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Consumption of dairy products in urban China: results from Beijing, Shanghai and Guangzhou

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Using urban survey data collected by the authors in 2001–02, this paper analyses demographics, cultural factors and purchasing behaviours influencing the consumption of fresh milk, yogurt, ice cream and powered milk in Beijing, Shanghai and Guangzhou, China. Results from estimation of a double-hurdle model of consumption show that income and marketing channels are the key determinants of milk consumption levels; however, education, advertising and convenience play a more important role in consumption of other dairy products. There is some evidence that milk powder, as a consumer good, may be becoming an inferior product in urban China. Finally, the survey data suggest that the growing sophistication of China's retail sector is influencing consumption of dairy products.

Key words: consumer demand, demand analysis, livestock, market development, marketing.

1. Introduction

China has one of the lowest levels of per capita fluid milk consumption in the world, averaging 5 kg per year from 2000 to 2004 (FAPRI 2005). This statistic hides the fact that there is great variation in milk consumption levels across regions and from rural to urban areas. In many regions, milk and dairy products have not been part of the local diet (particularly in Southern China), while in other regions, there is a longer history of milk production and consumption (Inner Mongolia, Shanghai, Beijing and Tianjin). Historically, milk consumption in China was promoted for its health benefits as the 'key to Darwinian success' (Glosser 1999). This perception of milk's nutritious benefits persists in modern China (Wu 2003). However, until China's economic reforms accelerated growth in agricultural output, limited supplies, high prices and lack of refrigeration prevented widespread consumption of milk and dairy products.

In the last decade, China's dairy industry has rapidly emerged. Milk production doubled between 1990 and 2000, and doubled again between 2000 and 2004. Fluid milk consumption has risen by 180 per cent over the last five years, largely in urban areas. With the rapid expansion of China's dairy sector, the widespread availability of dairy products has improved in large urban areas. Nevertheless, milk products are still scarce in many other parts of

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China. Both the central and local governments in China are promoting the expansion of milk production and consumption. Milk production has been boosted by the presence of foreign direct investment (FDI) and coordination of supply chains by large retailers. China has been following a hybrid policy of expanding and modernizing its domestic industry using FDI and imported technology and genetics leading to lower domestic prices, an increased choice set and quality while still importing basic milk powder (Fuller *et al.* 2006). School milk programs have emerged in recent years, promoting milk consumption by children. In addition, several scholars have noted the leading role of supermarkets in supporting the expansion of urban consumption of dairy products (Reardon *et al.* 2003; Hu *et al.* 2004). Finally, fast-food outlets are now present in China, and travel outside the nation is increasing; both developments may have a role in globalising the Chinese urban diet and promoting the availability of new dairy products.

A number of demand studies have noted that consumption patterns in China are shifting toward diets with a greater share of animal products (Huang and Bouis 1996; Rae 1997; Rutherford 1999; Shono *et al.* 2000; Wang *et al.* 2004), and an increasing number of studies are examining China's dairy consumption. However, the lack of appropriate data have prompted a number of researchers to aggregate dairy products into a single variable in their analysis (for example: Gould and Dong 2004; Ma and Rae 2004). A few studies have disaggregated their data into fresh milk, milk powder and yogurt (Liu and Chern 2003; Zhang and Wang 2003). These studies consistently show that Chinese demand for dairy products is expenditure elastic but income inelastic. These findings suggest that dairy consumption will increase as incomes rise.

Beyond aggregate price and income responses, our knowledge of the purchasing behaviour and the dairy product consumption profile of Chinese consumers is limited. Other economic, demographic and cultural forces are likely to influence dairy consumption, as will changes in government policies and food retailing (Guo *et al.* 2000; Fuller *et al.* 2006); but empirical findings are sparse in these areas. This paper contributes new knowledge on dairy consumption patterns in China based on an analysis of survey data collected from households in Beijing, Shanghai and Guangzhou. The survey questions were directed toward household consumption behaviour, with a specific emphasis on disaggregated dairy products. The next section provides a summary of the household characteristics, dairy product information and purchasing behaviour. Additional statistics from the survey data are available in Fuller *et al.* (2004). We use our data to establish a set of stylised facts on patterns of dairy products consumption for large urban areas in China. We follow with results from an econometric investigation of dairy consumption, focusing on isolating factors important to market participation and purchasing decisions for selected disaggregated dairy products. The paper concludes with a summary of the findings and discussion of the research implications.

