FOOD DEMAND IN URBAN CHINA

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PREFACE

This dissertation is composed of three essays. The first essay, "An Analysis of Household Food Demand in China," estimates the impacts of economic (price and expenditure) and non-economic (demographic) factors on food consumption patterns in China using the 2004 China's urban household survey data for Jiangsu province. A complete food demand system of households is estimated using a two-stage budgeting procedure which incorporates both an almost ideal demand system (AIDS) and a quadratic almost ideal demand system (QUAIDS) in each stage. The results of this study show that region, city size, and the ratio of food-away-from-home spending to total food expenditures significantly influence consumption of most food categories examined. Additionally, the demand for grains and oils & fats is more dependent upon price changes than expenditure changes. Finally, the demand for animal products is shown to be significantly more sensitive to consumer food expenditure changes than other food categories. And therefore, it can be concluded that the per capita consumption of animal products is expected to grow at a much faster rate compared to other food categories in response to the current and expected future growth in per capita incomes of Chinese consumers. Regarding the theoretical models used in this study, the AIDS and the QUAIDS models yield very similar results in this application.

The second essay, "An Analysis of Household Food Consumption Patterns by Income Groups," estimates the differences in price and income elasticities across income

classes using the 2004 China's urban household survey data for Jiangsu province. An incomplete demand system for 10 major food commodity groups that were consumed at home is estimated using the LINQUAD model, which is defined as being linear in income and linear and quadratic in prices, for low-, medium-, and high-income groups, respectively. Results of this study indicate that the high-income households are less responsive to price and income changes for most food groups examined in this study compared to the both low- and medium-income families in urban Jiangsu, indicating the rejection of null hypothesis of constant elasticities of demand for foods in urban Jiangsu, China. From the results of this study it may be concluded that a policy analysis for a specific population group should be based on the data set indigenous to the targeted population group.

The essay, "The Impact of Changes in Income Distribution on Food Demand," estimates the impact of changes in income distribution on food demand in urban Jiangsu, China. Results of this study indicate that a drive toward a more equal distribution of income would increase expenditures for food groups that were consumed at home. Results of this study also reveal that distribution-neutral income growth would increase food demand much more than did income growth in an income distribution favored higher income households. Thus, the income growth along with the more equal income distribution would greatly increase food demand in China.

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ESSAY I

AN ANALYSIS OF HOUSEHOLD FOOD DEMAND IN CHINA

Introduction

China has had one of the world's most rapidly developing economies for at least the past two decades. Population growth, combined with economic growth and rapid urbanization, has increased food demand as well as changed the composition of food consumed. Typically, direct per capita consumption of food grains has declined considerably, whereas the per capita consumption of animal products such as red meats, poultry, eggs, aquatic products, and dairy products has increased dramatically. Considering that China has over one-fifth of the world's consumers and an economy growing at 9-10% annually, this country's changing food consumption patterns have the potential to significantly impact the global magnitude and pattern of demand for food. Research is therefore needed to offer a better understanding of China's food buyer preferences and the future potential for food marketing in China.

There have been many studies of China's household demand for food; however, these previous studies may not reflect current situations due to the recent changes in economic structure and the rapidly rising incomes in China. These studies have used a variety of data, including aggregate time-series data (Lewis and Andrews 1989), aggregate urban-level based cross-sectional data (Wu, Li, and Samuel 1995; Wang et al.

1998), aggregate time-series of cross-sectional data at the provincial level (Fan, Wailes, and Cramer 1994; Chern and Wang 1994), and aggregate time-series of cross-sectional data at the county level (Zhang, Mount, and Boisvert 2001). More recent studies have used household survey data collected by China's National Bureau of Statistics (NBS), which has significant advantages over aggregate time-series data. More specifically, the household survey data encompass detailed demographic characteristics and therefore, allow for the assumption of heterogeneity in preferences across households. The large sample size also allows estimating a relatively large demand system. Among the published studies based on the household survey data, Halbrendt et al. (1994) and Gao, Wailes, and Cramer (1996) focused on rural households in Guangdong and Jiangsu provinces, respectively. Zhang and Wang (2003) and Yen, Fang, and Su (2004) centered their attentions on urban households in China in 1998 and 2000, respectively. Liu and Chern (2003) analyzed food demand of urban families using the household survey data for Shandong, Jiangsu, and Heilongjiang provinces in 1997. Some studies have taken advantage of availability of household survey data over the years and have analyzed food demand using the available pooled time-series of cross-sectional data at household-level. Gould (2002) used three consecutive years of NBS's urban household survey data (1995-97) for Jiangsu, Shandong, and Guangdong provinces to estimate a system of demands for food commodities; and Guo et al. (2000) used data for 1989, 1991, and 1993 from the China Health and Nutrition Survey to examine food consumption behaviors of urban households across income levels.

This study goes beyond the previous studies in data use by utilizing the most updated data- the 2004 NBS's urban household survey data for the Jiangsu province.

Also, a two-stage budgeting system is used to estimate the demand for the more broad categories of foods in the first stage while estimating the demand for individual grain commodities within the grain subgroup and the individual meat products within the meat subgroup, respectively, in the second stage. The broad food categories considered in the first stage include: grains, oils & fats, meats, poultry, eggs, aquatic products, dairy products, vegetables, fruits, and other foods. The primary objective of this study is to estimate the impacts of economic factors (prices and expenditures) and non-economic factors (demographic variables) on urban household demand for food in the Jiangsu province of China.

China is expected to undergo massive urbanization during the 21st century, which could have a dramatic effect on food demand (Hsu, Chern, and Gale 2002). According to China's official statistics (NBS 2005b), only 42% of the population lived in cities and towns in 2004. This urban population share is expected to grow to 50% by 2020 (Hsu, Chern, and Gale 2002). Urban residents in China have much higher per capita incomes compared to those residing in rural areas. With the rather strong purchasing power, China's urban households have been the driving force behind the growth in food demand and the emerging demand for better quality food. This changing food demand has led to a significant increase in the number of supermarkets, convenience stores, and food-away-from-home (FAFH) outlets that offer greater convenience and quality in food purchase (Gale and Huang 2007). Given the importance of China's urban consumer food demand to domestic and global markets, the results of this study are expected to help the policymakers, researchers, and trading firms both in China and in grain-exporting countries. Shedding light on China's contemporary consumer preferences, the results of this study are expected to be useful to food exporting countries' decision makers, such as those in the United States, in developing effective trade policies and marketing programs for trade with China. More specifically, the food demand elasticities obtained here may be used in the analysis of the impacts of trade policies on China's economy and the world food markets.

The remainder of this study is organized as follows. The background for food consumption patterns in the urban Jiangsu province of China is described in the following section. A model of urban household food demand in China is then presented, followed by a description of the data, estimation procedures, and statistical tests. The economic and demographic parameter results are presented next, followed by summary remarks, conclusions, and policy implications.

Background

Jiangsu province is located in southeast China with population of 74 million, 48% of whom are urban residents. As one of the most economically advanced provinces, its gross domestic products (GDP) accounted for more than 9% of China's national GDP, and its urban per capita disposable income was ranked seventh among thirty-one provinces in the nation in 2004 (NBS 2005b). Moreover, urban households in Jiangsu province devote more of their disposable incomes to food than the national average, reflecting the central importance of food in Jiangsu's culture. The disposable income per capita in urban China and urban Jiangsu in 2004 were 9,422 yuan and 10,482 yuan, respectively, whereas the proportion of food spending to total living expenditures were 37.7 and 40.0 for urban China and urban Jiangsu, respectively (NBS 2005b). With the rapid growth in per capita disposable incomes, the share of food as a percentage of total living expenditures in urban Jiangsu has decreased. Nevertheless, food spending remains the single largest item in urban household budgets in Jiangsu.

Rising income has had a major impact on the structure of food economy in urban China. More specifically in Jiangsu, the share of food that was consumed at home (FAH) as a percentage of total food expenditures has declined while the share of food-away-from-home (FAFH) as a percentage of total food expenditures has increased. Between 1995 and 2004, the real per capita income in urban Jiangsu rose by 97% (table I-2, column 1). During the same period, the share of expenditures spent on FAH decreased from 90% to 82%, whereas the share of food expenditures on FAFH rose from 10% to 18% (table I-2, column 3 and 4). Furthermore, food consumption data for urban Jiangsu show that during the 1995-2004 period, total per capita FAH expenditure grew at an average rate of 2.3% while total per capita FAFH expenditure increased at an average rate of 10.9% during this time period.

Income growth in China is believed to have played a significant role in affecting food consumption patterns and the structure of China's food economy in general. Table I-1 presents a comparison of consumption patterns between urban Jiangsu and urban China as a whole.[1] The per capita direct consumption of food grains declined substantially in both urban Jiangsu and urban China from 1995 to 2000 and thereafter decreased slightly, although the per capita grain consumption figures were slightly lower for the urban Jiangsu consumers than the urban national average. The per capita consumption of food grains in urban Jiangsu in 2004 was 74 kg, which measures at 76% of the national average for China's urban population in 1995.

[1] This table refers to only food that was consumed at home.

The consumption of various meat categories and aquatic products has increased less rapidly in urban Jiangsu than urban China, although the per capita meat and aquatic product consumption in urban Jiangsu was still slightly higher than the national average. In 2004, the per capita consumption of meats (including pork, beef, mutton, and poultry) and aquatic products (mainly including fish and shrimp) in urban Jiangsu reached 34 kg and 16 kg, 9% and 28% higher than the national average, respectively. Of which, the higher than national average per capita consumption of aquatic products may be attributed to the fact that Jiangsu province is one of the most fresh-water fish producing regions. Additionally, the growth rates for poultry in both urban Jiangsu and urban China have been significantly higher than that for pork. The share of pork as a percentage of total quantities of meats consumed has declined from 66% in 1998 to 59% in 2004.

The consumption of dairy products has significantly increased in both urban Jiangsu and urban China. The per capita consumption of fresh milk and yogurt in urban Jiangsu has increased from 4 kg in 1995 to 12 kg in 2000 and to 22kg in 2004, an increase of more than 400% over the past decade. It is likely that dairy consumption will continue to increase in the future (Yen, Fang, and Su 2006; Fuller, Beghin, and Rozelle 2007).

The per capita consumption of vegetable oils in urban Jiangsu has increased less rapidly than in urban China. Before 2003, urban residents in Jiangsu consumed more vegetable oils than the national average. By 2004, the per capita consumption of vegetable oils in urban Jiangsu was 9.1 kg, whereas it averaged 9.3 kg per capita in urban China. The per capita consumption of eggs and fruits in urban Jiangsu has been relatively stagnant since 1998, while urban China has experienced a significant growth in the consumption of both food categories since 2002. In 2004, the per capita consumption of eggs in urban Jiangsu and urban China was 12 kg and 10 kg, respectively, and the per capita consumption of fruits in urban Jiangsu and urban China was 54 kg and 56 kg, respectively. Regarding vegetables, the per capita consumption of both urban Jiangsu and urban China has stayed relatively stable over the past 10 years.

The comparison above shows that the per capita consumption of food grains in urban Jiangsu is lower than the national average, while the per capita consumption of animal products is higher than the national average. Following Jiangsu's lead, this may suggest a further outward-shift of the demand for animal products in China given the growing per capita disposable income that is expected to continue in the future. Therefore, if current changes in food consumption patterns continue into the future— the negative growth in per capita consumption of food grains and the positive growth in the consumption of animal products[2] —feed, rather food demand would be expected to be the main cause of any future grain shortage (Tian and Chudleigh 1999).

Model Specification

This study encompasses eighteen food categories: 10 major food groups, 4 individual grain commodities, and 4 individual meat products. A full demand system for these food items is not practical because a large number of parameters need to be estimated To solve this problem, a two-stage budgeting approach is used for this study. In the first-stage, a demand system is specified for 10 broad groups of food commodities

[2] Ma et al. (2006) indicated that the average urban resident spends 45% of their food budget on meats, eggs, and fish versus only14% on grains when he/she is eating out, which is supported by Zhou and Tian (2005). Thus, despite slow growth in consumption per capita of animal products at home, the rapid growth in spending on FAFH assures a rapid increase in consumption of animal products in an average urban household in China.

selected for this study, including grains, oils & fats, meats, poultry, eggs, aquatic products, dairy products, vegetables, fruits, and other foods. In the second-stage, two separate demand systems are specified. One is a demand system for more detailed grain commodities, consisting of rice, wheat flour, coarse grains, and processed wheat, while the other demand system is for more detailed meat product categories, including pork, beef, mutton, and processed meats. Each of these two demand systems are estimated separately.

The specification given here implies that the demand for 10 broad groups of food commodities that were consumed at home is weakly separable with respect to the rest of the items in the consumer's budget. Thus, this is a typical three-stage budgeting procedure, i.e., consumers decide how much of total income to spend on FAH considered in this study and then allocate this total among the 10 broad groups of food commodities and finally allocate grain and meat expenditures, respectively, over their respective more specific sub-categories (figure I-1). The first-stage demand relation is not estimated in this study. Hence, this study is concerned only with the economic and demographic effects within the second- and third-stage of the consumer budget allocation. For consistency, the first-stage and the second-stage in this study denote specifically the second-stage and the third-stage, respectively, in the three-stage budgeting procedure as explained above.

Model Specification: The AIDS and QUAIDS Systems

The two-stage budgeting framework assumes that the consumer's utility maximization decision can be decomposed into two stages. In the first stage, total expenditure is allocated over broad groups of goods. In the second stage, group expenditures are allocated over more specific sub-categories of 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. Carpentier and Guyomard (2001) derived a relationship between expenditure and price elasticities at various levels of a multi-stage budgeting procedure which justifies the definition and estimation of non-homothetic two-stage models under the condition (a) above. In other words, functional form selection in the first stage is not restricted by the assumption that the direct utility function is weakly separable. Thus, a flexible functional form can be used in both stages in a two-stage budgeting procedure.

The almost ideal demand system (AIDS) developed by Deaton and Muellbauer (1980a) and the quadratic almost ideal demand system (QUAIDS) developed by Banks, Blundell, and Lewbel (1997) are used as the functional forms in both stages in this study. That is, the AIDS is used as the functional form in both stages while the QUAIDS model is also used as the functional form in both stages. The purpose of doing so in this study is to test which of the two models is superior in this study. Because the AIDS is nested within the QUAIDS, the specification of AIDS can be easily seen from that of the QUAIDS.

As derived by Banks, Blundell, and Lewbel (1997), the QUAIDS system is defined as

(1) $$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln p_j + \beta_i \ln\left[\frac{m}{a(p)}\right] + \frac{\lambda_i}{b(p)} \left\{\ln\left[\frac{m}{a(p)}\right]\right\}^2 + u_i,$$

where subscripts *i* and *j* indicate goods (10 major food groups in the first stage, 4 individual grain commodities, or 4 individual meat products in the second stage), α_i, γ_{ij}, β_i, and λ_i are parameters to be estimated, m is the total expenditure on the group of goods being analyzed, p_j is the price of the *j*th good within the group, w_i is the share of total expenditure allocated to the *i*th good, u_i is an error term, $a(p)$ is the price index and defined as

(2) $$\ln a(p) = \alpha_0 + \sum_{j}^{n} \alpha_j \ln p_j + 0.5 \sum_{i}^{n} \sum_{j}^{n} \gamma_{ij} \ln p_i \ln p_j,$$

and *b(p)* is the Cobb-Douglas price aggregator and defined as

(3) $$b(p) = \prod_{i=1}^{n} p_i^{\beta_i}.$$

Demographic variables that influence food demand are incorporated in the model by allowing the intercept in (1) to be a function of these variables, that is,

(4) $$\alpha_i = \rho_{i0} + \sum_{k=1}^{12} \rho_{ik} d_k,$$

where ρ_{i0} and the $\rho_{ik}'s$ are parameters to be estimated and the d_k are the demographic variables, and k = 1, …, 12 represents demographic variables that have a total of 12, involving region, city size, household age structure, educational attainment of household heads, and the ratio of expenditures for FAFH to total food expenditures.

