Income Growth, Urbanization, and Food Demand in China

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Abstract

A complete demand system is estimated separately for urban and rural residents using a two-stage AIDS-QUAIDS model and pooled provincial and time-series data from 2000 to 2010. The estimated models are then used to project China's rural and urban food demand in the future. Results suggest that with the continued rise in per capita income and urbanization rate, the budget shares of food grains and vegetables are expected to decrease while the shares of foods with animal origin and other high-valued foods are expected to rise. Moreover, urban residents will dominate the food demand in China.

***Key word*:** income growth in China; food demand; urbanization; urban and rural residents

JEL: C33, D12, Q18

I. Introduction

Food consumption in China has undergone significant changes during the past two decades. In urban areas, real per capita food expenditures, in 1990 constant prices, increased from 694 Yuan in 1990 to 1374 Yuan in 2010 at an annual growth rate of 3.7%. Whereas, in rural areas, real per capita food expenditures rose at an annual growth rate of 1.9%, from 344 Yuan in 1990 to 499 Yuan in 2010. During the same period, per capita consumption of food grains in China decreased while the consumption of foods with animal origin (including pork, beef, mutton, aquatic products, eggs, and milks) increased. More specifically, urban residents decreased their per capita at-home consumption of food grains, from 131 kg in 1990 to 82 kg in 2010, while they raised their per capita at-home consumption of foods with animal origin, from 45 kg to 76 kg. Between 1990 and 2010, per capita at-home consumption of food grains (unprocessed) for rural residents declined from 262 kg to 181 kg, whereas per capita at-home foods with animal origin rose from 18 kg to 34 kg (tables 1 and 2). Expenditures on food in China is expected to rise as China continues to evolve into more consumption of animal protein as compared to grains and plant products.

While income, price, and non-economic variables such as tastes and urbanization have an impact on food demand changes, income and urbanization are said to be the key determinants shaping food demand patterns in China in the medium- and long-term future. Engel's law states that food's share of total expenditure declines as expenditures increase. Bennett's law indicates that the "starchy staple ratio" declines as household incomes rise, which suggests a change in dietary patterns towards less consumption of low-value foods such as grains, but more consumption of high-value foods such as meats, milks, and fruits (Timmer, Falcon, and Pearson 1983). Huang (1999) finds that changes in lifestyle and food preferences stemming from urbanization have an impact on changes in the structure of food demand. From the above-stated laws and research findings, it is concluded that, if strong economic growth and rapid urbanization continued in the future, per capita food expenditures would be expected to continue their upward trend, while per capita food budget shares would be expected to continue their downward trend. In the meanwhile, per capita consumption of food grains would decrease while per capita consumption of high-value foods such as meats, milks, and aquatic products is expected to increase.

Since the 1980s, particularly since the 21st century, China's per capita incomes have risen sharply along with its accelerated urbanization rate. It is anticipated that per capita income and urbanization continue their upward trend in the future. Thus, the general question that this study focuses on is: Will the food demand patterns in China continue their trend, following the Engel's law, Bennett's law, and Huang's findings? More specifically, this study attempts to address the following four questions: (1) What are the impacts of incomes on at-home food demand in China? (2) Will the level and composition of food demand vary in a systematic way with per capita income levels and urbanization rates in the future? (3) Will the structure of food demand in China follow diets in the West increasing consumer's dependence on meats for a source of protein; or, will China's dietary pattern follow those in Japan characterized by compatible proportions of animal and plant foods? And, (4) What would be the share of urban food expenditures in total China's food expenditures in the future?

In order to find out the answers to these questions, this study aims to examine the impact of income growth and urbanization on food demand patterns for population as a whole as well as for China's urban and rural residents. This study includes the analysis of demand for both at-home and away-from-home foods related to urban population and for at-home foods for rural population. More specifically, this study employs a two-step procedure to accomplish the objective. The first step involves estimating a complete demand system, separately for rural and urban residents. A two-stage budgeting framework and pooled provincial and time-series data from 2000 to 2010 is used for this first phase estimation. A demand system including several broad commodity groups such as food, clothing, housing, etc. are estimated in the first stage, while individual commodities within the at-home food group are estimated in the second stage of this first step. The second step involves predicting the level and composition of food demand separately for the rural population, the urban population, and the Chinese population as a whole, using the estimates from the first step (chart I).

There have been several studies related to China's food demand, for both urban and rural residents, since the 1980s. These include Lewis and Andrews (1989), Wang and Chern (1992), Fan,Wailes, and Cramer (1995), Huang and Rozelle (1998), Huang (1999), Guo et al. (2000), Gould and Villarreal (2006), Ma et al. (2006), Min, Fang, and Li (2004), Gale and Huang (2007), Zheng and Henneberry (2010), and Zheng and Zhao (2012). These studies estimate the impact of income, food prices, and non-economic demographic variables on demand for foods at home (FAH) or demand for foods away from home (FAFH), either for urban residents or for rural residents, but not for China's population as a whole. Moreover, given that urbanization has speeded up in Asian nations, Huang and David (1993) and Rae (1998) estimated the impact of urbanization on food demand for Asian population. The results of these studies indicate that income and urbanization affect food demand in general, but few studies have examined the effect of changes in income and urbanization level on Chinese specific food consumption patterns. Moreover, this study not only estimates urban and rural food demands separately, but also combines the demand for foods at-home and for foods away from home in the prediction of food demand, which is a better reflection of the current situation and gives a more accurate estimate of future trends in the China's food demand trends.

It is of importance to understand China's food demand patterns in the future. China has the largest population in the world, accounting for 19% of the world total in 2010. Although population control policies implemented by the government in the 1970s have decreased birth rates substantially, China's population is projected to be 1.406 billion in 2030 due to its large population base and population growth inertia. More importantly, China's urbanization has accelerated since the beginning of this century, and the urbanization rates increased from 40% in 2000 to 50% in 2010, and are projected to reach 69% in 2030. It is thus anticipated that income growth, population expansion, and rapid urbanization are expected to drive changes in the food demand structure in the future. The results of this study can shed light on future food demand patterns in China. Specifically, results of this study are expected to be helpful for decision-makers in formulating appropriate policies and programs for food security as well as in developing strategies for food processing and logistic sectors. Because changes in dietary structure are correlated with people's nutrition intakes and health, results of this study are expected to be useful for policy-makers in developing relevant nutrition and health policies.

The remainder of this study is organized as follows. A review on the evolution of food consumption patterns in China is provided. The two-stage AIDS-QUAIDS model and the data used for this study are then described. Next, estimation procedures and the estimated demand elasticities are presented. In the following section, the estimated models and income elasticities are used to predict the impact of income growth and urbanization on the structure of food demand patterns in for 2030 in China. Finally, concluding remarks and policy implications are given.

II. Features and Trends of Food Consumption in China

Food consumption patterns for urban residents differ substantially from those of rural residents due to China's dualistic economic structure, a term used by Lewis (1954). Before quantitatively measuring the impact of economic variables on China's rural and urban food demands, a descriptive analysis of food demand will be given in the following subsections by examining consumption data over the past two decades.

Food Consumption Patterns for Urban Residents

Urban food consumption patterns have kept changing since the 1990s, although the change has been marginal over the last 10 years. There are various aspects of the change. First, the decline in food share of total expenditures has slowed down. As shown in table 1, per capita incomes and food expenditures have displayed an upward growth trend since 2000. During 1990-2000, real per capita incomes and food expenditures grew at an annual rate of 6.3% and 2.8%, respectively; while the growth rates accelerated to 9.3% and 3.9% per year, respectively, during 2001-2010. As per capita incomes rose rapidly, food shares of total expenditures declined continuously from 54.3% in 1990 to 35.7% in 2010. Yet, the declines were slower during 2001-2010 than during 1990-2000. The food expenditure share decreased by 3.0% annually during the former period, while it declined by 0.5% annually during the latter period. [1]

Second, the growth in the shares of expenditures on foods away from home (FAFH) in total food expenditures has slowed down. Rising living standards in urban areas are changing the way consumers have their diets. Typically, the share of foods consumed at home as a percentage of total food expenditures has declined, while the share of FAFH in total food expenditure has increased. As shown in table 1, the shares of FAFH spending increased from 9.1% in 1990 to 21.2% in 2010, suggesting that FAFH spending has become an important component of food expenditures for urban residents. However, the growth in the shares of FAFH spending has slowed down over the past 10 years. The shares of FAFH spending grew at an annual rate of 7.9% during 1992-2000, whereas it increased by 3.0% yearly from 2001 to 2010.

Finally, the level and composition of at-home food (FAH) demand has been relatively unchanged. At-home food demand of urban residents shows different features at different periods of time. In the first period (1990-2001), per capita consumption of grains and vegetables decreased dramatically, from 130.7 kg and 138.7 kg in 1990 to 76.7 kg and 115.9 kg in 2001, respectively. With the exception of the consumption of pork and beef (and mutton) that declined marginally, per capita consumption of other food items increased considerably during this period. Per capita consumption of dairy products rose the most at a rate of 9.2% annually, poultry 4.1%, fruits 2.9%, eggs 3.3%, aquatic products 2.7%, and edible oils 2.2%.

