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At-home meat consumption in China: an empirical study*

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The remarkable economic changes occurring within China since 1978 have resulted in a striking alteration in food consumption patterns, and one marked change is the increasing consumption of meat. Given China's large population, a small percentage change in per capita meat consumption could lead to a dramatic impact on the production and trade of agricultural products. Such changes have major implications for policy makers and food marketers. This paper concentrates on meat consumption patterns in the home in China. A censored linear approximate almost ideal demand system model was employed in the study, and major economic parameters were estimated for different meat items. Data used in this study were collected from two separate consumer surveys – one urban and one rural in 2005.

Key words: censored demand, China, linear approximate almost ideal demand system model, meat consumption.

1. Introduction

An anecdote says that McDonald's has created a new trend in Chinese beef consumption, while Kentucky fried chicken has increased the consumption of poultry. Are these true? 'What is happening in the Chinese market?' and 'what is it that Chinese consumers want?' are the questions every marketer is keen about. The answers to these questions lie in understanding consumer behaviour and consumption patterns.

As the country with the world's largest population, China's rapid economic development has attracted much attention (Chow 1984; Fan *et al.* 1994; Rozelle *et al.* 1997; Zhou *et al.* 2003). With rapid economic development, many changes are occurring in Chinese society, and one marked change in food consumption is the increasing consumption of meat that has occurred during the last two decades (Figure 1). Given the massive potential purchasing power embedded in its large population, China has turned out to be a key

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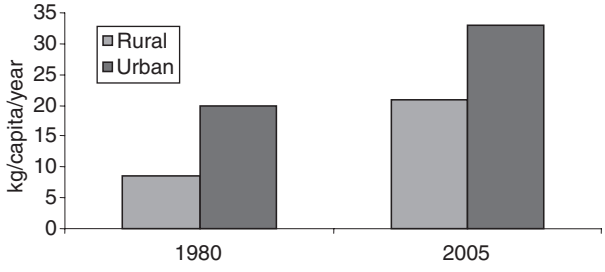

Figure 1 Meat consumption per capita in rural and urban China (1980 and 2005). Note: meat consumption refers to the consumption of pork, poultry, beef and mutton.
Source: *China Statistical Yearbook (1981, 2006)*.

market that any strategic business planner cannot overlook (Samuel *et al.* 1996; Carter 1997; Zhang 2002; Zhou *et al.* 2003).

Changes in food consumption have a great impact on food supply policy, because to provide nutritionally adequate food for 22 per cent of the world population has always been a stated goal of the Government of China. In addition, updated information on meat consumption is an essential component of effective industry planning, market access negotiations and successful marketing programs for various industries within and outside China. In addition, to meet the increasing meat demand, structural adjustments in employment to expand the livestock industry are required (Johnson 2000). Consequently, the expansion of the livestock industry will involve different use of land, greater dependence on pesticides and artificial fertilizers and a big increase in agricultural waste (Tian 2003; Zhou and Tian 2005). Elsewhere, such an expansion of the livestock industry has contributed significantly to pressing environmental problems, including climate change, land degradation, air and water pollution and loss of biodiversity (Steinfeld *et al.* 2006; Tickell 2007). Therefore, the changes taking place in recent years in Chinese meat consumption have attracted the attention of policy makers, researchers and international agricultural food analysts (Brown 1995; Paarlberg 1997; Yang and Huang 1997; Cai *et al.* 1998; Wu 1999; Rae and Hertel 2000; Veeck and Veeck 2000; Zhou *et al.* 2003; Zhang 2004; Zhou and Tian 2005).

Although numerous papers on Chinese household consumption issues have been published since the 1980s (Lardy 1984; Lewis and Andrews 1989; Garnaut and Ma 1993; Fan *et al.* 1995; Shi *et al.* 1995; Gao *et al.* 1996a,b; Wu 1999; Gould 2002; Zhou and Tian 2005), these studies have either tended to focus on the broader segment of household food consumption or used outdated or unreliable data and have not explained the recent meat-consumption issues convincingly. In addition, most previous studies using micro-level survey data did not consider zero expenditure on some items (Fan *et al.* 1995; Cai *et al.* 1998; Ma *et al.* 2004; Wang *et al.* 2004, 2005), which has been found to lead to bias in estimation (Haines *et al.* 1988; Heien and Wessells 1990; Perali and Chavas 2000; Mihalopoulos and Demoussis 2001; Jabarin 2005; Yen

and Lin 2006). Furthermore, following its entry into the WTO in 2001, China has become the fastest-growing food market in the world. To assist policy formation and business planning in such circumstances of rapid change in consumer behaviour, it is important to have recent estimates of parameters such as demand elasticities. Therefore, a need for a systematic examination of Chinese meat consumption exists.

The objective of this paper is to provide empirical evidence about meat consumption patterns in the home in China. This study attempts to fill a gap in the literature by providing the most recent estimates of demand elasticities. It does this by considering, as separate items, the five meats commonly consumed in China using a censored almost ideal demand system (AIDS) model (Deaton and Muellbauer 1980). This study will help to provide updated information on meat consumption trends in China, overcoming the ineffectiveness of data used by earlier studies.

2. Methods of analysis

Essential criteria for selecting a demand model are relative illustrative power, consistency with economic theory and simplicity of estimation (Wang *et al*. 1996). Therefore, the AIDS model has been chosen in the present study because of its theoretical and practical considerations, and popularity in demand analysis (Blanciforti and Green 1983; Fujii *et al*. 1985; Fulponi 1989; Heien and Wessells 1990; Fan *et al*. 1995; Huang 1999; Wu 1999; Ma *et al*. 2004; Jabarin 2005; Gould and Villarreal 2006). In addition, the estimated coefficients in a linear approximate almost ideal demand system (LA–AIDS) are easy to interpret (Fulponi 1989; Jabarin 2005).