The properties from neoclassical demand theory can be imposed on this system by restricting the parameters.

Adding up conditions ($\sum w_i = 1$) are given by:

(5) $\sum_i^n \alpha_i = 1$ (i.e., $\sum_i^n \rho_{i0} = 1$ and $\sum_i^n \rho_{ij} = 0$); $\sum_{i=1}^n \gamma_{ij} = 0$; $\sum_{i=1}^n \beta_i = 0$; and $\sum_{i=1}^n \lambda_i = 0$.

Homogeneity (w_i unchanged by a proportional change of all prices and income) is defined as

(6) $\sum_j^n \gamma_{ij} = 0$ for all *i*.

Symmetry of the Hicksian cross price effects suggests

(7) $\gamma_{ij} = \gamma_{ji}$ for all *i* and *j*.

The price and expenditure elasticities are calculated from the estimated parameters of the QUAIDS system following Bank, Blundell, and Lewbel (1997). The Marshallian (uncompensated) price elasticities are given,

(8) $$\eta_{ij} = w_i^{-1}\left[\gamma_{ij} - \left(\beta_i + \frac{2\lambda_i}{b(p)}\ln\left(\frac{m}{a(p)}\right)\right)\times\left(\alpha_j + \sum_k \gamma_{jk}\ln p_k\right) - \frac{\lambda_i\beta_j}{b(p)}\left(\ln\left[\frac{m}{a(p)}\right]\right)^2\right] - \delta_{ij},$$

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

The expenditure elasticities are defined as

(9) $$\varepsilon_i = 1 + w_i^{-1}\left[\beta_i + \frac{2\lambda_i}{b(p)}\ln\left(\frac{m}{a(p)}\right)\right].$$

The equation (1) without the last quadratic term on the right hand side, i.e., if $\lambda_i = 0$ for all *i*, is the AIDS system. Consequently, the Marshallian price elasticities under the AIDS are given by

(10) $$\eta_{ij} = -\delta_{ij} + w_i^{-1}\left[\gamma_{ij} - \beta_i(\alpha_j + \sum_k^n \gamma_{kj}\ln p_k)\right],$$

The expenditure elasticities under the AIDS is defined as

$$(11) \quad \varepsilon_i = 1 + \beta_i / w_i .$$

Elasticities of demand for the individual grain commodities and for the individual meat products are conditional on total grain and meat expenditures, respectively. To convert these elasticities into those conditional on total expenditures for FAH considered in this study, the formulas suggested by Carpentier and Guyomard (2001) are used. Drawing on Carpentier and Guyomard, the unconditional (total) expenditure elasticity for the *i*th commodities within the *r*th food group (i.e., grains or meats), e_i, is given as

$$(12) \quad e_i = e_{(r)i} e_{(r)}$$

where $e_{(r)i}$ is the conditional (within-group) expenditure elasticity for commodity *i*, and $e_{(r)}$ is the expenditure elasticity for the *r*th food group.

The unconditional Marshallian price elasticity between two commodities *i* and *j* within the *r*th food group can be calculated as

$$(13) \quad \Sigma_{ij} = e_{ij} + w_{(r)j} \left(\frac{1}{e_{(r)j}} + \Sigma_{(r)} \right) \times e_{(r)i} e_{(r)j} + w_{(r)j} w_{(r)} e_{(r)} e_{(r)i} \times (e_{(r)j} - 1),$$

where Σ_{ij} is the unconditional Marshallian cross-price elasticity of commodity *i* with respect to the price of commodity *j*, e_{ij} is the conditional Marshallian cross price elasticity of commodity *i* with respect to the price of commodity *j*, $\Sigma_{(r)}$ is the Marshallian own-price elasticity of the *r*th food group, $w_{(r)j}$ is the expenditure share of good j with respect to group r expenditure, and $w_{(r)}$ is the share of total food expenditure allocated to group r.[3]

Two-Step Estimation of A Censored System

As noted later, the data set used for this study had some missing observations. More specifically, there were no data available for rice, wheat flour, coarse grains, processed wheat, pork, beef, mutton, and processed meats for 4.4%, 37.8%, 27.9%, 0.7%, 0.3%, 27.1%, 54.4%, and 4.5% of households, respectively. These non-purchases could be due to no preference, but they could also be caused by infrequent food purchases by consumers and the fact that the timing of the survey may not have taken place at the time that the consumers buy those food items. This second reason is not relevant because the data are from a household's diary for food consumption/expenditures over an entire year. The fact that the observed expenditure shares cannot take on negative values means that the dependent variables are censored (Heien and Wessells 1990). Estimation techniques that fail to accommodate the censoring of the dependent variables lead to biased estimates (Park et al. 1996). In order to account for zero budget shares, the consistent two-step (CTS) estimation procedure for systems of equations with limited dependent variables, proposed by Shonkwiler and Yen (1999), was used in the second stage in this study. The CTS is computationally simple and provides consistent parameter estimates.

Drawing on the mathematical notation used by Shonkwiler and Yen (1999), the system of equations with limited dependent variables is given

[3] The "unconditional" demand elasticities here denote specially the demand elasticities conditional on total expenditures for the 10 food groups considered in this study (i.e., the expenditure elasticity for each of the 10 food groups is a function of total expenditure for the 10 food group). The "conditional" demand elasticities refer to the demand elasticities conditional on the broad category expenditures (grain expenditures or meat expenditures).

(14) $$y_{ih}^{*} = f(x_{ih}, \theta_i) + \varepsilon_{ih}, \quad d_{ih}^{*} = z_{ih}^{'}\tau_i + \upsilon_{ih},$$

$$d_{ih} = \begin{cases} 1 & if \quad d_{ih}^{*} > 0, \\ 0 & if \quad d_{ih}^{*} \le 0, \end{cases} \quad y_{ih} = d_{ih} y_{ih}^{*},$$

$$(i = 1, 2, 3, 4; h = 1, 2, \ldots, 902)$$

where subscripts i and h denote, respectively, equation number and household observation, y_{ih} and d_{ih} are the observed dependent variables, y_{ih}^{*} and d_{ih}^{*} are corresponding latent variables, x_{ih} and z_{ih} are vectors of exogenous variables, θ_i and τ_i are parameter vectors, and ε_{ih} and υ_{ih} are random errors. Shonkwiler and Yen (1999) proved that the system of equations (14) can be rewritten as

(15) $$y_{ih} = \Phi(z'_{ih}\,\tau_i) f(x_{ih}, \theta_i) + \delta_i \phi(z'_{ih}\,\tau_i) + \xi_{ih},$$

where $\Phi(z'_{ih}\,\tau_i)$ and $\phi(z'_{ih}\,\tau_i)$ are the standard normal cumulative distribution functions (CDF) and the standard normal probability density functions (PDF), respectively, δ_i is the parameter to be estimated, and ξ_{ih} is the error term and equals $y_{ih} - E(y_{ih} | x_{ih}, z_{ih})$.

The system (15) can be estimated by a two-step procedure using all observations. First, using the binary outcome $d_{ih} = 1$ and $d_{ih} = 0$ for each i, the maximum likelihood (ML) probit estimates $\hat{\tau}_i$ of τ_i were obtained. The estimated $\hat{\tau}_i^{'}s$ are then used to calculate $\Phi(z'_{ih}\,\hat{\tau}_i)$ of $\Phi(z'_{ih}\,\tau_i)$ and $\phi(z'_{ih}\,\hat{\tau}_i)$ of $\phi(z'_{ih}\,\tau_i)$ for each household. Second, the calculated $\Phi(z_{ih}^{'}\hat{\tau}_i)$ and $\phi(z_{ih}^{'}\hat{\tau}_i)$ in the first step are augmented in equation (15) to generate a model as

(16) $$y_{ih} = \Phi(z'_{ih}\,\hat{\tau}_i) f(x_{ih}, \theta_i) + \delta_i \phi(z'_{ih}\,\hat{\tau}_i) + \xi_{ih},$$

where $\xi_{ih} = \varepsilon_{ih} + \left[\Phi(z_{ih}^{'}\tau_i) - \Phi(z_{ih}^{'}\hat{\tau}_i)\right] f(x_{ih}, \theta_i) + \delta_i \left[\phi(z_{ik}^{'}\alpha_i - \phi(z_{ih}^{'}\hat{\alpha}_i\right]$. Therefore, the estimated equations for the QUAIDS system in the second-stage take on the following form for each household

$$(17) \qquad s_i = \Phi_i \left[\alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_i \log\left(\frac{m}{a(p)}\right) + \frac{\lambda_i}{b(p)} \left\{ \log\left[\frac{m}{a(p)}\right] \right\}^2 \right] + \delta_i \phi_i + \xi_i,$$

where s_i indicates the share of total expenditure allocated to the *i*th good, and Φ_i, ϕ_i, and ξ_i are generalized expressions of $\Phi(z_{ih}^{'}\hat{\tau}_i)$, $\phi(z_{ih}^{'}\hat{\tau}_i)$, and ξ_{ih} in the equation (16), respectively.

The augmented QUAIDS model (equation (17)) has two features. First, the adding-up condition does not hold in the system of equations (17). Thus, the second-step estimation of system (17) should be based on entire equations in the system.[4] Second, the incorporation of Φ_i and ϕ_i from the probit model in the first-step estimation introduces heteroscedasticity into the second-step estimation (Shonkwiler and Yen 1999; Greene 2004), i.e., the model (17) is intrinsically heteroscedastic.

Data Sources and Descriptions

The data set used for this study is collected and provided by NBS for Jiangsu province in 2004. The NBS conducts a nationwide urban household survey annually. As an official statistical activity, the urban household survey collects extensive socio-economic information on income, consumption, employment, housing, demographics, education, and asset ownership.

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[4] Conventional estimation procedure for a complete demand system is to drop one of the equations in the system in order to avoid singular variance-covariance matrix for the system.

The urban household survey has been administered directly by NBS, through its provincial and local survey network. The urban survey sample includes households registered in an urban area and those who lived there at least ½ year but are registered elsewhere. The sample is drawn based on several stratifications. The first step is to draw sample cities in each of several groups of cities that are classified based on their geographic locations and population size, with the number of the sample cities being proportional to that city-group's population. The sample county towns[5] are chosen randomly and systematically from the entire county towns that are listed according to their geographic locations and per capita incomes. Next, within the chosen cities and county-towns, the neighborhood committees and finally households are drawn by a further random selection (NBS 2001). The urban sample in 2004 includes over 48,000 households in 146 cities and 80 counties of 31 provinces. Unlike most income and expenditure surveys that cover only a short period of time, the urban household survey in China captures expenditures and consumptions via a diary kept by the chosen household over the course of an entire year. Thus, the data set used for this study reflects actual consumption patterns of a household during an entire year.

The sample of households selected for the survey in Jiangsu province has a total of 5,000 households, accounting for 0.56% of total urban households in the province in 2004. However, the data set available for this study has only a total of 922 households, which were drawn systematically from the 5,000 sample households. That is, one household was drawn for every five households from the beginning to the end in the list of households based on the address codes for the 5,000 households. After deleting

[5] The county town here refers to the town where a county government is located. In general, the county-town in China is smaller than a city in size.

households with missing observations, only the data set for 902 households was actually used for this study.

Comparing the means of key food categories that are generated from the 902 households with the published averages based on the 5,000 sample households, it is found that most are consistent except those for FAFH spending and expenditures for dairy products (table I-3, row 4 and row 11). For instance, the difference in per capita disposable incomes between the two data sets is only 2.6% (10,203 yuan vs. 10,481 yuan). The difference in per capita total expenditure for the 10 food groups is almost equal. On the contrary, there is a relatively large difference in the estimate of FAFH spending and expenditures for dairy products. More specifically, the estimate of average annual per capita expenditure for FAFH based on the 902 households is 455 yuan, whereas it is 524 yuan based on the 5,000 households, a gap of 69 yuan or a difference of 13.2%. The estimate of average annual per capita expenditure for dairy products based on the 902 households is 135 yuan, whereas it is 144 yuan based on the 5,000 households, a gap of 9 yuan or a difference of 6.2%. Since this study focuses on an analysis of expenditure patterns for food that was consumed at home, the data set for 902 households can be used to basically represent whole urban households in Jiangsu province in 2004.

The 10 food groups that were consumed at home in this study are defined as follows: grains, including rice, wheat flour, coarse grains (mainly including corn, millet, and oats, etc.), and processed wheat (including uncooked and cooked products such as steamed bread, noodles, and dumplings); oils and fats; meats, including pork, beef, mutton, other meats such as rabbits, and processed meats; poultry, including chicken, duck, other poultry, and poultry products; eggs, including fresh eggs and egg products;

aquatic products, including fish, shrimp, and other aquatic products; dairy products, including fresh milk, milk powder, and yogurt; vegetables, including fresh and dried vegetables; fruits, including fresh fruits, fresh melon, dried fruits, fruit and melon products, and nuts and fruit nuts; other foods, including starch and tubers, alcoholic beverages (Chinese liquor, wine, beer, and other alcoholic beverage), beverages (carbonated drinks, fruit and vegetable drinks, bottled water, tea, and coffee), and cakes (for detailed introduction see also Gale and Huang, 2007, p.31-32). On a per capita basis, average total expenditure for above food categories accounts for 82.6 percent of total expenditures for food that was consumed at home and 69.4 percent of total food expenditures, respectively.

The data set used for this study indicates that there are 46 missing observations in oils & fats over a year. It is not feasible that Chinese people did not consume any amounts of oils & fats if they chose to consume other food commodities that were consumed at home. Hence, the values for the 46 households for oils & fats were recovered by imputed values. That is, observations for those households consuming oils & fats were regressed on income, household size, and other household characteristic variables. The regression was then used to estimate the missing expenditures for the 46 households with the corresponding independent variables.

The data used in this study do not contain information for prices. Thus, prices are calculated by dividing the total expenditures on a particular food category by its corresponding total quantities. The calculated price, i.e., unit value, is not a price of food category that can be readily used in a demand analysis as it reflects quality as well as price variation (Chung et al. 2005). Assuming the quality effects are due largely to heterogeneity of composite commodities, the quality price adjustment in this study is done by estimating a hedonic price equation. The quality-adjusted price is defined as the difference between the calculated price (unit value) and the quality price, given its specific quality characteristics. Following Cox and Wohlgenant (1986), the price/quality price functions are given

(18) $P_{ih} = \alpha_i + \sum_j \gamma_j b_{ijh} + e_{ih}$,

where P_{ih} is the unit value for *i*th food category in *h*th household; α_i is the regional mean price (regional unit value) of food category *i*; e_{ih} is the regression residual which is assumed to reflect nonsystematic, supply-related factors; $\sum_j \gamma_j b_{ijh}$ reflects the sum of component quality prices per unit q_{ih} which refers to the quantity consumed of food category *i* by *h*th household; and b_{ijh} are variables affecting consumer choice of qualities such as income and demographic variables as proxies for household preferences for unobserved quality characteristics. The quality-adjusted price is given by

(19) $P_{ih}^* = P_{ih} - \sum_j \hat{\gamma}_j b_{ijh}$.

The data set in this study shows that oils & fats, dairy products, grain commodities (i.e., rice, wheat flour, coarse grains, and processed wheat), and meat products (i.e., pork, beef, mutton, and processed meats) have missing observations. The quality-adjusted price for zero observation was equal to its regional average price for that food category. The generation of quality-adjusted prices allows the possibility that some of the prices may be negative. This situation suggests that, after accounting for quality differences, one would have to pay a particular household to consume the good in question (Park et al. 1996). Three households had a negative quality-adjusted price for dairy products, and twenty-seven households had a negative quality-adjusted price for other foods. This situation also happened in the study by Park et al. (1996). The solution to these negative quality-adjusted prices is the same as the approach for dealing with zero observations in either expenditure or quantity, that is, those negative values were in place of their regional imputed prices.[6]

Table I-4 presents summary statistics about the quality-adjusted prices along with per capita expenditures and quantities consumed. For foods examined in this study, 12% of total spending is allocated to grains while 22% to meats. Within the grain subgroup, expenditure shares of rice, wheat flour, coarse grains, and processed wheat are 63%, 6%, 3%, and 29%, respectively, indicating that rice dominates consumers' foodgrain diet in urban Jiangsu. For the meat subgroup, pork, beef, mutton, and processed meats account for 70%, 7%, 2%, and 20%, respectively, of total meat expenditures. Since a large portion of processed meats is made from pork, pork is a main meat product consumed in urban Jiangsu. Additionally, meat products have the highest prices among food categories examined in this study, followed by poultry and aquatic products in order.