In the second period (2002-2010),[2] the composition of foods consumed was relatively unchanged. During this period, per capita consumption of grains kept at about 80 kg, and per capita consumption of vegetables, oils, pork, fresh eggs, and fruits also changed only marginally. In contrast, the per capita consumption of aquatic products, poultry, and beef and mutton increased relatively appreciably; whereas per capita consumption of milk rose first and then declined. It is noted that per capita consumption of oils, meats, eggs, aquatic products, milk, and fruits during the second period is notably more than the consumption during the first period, suggesting the composition of food demand for urban residents is shifting to a dietary structure with more foods with animal origin and fruits while per capita consumption of grains and vegetables keeping stable.

Food Consumption Patterns for Rural Residents

Unlike urban food demand patterns, the food expenditure shares, FAFH spending shares, and total per capita food consumption for rural residents changed substantially over the last 10 years. First, the decreases in food expenditure shares accelerated. As shown in table 1, the annual growth rates in real per capita incomes rose from 6.3% during 1990-2000 to 7.6% during 2001-2010, while the annual growth rates in real food expenditures increased from 1.5% during the first decade to 3.0% during the second decade. As farmer's incomes rose the food expenditure shares declined continuously, from 58.8% in 1990 to 41.1% in 2010. Unlike those in urban areas, food shares in rural areas displayed a rapidly decreasing trend, from an annual average rate of 1.5% during 1990-2000 to 1.7% during 2001-2010 (table 1).

Second, the growth in proportion of FAFH spending in total food expenditures accelerated distinctly. As farmers' incomes rise, their food consumption patterns changed. Spending on FAFH has become an important component of rural population food expenditures, showing a rapidly increasing trend over the last decade. While the FAFH spending shares rose at an annual rate of 1.3% during 1990-2000, they increased by 5.5% annually during 2001-2010.

Third, per capita consumption of at-home grains and vegetables declined while per capita consumption of at-home foods with animal origin rose. As shown in table 2, with the exceptions of oils, pork, and fruits that changed marginally, per capita consumption of other food items changed considerably during 2001-2010. Per capita consumption of grains and vegetables decreased continuously during this period, with the consumption of grains dropping from 250 kg in 2000 to 181 kg in 2010, an average decline of 28% over a10-year period; whereas per capita consumption of other foods (including beef and mutton, poultry, eggs, aquatic products, and milk) rose continuously. As compared to urban residents, rural per capita consumption of grains is substantially higher, while rural consumption of other food items is considerably lower. In particular, per capita consumption of foods with animal origin and fruits of rural population is substantially lower than those of urban population..

Finally, rural per capita consumption of foods purchased in the market rose rapidly over the past two decades. The shares of expenditures on foods purchased in the market to total food expenditures increased from 46.0% in 1990 to 72.9% in 2010, suggesting that food prices have played a more important role in shaping food demand pattern in rural areas. Yet, the share of expenditures on cereals, vegetables, and milk purchased in markets are still lower than 50% of total food expenditures. In 2010, the shares of expenditures on cereals, vegetables, and milk purchased were 32%, 31.3%, and 38.9%, respectively, of total food expenditures (*China Yearbook of Rural Household Survey*, various years).

Preliminary findings can be derived by comparing the food demand patterns between urban and rural residents. First, rural food demand pattern differs substantially from urban pattern. Although the real per capita net income for rural population was 2420 Yuan in 2010, which is comparable to urban real disposable income (2514 Yuan) in 1998; the rural food demand pattern in 2010 comparable to urban pattern in 1990 in terms of the level and composition of food demand (see tables 1 and 2). The difference reflects lower incomes and more of self-produced foods in rural areas, as well as less eating out in restaurants and fewer purchases of processed foods. Therefore, an upgrade in Chinese food demand patterns will depend on the rise in rural population's incomes and rapid urbanization. Second, the composition of demand for foods away from home differs from that of at-home foods. More specifically, the former includes more of meats and aquatic products and less of grains and fruits as compared to the latter (Ma et al. 2006). The rise in spending shares of FAFH as well as the changes in composition of demand for FAH during the past two decades suggest that per capita consumption of food grains is expected to further decline while per capita consumption of foods with animal origin and fruits to further rise as China's economy continues its growth and its urbanization speeds up.

III. A Two-Stage AIDS-QUAIDS Model

Two-Stage Budgeting

The first phase of this study employs a two-stage budgeting approach. The two-stage budgeting framework assumes that consumer's utility maximization decision can be decomposed into two stages. At the first or higher stage, expenditure is allocated over broad groups of goods, while at the second or lower stage, group expenditures are allocated to the individual commodities. According to Gorman (1959), defining and estimating both the first and second stages is possible if and only if (a) the direct utility function is weakly separable and each sub-utility function is homothetic or (b) the direct utility function is strongly separable and each sub-utility function has the Generalized Gorman Polar Form. The demand functions for the second stage under (a) and for the first stage under (b) are derived from the homothetic utility functions and consequently restrictive and unrealistic. “A reasonably general solution must thus be either an approximate one or one that abandons weak separability.” (Deaton and Muellbauer 1980b, p.131).

According to Deaton and Muellbauer (1980b, pp.129-132), if preferences are weakly separable and the group price indices being used do not vary too greatly with sub-utility (or, equivalently, expenditure) level, two-stage budgeting will lead to an approximately correct allocation. The assumption suggests that the variation of group true cost-of-living price indices with sub-utility is not very great so that the indices involved in the first stage can be approximated by Paasche or Laspeyres indices, which are exactly the same as indices that are used when demand systems are estimated for aggregated groups at the first stage. Since prices of individual commodities within a commodity group tend to be collinear, there is a theoretical reason for expecting the true cost-of-living indices to be well approximated by the Paassche and Laspeyres indices (Deaton and Muellbauer 1980b, p.174). The assumption concerning price indices is checked and seems generally to be justified. [3] Moreover, the demand systems in the first stage include commodity groups such as food, housing, clothing, etc., suggesting that the weak separability assumption is reasonable. The assumption of approximating two-stage budgeting, therefore, is acceptable for this study.

The AIDS and QUAIDS Model

Assuming that preferences are weakly separable and the group price indices being used do not vary too greatly with sub-utility level, this study chooses the almost ideal demand system (AIDS) of Deaton and Muellbauer (1980a) in the first stage and the quadratic almost ideal demand system (QUAIDS) of Banks, Blundell, and Lewbel (1997) in the second stage. The AIDS model satisfies the axioms of choice exactly, allows consistent aggregation of individual demands to market demands, and does not impose additive preferences (Deaton and Muellbauer 1980a). The AIDS model, thus, is used to estimate the demand for aggregate goods.

However, the AIDS specification is in the class of *rank two* demand models, which offers limited Engel responses as compared to *rank three* demand systems (Lewbel 1991). In addition to having the same properties as the AIDS model, the QUAIDS model has the flexibility to be applied to populations at different income levels. The model's leading terms are linear in logarithmic expenditure while including the empirically necessary *rank three* quadratic term, which provides a sufficiently general approximation to the Engel relationship in the raw data (Banks, Blundell, and Lewbel 1997). Thus, the QUAIDS specification permits an evaluation of higher-rank Engel curves while at the same time maintaining consistency with assumed utility-maximization behavior as compared to simpler models such as the AIDS (Gould sand Villarreal 2006). Because of these advantages of the QUAIDS specification, the QUAIDS model is used in this study to estimate the response of food demand to expenditure changes in the second stage (Cranfield et al. 2002, 2003; Yu et al. 2004; Seale and Regmi 2006).