The AIDS demand function used in this study is as follows:

$$w_i = \alpha_i + \sum \alpha_{is} Z_s + \sum_j \gamma_{ij} \ln p_j + \beta_i \ln(x/P) \tag{1}$$

where Z_s are social and demographic variables (viz., education, presence of child(ren) and urban and rural experiences), x is the total expenditure, P_j are prices of meat items, and P is a price index. Stone's price index (Stone 1953) is commonly used instead of P, which is:

$$\ln P^* = \sum w_k \ln p_k. \tag{2}$$

By using Stone's price index as a proxy, the model becomes linear in parameters α, β and γ, and becomes the LA–AIDS model (Deaton and Muellbauer 1980; Chalfant 1987; Cai *et al*. 1998). In practice, the LA–AIDS model is used more frequently than the non-linear AIDS model (Huang and Rozelle 1998; Wu 1999; Mu 2001). The estimates from an LA–AIDS model would approach the estimates for AIDS except for an intercept term (Green and

Alston 1990). Although using Stone's price index has been found to affect the approximation properties of the model with changes in the units of measurement (Moschini 1995), in the present study, the usage of it has been found appropriate because of careful choice of unchanging units of measurement for prices and quantities. In addition, Zellner's (1962, 1963) iterative seemingly unrelated regression (ITSUR) is used in this paper because it is usually regarded as a better tool to improve the efficiency of the estimates (Chalfant 1987; Heien and Wessells 1990; Shonkwiler and Yen 1999; Jabarin 2005).

As in many other household consumption surveys, the collected data contain zero expenditures for some meat items. Thus, estimation techniques that fail to consider this censoring problem would encourage biased parameter estimates (Park *et al.* 1996). To solve this problem, a two-step estimation procedure based on the Amemiya–Tobin approach was used to include all the observations at both steps to estimate a system of home-meat-consumption equations (Heien and Wessells 1990).

The first step involves probit regressions to determine the probability of participation or consumption. Dummy variables are used to distinguish between different regions, as dietary habits vary among the different regions. In particular, one of our sample areas is Inner Mongolia, where major beef and mutton consumers live. In the second step, the inverse mills ratios (IMR) are calculated from the probit estimates and employed in the LA–AIDS model as an instrument, which approximates a variable representation of the unobservable influence on the participation decision, to estimate meat demand elasticities.

To be consistent with the demand theory, the following restrictions must be adhered to: the adding-up restriction as in Equation (3), the homogeneity condition as in Equation (4) and the Slutsky symmetry condition in Equation (5) (Deaton and Muellbauer 1980).

$$\sum_{i}^{n} \alpha_i = 1, \quad \sum_{i}^{n} \alpha_{is} = 1, \quad \sum_{i}^{n} \beta_i = 0, \quad \sum_{i}^{n} \gamma_{ij} = 0. \tag{3}$$

$$\sum_{j} \gamma_{ij} = 0 \tag{4}$$

$$\gamma_{ij} = \gamma_{ji} \tag{5}$$

Given the above specifications, Marshallian (compensated) and Hicksian (uncompensated) elasticities were computed from the estimated parameters of the LA–AIDS model using the close approximation of the exact formulas developed by Green and Alston (1990), which are given in Equations (6)–(8).

Expenditure elasticities:

$$e_{ix} = 1 + \frac{\beta_i}{w_i} \tag{6}$$

Marshallian (uncompensated) price elasticities:

$$\eta_{ij} = -\delta_{ij} + \frac{\gamma_{ij}}{w_i} - \frac{\beta_i}{w_i}\left[w_j + \sum_k w_k \ln P_k\left(\delta_{kj} + \eta_{kj}\right)\right] \tag{7}$$

where δ_{ij} is the Kronecker delta, $\delta_{ij} = 1$ for $i = j$; $\delta_{ij} = 0$ for $i \neq j$.
The Hicksian (compensated) price elasticities:

$$\eta^*_{ij} = \eta_{ij} + w_j\left(1 + \frac{\beta_i}{w_i}\right) = \eta_{ij} + w_j e_{ix} \tag{8}$$

3. Data

In the absence of reliable household census data, a survey was conducted as part of research collaboration between Meat and Livestock Australia (MLA) and the Faculty of Rural Management, the University of Sydney. The purpose of the survey was to collect data that could be used to examine the changing meat consumption patterns in China. The survey covered five provinces (Jiangsu, Shandong, Inner Mongolia, Liaoning and Sichuan) representing different food cultures of eastern, central, north, northeast and southwest China. These regions also vary in geography, economic development, ethnic group, food culture and lifestyle. Two separate household surveys, one urban and one rural, were carried out in the period September–December 2005. A stratified data-sampling method was applied to draw samples.

To monitor the changes in meat consumption patterns, questions addressed weekly meat expenditure, the price of meat items and demographic and socio-economic status of each household and its members. Weekly meat consumption data provided detailed information on consumer behaviour, and the impact on changing behaviour patterns. For rural consumers, special questions covered the meat consumption of goods produced by the household, considering the effect of joint consumption–production decision-making (Yan and Chern 2004). The questionnaire was first developed in English and discussed thoroughly with professionals in various related sectors and consumer research. This was later translated into Chinese and pre-tested. Based on the pilot study, questions on some products (e.g. duck and fish) were deleted and the questionnaire was finalised for the survey. The total number of responses from urban areas was 232, and from rural areas was 108 (Table 1). A sample of 340 was considered appropriate to ensure validity in this exploratory study, and the sample size obtained from each area was more than 30. Ideally, household census data of the type available for Malaysia would have been used (Heng and Guan 2007). However, such census data do not exist in China, and some previous survey data have been observed to be unreliable (Lu 1998; Ma *et al.* 2004).