Demographic variables included in the estimation of quality-adjusted prices and in the AIDS and QUAIDS models in this study are as follows: *SOUTH*, a binary variable representing a household located in the south of Yangtze River; *CITYSIZE1*, a binary variable representing a household located in the large-size city; *CITYSIZE2*, a binary variable representing a household located in the medium-size city; *CITYSIZE3,* a binary variable representing a household located in the small-size city; *AGE1840*, number of

[6] Recently there have been several studies (Chung et al. 2005; Gould and Dong 2004) that develop new approaches to obtain quality-adjusted prices from unit values in the cross-sectional data. However, the complication of estimation and requirement of a large data set with these approaches hinder application of these approaches to this study.

family members aged 18-40; *AGE4160*, number of household members aged 41-60; *AGE61*, number of family members aged 61 and above; *CH05*, number of children aged 5 and below; *CH617*, number of children aged 6-17; *EDU1*, a household head with educational attainment at junior-middle school and below (equivalent to 9 years); *EDU2*, a household head with educational attainment at senior-middle school (equivalent to 12 years); and *FAFHR*, the ratio of expenditures for FAFH to total food expenditures.

Table I-5 reports summary statistics for basic demographic characteristics in urban Jiangsu. The low percentage of number of children and high percentage of number of people aged 61 and above indicate that population in urban Jiangsu has been aging resulting from government policy advocating later marriage, fewer births, and one birth per couple in urban areas. The changing age structure of the population will impact the composition and quantity of food commodities consumed. Moreover, the summary statistics also indicate that the sampled urban households in the survey cover more households headed by old people than the percentage they account for in whole population. The old-people headed households usually have lower per capita incomes, which may explain the comment that NBS underestimates urban household's incomes and expenditures (Wang and Zhou 2005).

Estimation Procedure and Statistical Tests

The estimation procedures, system misspecification tests, and likelihood ratio and Wald tests which are used to compare the AIDS and QUAIDS systems are described separately for food groups, grain commodities, and meat products below.

Food Groups

The first-stage demand system consisting of 10 food groups was estimated with the AIDS and again with QUAIDS model specifications using the nonlinear iterative seemingly unrelated regressions (ITSUR), with imposition of homogeneity and symmetry. To avoid singular variance-covariance matrix for the complete 10-good system, the usual procedure is to omit one of the equations. The equation for dairy products was dropped from estimation because the dairy product category has zero observations. The coefficients for dairy products can be retrieved from the other equations using the properties of adding up, homogeneity, and symmetry.

McGuirk et al. (1995) proposed system misspecification tests for multi-equation linear regression models (MLRM) to test the assumptions of normality of the error terms, joint conditional mean (no autocorrelation, appropriateness of functional form, parameter stability), and joint conditional variance (static and dynamic homoskedasticity, and variance stability). Because this study used the multi-equation non-linear regression models (MNLRM) with cross-section data, the system misspecification tests in the system focused on the tests for normality, static homoskedasticity, and parameter stability that may result from variation of household incomes. The normality test for an individual equation was performed with the Shapiro-Wilk W test, and the system normality test for all equations was conducted with Mardia's skewness test and kurtosis test and the Henze-Zirkler test. The system static homoskedasticity test was performed with the modified Breusch-Pagan test. Finally, the parameter stability test was implemented with the Chow

F-test.[7] All three types of tests described above were conducted in Model Procedure in the SAS program.

The p-values from the full-system tests are reported in tables I-6 and I-7. Results show that the assumption of stable parameters holds for both the AIDS and the QUAIDS systems. Furthermore, results indicate rejection of the assumptions of normality of error terms for all equations using the AIDS and QUAIDS models at the 5% significance level. Additionally, the homoskedasticity assumption of conditional variance of error terms for eight of nine equations using the AIDS and the QUAIDS models is rejected at the 5% significant level. To correct for heteroskedasticity together with nonnormality problem, the AIDS and QUAIDS models were regressed using the Generalized Method of Moments (GMM). The GMM is robust to non-normality requirement and a White consistent variance-covariance estimator in the heteroscedastic regression model (Greene 2004).

Wald tests and likelihood ratio test were performed in this study. Wald tests are to test for the significance of the quadratic terms (i.e., λ_i) in the log of expenditure variables in the QUAIDS model to see whether QUAIDS should be used (versus AIDS), whereas likelihood ratio test is to check whether the QUAIDS or the AIDS is superior in this study when the QUAIDS model is valid based on Wald tests. Table I-12 presents the results for Wald tests and likelihood ratio test. The null hypothesis that the quadratic terms in the log of expenditure variables for all 10 equations in the system equal zero is rejected at the 1% significance level, although the null hypothesis that the quadratic term in the log of expenditure for an individual equation is equal to zero is rejected only for four (i.e., oils

[7] Higher-income households may respond differently to income and price changes than lower-income households. The Chow F-test was then performed based on the households that were regrouped based on per capita incomes.

& fats, poultry, vegetables, and other foods) of nine food groups at the 5% significance level. Thus, the Wald test results justify the use of the QUAIDS model in this study.

The likelihood ratio test in this study is based on the optimization criterion suggested by Gallant and Jorgenson (1979). According to Gallant and Jorgenson, a test based on the optimization criterion is an analog of the likelihood ratio test. Following Gallant and Jorgenson, the test statistic is defined as

$$(20) \qquad T_0 = N\left(S(\tilde{\theta}) - S(\hat{\theta})\right),$$

where N is the total number of observations, $S(\tilde{\theta})$ is the optimal objective value of the restricted model (i.e., AIDS), and $S(\hat{\theta})$ is the optimal objective value of the unrestricted model (i.e., QUAIDS). Gallant and Jorgenson showed that T_0 has an asymptotic χ^2_{r-s} distribution with *r-s* degrees of freedom, where *r* is the number of parameters in the unrestricted model and s is the number of parameters in the restricted model. Table I-12 shows that the test statistic is much smaller than the critical value, suggesting that the null hypothesis of the AIDS and QUAIDS being the same fails to be rejected at the 5% significance level. Thus, in this particular application, the AIDS and QUAIDS systems are essentially the same.

Grain Commodities

The first-step probit model was estimated first separately for rice, wheat flour, coarse grains, and processed wheat using maximum likelihood to obtain the standard normal probability density functions (pdf) and the standard normal cumulative distribution functions (cdf). The second-step AIDS and QUAIDS demand systems (equation (17)) for 4 grain commodities in the second-stage of the two-stage budgeting were estimated using the nonlinear seemingly unrelated regressions (SUR)[8] with imposition of homogeneity and symmetry, using the estimated CDF's and PDF's from the first-step probit estimation. Because the adding-up does not hold in the second-step demand system, the AIDS and QUAIDS demand systems were estimated for all the 4 grain commodities.

System misspecification tests, including the tests for normality, homoskedasticity, and parameter stability, were the same as those used for the AIDS and QUAIDS models in the first-stage for food groups. The results from the AIDS and QUAIDS misspecification tests for grain commodities are reported in tables I-8 and I-9. Results show that the assumption of normality does not hold at the 5% significance level. Moreover, results indicate rejection of the homoskedasticity assumption of error terms while the assumption of stable parameters holds. To correct for heteroskedasticity together with nonnormality problem, the AIDS and QUAIDS models were regressed using the Generalized Method of Moments (GMM).

The Wald and likelihood ratio tests were also performed for grain commodities in the second stage. The Wald and likelihood ratio test results are presented in table I-12. The Wald test results show that the null hypothesis that the quadratic terms in the log of expenditure for all the 4 equations in the system equal zero is rejected at the 1% significance level, and that the quadratic term in the log of expenditure for an individual equation is equal to zero is rejected for three (i.e., rice, wheat flour, coarse grains) of four

[8] Some studies tend to use full information maximum likelihood (FIML) instead of SUR in the second-step estimation. FIML assumes that the equation errors have a multivariate normal distribution. If the errors are not normally distributed, the FIML method may produce poor results. SUR is more robust to the normality requirement compared to FIML. The demand systems for grains and meat products, respectively, were also estimated using FIML. However, the estimated parameters are quite different from those using SUR and contrary to prior expectations.

grain commodities at the 1% significance level. Thus, it is justified to use the QUAIDS model in estimation of grain demand system in this study. The likelihood ratio test statistic based on equation (20) for the AIDS versus the QUAIDS is smaller than the critical value, indicating that the null hypothesis of the AIDS and QUAIDS being the same fails to be rejected at the 5% significance level. Thus, the AIDS and QUAIDS are the same in estimating the demand system for grain commodities in urban Jiangsu.

Meat Products

The estimation procedures, the system misspecification tests, and the tests for model selection for meat products are similar to those for grain commodities. Tables I-10 and I-11 present the results for the system misspecification tests. Similar to the demand system estimation related to grain commodities, results show that the assumption of normality does not hold at the 5% significance level; and that the homoskedasticity assumption is violated while the assumption of stable parameters holds. To correct for heteroskedasticity together with nonnormality problem, the AIDS and QUAIDS models were regressed using the Generalized Method of Moments (GMM).

Wald test results show that the null hypothesis that the quadratic terms in the log of expenditure for all the 4 equations in the system equal zero is rejected at the 1% significance level, and that the quadratic term in the log of expenditure for an individual equation is equal to zero is rejected for three (i.e., beef, mutton, and processed meats) of four meat products at the 5% significance level (table I-12). Therefore, the quadratic terms should be included which supports the use of QUAIDS model for meat demand system in this study. The likelihood ratio test statistic based on equation (20) for the

AIDS versus the QUAIDS is much smaller than the critical value. Thus, the statistical evidences above show that the AIDS and QUAIDS specifications are essentially the same in estimating the demand system for meat products in urban Jiangsu, China.

The estimated coefficients, the t-statistics associated with the estimates, and the adjusted R^2 of the QUAIDS demand systems for the 10 food groups, 4 grain commodities, and 4 meat products are reported in tables I-13, I-16, and I-19, respectively. The estimated Marshiallian own-price and expenditure elasticities for the 10 food groups, the 4 grain commodities, and the 4 meat products using the QUAIDS model are presented in table I-24. Compared with corresponding estimates using the AIDS model (tables I-21, I-22, and I-23), all the demand elasticities except for the own-price elasticities for wheat flour and coarse grains using the QUADS are similar to those using the AIDS model. These results indicate that the estimated demand elasticities are consistent with the results of Wald and likelihood ratio tests. It is therefore concluded that the AIDS and QUAIDS models perform equally well in estimating China's urban food consumers' behavior. Since the own-price elasticities for wheat flour and coarse grains using the AIDS are more consistent with the prior expectation than those using the QUAIDS, the empirical results and conclusions described in the following sections are only based on the AIDS system.

Empirical Results

Results for food groups, grain commodities, and meat products are described and discussed separately below. Then comparisons between this study and other previous studies are made in relation to own-price and expenditure elasticity estimates.

Food Groups

The GMM in the Model Procedure in SAS was used to estimate the AIDS system. Table I-14 presents the estimated coefficients, the t-statistics associated with the estimates, and the adjusted R^2 of the AIDS demand system for 9 food groups. Among demographic variables considered, more than half are significant at the 10% or lower levels. Among 90 price coefficients, about three fifths are significant at the 10% or lower levels. Among 9 expenditure terms, 8 of them are significant at the 5% or lower levels. The adjusted R^2s for grains, oils & fats, meats, poultry, eggs, aquatic products, vegetables, fruits, and other foods are, respectively, 0.22, 0.13, 0.07, 0.12, 0.17, 0.26, 0.20, 0.18, and 0.17.

The full matrix of the Marshallian demand elasticities for the 10 food groups is reported in table I-21. These elasticities were computed at the mean values of the exogenous variables using equations (10) and (11). Consistent with economic theory, all own-price elasticities are significant and negative at the 1% level. Own-price elasticities for grains, oils & fats, and dairy products[9] are significantly more than unity in absolute terms; and other food groups including meats, poultry, eggs, aquatic products, vegetables, fruits, and other foods are significantly less than unity in absolute values. The dairy product category is the most price-responsive, having an own-price elasticity of – 1.308; whereas aquatic product category has the lowest own-price elasticity at – 0.157 in absolute terms among all food groups considered.

[9] The parameters for dairy product category are retrieved from other equations using properties of adding-up, homogeneity, and symmetry. Consequently, no standard errors for the parameters and corresponding elasticities are available. This study assumes that all estimated parameters and corresponding elasticities for dairy products are significant at the 5% level.

The non-diagonal elements in table I-21 are the estimated Marshallian cross-price elasticities. As shown in table I-21, more than half of cross-price elasticities are significant at the 10% or lower levels. These cross-price elasticities indicate a mixture of gross complements and substitutes. Grain category, for example, is a gross substitute of meats, eggs, dairy products, and fruits, but a gross complement of aquatic products and vegetables. The meat category is a gross substitute for grains and oils & fats, but a gross complement of aquatic products, fruits, and other foods. Similar patterns exist also for other food groups. Relative to own-price and expenditure elasticities, the cross-price effects are less pronounced, with the largest elasticity being between eggs and grains at 0.45, which shows that consumers are more responsive to changes in own prices.

In view of the estimates of expenditure elasticities, it is found that all food groups examined in this study are positive and significant at the 1% level. As expected, expenditure elasticities for meats (including pork, beef, and mutton), poultry, aquatic products, dairy products, and other foods that mainly include beverage products are more than unity, with aquatic product category having the largest value at 1.31. Expenditure elasticities for grains, oils & fats, eggs, vegetables, and fruits are below one, with the oils & fats having the smallest value at 0.72. Hence, the results indicate that in urban Jiangsu animal products are more responsive to expenditure changes than grains, oils & fats, eggs, vegetables, and fruits. If the prevailing price structure continues into the future, expenditure on each of these 10 food groups will grow in response to increases in household incomes; however, the growth rates for meats, poultry, aquatic products, dairy products, and other foods are much faster than for grains, oils & fats, eggs, vegetables, and fruits.

Additionally, there are three more major findings from this study related to the analysis of food demand in China. First, grains and oils & fats have relatively lower expenditure elasticities and relatively higher own-price elasticities in absolute terms when compared to those of other food groups. Thus, demands for these two categories are more dependent on changes in prices than changes in expenditures.

Second, the aquatic food has the highest expenditure elasticity and the lowest own-price elasticity - suggesting that aquatic food consumption is governed more by a change in expenditures than in price. Thus, the demand for aquatic products is expected to increase rapidly as the result of rising per capita incomes. Moreover, the evidence that the expenditure elasticity for aquatic products is greater than those of other food groups for urban Jiangsu supports the finding of Shono, Suzuki, and Kaiser (2000) that indicate China's dietary pattern is moving towards the diets of consumer in Asian developed countries of Japan, Korea, and Hong Kong. These developed Asian countries depend more on seafood as the source of protein than the western countries.

Finally, this study shows that the dairy category is more responsive to changes in price and expenditure than most food groups examined in this study. The high expenditure and price elasticities for dairy products illustrate that both income and price will play important roles in dairy food consumption. If the prevailing price structure stays constant, the demand for dairy products will increase as household incomes rise. The current per capita consumption for dairy products in urban Jiangsu was 21 kilogram in 2004, which is much lower than those in other developed countries such as Japan (65.8

kg), South Korea (28.6 kg), Taiwan (43.0 kg) and the United States (256.6 kg) (FAO, 2004).[10] It is likely that the demand for dairy products will grow rapidly in the future.