The QUAIDS functional form is:

(1) $$w_{it} = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln(p_{jt}) + \beta_i \ln\left[\frac{x_t}{a(p_t)}\right] + \frac{\lambda_i}{b(p_t)} \left\{\ln\left[\frac{x_t}{a(p_t)}\right]\right\}^2 + u_{it}$$

where i and j indicate goods, n denotes the number of goods included in the demand system; w_{it} is the share of spending on good i in year t; p_{jt} indicates price of good j in year t; x_t is the total expenditure on the n goods in the system in year t; α_i, γ_{ij}, β_i and λ_i are parameters; u_{it} is error term; $a(p_t)$ and $b(p_t)$ are price indices and defined as follows:

(2) $$\ln a(p_t) = \alpha_0 + \sum_{j}^{n} \alpha_j \ln(p_{jt}) + 0.5 \sum_{i}^{n} \sum_{j}^{n} \gamma_{ij} \ln(p_{it}) \ln(p_{jt})$$

(3) $$b(p_t) = \prod_{i=1}^{n} p_{it}^{\beta_i}$$

The properties of demand from the neoclassical theory can be imposed on model (1) by restricting its parameters. The adding-up restriction is given by:

(4a) $$\sum_{i=1}^{n} \alpha_i = 1,\ \sum_{i=1}^{n} \gamma_{ij} = 0,\ \sum_{i=1}^{n} \beta_i = 0,\ \sum_{i=1}^{n} \lambda_i = 0$$

Homogeneity is imposed as:

(4b) $$\sum_{j=1}^{n} \gamma_{ij} = 0$$

Slutsky symmetry is given by:

(4c) $$\gamma_{ij} = \gamma_{ji}, \quad i \neq j$$

The price and expenditure elasticities of demand are calculated from the estimated parameters of the QUAIDS model following Banks, Blundell, and Lewbel (1997). The uncompensated (Marshallian) price elasticities are denoted by:

(5)

$$e_{ij} = w_i^{-1} \left\{ \gamma_{ij} - \left(\beta_i + \frac{2\lambda_i}{b(p)}\right) \left[\ln\left(\frac{x}{a(p)}\right)\right] \left(\alpha_j + \sum_{k}^{n} \gamma_{jk} \ln(p_k)\right) - \frac{\lambda_i \beta_j}{b(p)} \left[\ln\left(\frac{x}{a(p)}\right)\right]^2 \right\} - \delta_{ij}$$

where is δ_{ij} the Kronecker delta, which is equal to 1 when $i = j$,otherwise $\delta_{ij} = 0$.

The food expenditure elasticities are calculated as:

$$(6) \qquad e_i = 1 + w_i^{-1}\left[\beta_i + \frac{2\lambda_i}{b(p)}\ln\left(\frac{x}{a(p)}\right)\right]$$

The AIDS model is nested within the QUAIDS model. The equation (1) without the last expenditure term on the right hand side, i.e., if $\lambda_i = 0$ for all i, is the AIDS functional form. Consequently, the Marshallian price and expenditure elasticity formulae derived from the QUAIDS model become the same as those derived from the AIDS model.

Based on Edgerton (1997), the income (unconditional expenditure) elasticity of demand for food commodities in the second stage are computed as:

$$(7) \qquad \eta_i = e_{(r)i} \cdot e_{(r)}$$

where η_i denotes income elasticity of demand for the ith commodity, $e_{(r)i}$ is food expenditure elasticity of demand for the ith commodity, and $e_{(r)}$ represents income elasticity of demand for at-home food.

IV. Data Sources and Explanations

Urban demand analysis is conducted using pooled time-series and cross-section data (provincial cell means) for urban China, covering 31 provinces, from 2000 to 2010. There are 8 commodity groups in the first stage, namely at-home food (FAH), FAFH, clothing, household appliances and services (service), transport and telecommunications (transport), education, cultural and recreation services (education), health care and medical services (health), and housing. Expenditure and price index data for the latter seven groups come from *China Statistical Yearbook*

(2001-2011) published by CNBS. The expenditure data for FAH are the total of expenditures on 10 individual commodities included in the second stage, while the index data for FAH are Laspeyres indices calculated from Stone's price indices for the 10 individual commodity prices.

The 10 major at-home food commodities in the second stage for urban residents consist: grains, beans (including soybean, other beans, and Tofu), oils and fats, meats (including pork, beef, and mutton), poultry, eggs, aquatic products, vegetables, fruits, and dairy products (including milk, milk powder, and yogurt). Expenditure data for the 10 commodities during 2000-2010 come from *China Urban Life and Price Yearbook* (2001-2011) published by CNBS. Price data are from various sources. Except for Heilongjiang, Anhui, and Hebei provinces, data on food consumption for other 28 provinces during 2000-2009 come from provincial statistical yearbook (2000-2009) published by respective provincial statistical bureaus, while price data for the 28 provinces are unit values calculated with expenditure and quantities. Price data for Heilongjiang, Anhui, and Hebei provinces during 2000-2009 come from *China Yearbook of Agricultural Price Survey* (2004-2009) published by CNBS. Price data on grains, meats, aquatic products, and dairy products for 31 provinces in 2010 are from *China Yearbook of Agricultural Price Survey* (2011), while price data for other commodities are extrapolated based on the data for prices in 2009 and urban consumer price indices.

Rural demand analysis is carried out using pooled time-series and cross-section data for rural China, covering 30 provinces (not including Tibet) during 2000-2010.

There are 7 commodity groups in the first stage: FAH, clothing, service, transport, education, health, and housing. Expenditure and price index data for the latter six groups come from *China Statistical Yearbook* (2001-2011) and *China Rural Statistical Yearbook* (2001-2011) published by CNBS. Similar to the data for urban population, the expenditure data for FAH are the total of expenditures on 10 individual commodities in the second stage; while the index data for FAH are Laspeyres indices calculated from Stone's price indices for the 10 individual commodity prices.

The ten food categories that are included in the rural population FAH are: grains, oils and fats, pork, beef (including beef and mutton), poultry, eggs, aquatic products, vegetables, fruits, and dairy products. Quantity data for the 10 commodities during 2000-2010 come from *China Yearbook of Rural Household Survey* (2001-2011) published by CNBS. Price data come from various sources. Price data for grains, vegetables, oils and fats, poultry, aquatic products, and fruits are calculated based on farmer's market price data in 2010 from *China Yearbook of Agricultural Price Survey* (2011) and the rural consumer price indices from *China Rural Statistical Yearbook* (2001-2011). Price data for pork, beef, and eggs during 2000-2010 are from *China Animal Husbandry Yearbook* (2001-2011) published by China Ministry of Agriculture (MoA), of which, data for 2000 and 2002 are derived based on rural consumer price indices. Price data for dairy products during 2000-2009 are data on procurement prices for fresh milk from *China Dairy Industry Yearbook* (2001-2011) published by MoA, while prices in 2010 are derived consequently. Finally, expenditure data for the 10 commodities are computed as the product of per capita consumption and prices.

Note that income, expenditure, and consumption data from CNBS yearbooks come from urban and rural household sample surveys conducted by CNBS.

V. Estimation Procedures and Results

Estimation Procedures

The two-stage AIDS and QUAIDS model is estimated in the form of a two-way fixed model (regional effect and time effects). Specifically, based on the assumption that the households in the provinces with each group have roughly similar preference, all provinces are grouped into 5 groupings via cluster analysis. The period from 2000 to 2010 is divided into 5 periods in chronological order. The 4 regional dummies and 4 time dummies are then incorporated into the intercept terms of the AIDS and QUAIDS models. Using a two-way fixed model can not only account for regional differences and dynamic changes in consumer preference to obtain consistent estimates, but also ensure sufficient degrees of freedom for accurate estimation.

Homoskedasticity and first-order autocorrelation are tested at the first- and second-stages of the demand systems. The null hypothesis of homoskedasticity is rejected at the 5% significance level only for the AIDS model for urban residents, while the null hypothesis of no first-order autocorrelation is rejected at the 5% significance level for all models in the estimation. Accordingly, a vector auto regression (VAR) is embedded into the AIDS and QUAIDS models to eliminate the serial autocorrelation problems inherent in the models (Zhang, Mount, and Boisvert 2001). The AIDS model for the rural is estimated using White's heteroscedasticity consistent estimator (i.e., Heteroscedasticity-Consistent Covariance Matrix Estimation, HCCME, in SAS) to eliminate the bias's standard errors of parameters, while the AIDS model and the QUAIDS models for both urban and rural residents are estimated separately using iterative seemingly unrelated regression method. All the models are estimated with homogeneity and symmetry imposed. Since the adding-up structure for a complete set of expenditure shares is inherent in the AIDS and QUAIDS models, the full system including all equations will be singular. Following a standard convention, the housing equation in the AIDS models, the beans equation in the QUAIDS model for the urban, and the dairy products equation in the QUAIDS model for the rural are dropped from estimation. Their price, income, and expenditure elasticities are calculated using the adding-up restrictions.[4]

This study checks the appropriateness of the chosen models. The null hypothesis that the AIDS models are the same as the QUAIDS models is tested. The $\lambda_i = 0$ for FAH and FAFH in the QUAIDS models are not rejected at the 5% significance level, suggesting that the AIDS models chosen for the first stage are appropriate. Wald joint testing rejects the null hypothesis of $\lambda_i = 0\ \forall i$ in the second stage, suggesting that the QUAIDS models are superior to the AIDS models. Furthermore, the out-of-sample tests for urban residents show that the AIDS and QUAIDS models perform similarly well in forecasting expenditures on FAH and FAFH in the first stage, whereas the QUAIDS model is superior to the AIDS model in the second stage.[5]

Results

Marshallian price and income elasticities of demand for both urban and rural residents in the first stage are reported in table 3. For urban residents, except for own-price elasticity for transport, all income elasticities, other own-price elasticities, and almost 40% of cross-price elasticities are statistically significant at the 5% level. For rural residents, all income and own-price elasticities, as well as nearly one third of cross-price elasticities are at the 5% significance level. Accordingly, the AIDS models for both urban and rural residents are a good fit.