Table 1 Basic statistics of survey samples at province level

Province	Households	Household size	Age	Education
Urban				
Inner Mongolia	56	3.07	42.9	12.4
Liaoning	46	2.91	43.2	13.0
Shandong	40	3.03	44.6	12.4
Sichuan	30	3.00	44.3	13.4
Jiangsu	60	3.40	45.9	11.8
Rural				
Jiangsu	39	3.26	44.6	9.6
Liaoning	35	3.23	45.7	7.0
Shandong	32	2.94	43.4	8.6

Note: Household size – average household size, age – the average age of meal planner of the household, education – the average years of education, which the meal planner has attained. It was observed during the survey that many of the households in rural Shandong had former members who were now living in the cities, having taken-up job opportunities there. This may, in part, account for the lower than expected average household size in rural Shandong.

Sampled households differed in age, education, income level and ethnic group. Characteristics of the sampled households, disaggregated by urban and rural residents, are reported in Table 2. Most of the means of the key variables generated in the sample were consistent with those in NBS (2006a,b). For example, per capita annual income of the urban sample was 11 202 RMB Yuan, and that of NBS (2006a) was 10 493; family size in the sample was 3.1, while that of NBS (NBS 2006b) was 3.4. Therefore, compared with NBS data, the survey data are representative and reasonable, indicating that the survey provides a reliable source for further estimation.

4. Results and discussion

The parameters of the LA–AIDS model were estimated using Zellner's ITSUR procedure. Social and demographic variables, such as education, presence of child(ren) and urban and rural experiences, are included in the model reflecting the influence of the most recent developments in Chinese society. Because all meat expenditure shares add to one, a demand system composed of five individual expenditure share equations would be singular. Thus, one of the equations must be excluded to estimate the equation as a system (Hayes *et al.* 1990; Heien and Wessells 1990; Jabarin 2005). In the present study, the 'pork-share equation' was chosen to be excluded in the estimation. To be consistent with consumer theory, this model was estimated with the imposition of homogeneity and Slutsky symmetry. To test the homogeneity and Slutsky symmetry restriction, a Wald test was used in the present study. The Wald test for homogeneity yielded $\chi^2 = 73.7378$, $P = 0.0$, and for Slutsky symmetry yielded $\chi^2 = 27.3557$, $P = 0.0001$. Thus, homogeneity and Slutsky symmetry were reasonable restrictions.

Table 2 Characteristics of the surveyed households

	Survey sample		
	Urban	Rural	All
Average household size	3.1	3.1	3.1
Age	44.2	44.6	44
Maximum age (minimum age)	79 (22)	77 (20)	79 (20)
Education (% of the sample)			
Less than primary school	10.8	33.3	17.9
Middle school graduate	17.2	42.6	25.3
High school graduate	32.3	24.1	29.7
College graduate	38.8	0.0	26.5
Postgraduate	0.9	0.0	0.6
Ethnic group (% of the sample)			
Han Chinese	92.5	91.7	92.1
Non-Han Chinese	7.5	8.3	7.9
Annual household income (% of the sample)			
Less than 6000	2.2	28.7	10.6
RMB 6000–10 000	3.0	28.7	11.2
RMB 10 001–20 000	22.0	26.9	23.5
RMB 20 001–30 000	28.5	9.3	22.4
More than RMB 30 001	44.4	6.5	32.4
Total number of the samples	232	108	340

Note: Age – average age of meal planner of the household surveyed, education – the education level, which the meal planner of the household surveyed has attained.

Table 3 shows that the share of pork in the meat budget is the highest (40 per cent), followed by aquatic products (21 per cent). The proportion of households with non-zero expenditure is also provided in Table 3, showing that 50 per cent of the households had bought mutton during the survey, 70 per cent of them had bought beef and 86 per cent of them had bought both poultry and aquatic products. The 98 per cent purchase rate for pork indicated that the zero expenditure issue might not affect the estimation for pork. Indeed, the probit regression for pork failed to explain the purchasing behaviour, confirming our assumption of little influence from zero expenditure. Therefore, the IMR has not been added into the pork equation. However, in

Table 3 Probit regression and its application to LA–AIDS model

	Budget share	Purchase rate	R^2	
			Uncensored	Censored
Pork	0.40	0.98	NA	NA
Poultry	0.19	0.86	0.04	0.09
Beef	0.11	0.70	0.12	0.15
Mutton	0.08	0.50	0.22	0.23
AP	0.21	0.86	0.10	0.36

AP, aquatic products.

general, using LA–AIDS as a censored multiple-regression system provides improved results in terms of goodness-of-fit (Table 3). Therefore, the two-step estimation procedure enabled a better explanation of meat consumption behaviour at home.

The estimated coefficients of the joint censored LA–AIDS model (including urban and rural samples) are presented in Table 4. Table 4 shows that the model works well in explaining meat consumption behaviour at home. Many coefficients reported therein are statistically significant and have the expected signs. The coefficients of the presence of children, urban experience and education are significant for some meat items, such as aquatic products, beef and mutton, indicating that social and demographic factors have a significant effect. But they are insignificant for poultry.

Given the differences existing in urban and rural China, we ran two regressions using the rural and urban samples separately. The expenditure elasticities, budget share, Marshallian and Hicksian price elasticities for average, urban and rural China are shown in Tables 5 and 6.