The parameter estimates of demographic variables are presented in table I-14. Although many of the demographic variables in the model for food groups were statistically significant, their impacts were considerably small. The results show that region, city size, and the ratio of expenditures for FAFH to total food expenditures significantly influence consumption of most food groups examined. The variables associated with household age structure and educational attainments for household heads have significant effects only on consumption of a limited number of food groups. Nevertheless, the results warrant the inclusion of demographic variables in the cross-sectional analysis of household food demand in urban Jiangsu.

The regional factor is shown in this study to have a significant impact on the demand for most food groups. Households in the south of Yangtze River spent more of their annual income on poultry, aquatic products, vegetables, and fruits, but less of their annual income on grains, oils & fats, meats, eggs, dairy products, and other foods. Geographically Jiangsu province consists of two parts, one in the north of Yangtze River- a region that is less economically developed relative to the south, and another in the south of Yangtze River- a region that is more economically developed. Apart from the difference in economic development levels, people's food preferences are also apparently different between the north and the south. Typically, people in the south prefer to eat more rice and seafood while people in the north like to have more wheat products in their diets. Thus, the difference in food demand between the south and the north reflects the differences in both economic development levels and people's food preferences.

[10] Milk statistics in parentheses are reported in Yen, Fang, and Su (2004).

City size exhibits a significant effect on the demand for grains, oils & fats, meats, poultry, aquatic products, dairy products, and vegetables. Relative to households located in county town, households located in large-, medium-, and small-size cities tend to consume more grains, oils & fats, dairy products, and vegetables, but less meats, poultry, and aquatic products. Hence, as city size grows due to rapid urbanization in the future, the demand for grains, oils & fats, dairy products, and vegetables is expected to increase, while the demand for meats, poultry, and aquatic products is expected to decrease. The finding, however, seems to be inconsistent with actual household consumption data that show consumers in large-cities in China who tend to earn higher income and have access to a wide range of food product varieties and qualities compared to those residing in smaller towns consume more meats, poultry, and aquatic products than small-size cities or county towns in China. A further research is therefore needed.

Variables associated with household age structure are mixed and difficult to interpret. Nevertheless, the results indicate that households with more members aged 41 and above tend to consume more grains, oils & fats, eggs, and vegetables, but less aquatic products, dairy products, fruits, and other foods. Hence, the results show clearly that the old generation has a generally different dietary habit compared to younger people. Seniors tend to consume more grains, eggs, and vegetables. This is consistent with the findings related to Japanese seniors in a study by Hsu, Chern, and Gale (2002).

Variables associated with educational attainments of household heads have a significant effect only on the consumption of grains and meats. Results show that households headed by a better-educated person tend to consume more meats, but less grains. This might be due to the fact that higher educated households usually have higher living standards than other families in current China. Consequently those higher-income households are able to have more meats in their diets. Furthermore, the results are also consistent with findings reported by Yen, Fang, and Su (2004).

The ratio of expenditures for FAFH to total food expenditures is one of the variables that significantly influence demand for all the 10 food groups examined. It has a significantly positive relationship with consumption of aquatic products, dairy products, fruits, and other foods, but a negative relationship with consumption of grains, oils & fats, meats, poultry, eggs, and vegetables. A survey conducted by Chinese Academy of Agricultural Science (CAAS) in 1999 found that a Chinese consumer consumes about 21% meats and poultry, 30% of aquatic products, 15% dairy products, and 13% eggs outside the home during the course of a year (Wang and Zhou 2005, p.96). Therefore, as the proportion of expenditures on meals away from home increases, the at-home consumption of grains, oils & fats, meats, eggs, poultry, and vegetables are expected to decrease; while the at-home consumption for aquatic products, dairy products, fruits, and other foods is expected to increase.

Grain Commodities

The first-step maximum likelihood probit estimates for each of the 4 grain commodities are presented in table I-15. The independent variables included in the regressions are price variables, household income, and the demographic variables which are identical to those incorporated in the second-step AIDS model. While many of the coefficients in the participation equations are insignificant, variables associated with region, city size, household age structure, and prices play an important role in determining the consumption of grain commodities. It is of interest to note that household income only has a significant influence on the probability of consumption of coarse grains which consists mainly of corn, millets, and oats, etc. From the results of this study it is concluded that urban consumers in Jiangsu are more likely to consume coarse grains as household incomes rise. The finding is consistent with observations about current dietary habits of the consumers in China that coarse grains have now been viewed as the food with higher nutritional value (Wang and Zhou 2005).

The second-step AIDS model was estimated by the GMM in the Model Procedure in SAS. Table I-17 presents the estimated coefficients, t-statistics associated with estimates, and adjusted R^2 of the AIDS demand system for grain commodities. Less than half of demographic variables are significant at the 10% or lower levels; most price variables are significant at the 1% level; all the four expenditure terms are significant at the 5% or lower levels. The adjusted R^2s for rice, wheat flour, coarse grains, and processed wheat are, respectively, 0.31, 0.31, 0.03, and 0.35.

The full matrix of the conditional Marshallian demand elasticities for the 4 grain commodities is presented in table I-22. The conditional elasticities were calculated at the mean values of the exogenous variables using equations (10) and (11). The unconditional demand elasticities were computed using equations (12) and (13) and presented in table I-23. All conditional own-price and expenditure elasticities are significant at the 1% level; most conditional cross-price elasticities are significant at the 5% level. The following discussions are only based on the calculated unconditional elasticities.

Consistent with economic theory, all own-price elasticities are negative. Own-price elasticities for rice, wheat flour, and coarse grains are -1.87, -2.09, and -1.07, respectively. Own-price elasticity for processed wheat is -0.75. Thus, the own-price elasticities for wheat flour and rice are much higher than those of food categories as estimated in the first-stage. Results of this study imply that urban consumers in Jiangsu are highly price sensitive in grain product purchase decision. Thus, prices of food, particularly grain products, are important in agricultural and trade policy as well.

The cross-price elasticities indicate clear substitute and complementary relationships among the commodities in the system. Rice is shown to be a gross substitute for wheat flour, coarse grains, and processed wheat, while wheat flour, processed wheat, and coarse grains are gross complements one another. Thus, as prices of wheat products become more expensive, rice consumption should be rise markedly.

All expenditure elasticities are positive. More specifically, the expenditure elasticities for rice, wheat flour, coarse grains, and processed wheat are 0.98, 0.93, 0.54, and 0.33, respectively. The highest expenditure elasticity for rice obtained in this study is consistent with the dietary habits of consumers in Jiangsu who are with rice as their main staple grain product and who consider rice as a more important grain product than wheat products. The low elasticity for processed wheat is contrary to the observation that urban consumers tend to purchase more uncooked and cooked wheat products such as steamed bread and noodles than wheat flour as household income rises (Zhou and Tian 2005).

Based upon the estimated expenditure elasticities, income elasticities for the grain commodities ranged from 0.47 to 0.16 when the income elasticity for the 10 food groups examined in this study is 0.48.[11] The result classifies these grain commodities as normal

[11] An auxiliary regression of total expenditures for the 10 food groups to total living expenditures is run to estimate the income elasticity of total expenditure for the 10 food groups. Consequently, the income elasticity for a specific commodity is the product of the expenditure elasticity for the commodity and the

goods. In addition, the grain commodities are shown to have relatively low expenditure elasticities compared to their corresponding own-price elasticities in absolute terms. For instance, the expenditure and own-price elasticities for wheat flour are 0.93 and -2.09, and the expenditure and own-price elasticities for processed wheat are 0.33 and -0.75. Thus the demand for these grain commodities, particularly for rice and wheat flour, is governed more by changes in price than by changes in expenditure. Additionally, the composition of grains may change slightly, which is mainly depending upon changes in prices and expenditures. Nevertheless, because rice accounts for 63% of food grain consumption, rice is expected to continue to dominate in food grain consumption in urban Jiangsu.

The parameter estimates of demographic variables are reported in table I-17. The demographic variables associated with region, city size, and the ratio of FAFH spending to total food expenditures in the model for grain commodities significantly affect the consumption of most grain commodities. Variables associated with household age structure have an impact on demand for limited grain commodities. Variables related to educational attainments for household heads do not have significant effects on the consumption of all the 4 grain commodities.

Households living in the south tend to consume more rice but less wheat flour and processed wheat. The finding is consistent with consumers' food preferences in urban Jiangsu that for consumers in south of the Yangtze River rice is considered a staple food. Relative to county town, households living in city including small-, medium-, and large-size city, tend to consume less rice but more processed wheat that includes cooked and

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income elasticity of total expenditure for the 10 food groups. To make a difference, income elasticity in this study refers specially to total expenditure elasticity.

uncooked products such as steamed bread and noodles. The findings are consistent with observations that wheat consumption has increased in southern China due to (a) changes in tastes and preferences induced by increased inter-regional movement of people and exchanges with foreign cultures and (b) market development that has improved the availability of different grains across regions (Zhou and Tian 2005, p. 230). It is therefore expected that increased urbanization will lead to an increase in wheat product consumption in urban Jiangsu.

Many of the variables associated with household age structure are insignificant. Nevertheless, larger numbers of household members aged between 6 and 17 have a positive effect on the consumption of processed wheat, but a negative impact on the consumption of rice and coarse grains. Households having members aged 61 and above tend to consume more coarse grains, but less processed wheat. The findings indicate that old people are more likely to consume grain products with higher nutritional values and less processed, while younger consumers tend to consume time-saving processed grain products.

The ratio of expenditures for FAFH to total food expenditures has a positive effect on the consumption of processed wheat and coarse grains but a negative impact on consumption of wheat flour. Therefore, as urban consumers in Jiangsu eat out more, at-home consumption of processed wheat and coarse grains is expected to grow while the direct at-home consumption of wheat flour is expected to decrease.

Meat Products

The first-step maximum likelihood probit estimates for each of the four meat products are presented in table I-18. The independent variables included in the regressions are price variables, household incomes, and the demographic variables which are identical to those incorporated in the second-step AIDS model. While many of the coefficients in the participation equations are insignificant, city size, the ratio of FAFH spending to total food expenditures, prices, and household income play an important role in determining the consumption of meat products. Contrary to the role the household income plays in probit regressions for grain commodities, household incomes exhibit significant influences on the probability of consumption of beef, mutton, processed meats. As household incomes rise, urban consumers in Jiangsu are more likely to consume beef, mutton, and processed meats.

The second-step AIDS model was estimated by the GMM in the Model Procedure in SAS. Table I-20 presents the estimated coefficients, t-statistics associated with estimates, and adjusted R^2 of the AIDS demand system for meat products. More than one third of demographic variables are significant at the 10% or lower levels; about half of price variables are significant at the 1% level; only one (i.e., mutton equation) of four expenditure terms are significant at the 5% level. The adjusted R^2s for pork, beef, mutton, and processed meats are, respectively, 0.07, 0.15, 0.10, and 0.19.

The full matrix of the conditional Marshallian demand elasticities for the 4 meat products is reported in table I-22. The conditional elasticities were computed at the mean values of the exogenous variables using equations (10) and (11). The unconditional demand elasticities were calculated using equations (12) and (13) and are reported in table I-23. All conditional own-price and expenditure elasticities are significant at the 5% or lower levels; about half of conditional cross-price elasticities are significant at the 5% or lower levels. The following discussions are only based on the estimated unconditional elasticities.

Consistent with economic theory, all own-price elasticities are negative. The own-price elasticities for pork and mutton are -1.031 and -1.011, respectively, while the own-price elasticities for beef and processed meats are -0.275 and -0.466, respectively. Results of this study present clear gross substitute and complementary relationships among meat products. Pork and processed meats are gross complements while beef and mutton are gross complements; pork is a gross substitute of beef and mutton, and processed meats a gross substitute of mutton but a gross complement of beef. Because the cross-price elasticity of beef with respect to price of pork is relative high (0.42), higher price of pork will lead to greater demand adjustments in beef than in pork.

All expenditure elasticities of meat products are positive and greater than unity. The estimated expenditure elasticities are 1.36 for mutton, 1.14 for beef, 1.08 for pork, and 1.04 for processed meats. Compared with the pork, the beef, mutton, and processed meats in this study have higher expenditure and lower own-price elasticities in absolute terms, indicating that demand for beef, mutton, and processed meats is expected to increase more rapidly than that for pork in response to a rise in income. In addition, the survey of CAAS in 1999 indicated that the processed meats are mainly made of pork and beef (Wang and Zhou 2005, p.98). Therefore, the consumption of meats as a whole will increase while the composition of meats will move towards more of beef and mutton and less of pork. Nevertheless, since pork accounts for 70% in meat consumption in urban

Jiangsu, pork consumption will still be predominant in meat dietary structure in urban Jiangsu.

The parameter estimates of demographic variables are reported in table I-20. Demographic variables associated with region and city size significantly influence demand functions for most meat products. Households living in the south tend to consume more pork, but less beef and mutton. Relative to households living in county-town, households residing in cities, namely small-, medium-, and large-size cities, tend to consume more beef, mutton, and processed meats, but less pork, which is consistent with observations that consumption of beef and mutton has increased in urban China because of market development that has improved the availability of beef and mutton across regions. It is thus expected that increased urbanization will increase demand for beef and mutton in urban Jiangsu.

Although many variables associated with household age structure are insignificant, variables related to household members aged 41 and above exhibit a positive and significant effect on pork consumption but a negative impact on consumption of processed meats. Hence, old generation tends to consume fresh pork instead of processed meats. Variables associated with educational attainments for household heads have a positive relationship with consumption of pork but a negative relationship with consumption of beef. The ratio of expenditures for FAFH to total food expenditures has a positive effect only on consumption of processed meats. Thus, as consumers in urban Jiangsu eat out more, at-home consumption of processed meats is expected to increase.

Comparisons with Other Studies

Table I-25 presents own-price and expenditure elasticities reported by studies based on NBS's urban household survey data between 1995 and 2000, which is more relevant to this study than other studies using data prior to 1995. As shown in table I-25, the own-price and expenditure elasticities for meats, pork, beef, mutton, and processed meats, poultry, eggs, dairy products, vegetables, and fruits as estimated by this study are consistent with the estimates reported by Gould (2002), Liu and Chern (2003), Zhang and Wang (2003), and Yen, Fang, and Su (2004).

However, the findings for grains from this study do not agree with previous studies. This study obtained relatively lower expenditure elasticities and higher own-price elaticities in absolute terms for grains compared to those reported by other studies. With an exception of the study by Zhang and Wang (2003), previous studies including studies in table I-25, Halbrendt et al. (1994), Fan, Wailes, and Cramer (1995), Wu, Li, and Samuel (1995), Gao, Wailes, and Cramer (1996), Zhang, Mount, and Boisvert (2001), and Zhuang and Abbott (2007) report less-than-unity own-price elasticities for grains in absolute terms. The relatively high own-price elasticities for grains, particularly rice and wheat flour as obtained in this study, may be attributed to the sharp rise in grain price levels in 2004. According to China's official statistics, triggered by a sharp rise in rice price in the late 2003, the consumer price index (CPI) for food in 2004 was 9% higher than the previous year, and the grain, rice, and wheat flour price indexes in 2004 were 26.4%, 33.2%, and 24.1%, respectively, higher than those in 2003 (NBS 2005b). The substantial variations in grain prices function as a platform for verifying the response of consumers in urban Jiangsu to price changes; therefore the relatively high own-price elasticities for grains actually reflect the strong responsiveness of the urban Jiangsu's consumers to changes in prices of grain commodities. In addition, urban consumers in China now differentiate rice and wheat according to quality and attributes. While the broad category of rice and wheat may have a low price elasticity, high-quality rice and wheat may have a high elasticity (Hsu, Chern, and Gale 2002).

While the expenditure elasticity for aquatic products in this study is consistent with the estimates found by Liu and Chern (2003) and Yen, Fang, and Su (2004), the own-price elasticity for aquatic products estimated by this study is much smaller in absolute terms than those reported by other studies. The low own-price elasticity for aquatic products may be a reflection of food preference of people of consumers in Jiangsu. Because consumers in Jiangsu allocate a higher percentage of their food expenditures to aquatic products compared to the national average, the price of aquatic products might not play such an important role in consumers' purchase decisions.