The conditional price, food expenditure, and income elasticities of demand for at-home food commodities in the second stage are presented in tables 4 and 5. For urban residents, with the exception of the own-price elasticity for beans that is not significant statistically, all other own-price elasticities, food expenditure as well as income elasticities of demand are statistically significant; while more than 50% of cross-price elasticities are statistically significant at the 5% level. For rural residents, all food expenditure and income elasticities are at the 5% significance level, while own-price elasticities only for grains, vegetables, pork, poultry, and eggs are negative and statistically significant. In addition, about 38% of cross-price elasticity estimates are statistically significant at the 5% level. It appears that the QUAIDS model for the urban population fits better as compared to the model for the rural population.[6]

Because in this study the main objective is to understand the relationship between income and food demand, elaboration is given on income elasticities for at-home food, FAFH, and commodities within the at-home food group. The income elasticities of FAH for urban and rural residents are 0.488 and 0.646, respectively; while the income elasticity for FAFH for urban population is 1.059 (table 3). The result is consistent with China's reality and expectation from economic theory. Although the income elasticity for FAFH is slightly lower from this study than those from Min, Fang, and Li (2004), Ma et al. (2006), and Zheng and Zhao (2012), based on the results from this study, the FAFH can be still classified as luxury good. Therefore, the results of this study indicate that the growth of the income of urban residents is expected to increase the per capita spending on FAFH at a higher rate than the growth rate in per capita total expenditures.

For urban residents, as shown in table 4, the income elasticities for meats, poultry, eggs, aquatic products, dairy products, fruits, and vegetables range from 0.45 to 0.911 and are considerably higher than those for grains, oils, and beans that range from 0.28 to 0.31. In particular, the income elasticities for aquatic products and dairy products are the highest. As compared to the results of Gould and Villarreal (2006) and Zheng and Henneberry (2010) who employed CNBS's urban household survey data, the elasticities for grains, oils and fats, vegetables, and fruits from this study are somewhere between the two studies; the elasticties for eggs, aquatic products, and dairy products from this study are higher; and the elasticties for meats and poultry from this study are lower than the above-mentioned two studies.

For rural residents (table 5), the income elasticities for beef and aquatic products are marginally higher than one, and the elasticties for the other 8 commodities range from 0.33 to 0.93. As compared to results from Huang and Rozelle (1998), Fan, Wailes, and Cramer (1995), and Zhang, Mount, and Boisvert (2001) who used similar aggregate data in the 1990s, the elasticities for grains and fruits from this study are lower; the elasticities for vegetables, meats, and poultry from this study are somewhere between these studies; and the elasticity for aquatic products is higher. As noted by Abler (2010), differences of elasticities from different studies may be attributed to the time period for the data analyzed in a study, as well as whether a study uses a single-stage demand system model or a two- or three-stage demand system model.

A comparison of the income elasticities between urban and rural residents will shed light on food demand patterns in China. While the elasticity for dairy products is lower for the rural residents than for the urban residents, the elasticties for the other 8 commodities, including grains, meats, poultry, eggs, aquatic products, oils and fats, vegetables, and fruits, are considerably higher for the rural as compared to the urban residents. Lower incomes and underdeveloped markets in rural areas seem to be attributable to the lower elasticity of dairy products for rural residents. The lower income elasticties in urban areas as compared with those obtained for rural areas is consistent with observed patterns in tables 1 and 2 and also adheres to the Engel's law. The results suggest that, if prices are held constant, per capita consumption of major food commodities are expected to increase at a higher rate for the rural than for the urban residents as incomes further rise. It is hence concluded that the rural residents will be the main force driving the future growth in food demand in China.

VI. Food Demand Patterns in the Future

Assumptions and Methods

The second phase of this study is to predict the impact of strong income growth and rapid urbanization on food demand patterns. On the basis of the framework of

Cranfield et al. (1998), both urban and rural per capita food expenditures and budget shares of various commodities are predicted, with income levels in 2020 and 2030 being predicted for the rural and the urban population separately. Then, using the estimates predicted above, China population growth rates, and urbanization rates, total food expenditures and budget shares of various commodities for Chinese population as a whole as well as the urban budget shares of the studied commodities to national total food expenditures in 2020 and 2030 are computed accordingly. According to a forecast from CNBS, total and urban population in China was 1340.91 million and 669.78 million in 2010, respectively, while they were forecasted to be 1400.1 million and 854.54 million in 2020, and 1406.15 million and 974.9 million in 2030, respectively.

Several assumptions for this analysis are made to perform these projections. First, preferences are assumed to be constant for both the rural and the urban population. Second, prices of food commodities are held constant at 2010 levels in urban areas. Third, income distribution is assumed to be constant. Assuming that the relationship between the growth rates of per capita gross domestic products (GDP) and the growth rates of per capita expenditure for the urban and the rural population during 2000-2010 continues into 2030, the growth rates of total expenditure during the periods of 2010-2020 and 2020-2030 are estimated separately for the urban and the rural population.[7] Note that all expenditures and budget shares are measured at 2010 prices of foods at home in urban areas in order to approximate food demand patterns.

For urban residents, the fitted and predicted values for per capita at-home food expenditures, FAFH expenditures, and at-home food budget shares of various commodities are estimated using the estimated AIDS and QUAIDS models. In order to obtain the estimates of food expenditures and budget shares of foods at home and away from home, FAFH spending needs to be converted into a total of expenditures on various commodities, which is equivalent to expenditures on at-home foods. Following Subramanian and Deaton (1996), only 50% of FAFH spending is assumed to be spent on foods consumed. Hence, the converted FAFH spending is decomposed into expenditures on various commodities, using data on FAFH spending shares of various commodities from a survey study (Bai et al. 2012)[8]. Finally, the converted FAFH expenditures on various commodities totaling the corresponding expenditures on at-home foods generate the total expenditures and budget shares of food commodities (see table 6). By this way, the food expenditure obtained in this study can be used to approximate to the food consumption.

For rural residents, total expenditures and budget shares of food commodities are estimated using a more complex procedure. In order to make comparisons between the urban and the rural, the fitted and predicted values on expenditures and budget shares of commodities are obtained via three steps. In the first step, food expenditure elasticities are projected separately for 2020 and 2030. In the second step, per capita consumption of foods consumed at home and away from home in 2010 is calculated as a summation. The half of FAFH spending in 2010 is converted into the amount of foods consumed using prices of foods at home, while per capita consumption of foods at home in 2010 is estimated using the corresponding expenditure elasticities. Finally, per capita consumption of foods for 2020 and 2030 are estimated, using the expenditure elasticities estimated in the first step, the per capita consumption of foods calculated in the second step, and the growth in at-home food expenditures estimated in the first stage employing the AIDS model.[9] Then per capita food expenditures are computed as the product of per capita consumption of foods and the prices paid in urban areas in 2010, and consequently budget shares of foods are computed.

Food Demand Patterns in the Future

As per capita incomes rise, people's diets tend to be diversified. Some food items previously unaffordable may now be affordable while some food items that used to be consumed on a daily basis might now be reduced, or even disappear from the diet. The expected changes in food consumption patterns above are reflected in the fitted and predicted per capita budget shares of foods in table 6. As urban per capita food expenditures rise, the budget shares of meats (including red meats and poultry), eggs, aquatic products, and dairy products present an increasing trend; while the budget shares of grains, oils and fats, vegetables, and fruits display a decreasing trend. During 2010-2030, the budget shares of foods with animal origin (including red meats, poultry, eggs, aquatic products, and dairy products) are expected to rise from 52.5% to 55.9%; while the budget shares of other foods are expected to be decreased from 47.5% to 44.1%. In these latter budget share groups, the budget shares of grains are expected to decline by 0.8 percentage points (table 6).

The budget shares and their changing trends for rural residents do not follow the same trends. In 2010, the budget shares of grains and vegetables for the rural population are substantially higher than those of the urban residents. Whereas the budget shares of foods with animal origin, oils and fats, and fruits for the rural population are considerably lower than for the urban, suggesting that the rural living standards are much lower than the urban living standards. As is shown in table 6, as rural residents' incomes rise, the budget shares of grains are expected to decline sharply, from 27.8% in 2010 to 21.3% in 2030; the budget shares of foods with animal origin are expected to rise from 39.7% to 42.1% from 2010 to 2030; the budget shares of oils and fats, vegetables, and fruits are expected to be on the rise. In these latter groups, the budget shares of vegetables and fruits are expected to rise from 23.6% and 3.3% in 2010 to 26.5% and 6.1% in 2030, respectively. In short, for urban residents, the budget shares of grains, vegetables, fruits, and oils and fats are expected to decrease at a relatively slow rate while the budget share of foods with animal origin are expected to be on the rise, as per capita incomes rise. For rural residents, the budget shares of grains are expected to decrease at a much higher rate while the budget shares of other foods are expected to be on the rise.

