its quadratic term (INCOME2) implies that the overall positive effect of income on milk consumption will be weakened as income increases. Estimated coefficients for YOUNG and SENIOR are also significantly positive, reflecting that both younger (under 30 years old) and older (50-year-old-and up) consumers are more likely to be fluid milk drinkers than middle-aged consumers, and they consume significantly more too.

The empirically estimated coefficient for RISK is negative but not statistically significant, implying that highly publicised incidents of poor milk quality have not significantly affected Qingdao consumers' confidence in milk safety. A possible reason may be related to the rapid development of modern food retailers such as supermarkets and hypermarkets, which have high consumer confidence for offering high quality food products. When these events happened, consumers simply bought their milk products from these modern stores rather than from traditional outdoor markets and small, independent stores. Similar to Fuller *et al*. (2004), the estimate for DISTANCE is significantly negative, implying negative effects of market availability on consumers' participation and demand for fluid milk. PRICE is also found to play a negative role in fluid milk consumption.

Table 4 presents marginal effects and predictions of fluid milk consumption. As mentioned in Methodology section, the unconditional marginal effect

Table 4 Marginal effects, predictions and elasticities

	Unconditional expected value of daily consumption	Conditional expected value of daily consumption	Probability of uncensored
Marginal effects	$\frac{\partial E(y)}{\partial x_k}$	$\frac{\partial E(y \mid y^* > 0)}{\partial x_k}$	$\frac{\partial F(z)}{\partial x_k}$
GENDER*	0.034	0.029	0.033
YOUNG*	0.037	0.031	0.036
SENIOR*	0.038	0.033	0.035
EDU	–0.005	–0.004	–0.005
SHOPPER*	0.026	0.022	0.029
INCOME	0.081	0.068	0.086
INCOME2	–0.022	–0.019	–0.024
REFR*	0.030	0.025	0.039
PRICE	–0.053	–0.045	–0.057
RISK*	–0.014	–0.012	–0.016
SUPMKT*	0.046	0.038	0.050
DISTANCE	–0.015	–0.013	–0.017
Predictions of expected values	$E(y)$	$E(y \mid y^* > 0)$	$F(z)$
PREDICTIONS	0.183	0.195	0.930
95% CONF. INT.			
Lower	0.180	0.193	0.925
Upper	0.186	0.198	0.934
Elasticities	ξ_{uncond}	ξ_{cond}	δ_{pp}
INCOME	0.475	0.375	0.100
PRICE	–0.439	–0.346	–0.092
DISTANCE	–0.047	–0.037	–0.010

*dF/dx is for discrete change of the dummy variable from 0 to 1.

(the second column in Table 4) in the Tobit model can be decomposed into two effects, the conditional marginal effect (the third column in Table 4) and the marginal effect on the probability of purchasing (the last column in Table 4). The former measures how the daily consumption for fluid milk changes due to a specific independent variable for current milk consumers, whereas the latter explains how those consumers who are at zero-consumption start consuming fluid milk due to the influence of the independent variable. For example, holding other variables constant, the average man is expected to consume 34 mL of fluid milk more than a woman in one day. This number falls to 29 mL if only current milk consumers are considered. Meanwhile, compared to women, men have about 3 per cent higher probability of being milk consumers. Another example is that a younger consumer and a senior consumer drinks 37 and 38 mL, respectively, more than a middle aged milk consumer. Further, they are 3.6 and 3.5 per cent, respectively, more likely than a middle-aged person to be a fluid milk consumer.

The unconditional and conditional estimates of expected daily consumption for fluid milk in Qingdao are 183 and 195 mL (or 65 and 69 kg per year), respectively. The estimated expected value for the probability of purchasing

shows that there is 93 per cent likelihood that urban consumers in Qingdao consume fluid milk. Table 4 also provides the 95 per cent confidence intervals for these predictions.

At the bottom of Table 4, the estimated elasticities of three continuous variables are presented. Although both income and price have significant effects on fluid milk consumption in Qingdao, their unconditional consumption elasticities with respect to both are < 1 (0.48 and –0.44, respectively), implying that fluid milk in Qingdao is a normal good but is price inelastic, and thus reducing price might not be a good strategy for firms seeking to expand market share. The corresponding conditional elasticities are 0.38 and –0.35, respectively. Further, among consumers who do not currently drink milk, income and price have only minor effects on the decision to start drinking fluid milk. For example, the estimated income elasticity of probability of the uncensored part of the distribution of respondents is 0.1, meaning that a 1 per cent increase in per capita disposable income only causes 0.1 per cent increase in the probability that a zero-consumption person becomes a fluid milk consumer. The unpleasant tastes of milk and lactose intolerance are possible explanations for the small income and price effects on zero-consumption customers.