Table 5 shows that all expenditure elasticities are positive. This means, on an average, meat is a normal product in China at present. Therefore, based on the assumption that consumer income keeps on rising, meat consumption will continue to increase accordingly in the near future. This is because: (i) as the survey results and earlier literature show, the level of meat consumption in urban China is higher than that in rural areas, so that if China is successful

Table 4 LA–AIDS parameter estimates for five meat items

	AP	Poultry	Beef	Mutton	Pork
α	28.7519**	−12.8431**	24.8321**	20.6038*	−60.3447
	(9.1283)	(−1.8053)	(6.6518)	(5.6864)	NA
β	0.0443**	−0.0202**	0.0381**	0.0316**	−0.0939
	(0.0141)	(−1.8326)	(0.0103)	(5.6581)	NA
γ_1	−0.0871*	0.1592**	−0.0192	−0.0142	−0.0387
	0.0536	(0.0428)	(0.0318)	(0.0383)	NA
γ_2	0.1592*	−0.1096**	−0.0345*	0.0429*	−0.0580
	(0.0428)	(0.0482)	(−1.4819)	(0.5517)	NA
γ_3	−0.0192	−0.0345	−0.0809**	0.0370	0.0977
	(0.0318)	(0.0274)	(0.0363)	(0.0364)	NA
γ_4	−0.0142	0.0429	0.0370	−0.0817**	0.0161
	(0.0383)	(0.0293)	(0.0364)	(0.0462)	NA
γ_5	−0.0387	−0.0580	0.0977	0.0161	−0.0170
	NA	NA	NA	NA	NA
Child	−0.0302**	−0.0018	−0.0103	−0.0050	0.0472
	(0.0176)	(0.0144)	(0.0103)	(0.0116)	NA
Urban/rural	0.0657**	−0.0330	−0.0012	0.0134	−0.0449
	(0.0246)	(0.0207)	(0.0188)	(0.0185)	NA
Education	0.0286	−0.0069	0.0011*	−0.0342**	0.0114
	(0.0231)	(0.0192)	(0.0160)	(0.0155)	NA
μ	0.0758**	−0.0759**	−0.0478**	0.0479	NA
	(0.0388)	(0.0410)	(0.0190)	NA	NA

Standard errors are in parenthesis, (**) and (*) indicate significance at 5 per cent and 10 per cent, respectively. AP, aquatic products.

Table 5 Own-price elasticities and expenditure elasticities

	Own-price elasticities			Expenditure elasticities			Budget share		
	Average	Urban	Rural	Average	Urban	Rural	Average	Urban	Rural
Marshallian price elasticities									
Pork	−1.00	−1.16	−0.94	0.77	0.63	0.93	0.40	0.33	0.54
Poultry	−1.55	−1.05	−2.11	0.90	0.98	0.80	0.19	0.20	0.18
Beef	−1.75	−1.64	−2.19	1.34	1.45	1.15	0.11	0.14	0.05
Mutton	−2.00	−1.89	−2.61	1.38	1.42	1.18	0.08	0.10	0.07
AP	−1.23	−1.16	−1.45	1.21	1.27	1.04	0.21	0.23	0.16
Hicksian price elasticities									
Pork	−0.69	−0.72	−0.64	NA	NA	NA	NA	NA	NA
Poultry	−1.37	−1.14	−2.02	NA	NA	NA	NA	NA	NA
Beef	−1.60	−1.65	−1.44	NA	NA	NA	NA	NA	NA
Mutton	−1.89	−1.21	−3.19	NA	NA	NA	NA	NA	NA
AP	−0.98	−0.78	−1.18	NA	NA	NA	NA	NA	NA

AP, aquatic products.

in modernising and urbanisation, there will be hundreds of millions of new urban residents with higher meat demand (Hu *et al*. 1998; Huang 1999); (ii) as rural meat consumption levels are still low, there is substantial room for an increase in meat consumption following rising incomes in rural China; and (iii) although there are some signs that high income households (mostly in urban China) may reduce meat consumption because of health concerns (Wan 1998; Shono *et al*. 2000; Chu 2003), they account for only a small proportion of the population. The increasing demands will surpass decreasing ones, and will not affect the general trend of increasing meat consumption. Moreover, simply because of the large population, a small increase in per capita meat consumption will result in a dramatic increase in total quantity demanded.

However, this increase in meat consumption is not distributed evenly among meat items. The elasticities of Table 5 show that as income increases, the consumption of aquatic products, beef, and mutton will increase more than pork and poultry, indicating that with more income, meat consumption in both urban and rural China would become more diversified. This trend may stimulate the creation of a large non-traditional meat market, such as beef and mutton, as indicated by their high expenditure elasticities (mutton: 1.38 for average, 1.42 for urban and 1.18 for rural; beef: 1.34 for average, 1.45 for urban and 1.15 for rural). The expenditure elasticity of aquatic products (1.21 for average, 1.27 for urban and 1.04 for rural) indicates their consumption is increasingly popular among Chinese consumers as they diversify their diet. In general, rural areas portray more traditional meat eating habits than urban areas. They have a higher budget share for pork and a lower share for other meat products. In addition, the expenditure elasticity for pork is higher in rural areas, whereas the expenditure elasticity of all the other meats is lower than in urban areas.