What is the impact of continued income growth and urbanization on China's food demand patterns in the future? As shown in table 7, as incomes rise and urbanization speeds up, China's budget shares of grains are expected to decease from 18.5% in 2010 to 14.1% in 2030; the budget shares of foods with animal origin are expected to increase significantly, from 47.9% in 2010 to 53.0% in 2030; the budget shares of oils and vegetables are expected to decrease marginally while the budget shares of fruits are expected to rise marginally. As a result, the focal points in structural changes of food demand patterns in China are the expected decline in consumption of grains and the expected rise in the consumption of foods with animal origin.

While the budget shares of food commodities illustrate different trends, the food expenditures related to all the studied food categories display an increasing trend. During 2010-2020, expenditures on aquatic products and dairy products are expected to increase at an average rate of 5% annually; the expenditures on meats, eggs, vegetables, and fruits are all expected to grow at a rate of more than 3% per year; and the expenditures on oils and fats and grains are expected to rise at an annual rate of 2.5% and 1.5%, respectively. Moreover, while the food expenditures on various commodities are expected to grow at a slower rate during 2020-2030, as compared to the rates in previous ten years, they are still on the rise. Thus, the income growth, rapid urbanization, and population expansion is expected to push up the rise of food expenditures in China.

Will the structure of food demand in China follow diets in the West, relying on meats as the main source of protein, or will it move towards Japanese dietary pattern as characterized by compatible proportions of animal and plant foods? The answer to this question is helpful in understanding the impact of changes in income growth and urbanization on food consumption patterns and on food security for both China and the world.[10] According to the national nutrition and health survey in 2005, the average per capita intakes of oils and fats and meats in China are higher than the Japanese levels, the average per capita intakes of grains, vegetables, and eggs in China are close to the levels in Japan, and the average per capita intakes of beans, fruits, aquatic products, and dairy products are substantially lower than the Japanese levels (Fan 2010, p.236). Results of this study indicate that the structure of food demand in China will move toward Japanese dietary patterns if the judgment is made only based on the annualized growth rates of expenditures on aquatic products in table 7, which are faster than the growth in meats demand, as Japanese households depend more on aquatic products as a protein source than the Western households (Shono, Suzuki, and Kaiser 2000). However, since the amount of aquatic products consumed currently in China is substantially lower than the amount of meats, the more rapid growth in expenditures on aquatic products, as compared to the growth in meat expenditures, is not expected to affect the role the meats play in Chinese dietary structure. It is consequently concluded that the structure of food demand in China is expected to fall between Western and Japanese dietary structures and that per capita meat consumption is expected to continue being higher than the Japanese, but lower than the Western levels; while per capita consumption of aquatic products is expected to continue being lower than the Japanese but higher than the Western levels.

From the results of this study, income growth and urbanization not only have an impact on total food expenditures and the composition of food demand in China, but also raise the share of the urban expenditures relative to total China's food expenditures. How much will be the share of urban food expenditures in total China's food expenditures in the future? As shown in table 7, during 2010-2030, the shares of national total grain expenditures by urban sector are expected to rise from 44.5% to 68.0%, the shares of national total expenditures on vegetables by the urban sector are expected to rise from 57.9% to 72.1%, and the shares of national total expenditures on other foods by the urban sector are expected to rise from 64-80% to 77-90%. Unlike rural population who grow much of their own foods, urban population consumes foods purchased from markets. A rise in the proportion of total food expenditure contributed by the urban population can have significant agricultural, food, and trade policy implications for the government of China.

VII. Concluding Remarks

This study estimates a complete demand system separately for urban and rural residents, using a two-stage AIDS-QUAIDS model and pooled provincial and time-series data from 2000 to 2010. The purpose of this study is to examine the impact of strong income growth and rapid urbanization on food demand patterns in China. Several findings are as follows. First, all income elasticties for foods for both the urban and the rural residents are significantly higher than 0.3, while the elasticities for the rural population are considerably higher than those of the urban population. It is thus concluded that rural population is expected to be the main force driving the growth in food demand in the future. Second, for urban residents, the budget shares of grains, vegetables, fruits, and oils and fats are expected to decrease slightly while the budget shares of foods with animal origin are expected to further rise as incomes rise. For rural residents, the budget shares of grains are expected to decrease considerably while the budget shares of foods with animal origin, oils and fats, vegetables, and fruits are expected to keep growing. It is thus concluded that the future trend in the composition of food demand for rural residents is expected to be different than that of the urban residents. Finally, as incomes rise and urbanization process speeds up in the future, the budget shares of grains, vegetables, and oils and fats in China are expected to decrease while the shares of foods with animal origin and fruits are expected to increase. Moreover, the structure of food demand in China is expected to fall between the Western and Japanese dietary structures. The share of the urban expenditures in total China's food expenditures are expected to rise substantially in the future, suggesting that the food demand patterns in urban sector will dominate the food demand patterns in China.

The findings of this study have important policy implications. First, dietary structural changes in China are expected to involve a significant increase in continuation of the proportion of foods with animal origin in total food consumption, leading to an increase in the demand for feed grains in China. Thus, food security in China translates into feed grain security. In recent years, China's grain self-sufficiency rates have been falling, suggesting that China's grain and food security may be in jeopardy. China's 2012 soybean import of 58.38 million tons was 10% of China's total grain output. If the amount of soybeans imported in 2012 were converted into planting acreage, the amount would account for 26% of arable land in China. In 1995, Brown provided a warning on China's food security (Brown 1995). 18 years later, such warning is still applicable.

Second, the rapid growth in both China's food expenditures and the growth in urban shares of national total food expenditure are expected to raise the rate of commercialization of agricultural products and to increase the demand for processed agricultural products. Such prospects in China's demand patterns provide opportunities and challenges in the development of agricultural product processing and logistics industry. Currently, the service capability and the level that agricultural products processing and logistic enterprises can provide cannot meet the need of urbanization development in China.

Finally, along with the rapid growth in the demand for oils and fats and foods with animal origin, the excessive intakes of nutrients and resulting health problems for Chinese people have been increasingly prominent. According to FAO, although per capita calorie intake in China is basically similar to that in Japan and South Korea, the composition of source of calorie intake for Chinese population is different from that of population of Japan and South Korean, and has become more similar to the Western population diets. In 2009, per capita calorie intakes per day in China, Japan, and South Korea are 3036 kcal, 2723 kcal, and 3200 kcal, respectively, while the shares of calorie intake from foods with animal origin are 23%, 21%, and 16%, respectively. Moreover, China's national nutrition and health survey in 2005 shows that the rates of overweight and obesity of total adult population in China are 22.8% and 7.1%, respectively (Yang et al. 2010). Thus, during the critical period when food consumption patterns have been changing, advocating healthy diet and a healthier food could be helpful for the health of whole population and for reducing the pressure on food security in China.

Footnotes

1. The slow decline in Engel's coefficients for the urban since 2002 might be attributable to continuous rise of food prices. According to China National Bureau of Statistics (CNBS), urban consumer price indices increased by 11.6 percentage points from 1995 to 2003, while it rose by 20.2 percentage points from 2003 to 2010; urban food consumer price indices declined by 0.2 percentage points during the period of 1995 to 2003, whereas it grew by 60.5 percentage points from 2003 to 2010. Thus urban food consumer price indices increased at a rate of higher than urban consumer price indices since the 21 century, which might retrain the decrease in Engel's coefficients.

2. Since 2002 the urban household survey sample has included households registered in an urban area and those who have lived there for at least six months but are registered elsewhere, which means the survey includes both permanent urban households and migrants from rural areas. At the same time, sample size has also been expanded. As shown in table 2, per capita quantities consumed are strictly incoherent before and after 2002. Thus this study explains the features of urban food consumption through comparing two periods, namely 1990-2001 and 2002-2010.

3. The assumption that the true cost-of-living indices for at-home food do not vary greatly with at-home food utility and can be replaced by Laspeyres indices is checked, using pooled provincial and time-series data from 2000 to 2010 for urban residents. The check is made by the AIDS model together with the formula used by Edgerton (1997) because the QUAIDS specification stemming from an indirect utility function

can not be used for deriving a formula for true cost-of-living index. Results show that the assumption of low variation in the true cost-of-living indices seems generally to be justified while the replacement of the true cost-of-living indices by Laspeyres indices seems also to be justified.

4. According to Yen, Kan, and Su (2002), the own-price and expenditure elasticties for omitted categories in a complete demand system can be calculated by:

$\sum_{i=1}^{n} w_i e_i = 1$, $\sum_{i=1}^{n} w_i e_{ij} = -w_j$, and $\sum_{j=1}^{n} e_{ij} + e_i = 0$.

5. As explained in data section, price data for rural residents come from different sources while farmers consume a portion of foods produced by themselves, which might lead to insignificance of some elasticties in this study. But, the several price elasticties that are not significant statistically should not affect the conclusions because this study focuses on the impact of income growth on food demand.