Table 1 Household demographic information: sample average or median

	Beijing	Shanghai	Guangzhou	Entire sample
Household size (<i>n</i>)	3	3	3	3
Children < 14 years (<i>n</i>)	0	0	1	0
Adults > 60 years (<i>n</i>)	0	0	0	0
Household income (Yuan/month)	2954	2803	3250	3013
Wages of male household head (Yuan/month)	1382	1204	1387	1327
Spouse's wages (Yuan/month)	996	1007	1201	1074
Other income (Yuan/month)	481	591	615	564
Age of household head (years)	48	52	46	49
Spouse's age (years)	48	50	43	47
Education of household head (years)	12	12	10	11
Spouse's education (years)	11	11	10	10

2. Description of the survey data

The data set used for this analysis was collected in the fall of 2001. Centering exclusively on dairy product consumption, the survey was administered to 100 households in Beijing, 100 households in Shanghai, and 114 households in Guangzhou, generating a total sample size of 314. While this is a relatively small sample, it is representative of the households in three of China's most important cities. The households were chosen randomly from the roster of urban households sampled in China National Bureau of Statistics' (NBS) Household Income and Expenditure Survey (HIES). The national urban HIES is conducted in about 20 000 households across urban China. Our sample constitutes between 10 and 38 per cent of the total HIES sample in 2001 for the three cities. As part of the nation's annual effort to track the income and expenditures of its population, China's survey is thought to be of fairly high quality and representative of urban China (Holz 2003).

Enumerators from our survey team visited selected households and elicited information on household expenditures for a broader set of dairy products than those currently covered in the HIES. Different sections of the survey instrument included questions about purchasing behaviour – such as the location of purchase, package size, preferred brand and frequency of purchase – as well as changes in dairy product consumption over time, the relative importance of various factors in the purchasing decision, consumption of imported dairy products, and the prevalence of dairy product advertisements in a variety of media.

The collected demographic data are summarised in Table 1. The median household size was three in the cities surveyed. Just fewer than 20 per cent of the households had four or more members, 46 per cent of which were reported in Guangzhou. Households tend to be larger in Guangzhou and smaller in Shanghai. Chi-squared tests of these differences are significant at the 5 per cent level. Household composition data reported in the *2003 China Statistical Yearbook* indicates that 77 per cent of households in Beijing,

Table 2 Household dairy product purchasing behaviour

	Fluid milk	Yogurt	Milk powder	Ice cream
Households reporting purchases (%)				
Beijing	91.0	78.0	25.0	59.0
Guangzhou	86.8	50.0	32.5	58.8
Shanghai	94.0	50.0	26.0	43.0
Total sample	90.4	58.9	28.0	53.8
Average purchases per week (<i>n</i>)				
Beijing	3.13	1.02	0.07	0.35
Guangzhou	2.19	0.70	0.11	0.41
Shanghai	4.07	0.58	0.08	0.11
Total sample	3.09	0.76	0.09	0.30
Average annual quantity purchased per capita (kg)				
Beijing	56.83	17.08	0.84	4.08
Guangzhou	27.35	7.06	1.14	2.41
Shanghai	51.45	7.64	0.68	0.59
Total sample	44.41	10.43	0.90	2.36

70 per cent of households in Shanghai, and 49 per cent of households in Guangdong provinces have three or less members. The average household size for urban China was 3.04 people in 2002, which is just about equal to the median of our subsample of households. Similarities between the age structure (number of young dependents, working age and retirees) in the urban HIES data and our subsample also show the representative nature of the sample.

A surprising finding from the survey data was the breadth of consumption of dairy products in China's main metropolises. All but five households reported purchases of one or more dairy products. Table 2 displays the per cent of households in each city sample indicating purchases of dairy products. All of the households in the sample own refrigerators, which contributes to the prevalence of dairy product consumption. Fluid milk purchases do not vary much by city, but yogurt purchases are significantly higher in Beijing. Likewise, a significantly higher percentage of households in Guangzhou indicated purchases of ice cream, although Beijing consumers consume larger quantities.