Table 6 Marshallian and Hicksian price elasticities

	Pork	Poultry	Beef	Mutton	AP
Marshallian price elasticities					
Pork					
Average	−1.00	—	—	—	—
Urban	−1.16	—	—	—	—
Rural	−0.94	—	—	—	—
Poultry					
Average	−0.02	−1.55	—	—	—
Urban	−0.10	−1.05	—	—	—
Rural	0.04	−2.11	—	—	—
Beef					
Average	0.27	−0.09	−1.75	—	—
Urban	0.43	−0.07	−1.64	—	—
Rural	0.13	−0.17	−2.19	—	—
Mutton					
Average	0.13	0.23	0.53	−2.00	—
Urban	0.14	1.13	1.03	−1.89	—
Rural	0.06	0.17	0.30	−2.61	—
AP					
Average	0.01	0.91	0.96	0.72	−1.23
Urban	1.20	1.02	1.83	1.45	−1.16
Rural	−1.04	0.68	0.79	0.44	−1.45
Hicksian price elasticities					
Pork					
Average	−0.69	—	—	—	—
Urban	−0.72	—	—	—	—
Rural	−0.64	—	—	—	—
Poultry					
Average	0.17	−1.37	—	—	—
Urban	0.50	−0.84	—	—	—
Rural	0.05	−2.02	—	—	—
Beef					
Average	0.33	−0.77	−1.60	—	—
Urban	0.36	−0.65	−1.65	—	—
Rural	0.12	−1.22	−1.44	—	—
Mutton					
Average	0.18	0.31	0.41	−1.89	—
Urban	0.09	0.38	0.45	−1.21	—
Rural	0.21	0.23	0.33	−3.19	—
AP					
Average	0.16	−0.09	1.07	0.40	−0.98
Urban	0.24	−0.12	0.88	0.61	−0.78
Rural	0.13	−0.07	1.36	0.22	−1.18

Compared with some recent studies (Cai *et al.* 1998; Ma *et al.* 2004; Gould and Villarreal 2006), the expenditure elasticities of the present study seem generally reasonable. For example, the higher expenditure elasticities for poultry, beef and mutton align with the recent official statistics and other studies showing rapid increases in the consumption of poultry, beef and mutton (NBS 1996, 2006a; Wang *et al.* 2005). This could be due to consumers' variety-seeking behaviour, which is possible with greater disposable income.

Moreover, consumers in higher-income brackets, mostly in urban areas, are found to concentrate more on quality and safety than those in lower income brackets. For example, respondents were asked how much more money they were willing to pay for quality-and-safety-guaranteed beef (unlike consumers in Australia, Chinese consumers still relate safety to quality characteristics of meat). About 68 per cent of higher-income consumers, with a household income of more than 30 000 RMB Yuan per year, chose to pay a price increase of '30 per cent and more', whereas only 4 per cent of lower-income consumers, with a household income no more than 6000 RMB Yuan per year, chose the same answer. Hence, as Chinese consumers become richer, they have a greater requirement for quality-and-safety-guaranteed meat, and seem willing to pay more for it.

In terms of own-price elasticities, the demand for pork (−0.69 for average Hicksian price elasticities) is price inelastic. However, it seems that urban consumers (−0.72) are slightly more sensitive to price changes of pork than rural consumers (−0.64), which indicates that Chinese rural consumers still tend to keep to the traditional habit of eating pork as the main meat item, whereas their urban counterparts are exposed to a more diversified food culture.

Generally speaking, the demand for aquatic products (−0.98 for average Hicksian price elasticities) is close to unity, implying that they are still necessary in the Chinese diet, and the demands are not very sensitive to price changes. However, the demand for aquatic products in rural China (−1.18) is sensitive to price changes, indicating that they are not as commonly consumed in rural areas.

The own-price elasticity of poultry (−1.37 for average, −1.14 for urban, −2.02 for rural Hicksian price elasticities) is greater than one; seemingly higher than expected (based on official statistics (NBS 1986, 2006a), poultry is widely consumed and regarded as almost necessary in the Chinese dietary pattern). The higher own-price elasticity of poultry in this study may be related to an outbreak of avian influenza during the survey period, which probably affected consumer behaviour and poultry supply. This is especially true in one of our survey areas, Liaoning province, where poultry products were banned in markets because of a sudden epidemic of H5N1 avian influenza on several poultry farms.

The own-price elasticity of mutton (−1.89) is the highest, indicating that the consumption of mutton is greatly influenced by change in price. This is especially true in rural China (−3.19), indicating that demand is very sensitive to the price changes.

The own-price elasticity of beef (−1.60 for average, −1.64 for urban, −1.44 for rural Hicksian price elasticities) indicates that the demand for beef is sensitive to prices. This is especially true for beef consumption at home, whereas food-away-from-home (FAFH) beef consumption is probably determined by different factors. The beef demand in rural areas is not as sensitive as in urban ones, because of the lower penetration of beef in rural

areas which remain influenced by the traditional view of beef cattle as traction and not for consumption. In addition, rural people are less familiar with cooking methods for beef.

The small data set in relation to the number of parameters estimated and the approximate nature of the model necessitate exercising caution in interpreting the estimated cross-elasticities (Table 6). In terms of magnitude, the high cross-price elasticities provide evidence for strong substitution and complementary relationships among meat items (Mansfield 1996). As expected, the cross-elasticities are generally lower in absolute value than own-price elasticities, implying that the consumers are more responsive to changes in own prices than in the price of other products.

The results indicate that, generally, pork is a substitute for all other meat items; poultry appears as a reasonable substitute for pork and mutton, but is complementary to beef and aquatic products; beef seems to be a substitute for pork, mutton and aquatic products, but is complementary to poultry; mutton seems to be a substitute for all other meat items except for aquatic products, and aquatic products are substitutes for pork and beef, but are complementary to mutton and poultry. Among the above complementary relationships, only mutton and aquatic products are statistically significant.