6. Out-of sample tests are performed using the method employed by Kastens and Brester (1996). The sample for 2000, 2005, and 2010 is chosen as targeting out-of-sample, then the remaining data are used for estimating parameters, and finally Root Mean Squared Error (RMSE) statistic is used to judge the comparison between true values for 2000, 2005 and 2010 and predicted values for these years.

7. For urban residents, during the period from 2000 to 2010, real per capita GDP in China grows at a rate of 9.7%, real per capita expenditure on eight items increased at a rate of 7.2%. Assuming that the linear relationship between GDP and expenditure is held fixed in the future, the growth rate of per capita expenditure is extrapolated to be 5% annually if real per capita GDP increases at a rate of 7% from 2010 to 2020; while

it is extrapolated to be 4% yearly if per capita GDP grows at a rate of 6% from 2020 to 2030. Similarly, the growth rate of per capita expenditure is extrapolated to be 4.5% yearly from 2010 to 2020, while it is extrapolated to be 3.9% per year during the period of 2020 to 2030.

8. According to Bai et al. (2012), the shares of expenditure on foods consumed away from home are as follows in 2010: 13.3% for grains, 2.8% for beans, 37.8% for meats including red and poultry meats, 3.6% for eggs, 11.5% for aquatic products, 3.2% for fruits, 1.6% for dairy products, and 13.1% for drinks.

9. In his widely read and cited article entitled “who will feed China?” Lester Brown (1995) argued that the rapid development of China and resulting increase in livestock consumption would lead to a huge shortage of food worldwide. Brown’s logic assumes that China’s diet will follow diets in the Western as incomes rise (Shono, Suzuki, and Kaiser 2000). Whether the structure of food demand in China will follow diets in the West depending upon meats as protein sources or move toward Japanese dietary pattern characterized as being compatible proportions of animal and plant foods is of importance in forecasting future demand for meats and feed grains.

10. Assuming that food preferences and relative prices are held constant, per capita consumption of a commodity can be computed using the formula as $q_i^n = (1 + e_i \Delta \ln x) q_i^0$, where q_i^0 and q_i^n denote the quantity of commodity i demanded in the beginning of and at the end of a period, respectively, e_i is the food expenditure elasticity for commodity i, and $\Delta \ln x$ is the rate of changes in per capita food expenditures. Per capita consumption of each commodity in 2020 is first

computed using the formula. Then, total expenditures on the 10 commodities in 2020 are calculated as the product of prices at 2010 and the quantities predicted in 2020. Finally, the food expenditure elasticities for 2020 are estimated with formula (6) by putting the estimated expenditures and budget shares. The food expenditure elasticities for 2030 are estimated similarly using the predicted elasticities for 2020. Note that FAFH spending in 2020 and 2030 is computed using the annual growth rate of 5.48% in table 1.

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Table 1. Annual Per Capita Income and Food Consumption Patterns, 1990-2010, China,

	Per Capita Income		Food as a % of Total Expenditures		Urban Food Expenditures and Composition			Rural Food Expenditures and Composition		
	Urban (￥)[d]	Rural (￥)	Urban (%)	Rural (%)	Total (￥)	FAH (%)[e]	FAFH (%)	Total (￥)	FAH (%)	FAFH (%)
1990	1510	686	54.3	58.8	694	na	na	344	97.7	2.3
1995	2213	893	50.1	58.6	805	90.9	9.1	345		
2000	2925	1184	39.4	49.1	923	85.3	14.7	381	92.2	7.8
2001	3173	1234	38.2	47.7	949	84.4	15.6	386		
2002	3599	1296	37.7	46.2	1068	81.7	18.3	397		
2003	3923	1351	37.1	45.6	1099	81.9	18.1	401		
2004	4224	1444	37.7	47.2	1133	80.3	19.7	417		
2005	4630	1566	36.7	45.5	1182	79.2	20.8	459	90.4	9.6
2006	5113	1700	35.8	43.0	1231	77.8	22.2	470		
2007	5735	1862	36.3	43.1	1285	79.0	21.0	473		
2008	6217	2010	37.9	43.7	1317	79.4	20.6	477		
2009	6828	2183	36.5	41.0	1371	78.2	21.8	488		
2010	7361	2420	35.7	41.1	1374	78.8	21.2	499	86.7	13.3
Growth[a]	6.32*	6.34*	-2.97*	-1.49*	2.75*	-0.95	7.90	1.50*	-0.58	1.30
Growth[b]	9.32*	7.60*	-0.52*	-1.65*	3.88*	-0.69*	2.96*	3.05*	-0.61	5.48

Notes: per capita incomes for both urban and rural residents are deflated using corresponding consumption price indices with 1990 price level as a base, while per capita food expenditures are deflated using corresponding food consumption price indices with 1990 price level as a base. [a]Growth here refers to the annual growth rate between 1990 and 2000 calculated using regression method. The yearly growth rate for FAFH and FAH for urban residents from 1992 to 2000 is calculated using a method. [b]Growth here refers to the annual growth rate between 2001 and 2010 calculated using regression method., while the annual growth rates for FAFH and FAH for rural residents are estimated using the compound annual growth rate (CAGR).[c]Data on FAFH for rural residents are from Xu (2011). Single asterisks (*) indicates significance at the 10% level.[d]￥refers to Chinese Yuan, which is equal to about 0.016 US dolloar or 6.2 Yuan/US$ in 2010. [e]FAFH refers to foods away from home while FAH indicates foods at home.

Source: *China Statistical Yearbooks* (various issues).

Table 2. Annual Per Capita Food Consumption, 1990- 2010, China (kilogram/person)

	Grains	Veg.	Oils	Pork	Beef[e]	Poultry	Eggs	Fish	Milk	Fruits
Urban										
1990	130.7	138.7	6.4	18.5	3.3	3.4	7.3	7.7	4.6	41.1
1995	97.0	116.5	7.1	17.2	2.4	4.0	9.7	9.2	4.6	45.0
2000	82.3	114.7	8.2	16.7	3.3	5.4	11.2	11.7	9.9	57.5
2001	76.7	115.9	8.1	16.0	3.2	5.3	10.4	10.3	11.9	56.5
2002	79.5	116.5	8.5	20.3	3.0	9.2	10.6	13.2	15.7	56.6
2003	79.5	118.3	9.2	20.4	3.3	9.2	11.2	13.4	18.6	57.8
2004	78.2	122.3	9.3	19.2	3.7	6.4	10.4	12.5	18.8	56.5
2005	77.0	118.6	9.3	20.2	3.7	9.0	10.4	13.0	18.3	60.2
2006	75.9	117.6	9.4	20.0	3.8	8.3	10.4	13.0	18.3	60.2
2007	77.6	117.8	9.6	18.2	3.9	9.7	10.3	14.2	17.8	59.5
2008	80.8	123.2	10.3	19.3	3.4	10.1	10.7	14.8	15.2	54.5
2009	81.4	120.5	9.7	20.5	3.7	10.5	10.6	15.4	14.9	56.6
2010	81.5	116.1	8.8	20.7	3.8	10.2	10.0	16.8	14.0	54.2
Growth[a]	-4.70	-1.61	2.20	-1.31	-0.30	4.10	3.31	2.71	9.24	2.90
Growth[b]	0.41	0.08	0.89	-0.00	1.95*	2.99	-0.58	3.01*	-2.63*	-0.53
Rural										
1990	262.1	134.0	5.2	10.5	0.8	1.3	2.4	2.1	1.1	6.8
1995	256.1	104.6	5.9	10.6	0.7	1.8	3.2	3.4	0.6	13.0
2000	250.2	106.7	7.1	13.3	1.1	2.8	4.8	3.9	1.1	18.3
2001	238.6	109.3	7.0	13.4	1.2	2.9	4.7	4.1	1.2	20.3
2002	236.5	110.6	7.6	13.7	1.2	2.9	4.7	4.4	1.2	18.8
2003	222.4	107.4	6.3	13.8	1.3	3.2	4.8	4.7	1.7	17.5
2004	218.3	106.6	5.3	13.5	1.3	3.1	4.6	4.5	2.0	17.0
2005	208.9	102.3	6.0	15.6	1.5	3.7	4.7	4.9	2.9	17.2
2006	205.6	100.5	5.8	15.5	1.6	3.5	5.0	5.0	3.1	19.1
2007	199.5	99.0	6.0	13.4	1.5	3.9	4.7	5.4	3.5	19.4
2008	199.1	99.7	6.3	12.6	1.3	4.4	5.4	5.2	3.4	19.4
2009	189.3	98.4	6.2	14.0	1.3	4.2	5.3	5.3	3.6	20.5
2010	181.4	93.3	6.3	14.4	1.4	4.2	5.1	5.2	3.6	19.6
Growth[c]	-0.36*	-2.07*	2.08*	2.01*	4.00*	7.92*	6.53*	6.84*	2.03	11.62*
Growth[d]	-2.95*	-1.73*	-1.23	0.19	1.48	4.94*	1.39*	2.74*	13.81*	0.79

Notes: [a] refers to the annual growth rates from 1990 to 2001calculated using CAGR. [b] refers to the annual growth rates during 2002-2010 estimated using regression method. [c] refers to the annual growth rates from 1990 to 2000 estimated using regression method.[d] refers to the annual growth rates during 2001-2010 estimated using regression method. Single asterisks (*) refers to significance at the 10% level. [e]Beef refers to beef and mutton.
Source: *China Statistical Yearbook* (various years) and *China Yearbook of Rural Household Survey* (various years).