Fang and Beghin (2002), based on the NBS's urban household-level survey data from 1992-1998, estimated that the own-price elasticities of demand for disaggregate oils & fats products in China range between - 0.22 and -1.32. Their estimated income elasticities for oils & fats products are from 0.04 to 0.32. The expenditure elasticity for aggregate oils & fats in this study is 0.72; thus, the income elasticity for oils & fats in this study would be 0.34 when the income elasticity for the 10 food groups examined in this study is 0.48. Though their estimates significantly differ from those reported by the studies in table I-25, the estimates of own-price and expenditure elasticities for oils & fats from this study fall within the range reported by Fang and Beghin (2002) for disaggregate oils & fats products.

Conclusions and Policy Implications

This study estimates the impact of economic (price and expenditure) and non-economic (demographic) factors on food consumption patterns in China using the 2004 NBS's urban household survey data for Jiangsu province. A complete food demand system of households is estimated using a two-stage budgeting procedure and utilizing both the almost ideal demand system (AIDS) and the quadratic almost ideal demand system (QUAIDS) in each stage. Moreover, the consistent two-step (CTS) estimation procedure proposed by Shonkwiler and Yen (1999) was used to account for zero budget shares resulting from missing values in the second-stage.

To assure that the system specification and estimation procedures were correct, various hypotheses regarding the 10 food group demands in the first-stage and the grain and meat models paralleled in the second-stage were tested. The tested hypotheses include normality, homoskedasticity, and parameter stability. Results of misspecification tests show that both the normality and homoskedasticity assumption are rejected at the 5% significance level. Thus, the models were estimated using the generalized methods of moments which is robust to non-normality requirement and gives consistent covariance estimates when the error terms are not homoscedastic. To compare the superiority of model between AIDS and QUAIDS, the likelihood ratio and Wald tests were performed. The results show that the two models perform equally well in estimating food demand system in urban Jiangsu.

The major findings of this study are summarized as follows. First, the results of this study clearly indicate that the demographic profile of urban consumers in Jiangsu does have a significant impact on the food demand. The most significant demographic effects come from region, city size, and the ratio of expenditures for FAFH to total food expenditures. The educational attainment for household heads which has been considered an important determinant in food consumption in previous studies and household age structure have significant impacts only on the demand for a limited number of food categories. The results of this study not only offer a number of explanations for the changing food consumption patterns in urban Jiangsu, but also are helpful in agricultural and food policy analyses and the determination of effective marketing strategies. For example, as shown in the text, region differences have a significant impact on the demand for most food categories. It is thus important to stratify by region when studying Chinese consumer behavior. This is especially important in a large country like China, where there is substantial heterogeneity among regions in socio-cultural characteristics. Moreover, the results of this study indicate that older-aged consumers tend to consume more coarse grains. This result may be useful to grain marketers who want to establish niche market targeted at the growing older-aged urban consumers in China.

Second, as one of the key determinants of the market demand for food, price has played an important role in determining food consumption patterns in urban Jiangsu. This study shows that consumers in urban Jiangsu are especially sensitive to prices of grain commodities and oils & fats. The small positive and statistically significant expenditure and the relatively large and statistically significant own-price elasticities for grains (as one broad category) and sub-categories of rice, wheat flour, coarse grains, and processed wheat suggest that the demand for grains depends more on a change in price than in income. Additionally, since rice accounts for 63% of food grain consumption, rice is expected to continue to dominate in food grain consumption in urban Jiangsu.

Third, the large positive and statistically significant expenditure elasticities for foods examined in this study imply that income has been a driving force behind the changing food consumption patterns. If the prevailing price structure stays constant, expenditure on each of the foods examined in this study will grow as household incomes increase. However, the growth rates in demand for animal products and other foods are expected to be much faster than for other food categories. Given that the consumption of animal products away from home has increased more rapidly than that consumed at home (Wang and Zhou 2005), it is concluded that per capita quantity of animal products consumed in urban Jiangsu is expected to grow rapidly as household income increases. In addition, consumption of beef, mutton, and poultry is expected to increase more rapidly than that of pork, although pork consumption is expected to be predominant in meat dietary structure in urban Jiangsu.

The results of this study have important implications for U.S. agriculture. This study indicates that the demand for animal products is expected to increase more rapidly than for food grains in China. As a result, the demand for feed grains to be used in the production of livestock is expected to increase much more rapidly than for food grains as household incomes rise. Although China's feed industry has grown rapidly over the past two decades in response to the fast growth in demand for livestock products, China's potential to increase production of feed grains, particularly corn, might be hindered by its limited land and water resources. According to USDA (2007), China imported 100,000 metric tons of corn from the U.S. for the first time in ten years in 2006. "The growing demand for feed grain by livestock and industrial users has led to discussions in Chinese think tanks that China's self-sufficiency objective should be shifted from rice, wheat, and corn to rice and wheat." (USDA 2007, p.3). As China's economy is expected to continue to grow rapidly in the future, China will be expected to demand more animal products and, consequently, China will face a pressure to import feed grains to increase its livestock inventory in the future. As a major feed grain exporting country and a prominent trading partner, the United States is expected to play an important role in feed grain markets in China.

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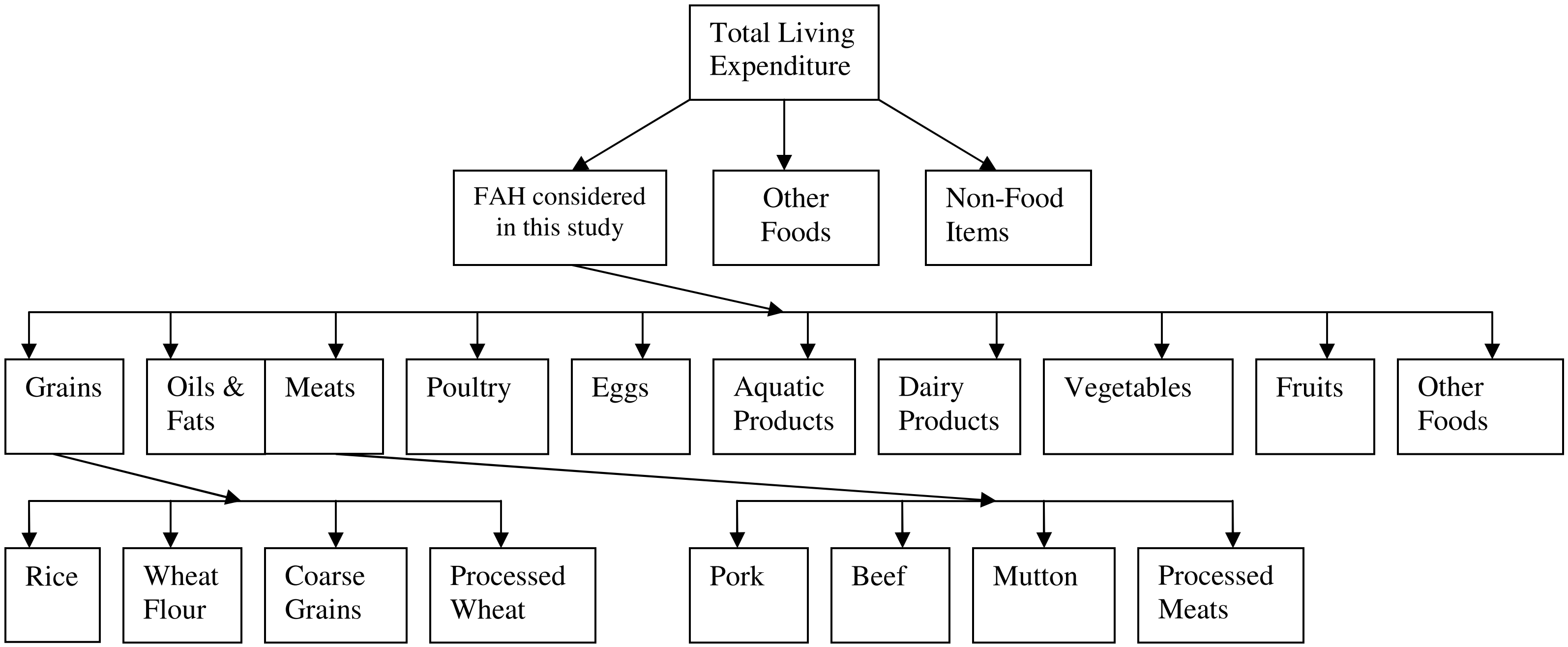

Figure I-1. A Utility Tree for Urban Households in Jiangsu, China

Table I-1. Changes in Per Capita Consumption of Major Food Commodities in Urban China

Item	1995	1998	1999	2000	2001	2002	2003	2004
China								
Grains	97.0	86.7	84.9	82.3	79.7	79.5	79.5	78.2
Vegetable oils	7.1	7.6	7.8	8.2	8.1	8.5	9.2	9.3
Fresh vegetables	116.5	113.8	114.9	114.7	115.9	116.5	118.3	122.3
Pork	17.2	15.9	16.9	16.7	15.9	20.3	20.4	19.2
Beef & mutton	2.4	3.3	3.1	3.3	3.2	3.0	3.3	3.7
Poultry	4.0	4.6	4.9	5.4	5.3	9.2	9.2	8.4
Fresh eggs	9.7	10.8	10.9	11.2	10.4	10.6	11.2	10.4
Aquatic products[b]	9.2	9.8	10.3	9.9	10.3	13.2	13.3	12.5
Fresh milk	4.6	6.2	7.9	9.9	11.9	15.7	18.6	18.9
Fresh fruits	45.0	47.9	46.1	49.1	50.9	56.5	56.6	56.4
Jiangsu Province								
Grains	96.3	86.97	86.35	75.81	74.1	78.8	74.6	73.6
Vegetable oils	7.3	8.25	8.78	8.6	8.5	8.7	9.1	9.1
Fresh vegetables	112.3	109.13	111.70	105.01	108.6	117.8	109.8	114.0
Pork	19.9	19.50	20.27	19.71	18.5	22.0	21.3	20.3
Beef & mutton	1.4	1.64	1.63	1.77	1.6	1.9	2.0	2.3
Poultry	7.1	8.38	8.9	9.89	9.4	12.7	12.5	11.5
Eggs[c]	10.9	12.12	12.75	12.78	12.2	13.1	12.7	12.2
Fish & shrimp	14.3	17.15	18.00	15.89	16.8	17.5	16.8	16.0
Milk & yogurt	4.2	na	na	12.04	13.2	20.4	22.5	22.1
Fresh fruits	48.9	56.71	50.80	52.81	53.4	59.2	51.1	53.9

Note: [a]The unit of consumption is kilograms/capita/year.
[b]Aquatic products include fish, shrimp, and fish products.
[c]eggs include fresh eggs and egg products.
Data sources: China Statistical Yearbook and Jiangsu Statistical Yearbook, various issues.

Table I-2. Income Growth and the Changes in Food Consumption Patterns in Urban China and Urban Jiangsu

Year	Per Capita Income	Per Capita Food Expenditure		
		Total	Share, at-home	Share, out-of-home
China				
1995	4283	1766	0.91	0.09
1996	4448	1769	0.90	0.10
1997	4599	1749	0.90	0.10
1998	4866	1791	0.88	0.12
1999	5317	1878	0.87	0.13
2000	5663	1954	0.85	0.15
2001	6141	2022	0.85	0.15
2002	6965	2276	0.82	0.18
2003	7592	2342	0.82	0.18
2004	8171	2406	0.80	0.20
Jiangsu				
1995	4634	1957	0.90	0.10
1996	4745	1889	0.90	0.10
1997	5186	1996	0.89	0.11
1998	5447	2093	0.88	0.12
1999	5995	2206	0.87	0.13
2000	6229	2237	0.85	0.15
2001	6702	2239	0.85	0.15
2002	7492	2502	0.84	0.16
2003	8402	2546	0.83	0.17
2004	9133	2639	0.82	0.18

Note: Per capita incomes are deflated by urban consumer price indexes for China and Jiangsu, respectively, and per capita food expenditures are deflated by urban food price indexes for China and Jiangsu, respectively. Both sets of columns are in 1995 real terms. The shares are calculated in terms of both at-home and away-from-home food expenditures.
Source: China's Statistical Yearbooks, 1996-2005.

Table I-3. Per Capita Income, Total Living Expenditure, and Food Expenditure in Urban Jiangsu and Urban China, 2004 (in yuan)

	Comparison of Data Sources in Jiangsu			
Category	Sample Average (yuan/person)	Published Average (yuan/person)	Discrepancy (%)	National Average (yuan/person)
Income	10203.5	10481.0	2.6	9421.6
Total living expenditure	7205.2	7332.3	1.7	7182.1
Total food expenditure	2850.1	2931.7	2.8	2709.7
Expenditure for food away from home (FAFH)	454.7	523.6	13.2	533.4
Expenditure for the 10 food groups [a]	2019.6	2014.2	-0.3	1879.3
Grains	231.3	225.0	-2.8	238.8
Oils	84.4	81.0	-4.2	89.2
Meats	430.1	423.0	-1.7	402.9
Poultry	169.8	165.6	-2.5	123.9
Eggs	74.0	73.9	-0.1	68.2
Aquatic products	264.6	263.5	-0.4	178.1
Dairy products	**135.2**	144.2	6.2	132.4
Vegetables	265.6	263.7	-0.7	256.5
Fruits	172.5	175.5	1.7	189.6
Other food	192.1	198.8	3.4	199.7

Note: [a] total expenditure for the 10 food groups as listed in the table

Source: "Sampe average" was calculated by author in light of tabulation formula provided by the NBS with the data set composed of 902 households. The "Published Average" and "National Average" are from "China Price and Urban Household Income and Expenditure Survey Statistical Yearbook", Beijing, China Statistics Press, 2005.

Table I-4. The Summary Statistics

Items	Quantity (kg/capita/year)	Expenditure (yuan/capita/year)	Quality-Adjusted Price (yuan/kg)
Grains	80.4	242.3	3.0
Rice	57.9	166.1	2.8
Wheat flour	7.4	16.2	2.5
Coarse grains	1.9	5.7	3.1
Processed wheat	13.2	54.2	4.3
Oils & Fats	10.2	92.2	8.7
Meats	27.9	452.4	16.2
Pork	21.9	321.7	14.7
Beef	1.7	31.7	18.5
Mutton	0.6	9.3	16.7
Processed meats	3.6	88.8	23.9
Poultry	12.3	173.2	13.8
Eggs	12.8	78.0	6.1
Aquatic products	20.9	270.5	12.5
Dairy products	21.9	126.0	6.1
Vegetables	124.2	269.3	2.2
Fruits	59.1	179.3	3.0
Other foods	34.7	186.6	6.4

Note: Figures here are calculated with a simple average, which differs from the approach used in Table I-3. The values in Table I-3 account for the weights of various kinds of sample households.
Source: 902 households, Jiangsu, 2004.

Table I-5. Percentage of Households in Each Demographic Category

Item	Percentage
Region	
South	45.90
North	54.10
Urbanization	
Large-city	10.75
Medium-city	26.61
Small-city	34.48
County-level city	28.16
Age structure[a]	
Adults aged 18-40	31.11
Adults aged 41-60	35.35
Adults aged 61 and above	17.23
Kids aged 0-5	2.32
Kids aged 6-17	13.99
Educational level of household head	
Junior middle-school and below	42.02
Senior middle-school	48.89
College and above	9.09
Ratio of FAFH[b]	13.50

[a] Family members by age-group indicates percentage of an age-group population to total sample population.
[b] ratio of FAFH refers to the expenditure for FAFH to total food expenditures calculated at mean within the sample households.
Source: 902 households, Jiangsu, 2004.