Table 2 also displays the average number of dairy product purchases made each week and the associated annual per capita consumption levels. The combination of the number of purchases, packages per purchase and package size determine the total quantity purchased by the household. Significant differences in each of these variables are observed. For example, households in Shanghai purchase milk more frequently than households in Beijing but purchase fewer packages per purchase. However, the amount of milk purchased per household member is virtually the same in the two cities. Reflecting its more southern location, milk consumption per person in Guangzhou is just over half the level of the other two cities. Although average annual consumption for the survey sample initially appears substantially

Table 3 Location of milk and yogurt purchases

Location	Beijing	Guangzhou	Shanghai	Entire sample
Percentage of households reporting purchases				
Milk				
Home delivery	15.38	18.09	32.32	22.18
Delivery point	0.00	7.45	21.21	9.86
Supermarket	56.04	71.28	48.48	58.45
Grocery store†	23.08	21.28	2.02	15.14
School	1.10	13.83	6.06	7.04
Street vendor	6.59	7.45	2.02	5.28
Other	10.99	5.32	2.02	5.99
Yogurt				
Home delivery	1.28	8.00	7.02	4.86
Delivery point	1.28	12.00	8.77	6.49
Supermarket	82.05	78.00	80.70	80.54
Grocery store†	14.10	28.00	0.00	13.51
School	0.00	6.00	1.75	2.16
Street vendor	3.85	6.00	0.00	3.24
Other	6.41	6.00	0.00	4.32

†Grocery stores refer to smaller retail outlets such as corner shops.

higher than the national averages in urban areas reported by the NBS, this is not unreasonable considering that incomes in Beijing, Shanghai and Guangzhou are some of the highest in the country. While not representative of China as a whole, the reported consumption levels in our survey are consistent with other data on these cities.

Table 3 shows the breakdown of household purchases by marketing venue. There is a greater frequency of milk purchases in Shanghai due to more frequent use of daily home delivery services and dedicated delivery points for procuring fluid milk compared to the other two cities. Home delivery and dedicated delivery services in Shanghai appear to substitute largely for milk purchases from grocery stores. Indeed, fluid milk and yogurt consumers in Shanghai depend less on grocery stores than consumers in the other cities, but more on home delivery and delivery points. Only 20 per cent of the sample's 88 households that reported purchasing milk through delivery services also reported purchasing milk from supermarkets or grocery stores.

Supermarkets are the main source of dairy products in all three cities. They offer a wide array of dairy products besides the staple of fluid milk. The majority of households in all three cities purchase milk from supermarkets, but 25 per cent of households also purchase milk from other outlets. Likewise, more than 80 per cent of households that purchase yogurt bought it at a supermarket. Just over 9 per cent of those households also purchased yogurt from other locations, primarily smaller grocery stores. The primary importance of supermarkets in supporting increased dairy product consumption is observed in other countries (Faiguenbaum *et al.* 2002; Gutman 2002; Reardon *et al.* 2003; Hu *et al.* 2004).

Finally, reported changes in dairy product consumption over time reveal that growth in milk and yogurt purchases has been greatest among consumers in Beijing. Over 46 per cent of the respondents (147 households) indicated that they had increased their milk consumption in the last two years, and 45 per cent of those households were in Beijing, representing 67 per cent of the Beijing sample. In contrast, 49 per cent of the households surveyed in Shanghai reported that their milk consumption had been stable over the last two years, and 17 per cent of the households in Guangzhou had decreased milk consumption. One factor contributing to this variation may be differences in the availability of higher-quality, more affordable domestic dairy products. Nearly 66 per cent of Guangzhou respondents reported purchases of imported dairy products compared to 40 per cent in Beijing and 36 per cent in Shanghai. More than 70 per cent of the Guangzhou households that purchase imported dairy products indicated that lack of domestic products was an important or very important factor in their decision. Likewise, a large majority of these households stated that the safety and lower cost of imported products were important factors.

While the appearance of school milk programs has coincided with the increase in milk demand, in fact, school milk programs account for only a fraction of milk consumption in our sample, especially in Beijing. For example, only 29 respondents indicated that their child's school had a school milk program. The limited use of school milk programs is not surprising as these programs were only in their second year of operation in China at the time of the survey. Also important is the fact that China's program targets rural development by expanding milk production in addition to promoting nutrition improvement. Consequently, milk is sold to children at a modest discount (25–30 per cent) compared to retail prices through the program by special arrangements with suppliers. The designated processors absorb the cost of the discount, but they gain from the volume and marketing benefits associated with being selected to supply school milk (Lai 2003).

3. Empirical analysis

Just over 91 per cent of the households surveyed purchase milk, but less than 60 per cent purchase yogurt or ice cream. Zero consumption observations can be the result of a corner solution in the utility maximisation process, perhaps because dairy prices are too high, but they can also be caused by factors that limit market participation, such as inadequate supplies, high transaction costs, or consumer characteristics (lactose intolerance, for example). A third possibility is that consumers make infrequent purchases of dairy products, and the timing of the survey did not capture their consumption (Blundell and Meghir 1987; Angulo *et al.* 2001). This third reason is not relevant because the enumerators recorded infrequent purchases in terms of the number of times per year when the time frame indicated in the question was shorter than the average period between purchases.