Table 3. Demand Elasticities for Commodity Groups, China, Step I, Stage I, Time-Series (2000-2010) and Cross-Provincial (31 Provinces).

Variables	FAH	FAFH	Clothing	Services	Health	Transport	Education.	Housing
Urban (31 Provinces)								
Marshallian Price Elasticities								
FAH	-0.539*	-0.032	-0.018	0.578*	-0.102*	-0.448*	-0.061	0.134
	(0.065)	(0.041)	(0.033)	(0.051)	(0.040)	(0.056)	(0.045)	(0.088)
FAFH	-0.280*	-0.999*	0.181	-0.158	0.149	-0.405*	0.144	0.308
	(0.141)	(0.205)	(0.116)	(0.182)	(0.150)	(0.174)	(0.135)	(0.211)
Clothing	-0.150*	0.115	-1.092*	-0.117	-0.040	0.042	0.151*	0.024
	(0.075)	(0.078)	(0.089)	(0.099)	(0.081)	(0.094)	(0.075)	(0.119)
Services	1.639*	-0.147	-0.164	-0.826*	-0.174*	-0.667*	-0.495*	-0.278
	(0.162)	(0.165)	(0.135)	(0.293)	(0.167)	(0.197)	(0.143)	(0.245)
Health	-0.518*	0.154	-0.059	-0.193	-1.252*	0.177	0.618*	0.028
	(0.146)	(0.156)	(0.126)	(0.192)	(0.214)	(0.173)	(0.132)	(0.221)
Transport	-1.368*	-0.314*	0.045	-0.563*	0.121	-0.298	0.655*	0.561*
	(0.157)	(0.136)	(0.111)	(0.169)	(0.130)	(0.242)	(0.142)	(0.267)
Education	-0.356*	0.046	0.099	-0.308*	0.289*	0.427*	-1.137*	-0.454*
	(0.085)	(0.072)	(0.059)	(0.083)	(0.068)	(0.096)	(0.108)	(0.145)
Housing	0.052	0.180	0.009	-0.214	-0.004	0.470*	-0.536*	-1.266*
	(0.201)	(0.138)	(0.116)	(0.176)	(0.138)	(0.222)	(0.179)	(0.492)
Income Elasticities								
	0.488*	1.059*	1.067*	1.112*	1.045*	1.163*	1.392*	1.305*
	(0.033)	(0.082)	(0.048)	(0.088	(0.080	(0.102)	(0.056)	(0.158)
Rural (30 Provinces)								
Marshallian Price Elasticities								
FAH	-0.711*	--	0.061*	0.038*	0.097*	0.088	-0.164*	-0.053
	(0.078)		(0.022)	(0.019)	(0.041)	(0.046)	(0.054)	(0.067)
Clothing	0.304	--	-0.944*	-0.405*	-0.156	-0.116	-0.077	0.501*
	(0.159)		(0.142)	(0.123)	(0.143)	(0.167)	(0.124)	(0.214)
Services	0.119	--	-0.561*	-0.689*	0.012	0.210	-0.015	-0.234
	(0.191)		(0.162)	(0.254)	(0.171)	(0.186)	(0.162)	(0.199)
Health	0.096	--	-0.152	-0.011	-0.936*	-0.373*	0.142	-0.264
	(0.203)		(0.100)	(0.091)	(0.185)	(0.147)	(0.146)	(0.204)
Transport	0.116	--	-0.109	0.100	-0.345*	-2.121*	0.582*	0.453
	(0.255)		(0.114)	(0.097)	(0.137)	(0.284)	(0.201)	(0.275)
Education	-1.030*	--	-0.066	0.000	0.202	0.689*	-1.103*	0.328
	(0.311)		(0.099)	(0.094)	(0.161)	(0.228)	(0.240)	(0.254)
Housing	-0.504*	--	0.148	-0.081	-0.135	0.229	0.114	-1.248*
	(0.165)		(0.077)	(0.055)	(0.102)	(0.146)	(0.122)	(0.246)
Income Elasticities								
	0.646*	--	0.894*	1.159*	1.497*	1.322*	0.979*	1.558*
	(0.037)		(0.088)	(0.106)	(0.101)	(0.184)	(0.179)	(0.075)

Notes: Numbers in parentheses are standard errors. Single asterisks (*) indicates significance at the 5% level. All the elasticities are estimated using the corresponding formulae while their standard errors are calculated using delta formulae.

Table 4. Demand Elasticities for Food Commodities, Urban China, Step I, Stage II, Food-at-Home, Time-Series (2000-2010) and Cross-Provincial (31 Provinces).

Variable	Grains	Beans	Oils & Fats	Meats	Poultry	Eggs	Aquatic Products	Vege-tables	Fruits	Dairy Products
Conditional Marshallian Price Elasticities										
Grains	-0.739*	-0.102*	0.061	-0.058	-0.153*	-0.083*	0.104	0.054	0.088*	0.166*
	(0.091)	(0.021)	(0.032)	(0.046)	(0.047)	(0.026)	(0.062)	(0.043)	(0.045)	(0.054)
Beans	-0.707*	-0.156	-0.151*	0.049	-0.144	0.087	-0.068	0.183*	0.238*	0.030
	(0.143)	(0.113)	(0.073)	(0.089)	(0.089)	(0.092)	(0.107)	(0.076)	(0.084)	(0.101)
Oils and fats	0.168	-0.060*	-0.338*	0.239*	0.155*	-0.038	-0.188*	-0.154*	-0.097	-0.256*
	(0.090)	(0.029)	(0.064)	(0.074)	(0.070)	(0.035)	(0.083)	(0.062)	(0.064)	(0.075)
Meats	-0.073*	-0.001	0.037*	-0.827*	0.080*	0.024*	0.053	-0.026	-0.070*	-0.118*
	(0.028)	(0.008)	(0.016)	(0.036)	(0.025)	(0.010)	(0.029)	(0.022)	(0.022)	(0.026)
Poultry	-0.281*	-0.038	0.090*	0.214*	-0.794*	-0.060*	-0.424*	0.027	0.139*	0.110
	(0.085)	(0.022)	(0.044)	(0.075)	(0.097)	(0.029)	(0.082)	(0.061)	(0.062)	(0.076)
Eggs	-0.346*	0.041	-0.069	0.132*	-0.129*	-1.018*	0.045	0.088*	-0.148*	0.400*
	(0.098)	(0.050)	(0.047)	(0.064)	(0.062)	(0.078)	(0.075)	(0.051)	(0.059)	(0.067)
Aquatic products	0.012	-0.038	-0.177*	-0.030	-0.397*	0.001	-0.806*	-0.099	-0.229*	0.151
	(0.102)	(0.025)	(0.049)	(0.079)	(0.075)	(0.033)	(0.125)	(0.073)	(0.065)	(0.092)
Vegetables	0.004	0.017	-0.071*	-0.026	0.020	0.026*	0.040	-0.896*	0.149*	-0.103*
	(0.040)	(0.010)	(0.020)	(0.032)	(0.030)	(0.013)	(0.038)	(0.039)	(0.029)	(0.036)
Fruits	0.065	0.035*	-0.062*	-0.148*	0.099*	-0.047*	-0.122*	0.183*	-0.974*	-0.005
	(0.055)	(0.015)	(0.028)	(0.044)	(0.043)	(0.019)	(0.049)	(0.040)	(0.052)	(0.047)
Dairy products	0.158	-0.014	-0.239*	-0.557*	0.097	0.172*	0.100	-0.416*	-0.103	-1.064*
	(0.099)	(0.027)	(0.050)	(0.079)	(0.078)	(0.033)	(0.100)	(0.072)	(0.070)	(0.124)
Food Expenditure Elasticities										
	0.662*	0.645*	0.569*	0.922*	1.017*	1.003*	1.613*	0.839*	0.976*	1.867*
	(0.059)	(0.097)	(0.096)	(0.047)	(0.107)	(0.068)	(0.109)	(0.049)	(0.065)	(0.118)
Income Elasticities										
	0.323*	0.314*	0.278*	0.450*	0.496*	0.489*	0.787*	0.409*	0.476*	0.911*
	(0.036)	(0.052)	(0.051)	(0.038)	(0.062)	(0.047)	(0.075)	(0.037)	(0.045)	(0.085)

Notes: Numbers in parentheses are standard errors. Single asterisks (*) indicate significance at the 5% level. All the price and expenditure elasticities are estimated using formulae (5), (6), and (8), and their standard errors are calculated using delta formulae. All income elasticities are estimated using formulae (7), and their standard errors are calculated using the method of Bohrnstedt and Goldberger (1969). That is, if the expectation and variance of random variables x and y are independent, then $\mathrm{Var}(xy) = E^2(x)\mathrm{Var}(y) + E^2(y)\mathrm{Var}(x) + \mathrm{Var}(x)\mathrm{var}(y)$.