Table I-6. Misspecification Tests for the QUAIDS of Food Groups

Hypotheses Tested	P-value
Normality	
Grains	0.0001
Oils & Fats	0.0001
Meats	0.0495
Poultry	0.0001
Eggs	0.0001
Aquatic products	0.0001
Dairy products	--
Vegetables	0.0001
Fruits	0.0001
Other foods	0.0001
Overall test	0.0001
Homoskedasticity	
Grains	0.0001
Oils & Fats	0.0152
Meats	0.0001
Poultry	0.0001
Eggs	0.0001
Aquatic products	0.0980
Dairy products	--
Vegetables	0.0001
Fruits	0.0001
Other foods	0.0035
Structural change (Chow test)	
Break points	0.9800

Note:
1. Normality tests for an individual equation are conducted with the Shapiro-Wilk W test, and system test is performed with Mardia's skewness test and kurtosis test and the Henze-Zirkler test. Detailed introduction sees “SAS help and documentation.”
2. Heteroskedasticity test is performed with the Breusch-Pagan test in Model procedure in SAS program.
3. Structural change test is performed with Chow F-test in Model procedure in SAS program. To perform this test, households are regrouped based on per capita incomes, and then the tests was conducted based on selected breakpoints.

Table I-7. Misspecification Tests for the AIDS of Food Groups

Hypotheses Tested	P-value
Normality	
Grains	0.0001
Oils & Fats	0.0001
Meats	0.0503
Poultry	0.0001
Eggs	0.0001
Aquatic products	0.0001
Dairy products	--
Vegetables	0.0001
Fruits	0.0001
Other foods	0.0001
Overall test	0.0001
Homoskedasticity	
Grains	0.0430
Oils & Fats	0.0001
Meats	0.0168
Poultry	0.0001
Eggs	0.3545
Aquatic products	0.0001
Dairy products	--
Vegetables	0.0001
Fruits	0.0001
Other-foods	0.0006
Structural change (Chow test)	
Break points	0.9000

Note:
1. Normality tests for an individual equation are conducted with the Shapiro-Wilk W test, and system test is performed with Mardia's skewness test and kurtosis test and the Henze-Zirkler test. Detailed introduction sees “SAS help and documentation.”
2. Heteroskedasticity test is performed with the Breusch-Pagan test in Model procedure in SAS program.
3. Structural change test is performed with Chow F-test in Model procedure in SAS program. To perform this test, households are regrouped based on per capita incomes, and then the tests was conducted based on selected breakpoints.

Table I-8. Misspecification Tests for the QUAIDS of Grain Commodities

Hypotheses Tested	P-value
Normality	
Rice	0.0001
Wheat flour	0.0001
Coarse grains	0.0001
Processed wheat	0.0001
Overall test	0.0001
Homoskedasticity	
Rice	0.0001
Wheat flour	0.0051
Coarse grains	0.0001
Processed wheat	0.0001
Structural change (Chow test)	
Breakpoints	0.9000

Note:
1. Normality tests for an individual equation are conducted with the Shapiro-Wilk W test, and system test is performed with Mardia's skewness test and kurtosis test (Mardia 1980) and the Henze-Zirkler test (Henze and Zirkler 1990). Detailed introduction sees “SAS help and documentation.”
2. Heteroskedasticity test is performed with the Breusch-Pagan test in Model procedure in SAS program.
3. Structural change test is performed with Chow F-test in Model procedure in SAS program. To perform this test, households are regrouped based on per capita incomes, and then the test was conducted based on selected breakpoints.

Table I-9. Misspecification Tests for the AIDS of Grain Commodities

Hypotheses Tested	P-value
Normality	
Rice	0.0001
Wheat flour	0.0001
Coarse grains	0.0001
Processed wheat	0.0001
Overall test	0.0001
Homoskedasticity	
Rice	0.0001
Wheat flour	0.0028
Coarse grains	0.0001
Processed wheat	0.0001
Structural change (Chow test)	
Breakpoints	0.9800

Note:
1. Normality tests for an individual equation are conducted with the Shapiro-Wilk W test, and system test is performed with Mardia's skewness test and kurtosis test (Mardia 1980) and the Henze-Zirkler test (Henze and Zirkler 1990). Detailed introduction sees "SAS help and documentation."
2. Heteroskedasticity test is performed with the Breusch-Pagan test in Model procedure in SAS program.
3. Structural change test is performed with Chow F-test in Model procedure in SAS program. To perform this test, households are regrouped based on per capita incomes, and then test was conducted based on selected breakpoint.

Table I-10. Misspecification Tests for QUAIDS of Meat Products

Hypotheses Tested	P-value
Normality	
Pork	0.0001
Beef	0.0001
Mutton	0.0001
Processed meats	0.0001
Overall test	0.0001
Homoscedasticity	
Pork	0.0001
Beef	0.0077
Mutton	0.0001
Processed meats	0.0477
Structural change	
Breakpoints	0.9500

Note:
1. Normality tests for an individual equation are conducted with the Shapiro-Wilk W test, and system test is performed with Mardia's skewness test and kurtosis test (Mardia 1980) and the Henze-Zirkler test (Henze and Zirkler 1990). Detailed introduction sees “SAS help and documentation.”
2. Heteroskedasticity test is performed with the Breusch-Pagan test in Model procedure in SAS program.
3. Structural change test is performed with Chow F-test in Model procedure in SAS program. To perform this test, households are regrouped based on per capita incomes, and then the test was conducted based on selected breakpoints.

Table I-11. Misspecification Tests for AIDS of Meat Products

Hypotheses Tested	P-value
Normality	
Pork	0.0001
Beef	0.0001
Mutton	0.0001
Processed meats	0.0001
Overall test	0.0001
Homoscedasticity	
Pork	0.0001
Beef	0.0244
Mutton	0.0228
Processed meats	0.0001
Structural change	
Breakpoints	0.9500

Note:
1. Normality tests for an individual equation are conducted with the Shapiro-Wilk W test, and system test is performed with Mardia's skewness test and kurtosis test (Mardia 1980) and the Henze-Zirkler test (Henze and Zirkler 1990). Detailed introduction sees "SAS help and documentation."
2. Heteroskedasticity test is performed with the Breusch-Pagan test in Model procedure in SAS program.
3. Structural change test is performed with Chow F-test in Model procedure in SAS program. To perform this test, households are regrouped based on per capita incomes, and then the test was conducted based on selected breakpoints.

Table I-12. Wald and Likelihood Ratio Tests

Item	Test	P-value
Food groups		
Grains	Wald	0.7290
Oils & Fats	Wald	0.0547
Meats	Wald	0.2201
Poultry	Wald	0.0074
Eggs	Wald	0.7651
Aquatic products	Wald	0.4615
Dairy products	-	-
Vegetables	Wald	0.0011
Fruits	Wald	0.2400
Other foods	Wald	0.0343
Overall	Wald	0.0049
Overall	Likelihood Ratio	0.1948[a]
Grain commodities		
Rice	Wald	0.0001
Wheat flour	Wald	0.0001
Coarse grains	Wald	0.0001
Processed wheat	Wald	0.8940
Overall	Wald	0.0001
Overall	Likelihood Ratio	8.8000[b]
Meat products		
Pork	Wald	0.3733
Beef	Wald	0.0091
Mutton	Wald	0.0007
Processed meats	Wald	0.0142
Overall	Wald	0.0009
Overall	Likelihood Ratio	-0.0006

Note:
Wald test is to test for whether or not the quadratic term in the QUAIDS model is zero. Likelihood ratio test is based on the optimization criterion proposed by Gallant and Jorgenson (1979). The values under likelihood ratio test are the calculated Chi-square values.

[a]Chi square's critical value for food groups (i.e., $\chi^2_{0.05,9}$) is 16.92.

[b]Chi-square's critical value for grain commodities and meat products (i.e., $\chi^2_{0.05,4}$) is 9.49.

Table I-13. Parameters of the QUAIDS Demand System for Food Groups

Item	Grains		Oils & Fats		Red Meats		Poultry	
	Param.	T-stat.	Param.	T-stat.	Param.	T-stat.	Param.	T-stat.
Constant	0.1244	2.27	0.1252	5.02	0.1466	2.25	-0.0403	-1.25
South	-0.0099	-1.91	-0.0063	-2.63	-0.0070	-1.06	0.0331	7.15
Large-size city	0.0226	3.47	0.0182	5.62	-0.0302	-3.54	-0.0027	-0.47
Medium-size city	0.0257	4.58	0.0138	5.02	-0.0261	-3.61	-0.0171	-4.21
Small-size city	0.0198	3.33	0.0135	5.19	-0.0134	-2.06	-0.0065	-1.66
Aged between 18 and 40	0.0076	2.81	0.0034	2.48	0.0028	0.91	0.0001	0.06
Aged between 41 and 60	0.0178	6.27	0.0026	1.82	0.0020	0.63	-0.0018	-0.87
Aged over 61	0.0214	6.92	0.0013	0.84	0.0016	0.43	-0.0019	-0.80
Children under 5	0.0050	0.64	0.0092	2.33	-0.0102	-1.17	-0.0084	-1.76
Children between 6 and 17	0.0023	0.55	0.0019	0.94	0.0018	0.40	0.0006	0.21
Edu1	0.0244	3.43	0.0020	0.56	-0.0116	-1.33	-0.0035	-0.70
Edu2	0.0161	2.30	-0.0015	-0.45	-0.0165	-1.93	-0.0084	-1.79
FAFHR	-0.1162	-7.51	-0.0582	-8.61	-0.0474	-2.40	-0.0109	-1.03
Price of grains	-0.0294	-3.12	-0.0012	-0.26	0.0283	2.31	0.0094	1.25
Price of oils &fats	-0.0012	-0.26	-0.0129	-3.08	0.0130	1.98	0.0093	1.88
Price of meats	0.0283	2.31	0.0130	1.98	-0.0034	-0.16	-0.0075	-0.73
Price of poultry	0.0094	1.25	0.0093	1.88	-0.0075	-0.73	0.0175	1.90
Price of eggs	0.0172	5.55	0.0022	0.86	0.0165	3.18	-0.0104	-2.69
Price of aquatic products	-0.0265	-4.43	-0.0123	-2.87	-0.0373	-4.25	-0.0207	-2.93
Price of dairy products	0.0174	4.43	0.0054	1.70	-0.0029	-0.49	-0.0014	-0.25
Price of vegetables	-0.0079	-1.06	0.0038	0.78	-0.0105	-0.98	-0.0046	-0.62
Price of fruits	0.0017	0.24	-0.0010	-0.22	0.0011	0.09	-0.0014	-0.20
Price of other foods	-0.0090	-1.51	-0.0063	-1.38	0.0028	0.26	0.0099	1.35
Linear log of expenditures	-0.0395	-0.98	-0.0478	-2.69	0.0819	1.60	0.0774	3.31
Quadratic log of expend.	0.0027	0.35	0.0067	1.92	-0.0126	-1.23	-0.0128	-2.68
Adjusted R^2	0.2230		0.1384		0.0721		0.1280	

(Continues)

Item	Eggs		Aquatic Products		Dairy Products	
	Param.	T-stat.	Param.	T-stat.	Param.	T-stat.
Constant	0.0486	2.43	0.0545	0.96	0.0557	-
South	-0.0032	-1.62	0.0046	0.93	-0.0095	-
Large-size city	0.0004	0.16	-0.0430	-6.29	0.0235	-
Medium-size city	0.0030	1.36	-0.0451	-7.30	0.0160	-
Small-size city	-0.0024	-1.17	-0.0168	-3.35	0.0030	-
Aged between 18 and 40	0.0006	0.52	-0.0079	-2.97	-0.0054	-
Aged between 41 and 60	0.0028	2.56	-0.0059	-2.15	-0.0128	-
Aged over 61	0.0041	3.31	-0.0084	-2.85	-0.0112	-
Children under 5	-0.0003	-0.10	0.0056	0.70	0.0045	-
Children between 6 and 17	0.0021	1.42	-0.0134	-3.54	0.0118	-
Edu1	0.0004	0.13	-0.0020	-0.29	-0.0053	-
Edu2	0.0009	0.29	0.0028	0.41	0.0090	-
FAFHR	-0.0230	-4.02	0.0477	3.31	0.1034	-
Price of grains	0.0172	5.55	-0.0265	-4.43	0.0174	-
Price of oils &fats	0.0022	0.86	-0.0123	-2.87	0.0054	-
Price of meats	0.0165	3.18	-0.0373	-4.25	-0.0029	-
Price of poultry	-0.0104	-2.69	-0.0207	-2.93	-0.0014	-
Price of eggs	0.0082	1.88	-0.0092	-3.34	-0.0005	-
Price of aquatic products	-0.0092	-3.34	0.1030	13.07	0.0012	-
Price of dairy products	-0.0005	-0.35	0.0012	0.47	-0.0180	-
Price of vegetables	-0.0142	-4.05	-0.0139	-2.02	0.0036	-
Price of fruits	-0.0066	-2.61	0.0217	3.44	-0.0067	-
Price of other foods	-0.0032	-1.50	-0.0061	-0.94	0.0018	-
Linear log of expenditures	-0.0048	-0.34	0.0074	0.17	-0.0026	-
Quadratic log of expenditures	-0.0008	-0.30	0.0059	0.74	0.0026	-
Adjusted R^2	0.0486		0.2818			

(Continues)

Item	Vegetables		Fruits		Other foods	
	Param.	T-stat.	Param.	T-stat.	Param.	T-stat.
Constant	0.1223	2.93	0.1655	2.98	0.1976	3.48
South	0.0098	2.59	0.0062	1.59	-0.0180	-3.76
Large-size city	0.0163	2.75	-0.0027	-0.44	-0.0025	-0.38
Medium-size city	0.0005	0.11	0.0179	3.48	0.0115	2.14
Small-size city	0.0108	2.73	0.0039	1.00	-0.0119	-2.73
Aged between 18 and 40	-0.0008	-0.41	-0.0019	-0.84	0.0015	0.56
Aged between 41 and 60	0.0070	3.46	-0.0040	-1.75	-0.0078	-3.14
Aged over 61	0.0108	4.21	-0.0079	-3.14	-0.0098	-3.17
Children under 5	-0.0019	-0.36	0.0026	0.43	-0.0061	-0.92
Children between 6 and 17	-0.0030	-1.04	0.0028	0.93	-0.0070	-1.89
Edu1	-0.0075	-1.57	-0.0016	-0.30	0.0046	0.66
Edu2	-0.0035	-0.71	0.0024	0.49	-0.0012	-0.19
FAFHR	-0.0958	-8.07	0.0838	6.15	0.1165	6.27
Price of grains	-0.0079	-1.06	0.0017	0.24	-0.0090	-1.51
Price of oils &fats	0.0038	0.78	-0.0010	-0.22	-0.0063	-1.38
Price of meats	-0.0105	-0.98	0.0011	0.09	0.0028	0.26
Price of poultry	-0.0046	-0.62	-0.0014	-0.20	0.0099	1.35
Price of eggs	-0.0142	-4.05	-0.0066	-2.61	-0.0032	-1.50
Price of aquatic products	-0.0139	-2.02	0.0217	3.44	-0.0061	-0.94
Price of dairy products	0.0036	0.68	-0.0067	-1.48	0.0018	0.33
Price of vegetables	0.0385	4.06	0.0038	0.48	0.0014	0.19
Price of fruits	0.0038	0.48	-0.0076	-0.73	-0.0050	-0.64
Price of other foods	0.0014	0.19	-0.0050	-0.64	0.0137	1.14
Linear log of expenditures	0.0736	2.44	-0.0622	-1.42	-0.0835	-1.92
Quadratic log of expenditures	-0.0193	-3.25	0.0100	1.18	0.0177	2.12
Adjusted R^2	0.2065		0.1810		0.1747	

Source: Estimated.