The above mentioned substitution and complementary relationships could be related to aspects of current Chinese diet. For example, the complementary relationships between meat items may partly result from two popular cooking methods: 'hot-pot' and 'meat-strings', which have recently become widespread in China. With the 'hot-pot' method, sliced beef (or veal) and mutton (or lamb), poultry, fish and other raw meat items are quickly dipped into boiling seasoned soup in the 'hot-pot' and then eaten by mixing with other seasonings, and a wide choice of side dishes. The 'meat-strings' method originated with the 'roasted-mutton-string' which evolved chiefly in China's northwest regions (e.g. Xinjiang), and is similar to satay consumed in some Southeast Asian countries. Mutton, beef, pork and poultry meat, and even squid, are cut into small cubes, then placed onto bamboo or iron skewers and roasted over an open fire stove. Seasonings of choice may be added after the meat is cooked. In addition, other foreign cooking methods, such as the Korean and Japanese style barbecue, are becoming popular in China now. Moreover, the present survey finds that young consumers in urban regions are tending to consume meat items that require less time to prepare, because of the faster rhythm of urban life (Huang and David 1993; Wang *et al*. 2005; Ma *et al*. 2006).

Per capita meat consumption in the surveyed regions was also calculated and is shown in Table 7. The comparison indicates that regional variations in terms of meat consumption exist in China. For example, people from Inner Mongolia, who are major beef and mutton consumers, have a different dietary habit from other regions. In contrast, people from Sichuan are tending to eat more poultry and aquatic products. The eating habits in coastal areas,

Table 7 Meat consumption per capita across the regions surveyed in 2005 (kg/annum)

	Jiangsu		Shandong		Liaoning		Inner Mongolia	Sichuan
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Urban
Pork	25.50	20.13	22.68	16.30	23.52	20.84	21.17	21.96
Poultry	14.32	9.15	16.23	7.69	10.73	10.06	12.59	18.17
Beef	2.15	1.01	4.14	2.13	4.25	2.18	7.16	1.11
Mutton	0.96	0.92	3.20	2.39	3.71	2.43	15.19	1.01
Aquatic	15.56	10.01	16.36	7.49	15.22	6.78	10.72	17.35

such as Jiangsu, Shangdong and Liaoning are becoming similar, because of rapid economic development. In general, pork still remains in a dominant position in meat consumption in China.

In addition, a comparison of per capita meat consumption from different studies is provided in Table 8. Our results are slightly higher than NBS data, because of the different method of estimating away-from-home meat consumption. In contrast, most of our results are lower than Wang (2004), whose prediction of meat consumption in 2005 is based on survey results from 1998. Many changes have occurred in the livestock industry and in consumption during the intervening period.

5. Conclusions

The present study shows that income and meat price are the two main influential factors affecting at-home meat consumption in China. As income increases, not only will the level of meat consumption increase, but also the composition of meat consumption will change. For example, although pork consumption is still in a dominant position, consumers have diversified their meat expenditure and, as incomes rise, will look forward to quality-and-safety-guaranteed meat. In addition, compared with away-from-home meat consumption, Chinese consumers are more responsive to the price of meat when they buy and consume it at home. For most lower-income consumers

Table 8 Comparison of per capita meat consumption across different studies (kg/annum)

	NBS (2006a)		Wang (2004)		Our survey	
	Urban	Rural	Urban	Rural	Urban	Rural
Pork	20.15	15.60	34.89	20.76	22.96	19.09
Poultry	8.97	3.70	12.35	5.22	14.41	8.97
Beef and mutton	3.70	1.51	10.69	3.49	8.58	3.69
Aquatic	12.60	4.90	19.64	6.40	15.04	11.24

Note: Wang (2004) is based on the survey done in 1998.

in both urban and rural China, the higher price of meat is still the main constraint restricting their meat consumption.

Other factors, such as urbanisation, preference, changing lifestyles and health concerns need to be considered when examining consumer behaviour and at-home meat consumption patterns in China. For example, this study finds that consumers' changing preferences provide more opportunities for some segments of meat markets, such as beef and mutton, with the aid of some new cooking methods. Also, greater health concern exists among higher income consumers. For example, some consumers are shifting from fatty meat item (such as pork) to some lean ones (such as beef and aquatic products) (Longworth *et al.* 2001; Wang *et al.* 2005). Some affluent consumers are even shifting from meat to vegetables because of health concerns, although this is a special case. Moreover, consumers with a hectic lifestyle are demanding more processed or semi-processed meat products for time saving and convenience purposes, especially in the cities. Given that most Chinese consumers are not familiar with the cooking methods of some non-traditional meat items (e.g. beef and mutton), they may prefer to consume them at restaurants. Therefore, when studying the changes of meat consumption patterns, processed food and FAFH consumption need to be taken into account, together with consideration of the rapid urbanisation process occurring in China.

The majority of difficult-to-explain elasticities are related to aquatic products. This may be due to the broad 'definition' of aquatic products used in the consumer survey, for they are far from homogeneous commodities. Furthermore, two animal epidemics, which occurred during the second half of 2005 (an outbreak of *Streptococcus suis* type II infection of pigs in Sichuan province in July and a sudden epidemic of H5N1 avian influenza in Liaoning province in November), gave an opportunity to observe consumers' reactions. For example, when consumers in Sichuan province felt unsafe with pork, they turned to poultry and aquatic products as compensation, whereas when consumers in Liaoning province felt unsafe with poultry, they shifted to beef and mutton instead. This difference basically originated from the diverse eating habits, which developed under a specific context, defined by food availability, cooking methods and preferences. But, another possibility exists: consumers may turn to non-animal products as well when they feel insecure about one or more types of animal products. There are two implications behind this: (i) if the safety of meat can be secured, it will create a promising market for high-quality meat, avoiding severe price competition; and (ii) if this need cannot be satisfied in time, consumers may lose interest in eating meat products, and substitute them with others. Thus, the demand for meat could become elastic in the long run, and the stability of the Chinese meat market will be in question. This unstable model will benefit neither consumers nor producers. As the present research only focuses on meat consumption issues, the changes in non-animal products consumption are beyond the present research scope. In further research, it may be worth exploring the

changes of both animal and non-animal products consumption induced by negative news on animal products.