4. Discussion and conclusions

Per capita consumption of fluid milk in China has increased tremendously since the mid-1990s, although it remains low by western standards (Dong 2006). The increase in the national growth rate of milk consumption, however, conceals regional, social and demographic differences in milk consumption. This paper explores this issue by examining the nature and influences upon consumer milk consumption in an urban region of China. Drawing on individual consumer survey data collected in urban Qingdao in China in 2005, a Tobit model of milk consumption is estimated.

The results of this study show that the market participation rate for fluid milk in Qingdao was over 90 per cent in 2005, and expected per capita daily consumption of fluid milk was 183 mL (or about 65 kg per year) which is triple the Chinese national level for urban areas (19 kg) in the same year. Fluid milk consumption in Qingdao is highly related to consumer demographics and their social and economic characteristics. Characteristics such as being male, the household's primary food shopper, having a higher income, and owning a refrigerator are all positively related to an individual's fluid milk consumption, both in market participation and level of demand. Further, the negative estimated effect on milk consumption of distance between one's home and the location of food shopping reflects how transportation costs and time affect demand for fluid milk.

Consistent with previous studies in Asian countries this study also indicates that income is a significantly positive effect on fluid milk consumption. Schluep Campo and Beghin (2006), for example, suggest that rising income

has been a major factor contributing to fluid milk consumption growth in Japan since the 1950s. Dong (2006) also indicated that income growth combined with demographic changes explain 60 per cent or more of dairy consumption expansion in Asia. The positive effect of income on milk consumption also has been found in Korea (Song and Sumner 1999), Indonesia (Fabiosa 2005) and China (Fuller *et al*. 2004, 2006).

In contrast to its effect on milk consumption, income growth in this study is found to contribute little to fluid milk market participation in Qingdao. The estimated income elasticity of the probability of purchasing fluid milk is close to zero, perhaps owing to a high level of dislike for the taste of milk or lactose intolerance among the remaining non-milk consumers.

The frequency of visits to modern retailers such as supermarkets and hypermarkets is found to be positively related to both market participation and consumption of fluid milk. This supports the conjecture of Reardon *et al*. (2003) that the growth of large retailers creates a new interface between producers and consumers in many regions of the globe. Beghin (2006) and Schluep Campo and Beghin (2006) found that the transformation of the food retailing system was one of the driving forces for the increasing demand for fluid milk in Japan in the 1960s to 1970s, and is causing dynamic changes in milk consumption and production in many Asian countries, including China.

The finding in this paper regarding how the frequency of visits to modern retailers is linked to both market participation and consumption of fluid milk, when combined with the likely continued growth of large retailers, has important implications for milk consumption trends in other parts of China and in other developing Asian countries such as Indonesia, where the spread of large retailers is just starting according to Beghin (2006). According to the Ministry of Commerce of the People's Republic of China, 70 000 supermarkets were opened in rural areas by the end of 2005, and an additional 180 000 rural supermarkets were planned to be established by the end of 2008. If these modern retailers facilitate the emergence and expansion of the milk market in rural China, then a further marked growth in demand for fluid milk in China is probable.

Consumers' age plays an important role in fluid milk consumption. Young consumers (under 30 years) in this study were largely born after China started implementing its reform and opening policy at the end of the 1970s. Different from their parents, people in this generation are generally more open to try new things, especially western products. In addition, senior consumers (> 50 years) generally are more health conscious and more susceptible to various health problems such as lack of calcium than people in middle age. This may explain the finding that senior consumers have a higher probability of being fluid milk drinkers and consuming more than those in middle age.

In conclusion, as more consumers in China buy their food from supermarkets and hypermarkets, often owned by multinational corporations, and store their food in refrigerators, positive changes in milk consumption patterns are likely. The implications are far-reaching from international trade opportunities,

through to mitigation of some potential health problems. However, a range of caveats apply to extrapolations from this study. First, and most importantly, the participants in this study were 18 years or older. Hence, the nature and importance of children's consumption was not investigated. The quoted annual consumption volumes therefore may be underestimated if children's per capita consumption levels are much higher than other age groups. Second, this study only reports on consumption in an urban region. By contrast, how milk consumption in China's rural areas, will be influenced by changes in rural incomes and growth in modern retailing remains unknown. Third, in coming years global milk supply and demands will change and impact on fluid milk markets in China and other Asian countries; and vice versa. It remains unknown to what degree these global changes will affect the nature and pattern of milk consumption in China. These issues need to be the subject of further investigation.

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