Several empirical models have been developed to handle censored or truncated data. The Tobit model (Tobin 1958) has been widely used to estimate demand equations for survey data with zero consumption observations. The standard Tobit model assumes observed consumption of a good by household is determined by a latent variable that can be modelled as function of a vector of independent variables and an error that is normally distributed. With both market participation and consumption levels determined by the same equation, zero consumption observations in the Tobit model are assumed to result from a corner solution to the utility maximisation problem. This may not be desirable if some factors affecting market participation do not impact consumption levels directly. Likewise, some independent variables may have opposite impacts on the participation and consumption decisions. In either case, it is beneficial to separate the two decisions into a double-hurdle model (Cragg 1971).

Fuller *et al.* (2006) argue that beyond changes in prices and income, changes in consumer perceptions of dairy products, modifications to food purchasing behaviour and innovations in dairy product marketing have also contributed to expanding dairy consumption. These factors represent changes in preferences or shifts in the demand curve over time. Factors that influence perceptions about dairy products may be more likely to affect the decision to participate in dairy product consumption rather than the quantity purchased. On the other hand, greater availability and improved quality of domestic dairy products may have a greater impact on the frequency and quantity of purchases. Thus, the double-hurdle model may be a better choice for analysing dairy consumption in China.

In the double-hurdle model, the household's decision to participate in the market is modelled as a binary variable, D_i , which is a function of a vector of independent variables, Z_i , a vector of coefficients γ and an error μ_i . The observed consumption variable has a truncated distribution because it is only non-zero when consumers decide to participate in the market and when economic conditions are favourable for actually purchasing dairy products. The equations for the double-hurdle model are given in (1):

$$\begin{aligned}
 D_i &= Z_i'\gamma + \mu_i && \text{if } Z_i'\gamma > -\mu_i \\
 D_i &= 0 && \text{if } Z_i'\gamma \leq -\mu_i \\
 y_i &= X_i'\beta + \varepsilon_i && \text{if } X_i'\beta > \varepsilon_i \text{ and } D_i > 0 \\
 y_i &= 0 && \text{otherwise.}
 \end{aligned} \tag{1}$$

The errors μ_i and ε_i are assumed to have a bivariate distribution with zero mean and a variance–covariance matrix Σ .

With a relatively small sample of cross-sectional data, the regression errors are likely to be heteroskedastic and non-normal. Indeed, moments tests

performed on errors generated by preliminary Tobit regressions rejected the null hypothesis of homoskedasticity and normality. While several techniques exist to correct for heteroskedasticity, the normality assumption for the error terms in Equation (1) is critical for application of maximum likelihood (MLE) methods for estimating the double-hurdle model. One alternative to MLE is the generalised maximum entropy (GME) estimator (Golan *et al.* 1996), which performs consistently better than the MLE, Heckman (1979) and Ahn and Powell (1993) estimators for estimating sample-selection models with small sample size (Golan *et al.* 2004). Moreover, the GME estimator does not require assumptions about the distribution or covariance of the errors for the participation and consumption equations. Their results suggest that the GME estimates are robust to ill-posed specifications. Given weak conditions on the errors, the GME estimates are both consistent and asymptotic normally distributed. Consequently, we applied the GME estimator to jointly estimate the parameters of the participation and consumption equations for fluid milk, yogurt, powder milk and ice cream. Wu's (1986) weighted jackknife estimator was employed to compute the covariance matrix for the estimated coefficients because of its consistency properties in the presence of heteroskedasticity.

The double-hurdle model was estimated over the survey sample for the consumption of the four dairy products. Descriptions of the dependent and independent variables included in the regressions are given in Table 4. In light

Table 4 Variable description for limited dependent variable regressions

Variable	Type/units	Description
HHSIZE	Number	Number of people in household
INPC	Yuan/person	Per capita household monthly income
INC2	(Yuan/person) ²	Square of per capita household income
YOUNG	Binary	Households with young children and no senior citizens
ELDERLY	Binary	Households with senior citizens and no young children
ADINTENS	Number	Number of different media through which the household has been exposed to milk advertisements (1–6)
DOCTOR	Binary	1 = A health care professional has suggested that a family member should drink milk
EDUC	Years	Average education of the household head and spouse (number of years)
SCHMILK	Binary	1 = Child has school milk program available
TRAVEL	Binary	1 = A household member has travelled abroad in last decade
INSTORE	Index	Frequency of in store advertisements for dairy products
DEL	Binary	1 = Purchases product through home delivery or at designated delivery point
OTHER	Binary	1 = Purchases product from a street vendor or other location
SUPER	Binary	1 = Purchases product at a supermarket
CCDIST	Kilometres	Distance from the household to the city centre
MCDIST	Kilometres	Distance to the nearest McDonalds restaurant
BJ	Binary	1 = Beijing resident
GZ	Binary	1 = Guangzhou resident
SH	Binary	1 = Shanghai resident