References

Blanciforti, L. and Green, R. (1983). An almost ideal demand system incorporating habits: an analysis of expenditures on food and aggregate community groups, *Review of Economics and Statistics* 65, 511–515.

Brown, L. (1995). *Who Will Feed China?* Norton, New York.

Cai, H., Brown, C., Wan, G. and Longworth, J. (1998). Income strata and meat demand in urban China, *Australian Agribusiness Review* 6, 100–120.

Carter, C. (1997). The urban-rural income gap in China: implications for global food markets, *American Journal of Agricultural Economics* 73, 1410–1418.

Chalfant, J. (1987). A globally flexible, almost ideal demand system, *Journal of Business and Economic Statistics* 5, 233–242.

China Statistical Yearbook (1981). China Statistics Press, Beijing.

China Statistical Yearbook (2006). China Statistics Press, Beijing.

Chow, G. (1984). *The Chinese Economy*. Harper and Row, New York.

Chu, Y. (2003). An analysis on China's feed market (in Chinese). PhD Thesis, China Agricultural University, Beijing.

Deaton, A. and Muellbauer, J. (1980). An almost ideal demand system, *American Economic Review* 70, 312–326.

Fan, S., Cramer, G.L. and Wailes, E.J. (1994). Food demand in rural China: evidence from rural household survey, *Agricultural Economics* 11, 61–69.

Fan, S., Wailes, E.J. and Cramer, G.L. (1995). Household demand in rural China: a two-stage LES-AIDS model, *American Journal of Agricultural Economics* 77, 54–62.

Fujii, E., Khaled, M. and Mak, J. (1985). An almost ideal demand system for visitor expenditure, *Journal of Transport Economics and Policy* 15, 161–171.

Fulponi, L. (1989). The almost ideal demand system: an application to food and meat groups for France, *Journal of Agricultural Economics* 71, 82–92.

Gao, X., Wailes, E.J. and Cramer, G.L. (1996a). Partial rationing and Chinese urban household food demand analysis, *Journal of Comparative Economics* 22, 42–62.

Gao, X., Wailes, E.J. and Cramer, G.L. (1996b). A two-stage rural household demand analysis: microdata evidence from Jiangsu province, China, *American Journal of Agricultural Economics* 78, 604–613.

Garnaut, R. and Ma, G. (1993). How rich is China? Evidence from the food economy, *The Australian Journal of Chinese Affairs* 30, 121–146.

Gould, B. (2002). Household composition and food expenditures in China, *Agribusiness* 18, 387–407.

Gould, B. and Villarreal, H.J. (2006). An assessment of the current structure of food demand in urban China, *Agricultural Economics* 34, 1–16.

Green, R. and Alston, J. (1990). Elasticities in AIDS models, *American Journal of Agricultural Economics* 72, 442–445.

Haines, P., Guilkey, D.K. and Popkin, B.M. (1988). Modeling food consumption decision as a two-step process, *American Journal of Agricultural Economics* 70, 543–552.

Hayes, D., Wahl, T.I. and Williams, G.W. (1990). Testing restrictions on a model of Japanese meat demand, *American Journal of Agricultural Economics* 72, 556–566.

Heien, D. and Wessells, C.R. (1990). Demand systems estimation with microdata: a censored regression approach, *Journal of Business and Economic Statistics* 8, 365–371.

Heng, H.L.S. and Guan, A.T.K. (2007). Examining Malaysian household expenditure patterns on food-away-from-home, *Asian Journal of Agriculture and Development* 4(1), 11–24.

Hu, D., Cai, H. and van Gelder, R. (1998). *Beef consumption and the beef marketing chain in China*, Proceedings of the Annual Conference of the Australian Agricultural and Resource Economics Society, the University of New England, Armidale.

Huang, J. (1999). Social development, urbanisation and food consumption (in Chinese), *Social Science of China* 28, 102–116.

Huang, J. and David, C. (1993). Demand for cereal grains in Asia: the effect of urbanization, *Agricultural Economics* 8, 107–124.

Huang, J. and Rozelle, S. (1998). Market development and food demand in rural China, *China Economic Review* 9, 25–45.

Jabarin, A. (2005). Estimation of meat demand system in Jordan: an almost ideal demand system, *International Journal of Consumer Studies* 29, 232–238.

Johnson, D. (2000). Agricultural adjustment in China: problems and prospects, *Population and Development Review* 26, 319–334.

Lardy, N. (1984). Consumption and living standards in China, *The China Quarterly* 100, 869–865.

Lewis, P. and Andrews, N. (1989). Household demand in China, *Applied Economics* 21, 793–807.

Longworth, J., Brown, C.G. and Waldron, S.A. (2001). *Beef in China: Agribusiness Opportunities and Challenges*. University of Queensland Press, St Lucia.

Lu, F. (1998). On discrepancies between production and consumption data of China's agricultural products and artificial inflation in production statistics (in Chinese), *China Rural Economy* 10, 23–43.

Ma, H., Rae, A., Huang, J.K. and Rozelle, S. (2004). Chinese animal product consumption in the 1990s, *The Australian Journal of Agricultural and Resource Economics* 48, 569–590.

Ma, H., Huang, J.K., Fuller, F. and Rozelle, S. (2006). Getting rich and eating out: consumption of food away from home in urban China, *Canadian Journal of Agricultural Economics* 54, 101–119.

Mansfield, E. (1996). *Microeconomics*, W.W. Norton, New York.

Mihalopoulos, V. and Demoussis, M. (2001). Greek household consumption of food away from home: microeconometric approach, *European Review of Agricultural Economics* 28, 421–432.