Table I-14. Parameters of the AIDS Demand System for Food Groups

Item	Grains		Oils & Fats		Red Meats		Poultry	
	Param.	T-stat.	Param.	T-stat.	Param.	T-stat.	Param.	T-stat.
Constant	0.2125	6.10	0.1360	8.15	0.1641	3.52	0.0007	0.03
South	-0.0100	-1.94	-0.0066	-2.75	-0.0070	-1.07	0.0333	7.22
Large-size city	0.0231	3.56	0.0179	5.49	-0.0299	-3.52	-0.0021	-0.37
Medium-size city	0.0258	4.60	0.0137	4.91	-0.0257	-3.60	-0.0167	-4.12
Small-size city	0.0196	3.31	0.0132	5.03	-0.0134	-2.06	-0.0057	-1.46
Aged between 18 and 40	0.0076	2.83	0.0037	2.62	0.0028	0.93	0.0000	0.01
Aged between 41 and 60	0.0179	6.28	0.0029	1.99	0.0019	0.60	-0.0020	-0.93
Aged over 61	0.0216	7.01	0.0018	1.16	0.0011	0.29	-0.0026	-1.05
Children under 5	0.0050	0.64	0.0098	2.52	-0.0114	-1.31	-0.0094	-1.99
Children between 6 and 17	0.0023	0.56	0.0022	1.08	0.0014	0.30	0.0001	0.04
Edu1	0.0239	3.37	0.0019	0.55	-0.0121	-1.37	-0.0036	-0.72
Edu2	0.0157	2.26	-0.0012	-0.36	-0.0171	-1.96	-0.0089	-1.90
FAFHR	-0.1153	-7.69	-0.0567	-8.54	-0.0525	-2.68	-0.0147	-1.41
Price of grains	-0.0312	-3.64	-0.0002	-0.05	0.0259	2.62	0.0056	1.06
Price of oils &fats	-0.0002	-0.05	-0.0108	-3.29	0.0076	1.69	0.0045	1.25
Price of meats	0.0259	2.62	0.0076	1.69	0.0060	0.38	0.0024	0.34
Price of poultry	0.0056	1.06	0.0045	1.25	0.0024	0.34	0.0269	3.88
Price of eggs	0.0162	5.39	0.0018	0.77	0.0166	3.53	-0.0105	-3.13
Price of aquatic products	-0.0209	-3.64	-0.0097	-3.31	-0.0411	-5.99	-0.0235	-4.79
Price of dairy products	0.0194	6.32	0.0065	4.49	-0.0045	-1.46	-0.0025	-1.04
Price of vegetables	-0.0160	-2.94	-0.0030	-0.91	0.0019	0.29	0.0065	1.20
Price of fruits	0.0039	0.76	0.0029	1.22	-0.0061	-1.03	-0.0086	-2.19
Price of other foods	-0.0027	-1.15	0.0005	0.34	-0.0088	-2.93	-0.0008	-0.40
Log of expenditures	-0.0261	-5.14	-0.0133	-5.64	0.0165	2.54	0.0107	3.14
Adjusted R^2	0.2230		0.1301		0.0710		0.1257	

(Continues)

Item	Eggs		Aquatic Products		Dairy Products	
	Param.	T-stat.	Param.	T-stat.	Param.	T-stat.
Constant	0.0906	6.15	-0.1335	-4.12	-0.0129	-
South	-0.0033	-1.65	0.0050	1.00	-0.0099	-
Large-size city	0.0007	0.29	-0.0440	-6.45	0.0231	-
Medium-size city	0.0030	1.38	-0.0459	-7.44	0.0155	-
Small-size city	-0.0023	-1.12	-0.0172	-3.44	0.0026	-
Aged between 18 and 40	0.0005	0.49	-0.0077	-2.95	-0.0056	-
Aged between 41 and 60	0.0028	2.60	-0.0058	-2.15	-0.0132	-
Aged over 61	0.0041	3.36	-0.0080	-2.75	-0.0116	-
Children under 5	-0.0001	-0.04	0.0058	0.72	0.0044	-
Children between 6 and 17	0.0022	1.47	-0.0134	-3.56	0.0119	-
Edu1	0.0006	0.19	-0.0021	-0.31	-0.0048	-
Edu2	0.0011	0.36	0.0025	0.38	0.0095	-
FAFHR	-0.0234	-4.24	0.0500	3.47	0.1052	-
Price of grains	0.0162	5.39	-0.0209	-3.64	0.0194	-
Price of oils &fats	0.0018	0.77	-0.0097	-3.31	0.0065	-
Price of meats	0.0166	3.53	-0.0411	-5.99	-0.0045	-
Price of poultry	-0.0105	-3.13	-0.0235	-4.79	-0.0025	-
Price of eggs	0.0076	1.76	-0.0071	-2.53	0.0002	-
Price of aquatic products	-0.0071	-2.53	0.0973	11.74	-0.0015	-
Price of dairy products	0.0003	0.19	-0.0015	-0.52	-0.0188	-
Price of vegetables	-0.0159	-4.90	-0.0088	-1.76	0.0052	-
Price of fruits	-0.0067	-3.10	0.0235	5.10	-0.0056	-
Price of other foods	-0.0023	-2.25	-0.0083	-2.46	0.0016	-
Log of expenditures	-0.0091	-4.96	0.0377	7.66	0.0123	-
Adjusted R^2	0.1724		0.2625		-	

(Continues)

Item	Vegetables		Fruits		Other Foods	
	Param.	T-stat.	Param.	T-stat.	Param.	T-stat.
Constant	0.3523	11.47	0.1368	4.27	0.0535	1.43
South	0.0103	2.72	0.0061	1.55	-0.0180	-3.78
Large-size city	0.0171	2.87	-0.0029	-0.47	-0.0031	-0.48
Medium-size city	0.0014	0.34	0.0176	3.42	0.0112	2.09
Small-size city	0.0116	2.96	0.0038	0.99	-0.0123	-2.81
Aged between 18 and 40	-0.0012	-0.59	-0.0019	-0.86	0.0018	0.68
Aged between 41 and 60	0.0065	3.35	-0.0038	-1.69	-0.0072	-2.90
Aged over 61	0.0098	4.10	-0.0075	-3.02	-0.0088	-2.84
Children under 5	-0.0035	-0.64	0.0035	0.59	-0.0042	-0.65
Children between 6 and 17	-0.0035	-1.27	0.0033	1.10	-0.0064	-1.76
Edu1	-0.0076	-1.61	-0.0012	-0.23	0.0050	0.70
Edu2	-0.0041	-0.84	0.0031	0.61	-0.0006	-0.09
FAFHR	-0.0996	-8.38	0.0859	6.34	0.1210	6.48
Price of grains	-0.0160	-2.94	0.0039	0.76	-0.0027	-1.15
Price of oils &fats	-0.0030	-0.91	0.0029	1.22	0.0005	0.34
Price of meats	0.0019	0.29	-0.0061	-1.03	-0.0088	-2.93
Price of poultry	0.0065	1.20	-0.0086	-2.19	-0.0008	-0.40
Price of eggs	-0.0159	-4.90	-0.0067	-3.10	-0.0023	-2.25
Price of aquatic products	-0.0088	-1.76	0.0235	5.10	-0.0083	-2.46
Price of dairy products	0.0052	2.00	-0.0056	-2.46	0.0016	0.91
Price of vegetables	0.0424	6.02	-0.0050	-1.20	-0.0074	-3.36
Price of fruits	-0.0050	-1.20	-0.0020	-0.39	0.0037	1.97
Price of other foods	-0.0074	-3.36	0.0037	1.97	0.0245	8.48
Log of expenditures	-0.0263	-6.49	-0.0097	-2.04	0.0074	1.28
Adjusted R^2	0.2024		0.1793		0.1678	

Source: Estimated.

Table I-15. First-Step Probit Estimates for Grain Commodities

	Rice		Wheat Flour		Coarse Grains		Processed Wheat	
Item	Param.	T-stat.	Param.	T-stat.	Param.	T-stat.	Param.	T-stat.
Constant	1.7948	0.98	1.7322	1.86	-1.7661	-1.88	5.9044	2.79
South	0.5800	2.36	-0.4828	-3.71	0.0598	0.45	0.0790	0.18
Large-size city	-	-	0.5276	2.93	-0.0534	-0.28	-	-
Medium-size city	0.4658	1.90	0.5061	3.65	0.1928	1.39	-	-
Small-size city	0.7553	3.19	0.1365	1.12	0.0679	0.56	0.1572	0.42
Aged between 18 and 40	0.0386	0.23	0.0205	0.29	-0.0816	-1.13	-0.1145	-0.50
Aged between 41 and 60	0.4595	2.83	0.1835	2.63	0.0557	0.79	-0.4850	-1.72
Aged over 61	1.3164	3.00	0.2623	3.22	0.1515	1.8	-0.2205	-0.73
Children under 5	0.3715	0.97	-0.1823	-0.97	-0.0203	-0.11	-0.3626	-0.77
Children between 6 and 17	-0.1171	-0.58	-0.1343	-1.41	-0.1962	-2.05	-	-
Edu1	0.4482	1.46	0.0738	0.42	-0.0207	-0.11	-4.4317	-4.20
Edu2	-0.0258	-0.09	0.0120	0.07	0.0426	0.24	-4.1085	-3.78
FAFHR	0.1261	0.18	-1.9313	-4.91	-0.3842	-1.02	0.2095	0.14
Log price of rice	0.2518	0.25	-0.5251	-1.02	0.1838	0.36	0.7302	0.40
Log price of wheat	-0.8539	-1.60	-0.9937	-3.37	0.0703	0.23	0.0003	0.00
Log price of coarse grain	0.0521	0.19	-0.2509	-2.11	-0.4452	-3.32	0.0199	0.04
Log price of processed wheat	-0.3361	-1.83	-0.2408	-2.45	0.2690	2.74	0.3940	1.09
Log Income	-0.0567	-0.33	0.0566	0.69	0.2177	2.64	5.9044	2.79
Log-likelihood	-12598		-527.861		-503.476		-32.04	

Source: Estimated.

Table I-16. Second-Step Estimates of the QUAIDS Demand System for Grain Commodities

	Rice		Wheat flour		Coarse grains		Processed Wheat	
Items	Param.	T-stat.	Param.	T-stat.	Param.	T-stat.	Param.	T-stat.
Φ *constant	0.4163	9.96	0.1398	5.89	0.0218	2.13	0.4582	12.88
Φ *South	0.1796	10.08	-0.1181	-10.90	0.0025	0.60	-0.0819	-5.38
Φ *Large-size city	-0.1013	-4.18	0.0181	1.42	-0.0099	-1.62	0.0853	4.12
Φ *Medium-size city	-0.1090	-5.30	0.0031	0.22	0.0011	0.22	0.0888	5.17
Φ *Small-size city	0.0517	2.60	-0.0879	-5.82	-0.0012	-0.25	0.0073	0.44
Φ *Aged 18-40	0.0016	0.15	-0.0058	-0.72	0.0015	0.49	0.0016	0.17
Φ *Aged 41-60	0.0035	0.33	-0.0021	-0.28	0.0047	1.56	-0.0141	-1.58
Φ *Aged over 61	0.0179	1.59	-0.0144	-1.83	0.0121	3.68	-0.0260	-2.73
Φ *Children under 5	-0.0190	-0.62	-0.0110	-0.55	0.0007	0.11	0.0264	0.95
Φ *Children aged 6-17	-0.0397	-2.66	0.0040	0.40	-0.0057	-1.56	0.0453	3.53
Φ *Edu1	-0.0065	-0.22	0.0179	0.95	-0.0033	-0.54	-0.0073	-0.30
Φ *Edu2	-0.0192	-0.66	0.0046	0.25	0.0043	0.63	0.0114	0.48
Φ *FAFHR	-0.0403	-0.67	-0.0474	-1.43	0.0372	2.53	0.0848	1.69
Φ *Price of rice	-0.2157	-8.06	0.1391	8.05	0.0289	4.13	0.0476	2.65
Φ *Price of wheat	0.1391	8.05	-0.1081	-6.65	-0.0152	-2.89	-0.0159	-2.57
Φ *Price of coarse grain	0.0289	4.13	-0.0152	-2.89	-0.0042	-1.03	-0.0096	-2.33
Φ *Price of processed wheat	0.0476	2.65	-0.0159	-2.57	-0.0096	-2.33	-0.0221	-1.46
Φ *log of expenditure	0.2455	12.28	-0.0197	-1.39	-0.0103	-1.38	-0.1986	-12.34
Φ *(log of expenditure)^2	-0.0484	-5.27	0.0248	3.39	-0.0017	-0.61	0.0241	3.48
ϕ	0.3723	19.27	-0.0175	-1.70	0.0249	2.37	0.1830	2.53
Adjusted R^2	0.3212		0.3199		0.0354		0.3556	

Note: Φ's and ϕ's indicate the standard normal cumulative distribution function (cdf) and the standard normal probability density functions (pdf) estimated in the first-step regressions.
Source: Estimated.

Table I-17. Second-Step Estimates of the AIDS Demand System for Grain Commodities

	Rice		Wheat Flour		Coarse Grains		Processed Wheat	
Items	Param.	T-stat.	Param.	T-stat.	Param.	T-stat.	Param.	T-stat.
Φ *constant	-0.3031	-4.03	0.0449	1.04	0.0740	3.68	1.1250	17.94
Φ *South	0.1731	9.69	-0.1341	-11.38	0.0007	0.17	-0.0768	-5.05
Φ *Large-size city	-0.0806	-3.43	0.0201	1.61	-0.0076	-1.28	0.0745	3.73
Φ *Medium-size city	-0.1016	-5.02	0.0136	0.98	0.0027	0.51	0.0831	4.88
Φ *Small-size city	0.0486	2.36	-0.0860	-5.44	-0.0009	-0.19	0.0081	0.49
Φ *Aged 18-40	-0.0171	-1.65	0.0003	0.04	0.0012	0.36	0.0108	1.21
Φ *Aged 41-60	-0.0070	-0.67	0.0053	0.77	0.0036	1.16	-0.0121	-1.36
Φ *Aged over 61	-0.0016	-0.15	-0.0019	-0.27	0.0105	3.04	-0.0197	-2.07
Φ *Children under 5	-0.0203	-0.65	-0.0143	-0.71	0.0005	0.07	0.0264	0.94
Φ *Children aged 6-17	-0.0490	-3.31	0.0038	0.37	-0.0061	-1.67	0.0508	3.94
Φ *Edu1	-0.0019	-0.06	0.0088	0.47	-0.0041	-0.65	-0.0095	-0.39
Φ *Edu2	-0.0134	-0.45	-0.0071	-0.37	0.0018	0.26	0.0114	0.48
Φ *FAFHR	-0.0286	-0.48	-0.1003	-3.00	0.0340	2.37	0.0866	1.73
Φ *Price of rice	-0.3269	-8.85	0.1298	7.31	0.0397	4.75	0.1573	5.61
Φ *Price of wheat	0.1298	7.31	-0.1030	-6.12	-0.0147	-2.54	-0.0122	-1.47
Φ *Price of coarse grain	0.0397	4.75	-0.0147	-2.54	-0.0039	-0.95	-0.0212	-3.78
Φ *Price of processed wheat	0.1573	5.61	-0.0122	-1.47	-0.0212	-3.78	-0.1240	-5.24
Φ *log of expenditure	0.1798	14.05	0.0197	2.41	-0.0110	-2.60	-0.1644	-15.94
ϕ	0.3452	16.79	0.0151	1.23	0.0173	1.43	0.2553	2.97
Adjusted R^2	0.3067		0.3107		0.0343		0.3522	

Note: Φ's and ϕ's indicate the standard normal cumulative distribution function (cdf) and the standard normal probability density functions (pdf) estimated in the first-step regressions.
Source: Estimated.