of the discussion above, we have grouped the explanatory variables in Table 4 into four categories: demographics, variables influencing consumer perceptions, marketing channels and location-specific effects. We include both per capita income and the square of per capita income because preliminary non-parametric estimates of Engle curves suggested potential non-linearities in the relationship between income and milk and yogurt consumption. The list of explanatory variables does not include prices because price data were not collected. Unit values computed for households that consume dairy products are unsuitable for estimation because they contain quality attributes as well as price information. Econometric methods to correct unit values for quality rely on spatial price differences (Deaton 1988). However, without detailed information about the location of households within the cities, we are left with three spatial clusters corresponding to the three city samples. This is insufficient information to estimate price impacts. Other demand studies of this type that have omitted price variables from their specification include Yen and Jensen (1996), Gould (1992), Jensen (1995) and Blisard and Blaylock (1993).

Estimation results for the participation equation for fluid milk consumption, yogurt, milk powder and ice cream are shown in Table 5. Given the low number of zero consumption observations for milk, it is not surprising that many of the coefficients in the participation equations are insignificant. Nevertheless, demographics have a significant influence on the milk purchase probability. In particular, elderly households are less likely to purchase milk.

Table 5 Regression results for participation equations

Dependent/ independent variable	Milk	Yogurt	Milk powder	Ice cream
INCP	0.0000 (1.25)	0.0006** (2.03)	-0.0001 (-1.37)	-0.0001 (-1.44)
INC2	—	-0.0000* (-1.85)	—	—
YOUNG	-0.0591 (-1.28)	0.1517** (2.43)	-0.0581 (-0.95)	0.0562 (0.84)
ELDERLY	-0.1245* (-1.70)	0.0980 (1.05)	-0.0143 (-0.17)	0.0918 (0.99)
ADINTENS	0.0243* (1.81)	0.0260 (1.23)	0.0227 (1.11)	0.0330 (1.44)
DOCTOR	0.0489 (1.36)	—	0.1877*** (3.11)	—
EDUC	0.0105 (1.31)	0.0252** (2.09)	—	0.0244** (2.19)
SCHMILK	0.0812 (1.52)	—	—	—
TRAVEL	0.0442 (0.96)	—	—	—
INSTORE	—	0.2298** (2.05)	—	—
CCDIST	-0.0037 (-0.76)	—	0.0129* (1.79)	—
MCDIST	—	—	—	-0.0306* (-1.84)
BJ	0.6915*** (6.68)	0.0235 (0.14)	0.1849* (1.89)	0.3450*** (2.68)
GZ	0.6367*** (6.21)	-0.2377 (-1.40)	0.2294** (2.17)	0.3471*** (2.74)
SH	0.7439*** (7.71)	-0.2000 (-1.20)	0.1399 (1.31)	0.2067 (1.65)
SIGMA	0.289*** (230.02)	0.461*** (734.37)	0.442*** (574.25)	0.491*** (1249.45)
R ²	0.071	0.150	0.061	0.058

t statistics given in parentheses. * significance at the 10% level; ** significance at the 5% level; *** significance at the 1% level.

On the contrary, more affluent and younger households with children are more likely to purchase yogurt. The squared income term in the yogurt equation is negative but very small in magnitude, indicating that the impact of income on the probability to purchase yogurt declines as income rises. With regard to perception variables, advertising intensity has a positive impact on the milk purchase decision. Higher education levels increase the probability of yogurt and ice cream purchases. Similarly, the probability of milk powder purchases is also positively associated with doctors' advice.

With respect to marketing channels, in-store promotions positively influence the yogurt purchase probability. This result is consistent with the observation that most yogurt is purchased in supermarkets where in-store promotions often take place. Location effects influence the probability of purchase of milk powder and ice cream. As the household's distance to the city centre increases, the probability of purchasing milk powder rises. Conversely, households in closer proximity to fast-food outlets (MCDIST) have a higher probability of ice cream purchases. Finally, location also appears to have a substantial impact on milk purchase decisions, with residence in Shanghai associated with a greater probability to purchase milk and residence in Guangzhou associated with a lower likelihood to purchase milk. The city of residence is also important for milk powder and ice cream purchase probabilities. Households in Guangzhou and then Beijing are associated with higher consumption probabilities than households in Shanghai.