Moschini, G. (1995). Units of measurement and the stone index in demand system estimation, *American Journal of Agricultural Economics* 77, 63–68.

Mu, Y. (2001). AIDS models of demand systems for China's urban and rural residents (in Chinese), *Economic Problems* 8, 25–28.

National Bureau of Statistics of China (1986). *China Statistical Yearbook (in Chinese)*. National Bureau of Statistics of China, Beijing.

National Bureau of Statistics of China (1996). *China Statistical Yearbook (in Chinese)*. National Bureau of Statistics of China, Beijing.

National Bureau of Statistics of China (2006a). *China Statistical Yearbook (in Chinese)*. National Bureau of Statistics of China, Beijing.

National Bureau of Statistics of China (2006b). *2005 Chinese Bulletin of Economical and Social Development (in Chinese)*. National Bureau of Statistics of China, Beijing.

Paarlberg, R. (1997). Feeding China: a confident view, *Food Policy* 22, 269–279.

Park, J., Holcomb, R.B., Raper, K.C. and Capps, O. (1996). A demand systems analysis of food commodities by US households segmented by income, *American Journal of Agricultural Economics* 78, 290–300.

Perali, F. and Chavas, J.P. (2000). Estimation of censored demand equations from large cross-section data, *American Journal of Agricultural Economics* 82, 1022–1037.

Rae, A. and Hertel, T. (2000). Future developments in global livestock and grains markets: the impacts of livestock productivity convergence in Asia-Pacific, *The Australian Journal of Agricultural and Resource Economics* 44, 393–423.

Rozelle, S., Park, A., Huang, J.K. and Jin, H. (1997). Liberalization and rural market integration in China, *American Journal of Agricultural Economics* 79, 635–642.

Samuel, S., Li, E. and McDonald, H. (1996). The purchasing behavior of Shanghai buyers of processed food and beverage product: implications for research on retail management, *International Journal of Retail and Distribution Management* 24, 20–28.

Shi, H., Mitterlhammer, R. and Wahl, T.I. (1995). Aggregate food demand analysis for a transitional economy: an application to Chinese household expenditure data, *Journal of Food Distribution Research* 26, 20–27.

Shonkwiler, J. and Yen, S.T. (1999). Two-step estimation of a censored system of equations, *American Journal of Agricultural Economics* 81, 972–982.

Shono, C., Suzuki, N. and Kaiser, H.M. (2000). Will China's diet follow western diets? *Agribusiness* 16, 271–279.

Steinfeld, H., Gerber, P., Wassenaar, T., Castel, V., Rosales, M. and Haan, C. (2006). *Livestock's Long Shadow: Environmental Issues and Options*. FAO, Rome.

Stone, R. (1953). *The Measurement of Consumers' Expenditure and Behaviour in the United Kingdom, 1920–1938*. Cambridge University Press, Cambridge.

Tian, W. (2003). *Developments in China's Animal Husbandry Industry*. The University of Sydney, Sydney.

Tickell, C. (2007). *China's environment: prospects and hazards*, Working Paper, James Martin Institute for Science and Civilization, Oxford University, Oxford.

Veeck, A. and Veeck, G. (2000). Consumer segmentation and changing food purchase patterns in Nanjing, PRC, *World Development* 28, 457–471.

Wan, G. (1998). Nonparametric measurement of preference changes: the case of food demand in rural China, *Applied Economics Letters* 5, 433–436.

Wang, J. (2004). *A study on China's livestock products consumption (in Chinese)*. Survey report, Beijing.

Wang, H., Halbrendt, C. and Johnson, S. (1996). A non-tested test of AIDS vs. the Translog demand system, *Economics Letters* 51, 139–143.

Wang, J., Zhou, Z.Y. and Yang, J. (2004). How much animal product do the Chinese consume? Empirical evidence from household surveys, *Australasian Agribusiness Review* 12. Available from URL: http://www.agrifood.info/review/2004/ [accessed 6 Aug 2009].

Wang, J., Zhou, Z.Y. and Cox, R. (2005). Animal product consumption trends in China, *Australasian Agribusiness Review* 13. Available from URL: http://www.agrifood.info/review/2005/ [accessed 6 Aug 2009].

Wu, Y. (1999). *China's Consumer Revolution*. Edward Elgar Publishing Limited, Cheltenham.

Yan, W. and Chern, W. (2004). *Food demand in rural China: an application of agricultural household models*, in WCC-101, Proceedings of the Conference on China's Agricultural Sector: Markets, Myths and Mavens, Western Coordinating Committee, East Lansing, MI, USA.

Yang, Y. and Huang, Y. (1997). How should China feed itself? *World Economy* 20, 913–934.

Yen, S. and Lin, B.H. (2006). A sample selection approach to censored demand system, *American Journal of Agricultural Economics* 88, 742–749.

Zellner, A. (1962). An efficient method of estimating seemingly unrelated regression and test for aggregation bias, *Journal of the American Statistical Association* 57, 348–368.

Zellner, A. (1963). Estimation for seemingly unrelated regression equations: some exact finite sample results, *Journal of the American Statistical Association* 58, 977–992.

Zhang, X. (2002). The dynamics of Chinese consumers: a case of Shanghai food consumption, *Journal of International Food and Agribusiness Marketing* 14, 47–66.

Zhang, W. (2004). The implications of the rise of China, *Foresight* 6, 223–226.

Zhou, Z. and Tian, W.M. (eds.) (2005). *Grains in China: Foodgrain, Feedgrain and World Trade*. Ashgate Publishing Company, Burlington.

Zhou, Z., Tian, W.M., Liu, X.A. and Wan, G.H. (2003). *Studying China's Feedgrain Demand and Supply: Research Methodological Issues*. Grains Research and Development Corporation, Canberra.