Table 5. Demand Elasticities for Food Commodities, Rural China, Step I, Stage II, Food-at-Home, Time-Series (2000-2010) and Cross-Provincial (30 Provinces).

Variables	Grains	Vege-tables	Oils & Fats	Pork	Beef	Poultry	Eggs	Dairy Products	Aquatic Products	Fruits
Conditional Marshallian Price Elasticities										
Grains	-0.400*	-0.257*	-0.024	-0.068	0.061	0.055	0.021	-0.004	0.035	0.070
	(0.080)	(0.043)	(0.048)	(0.037)	(0.038)	(0.029)	(0.020)	(0.010)	(0.035)	(0.037)
Vegetables	-0.563*	-0.418*	0.014	-0.201*	-0.149*	0.075*	-0.021	0.003	0.007	-0.039
	(0.062)	(0.065)	(0.049)	(0.040)	(0.042)	(0.026)	(0.015)	(0.008)	(0.033)	(0.033)
Oils and fats	0.496	-0.194	0.721*	-0.142	-0.906*	-0.164	0.242*	-0.015	-0.508*	-0.455*
	(0.274)	(0.182)	(0.289)	(0.202)	(0.204)	(0.139)	(0.092)	(0.054)	(0.172)	(0.185)
Pork	-0.355*	-0.179*	-0.046	-0.589*	-0.021	-0.008	0.009	-0.007	0.035	0.119*
	(0.069)	(0.049)	(0.068)	(0.057)	(0.049)	(0.031)	(0.022)	(0.010)	(0.038)	(0.039)
Beef	-0.742*	-0.655*	-1.468*	-0.221	-0.016	0.619*	-0.258*	-0.043	0.813*	0.297
	(0.378)	(0.247)	(0.332)	(0.240)	(0.367)	(0.182)	(0.121)	(0.068)	(0.228)	(0.235)
Poultry	0.202	0.332*	-0.135	-0.100	0.371*	-0.332*	-0.246*	-0.041	-0.629*	-0.716*
	(0.187)	(0.119)	(0.163)	(0.109)	(0.132)	(0.115)	(0.058)	(0.028)	(0.107)	(0.105)
Eggs	0.378	-0.183	0.478*	0.092	-0.287*	-0.428*	-0.624*	0.092	-0.339*	-0.024
	(0.210)	(0.112)	(0.182)	(0.128)	(0.146)	(0.099)	(0.150)	(0.054)	(0.135)	(0.138)
Dairy products	-0.557	0.285	-0.182	-0.152	-0.163	-0.297	0.421	-0.176	0.378	-0.460
	(0.521)	(0.263)	(0.500)	(0.281)	(0.383)	(0.227)	(0.253)	(0.176)	(0.334)	(0.335)
Aquatic products	-0.359	0.115	-0.614*	0.012	0.593*	-0.730*	-0.239*	0.046	0.049	-0.520*
	(0.278)	(0.162)	(0.237)	(0.153)	(0.189)	(0.122)	(0.093)	(0.049)	(0.223)	(0.164)
Fruits	-0.084	-0.092	-0.372*	0.258*	0.115	-0.574*	-0.013	-0.055	-0.354*	-0.270
	(0.210)	(0.115)	(0.175)	(0.107)	(0.137)	(0.086)	(0.067)	(0.035)	(0.116)	(0.165)
Food Expenditure Elasticities										
	0.511*	1.292*	0.924*	1.042*	1.674*	1.295*	0.845*	0.903*	1.647*	1.442*
	(0.058)	(0.081)	(0.165)	(0.076)	(0.282)	(0.168)	(0.143)	(0.385)	(0.207)	(0.157)
Income Elasticities										
	0.330*	0.834*	0.597*	0.673*	1.081*	0.836*	0.546*	0.583*	1.063*	0.931*
	(0.042)	(0.070)	(0.112)	(0.062)	(0.193)	(0.119)	(0.097)	(0.251)	(0.147)	(0.114)

Notes: Numbers in parentheses are standard errors. Single asterisks (*) indicate significance at the 5% level. All the price and expenditure elasticities are estimated using formulae (5), (6), and (8), and their standard errors are calculated using delta formulae. All income elasticities are estimated using formulae (7), and their standard errors are calculated using the method of Bohrnstedt and Goldberger (1969). That is, if the expectation and variance of random variables x and y are independent, then $\mathrm{Var}(xy) = E^2(x)\mathrm{Var}(y) + E^2(y)\mathrm{Var}(x) + \mathrm{Var}(x)\mathrm{var}(y)$.

Table 6. Fitted and Predicted Per Capita Budget Shares and Annualized Growth Rates for Foods, 2010, 2020, and 2030

	Urban			Rural		
Foods	Fitted 2010	Predicted 2020	Predicted 2030	Fitted 2010	Predicted 2020	Predicted 2030
Grains	0.130	0.123	0.122	0.278	0.24	0.213
		(-0.61)	(-0.06)		(-1.46)	(-1.19)
Oils and fats[a]	0.045	0.040	0.036	0.037	0.038	0.04
		(-1.29)	(-0.93)		(0.27)	(0.51)
Meats[b]	0.304	0.305	0.312	0.288	0.297	0.303
		(0.03)	(0.22)		(0.31)	(0.20)
Eggs	0.035	0.036	0.036	0.025	0.025	0.025
		(0.05)	(0.11)		(-0.12)	(-0.01)
Aquatic products	0.122	0.134	0.138	0.051	0.057	0.06
		(0.95)	(0.30)		(1.12)	(0.51)
Vegetables	0.191	0.187	0.185	0.236	0.253	0.265
		(-0.21)	(-0.13)		(0.70)	(0.46)
Fruits	0.108	0.103	0.099	0.052	0.057	0.061
		(-0.42)	(-0.45)		(0.92)	(0.68)
Dairy products	0.064	0.073	0.073	0.033	0.033	0.033
		(1.25)	(-0.01		(-0.06)	(-0.08)

Note: Figures in parentheses are annualized growth rates for 10 years.
[a]Oils and fats refers only those consumed at home.
[b]Meats here include pork, beef and mutton, and poultry.

Table 7. Fitted and Predicted Budget Shares, Expenditure Levels, and Annualized Growth Rates for Foods, 2010, 2020, and 2030

	Budget Shares (%)			Total Expenditure (100 million Yuan)			Of Which, Urban Shares (%)		
	Fitted	Predicted	Predicted	Fitted	Predicted	Predicted	Fitted	Predicted	Predicted
Foods	2010	2020	2030	2010	2020	2030	2010	2020	2030
Grains	0.185	0.155	0.141	6476	7571	8266	0.445	0.577	0.680
		(-1.78)	(-0.90)		(1.57)	(0.88)		(2.64)	(1.66)
Oils and fats[a]	0.042	0.039	0.037	1471	1915	2153	0.676	0.735	0.772
		(-0.71)	(-0.61)		(2.67)	(1.17)		(0.85)	(0.49)
Meats[b]	0.298	0.303	0.310	10433	14825	18127	0.643	0.732	0.793
		(0.16)	(0.23)		(3.58)	(2.03)		(1.30)	(0.80)
Eggs	0.032	0.033	0.034	1107	1598	1965	0.705	0.791	0.842
		(0.32)	(0.29)		(3.74)	(2.09)		(1.16)	(0.63)
Aquatic products	0.096	0.113	0.122	3360	5541	7133	0.803	0.863	0.895
		(1.66)	(0.75)		(5.13)	(2.56)		(0.72)	(0.36)
Vegetables	0.208	0.205	0.202	7275	10041	11798	0.579	0.663	0.721
		(-0.13)	(-0.17)		(3.27)	(1.63)		(1.36)	(0.85)
Fruits	0.087	0.091	0.091	3046	4444	5313	0.781	0.828	0.857
		(0.42)	(0.01)		(3.85)	(1.80)		(0.59)	(0.35)
Dairy products	0.053	0.062	0.064	1850	3034	3761	0.768	0.854	0.892
		(1.61)	(0.37)		(5.07)	(2.17)		(1.08)	(0.43)

Note: Figures in parentheses are annualized growth rates for 10 years.

[a]Oils and fats refers only those consumed at home.

[b]Meats here include pork, beef and mutton, and poultry.

Chart 1. China's Food Consumption Model