The results from the participation equations point toward the conclusion that the decision to purchase most dairy products in this analysis is greatly influenced by historical and environmental characteristics embodied in the fixed factors captured by the city location variables. Health concerns, education, exposure to advertisements and promotions contribute to the household's perception of the benefits from consuming dairy products and tend to increase the likelihood of purchases. The results for yogurt purchase decisions are consistent with the observation by Fuller and Hu (2005) that yogurt purchases in Kunming, China, appear to be greater for younger, more educated consumers. The estimates of the participation equation for milk powder tell a different story. A doctor's recommendation is one of the most significant and positive influences on the decision to purchase milk powder, highlighting the importance of health concerns. Higher transaction costs of purchasing fresh milk for households located farther from the city centre may induce some household to purchase milk powder.

Table 6 displays the estimated coefficients for the consumption equations. As expected, the quantity of fluid milk consumed is positively related to per capita income. Although we detected some evidence of non-linear income effects in Engle plots, we did not identify a statistically significant squared income term in the milk equation. Home delivery services and purchases from vendors have significant positive impacts on the level of fluid milk consumption. Per capita fluid milk consumption for households using home delivery or delivery points is 21 per cent higher on average than for all households.

Table 6 Regression results for consumption equations

Dependent/ independent variable	Milk	Yogurt	Milk powder	Ice cream
HHSIZE	-0.093 (-0.08)	-1.124* (-1.65)	—	-0.276 (-1.10)
INCP	0.046** (2.09)	0.003 (0.24)	-0.000 (-1.07)	0.001 (1.24)
INC2	-0.000 (-1.15)	0.000 (0.09)	—	—
YOUNG	-1.503 (-0.35)	1.463 (0.70)	-0.705*** (-2.70)	0.540 (0.72)
ELDERLY	0.962 (0.16)	2.247 (0.66)	-0.140 (-0.39)	-0.391 (-0.60)
ADINTENS	—	—	—	0.225* (1.76)
DOCTOR	—	—	0.310* (1.67)	0.076** (2.26)
EDUC	0.335 (0.32)	0.307 (1.41)	0.008 (0.63)	-0.014 (-0.21)
SCHMILK	0.509 (0.46)	0.812 (1.33)	—	—
TRAVEL	0.687 (0.31)	0.720 (1.08)	-0.028 (-1.04)	—
INSTORE	0.816 (0.29)	1.596 (0.47)	-0.007 (-1.25)	—
DEL	2.922** (1.97)	3.606** (2.36)	—	—
SUPER	1.984 (1.13)	5.783*** (5.28)	—	—
OTHER	3.503** (2.16)	0.168 (0.26)	—	—
CCDIST	0.139 (0.30)	—	0.022** (2.35)	—
MCDIST	—	—	—	-0.196** (-2.41)
BJ	16.798*** (3.32)	8.470*** (2.88)	1.064* (1.87)	3.263** (2.45)
GZ	-10.633*** (-3.62)	0.483 (0.19)	1.435*** (3.15)	1.469 (1.479)
SH	10.922*** (3.04)	0.887 (0.31)	0.766** (2.19)	0.034 (0.04)
Rho (correlation)	0.359*** (178.21)	0.345*** (151.70)	0.555*** (163.57)	0.375*** (158.99)
SIGMA	38.188*** (241.57)	16.980*** (154.86)	2.539*** (92.63)	5.578*** (114.62)
R ²	0.227	0.240	0.132	0.187

t statistics given in parentheses. * significance at the 10% level; ** significance at the 5% level; *** significance at the 1% level.

Similarly, more than half of the households that purchased milk from vendors or in other locations also purchased milk from supermarkets or grocery stores. These supplemental purchases raise their milk consumption 20 per cent above the survey average. We could not find a significant effect of school milk programs on milk consumption levels, but this may be due to the brief exposure to school milk programs at the time of the survey and the lack of a sizeable price subsidy. Given the disproportionate number of households in Guangzhou reporting availability of school milk programs, it is also possible that the program's impact is absorbed by the regional dummy variable.

While income coefficients are not statistically significant for the other dairy products, some demographic, perception and marketing variables are important factors. Household size has a negative impact on per capita yogurt consumption and may reflect the relatively greater scarcity faced by individuals in larger families. Powder consumption levels are lower for younger households with children. On the contrary, a doctor's advice positively influences both milk powder and ice cream consumption levels. Similarly, the intensity of advertisements has a positive impact on ice cream consumption.

The survey only collected location of purchase information for fluid milk and yogurt, but these variables are important determinants of consumption levels for both of these products. Households that purchase yogurt in supermarkets tend to consume higher levels than those that make purchases

Table 7 Unconditional consumption elasticities

	Milk	Yogurt	Milk powder	Ice cream
HHSIZE	-0.006 (-0.08)	-0.252 (-1.53)	—	-0.202 (-1.10)
INCP	0.948** (2.11)	0.332 (0.37)	-0.165 (-1.40)	0.213 (0.88)
INC2	-0.260 (-1.15)	-0.028 (-0.05)	—	—
YOUNG	-0.035 (-0.35)	0.185 (1.12)	-0.294*** (-2.86)	0.154 (0.71)
ELDERLY	0.022 (0.16)	0.197 (0.83)	-0.061 (-0.37)	-0.105 (-0.57)
ADINTENS	0.027 (1.38)	0.020 (0.85)	0.040 (1.07)	0.223* (1.94)
DOCTOR	0.000 (0.18)	—	0.190* (1.86)	0.021** (2.26)
EDUC	0.117 (0.47)	0.317 (1.50)	0.030 (0.62)	0.120 (0.50)
SCHMILK	0.012 (0.46)	0.050 (1.33)	—	—
TRAVEL	0.016 (0.31)	—	-0.011 (-1.03)	—
INSTORE	0.003 (0.29)	0.038 (0.65)	0.000 (-1.27)	—
DEL	0.068** (1.97)	0.226** (2.32)	—	—
SUP	0.046 (1.13)	0.367*** (5.42)	—	—
OTHER	0.082** (2.15)	0.010 (0.26)	—	—
CCDIST	0.009 (0.14)	—	0.101** (2.02)	—
MCDIST	—	—	—	-0.084** (-2.58)
BJ	0.408*** (3.40)	0.556*** (2.60)	0.577** (2.33)	1.001*** (2.82)
GZ	-0.240*** (-3.63)	-0.061 (-0.23)	0.699*** (3.84)	0.440 (1.64)
SH	0.260*** (3.05)	-0.025 (-0.10)	0.366** (2.45)	0.019 (0.08)

t statistics given in parentheses; * significance at the 10% level; ** significance at the 5% level; *** significance at the 1% level.

through other channels. Households that purchase yogurt through home delivery systems also have elevated consumption levels. As with fluid milk, school milk programs do not have a statistically significant influence on the level of consumption of yogurt.

Location effects matter for consumption levels, as well as for the likelihood of purchase. Milk powder consumption levels are positively associated with the household's distance from the city centre, reinforcing the idea that the implicit costs of transportation or limited access to delivery services or supermarkets in suburbs promote the use of milk powder over fresh dairy products. The proximity of convenient food outlets increases the level of consumption of ice cream. The survey results indicate that households in the sample typically purchased ice cream in single-serve quantities (50 g). Information collected about the brands purchased by households reveals that only a handful of households in the sample (all located in Guangzhou) actually preferred to purchase ice cream at McDonalds. Consequently, the MCDIST variable may capture the impacts of proximity to major shopping districts where vendors selling ice cream novelties are more likely to concentrate.

Several elasticity measures can be computed from the estimated coefficients; however, the two most relevant are the probability-of-consumption elasticities (Table 8) and the unconditional elasticities of consumption (Table 7). The probability-of-consumption elasticity measures the impact of a change in a variable on the likelihood of positive consumption. The unconditional consumption elasticity summarises the total effect of an exogenous variable on

Table 8 Probability-of-consumption elasticities

	Milk	Yogurt	Milk powder	Ice cream
HHSIZE	-0.000 (-0.06)	-0.054 (-0.82)	—	-0.003 (-0.59)
INCPC	0.018 (1.06)	0.191 (0.61)	-0.070* (-1.85)	-0.059 (-1.23)
INC2	-0.066 (-0.43)	-0.028 (-0.05)	—	—
YOUNG	-0.004 (-0.35)	0.100 (1.10)	-0.070** (2.36)	0.030 (0.63)
ELDERLY	0.003 (0.16)	0.068 (0.90)	-0.016 (-0.35)	-0.017 (-0.50)
ADINTENS	0.027 (1.38)	0.021 (0.86)	0.045 (1.02)	0.063 (1.32)
DOCTOR	0.000 (0.17)	—	0.075 (1.54)	0.004* (1.75)
EDUC	0.042 (1.06)	0.127 (1.04)	0.004 (0.55)	0.156 (1.49)
SCHMILK	0.001 (0.46)	0.004 (0.98)	—	—
TRAVEL	0.002 (0.32)	—	-0.003 (-0.98)	—
INSTORE	0.000 (0.14)	0.019 (0.88)	-0.000 (-0.98)	—
DEL	0.009 (1.60)	0.022 (0.81)	—	—
SUP	0.006 (1.05)	0.040* (1.68)	—	—
OTHER	0.010* (1.66)	0.001 (0.25)	—	—
CCDIST	-0.008 (-0.72)	—	0.062 (1.51)	—
MCDIST	—	—	—	-0.025 (-1.57)
BJ	0.066** (2.57)	0.078 (0.93)	0.207*** (2.75)	0.026*** (3.85)
GZ	-0.023* (-1.96)	-0.086 (-0.55)	0.227*** (4.19)	0.100** (2.23)
SH	0.038** (2.14)	-0.073 (-0.51)	0.114*** (2.61)	0.009 (0.19)

t statistics given in parentheses; * significance at the 10% level; ** significance at the 5% level; *** significance at the 1% level.

the actual consumption level for a good, including the impacts of the change in values on the probability of positive consumption. For fluid milk, changes in per capita income have the largest effect on consumption levels. The elasticity for per capita income alone is 0.948. Accounting for the effects of the squared income term on consumption lowers the total income elasticity to 0.428. Comparable elasticities from other studies range between 0.27 (Zhang and Wang 2003) and 0.66 (Liu and Chern 2003). The unconditional income elasticities are not significant for the other dairy products.

It is interesting to note that the income elasticity of the probability of consumption for milk powder is negative and significant at the 10 per cent level. This elasticity is small (-0.07), but the result suggests that as income rises, a household's likelihood of purchasing milk powder declines. A more substantial negative impact on milk powder consumption levels is apparent when young children are in the household. In general, demographic and location variables have the greatest impact on the probability of consumption, but several marketing and perception variables increase in importance and impact when the complete decision process is analysed (Table 8).

4. Concluding comments

Although the empirical results from the analysis above do not provide a strikingly clear picture of dairy product consumption in urban China, they do lead to some useful observations. First, in the three cities studied, milk is becoming a common food for households with over 90 per cent of households

consuming some milk. The fact that households purchase milk three to four times a week reveals that it is integrated into the regular diets for some members of the household. Although price effects were not measured, income and marketing channels are the key determinants of milk consumption levels. Household delivery systems provide a convenient way for consumers to regularly obtain fresh milk, increasing consumption levels.

Second, education, advertising and convenience play a more important role in consumption of other dairy products which lack the widespread acceptance of fluid milk. Yogurt, for example, is a fairly new product in the Chinese market, particularly flavoured yogurts and European style yogurts. It is not surprising that younger, wealthier and more educated households are more likely to purchase yogurt than other households because these households may be more aware of new products and may be more apt to shop in supermarkets. Furthermore, income has its greatest impact on yogurt consumption through the participation equation. Thus, it appears that income growth presently expands total demand for yogurt in the three cities more through an expansion of the consumer base than through increases in per capita consumption.

Third, milk powder, as a consumer good, may be becoming an inferior product. Milk powder has been available in China for many years. Until refrigeration and fresh milk availability improved, milk powder was the most practical dairy product for many households. Some consumers, particularly the elderly, continue to purchase milk powder as a health supplement. However, as incomes rise and convenient access to fluid milk improves, milk powder consumption is likely to decline. One important caveat on this conclusion is that our analysis only considers milk powder purchased for direct consumption. At the time our data were collected in 2001, flavoured milk products, which are often produced from reconstituted milk powder, were just beginning to appear in China's supermarkets. Since 2000, sales of these products have exploded, so indirect consumption of milk powder may be rising. Similarly, as the demand for dairy ingredients grows in China's food processing sector, imports of dairy components and the use of milk powder as a source of dairy proteins and solids will grow.

Finally, the growing sophistication of China's retail sector is influencing consumption of dairy products. Our survey clearly shows the importance of supermarkets for milk and yogurt distribution. The experiences from other countries shows that there is a symbiotic relationship between the development of dairy processing and marketing and the emergence of modern food retailing systems (Faiguenbaum *et al.* 2002; Gutman 2002). Parallel developments have been observed in China's dairy industry (Hu *et al.* 2007), and the result is that the domestic dairy products have rapidly improved in quality and variety. As modern retailing chains expand into second and third tier urban centres, consumers' access to quality dairy products improves. While the results from our study are most relevant for the cities surveyed, nonetheless they probably foreshadow consumption and marketing trends likely to emerge in other cities in their respective regions.

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