Table I-18. First-Step Probit Estimates for Meat Products

	Pork		Beef		Mutton		Processed Meats	
Items	Param.	T-stat.	Param.	T-stat.	Param.	T-stat.	Param.	T-stat.
Constant	23.3129	4.75	-0.1128	-0.06	-0.2276	-0.14	1.0170	0.32
South	0.8861	0.90	0.2018	1.53	-0.5617	-4.49	0.0844	0.39
Large-size city	-10.2089	-6.54	0.3960	1.70	0.8878	4.49	-	-
Medium-size city	-8.9845	-5.44	-0.1025	-0.70	0.2375	1.73	-	-
Small-size city	-8.5625	-4.29	-0.4747	-3.80	-0.5038	-4.21	1.3529	3.42
Aged between 18 and 40	0.4157	0.85	0.0018	0.02	0.0639	0.91	0.0446	0.31
Aged between 41 and 60	0.1833	0.32	0.1213	1.66	0.0941	1.39	0.0948	0.70
Aged over 61	-0.2516	-0.45	0.0491	0.58	-0.0188	-0.24	-0.1803	-1.18
Children under 5	-	-	-0.0287	-0.15	-0.2589	-1.37	-0.2351	-0.65
Children between 6 and 17	-	-	0.0121	0.12	-0.1446	-1.54	-0.0963	-0.52
Edu1	-5.6494	-1.15	-0.0697	-0.37	0.0104	0.06	-0.5314	-1.13
Edu2	-	-	-0.1215	-0.65	-0.0944	-0.55	-0.5330	-1.14
FAFHR	-0.3468	-0.15	-1.2305	-3.28	-0.8650	-2.33	-1.1108	-1.67
Price of pork	2.8723	0.79	0.5967	1.19	-0.1502	-0.31	1.4234	1.69
Price of beef	0.3137	0.19	0.1539	0.58	-0.1332	-0.55	-2.4453	-5.72
Price of mutton	-1.3132	-0.87	-0.5318	-2.06	-0.7092	-3.09	0.6811	1.95
Price of processed meats	-1.9791	-1.18	-0.7008	-3.67	-0.0740	-0.43	0.1036	0.31
Income	-0.5163	-0.97	0.2548	3.02	0.3442	4.23	0.2357	1.40
Log-likelihood	-12.57		-484.185		-560.015		-123.23	

Source: Estimated.

Table I-19. Second-Step Estimates of the QUAIDS Demand System for Meat Products

	Pork		Beef		Mutton		Processed Meats	
Items	Param.	T-stat.	Param.	T-stat.	Param.	T-stat	Param.	T-stat.
Φ *Constant	0.6934	11.53	0.0715	1.99	-0.0124	-0.42	0.2374	4.37
Φ *South	0.0506	3.54	-0.0464	-4.25	-0.0301	-3.39	0.0052	0.42
Φ *Large-size city	-0.1080	-4.95	0.0842	4.96	0.0101	0.79	0.0162	0.91
Φ *Medium-size city	-0.1126	-7.27	-0.0073	-0.78	0.0079	0.73	0.1181	8.08
Φ *Small-size city	-0.0316	-2.46	-0.0079	-0.62	-0.0252	-3.30	0.0722	6.46
Φ *Aged 18-40	0.0054	0.62	-0.0082	-1.14	-0.0026	-0.64	-0.0014	-0.18
Φ *Aged 41-60	0.0189	2.54	-0.0072	-1.10	-0.0049	-1.33	-0.0191	-2.77
Φ *Aged over 61	0.0322	3.95	-0.0029	-0.42	-0.0054	-1.69	-0.0307	-4.13
Φ *Children under 5	0.0002	0.01	0.0118	0.58	0.0096	0.75	-0.0064	-0.31
Φ *Children aged 6-17	-0.0048	-0.44	0.0092	1.03	-0.0016	-0.31	0.0000	0.00
Φ *Edu1	-0.0373	-1.85	0.0257	1.98	0.0070	0.64	0.0198	1.05
Φ *Edu2	-0.0441	-2.26	0.0284	2.35	0.0096	0.85	0.0223	1.21
Φ *FAFHR	-0.0668	-1.45	-0.0268	-0.82	0.0542	1.71	0.0867	2.09
Φ *Price of pork	-0.0423	-1.58	0.0475	3.02	0.0069	0.64	-0.0122	-0.61
Φ *Price of beef	0.0475	3.02	0.0737	4.57	-0.0225	-2.98	-0.0987	-8.74
Φ *Price of mutton	0.0069	0.64	-0.0225	-2.98	0.0015	0.20	0.0141	1.80
Φ *Price of meat-products	-0.0122	-0.61	-0.0987	-8.74	0.0141	1.80	0.0968	4.91
Φ *log of expenditure	0.0408	0.93	0.0506	2.57	0.0660	3.60	-0.1027	-2.49
Φ *(log of expenditure)^2	-0.0092	-0.89	-0.0128	-2.61	-0.0154	-3.39	0.0240	2.45
ϕ	0.1324	3.01	0.0266	1.36	-0.0115	-0.82	0.0924	7.69
Adjusted R^2	0.0725		0.1500		0.1079		0.1998	

Note: Φ 's and ϕ 's indicate the standard normal cumulative distribution function (cdf) and the standard normal probability density functions (pdf) estimated in the first-step regressions.
Source: Estimated.

Table I-20. Second-Step Estimates of the AIDS Demand System for Meat Products

	Pork		Beef		Mutton		Processed Meats	
Items	Param.	T-stat.	Param.	T-stat.	Param.	T-stat.	Param.	T-stat.
Φ *Constant	0.7566	12.18	0.1125	2.74	0.0014	0.05	0.1459	2.64
Φ *South	0.0491	3.34	-0.0478	-4.32	-0.0426	-4.87	0.0069	0.52
Φ *Large-size city	-0.1074	-5.01	0.0776	4.67	0.0250	1.99	0.0201	1.13
Φ *Medium-size city	-0.1137	-7.12	-0.0062	-0.67	0.0170	1.60	0.1180	7.71
Φ *Small-size city	-0.0342	-2.65	-0.0048	-0.38	-0.0295	-3.87	0.0731	6.48
Φ *Aged 18-40	0.0064	0.73	-0.0093	-1.29	-0.0030	-0.73	-0.0005	-0.07
Φ *Aged 41-60	0.0194	2.58	-0.0088	-1.33	-0.0045	-1.22	-0.0183	-2.65
Φ *Aged over 61	0.0329	4.01	-0.0062	-0.90	-0.0075	-2.28	-0.0282	-3.80
Φ *Children under 5	0.0013	0.06	0.0107	0.52	0.0011	0.08	-0.0043	-0.22
Φ *Children aged 6-17	-0.0051	-0.47	0.0071	0.79	-0.0063	-1.19	0.0024	0.26
Φ *Edu1	-0.0386	-1.86	0.0268	2.06	0.0062	0.56	0.0211	1.06
Φ *Edu2	-0.0456	-2.29	0.0290	2.42	0.0062	0.55	0.0246	1.28
Φ *FAFHR	-0.0663	-1.45	-0.0254	-0.77	0.0427	1.36	0.0907	2.22
Φ *Price of pork	-0.0373	-1.44	0.0438	2.82	0.0102	1.03	-0.0167	-0.88
Φ *Price of beef	0.0438	2.82	0.0739	4.70	-0.0193	-2.59	-0.0984	-8.83
Φ *Price of mutton	0.0102	1.03	-0.0193	-2.59	0.0000	-0.01	0.0092	1.27
Φ *Price of meat products	-0.0167	-0.88	-0.0984	-8.83	0.0092	1.27	0.1060	5.89
Φ *log of expenditure	-0.0024	-0.17	0.0050	0.54	0.0127	2.22	-0.0087	-0.69
ϕ	0.1303	3.04	0.0131	0.75	0.0097	0.78	0.0947	7.95
Adjusted R^2	0.0666		0.1478		0.1040		0.1919	

Note: Φ 's and ϕ 's indicate the standard normal cumulative distribution function (cdf) and the standard normal probability density functions (pdf) estimated in the first-step regressions.
Source: Estimated.

Table I-21. Estimated Marshallian Price and Expenditure Elasticities for Food Groups by the AIDS System

	Grains	Oils & Fats	Meats	Poultry	Eggs	Aquatic Products	Dairy Products	Vegetable	Fruits	Other Foods
Price Elasticities										
Grains	-1.204***	0.020	0.217***	0.044	0.149***	-0.189***	0.310***	-0.070*	0.080*	-0.002
	(0.065)	(0.026	(0.078)	(0.041)	(0.024)	(0.043)	(0.051)	(0.043)	(0.043)	(0.017)
Oils & fats	0.061	-1.201***	0.171*	0.094	0.062	-0.234***	0.101**	0.017	0.126**	0.037
	(0.068)	(0.069)	(0.094)	(0.076)	(0.047)	(0.060)	(0.024)	(0.068)	(0.050)	(0.028)
Meats	0.101**	0.027	-0.975***	0.011	0.069***	-0.180***	-0.067	-0.013	-0.045*	-0.047***
	(0.043)	(0.020)	(0.071)	(0.032)	(0.022)	(0.031)	(0.052)	(0.030)	(0.027)	(0.014)
Poultry	0.039	0.042	0.025	-0.669***	-0.141***	-0.276***	-0.036	0.043	-0.137***	-0.022
	(0.062)	(0.044)	(0.088)	(0.084)	(0.041)	(0.060)	(0.040)	(0.066)	(0.050)	(0.025)
Eggs	0.449***	0.066	0.416***	0.259***	-0.792***	-0.195***	-0.000	-0.327**	-0.113**	-0.035
	(0.072)	(0.055)	(0.116)	(0.082)	(0.108)	(0.068)	(0.022)	(0.079)	(0.054)	(0.023)
Aquatic products	-0.246**	-0.113***	-0.353***	-0.195***	-.087***	-0.157**	-0.006	-0.163***	0.124***	-0.099***
	(0.043)	(0.023)	(0.055)	(0.041)	(0.023)	(0.063)	(0.048)	(0.041)	(0.033)	(0.023)
Dairy products[a]	0.259	0.078	-0.095	-0.042	-0.018	0.007	-1.308	0.020	-0.126	0.019
	(--)	(--)	(--)	(--)	(--)	(--)	(--)	(--)	(--)	(--)
Vegetables	-0.077	-0.002	0.022	0.049	-0.104***	-0.087**	0.073	-0.617***	0.008	-0.038**
	(0.041)	(0.025)	(0.051)	(0.042)	(0.025)	(0.038)	(0.043)	(0.054)	(0.032)	(0.016)
Fruits	0.070	0.044*	-0.066	-0.100**	-0.067***	0.259***	-0.098**	-0.026	-0.997***	0.053**
	(0.059)	(0.027)	(0.067)	(0.045)	(0.025)	(0.049)	(0.038)	(0.047)	(0.056)	(0.022)
Other foods	-0.048**	-0.003	-0.099***	-0.009	-0.032***	-0.083**	0.030	-0.104***	0.022	-0.738***
	(0.024)	(0.014)	(0.034)	(0.023)	(0.010)	(0.034)	(0.028)	(0.023)	(0.022)	(0.032)
Expenditure Elasticities										
	0.789***	0.718***	1.075***	1.131***	0.776***	1.315***	1.204	0.798***	0.888***	1.081***
	(0.041)	(0.050)	(0.030)	(0.042)	(0.045	(0.041)	(--)	(0.031)	(0.055)	(0.064)

Note: Numbers in parentheses are asymptotic standard errors. Single, double, and triple asterisks (*) denote significance at the 10%, 5%, and 1% levels, respectively.

[a]These coefficients of elasticity are derived from the adding-up, homogeneity and symmetry conditions of demand parameters.

Table I-22. Estimated Conditional Marshallian Price and Expenditure Elasticities by the AIDS System

	Rice	Wheat Flour	Coarse Grains	Processed Wheat	Pork	Beef	Mutton	Processed Meats	Expend.
Rice	-1.443***	0.236***	0.031***	-0.063**					1.275***
	(0.046)	(0.028)	(0.011)	(0.025)					(0.020)
Wheat flour	1.393***	-2.044***	-0.175***	-0.353***					1.205***
	(0.184)	(0.175)	(0.061)	(0.082)					(0.085)
Coarse grains	1.034***	-0.447***	-1.076***	-0.249**					0.697***
	(0.217)	(0.160)	(0.114)	(0.104)					(0.116)
Processed wheat	0.425***	-0.120***	-0.124	-0.802***					0.433***
	(0.073)	(0.029)	(0.014)	(0.049)					(0.036)
Pork					-1.051***	0.062***	0.014	-0.022	0.997 ***
					(0.039	(0.022)	(0.014)	(0.028)	(0.200)
Beef					0.399**	-0.273**	-0.190***	-0.985***	1.049***
					(0.171)	(0.155)	(0.073)	(0.114)	(0.092)
Mutton					0.038	-.378***	-1.00***	0.089	1.248***
					(0.218)	(0.144)	(0.137)	(0.141)	(0.112)
Processed meats					-0.053	-.472***	0.044	-0.477***	0.958***
					(0.095)	(0.053)	(0.035)	(0.093)	(0.060)

Note: Numbers in parentheses are asymptotic standard errors. Single, double, and triple asterisks (*) denote significance at the 10%, 5%, and 1% levels, respectively.

Table I-23. Estimated Unconditional Marshallian Price and Expenditure Elasticities by the AIDS Systems

	Rice	Wheat Flour	Coarse Grains	Processed Wheat	Pork	Beef	Mutton	Processed Meats	Expend.
Rice	-1.866	0.184	0.037	0.094					0.985
Wheat flour	0.993	-2.094	-0.169	-0.185					0.931
Coarse grains	0.802	-0.473	-1.073	-0.164					0.539
Processed wheat	0.277	-0.138	-0.010	-0.749					0.335
Pork					-1.031	0.061	0.006	-0.011	1.085
Beef					0.419	-0.275	-0.199	-0.973	1.142
Mutton					0.062	-0.380	-1.011	0.104	1.359
Processed meats					-0.035	-0.473	0.036	-0.466	1.043

Note: calculated based on equations (12) and (13).

Table I-24. Estimated Marshallain Price and Expenditure Elasticities by the QUAIDS System

	Own-price Elasticity	Expenditure Elasticity
Elasticities for Food Groups		
Grains	-1.204 (0.065)***	0.785 (0.045)***
Oils & fats	-1.197 (0.068)***	0.673 (0.062)***
Meats	-0.985 (0.072)***	1.096 (0.030)***
Poultry	-0.691 (0.085)***	1.189 (0.051)***
Eggs	-0.790 (0.108)***	0.786 (0.052)***
Aquatic products	-0.175 (0.065)***	1.300 (0.053)***
Dairy products[a]	-1.306 (---)	1.166 (---)
Vegetables	-0.626 (0.053)***	0.848 (0.049)***
Fruits	-0.997 (0.058)***	0.840 (0.063)***
Other foods	-0.744 (0.034)***	1.022 (0.088)***
Elasticities for Grain Commodities[b]		
Rice	-1.286 (0.050)***	1.263 (0.019)***
Wheat flour	-3.420 (0.337)***	1.117 (0.108)***
Coarse grains	-0.200 (0.137)	0.526 (0.129)***
Processed wheat	-0.794 (0.050)***	0.443 (0.036)***
Elasticities for Meat Products[c]		
Pork	-1.064 (0.039)***	1.010 (0.018)***
Beef	-0.250 (0.159)	1.034 (0.092)***
Mutton	-0.896 (0.155)***	1.177 (0.107)***
Processed meats	-0.461 (0.089)***	0.933 (0.053)***

Note: Numbers in parentheses are asymptotic standard errors. Single, double, and triple asterisks (*) denote significance at the 10%, 5%, and 1% levels, respectively.

[a]The elasticity for dairy products is derived from the adding-up, homogeneity, and symmetry conditions of demand parameters.

[b]The elasticities within grain group refer to conditional elasticities.

[c]The elasticities within meat group refer to conditional elasticities.

Table I-25. Estimated Marshallian Own-price and Expenditure Elasticities by Other Studies

Items	Zhang and Wang	Liu and Chern	Yen, Fang, and Su	Gould	This study
Expenditure Elasticities					
Grains	1.180	-	0.82	1.302	0.789
Rice	1.173	1.138[b]			0.985
Wheat	1.450	1.093			0.931
Coarse grains	0.375	0.914			0.539
Processed wheat	0.537	-			0.335
Oils & fats	0.990	1.030	0.98		0.718
Meats	0.825[a]				1.075
Pork	0.958	1.093	0.94	1.164	1.085
Beef	1.136[c]	1.167[c]	1.41[c]	0.965[c]	1.142
Mutton					1.359
Processed meats	0.801		1.31[e]		1.043
Poultry	1.243	1.158	1.26	0.637	1.131
Eggs	1.043	0.890	0.77		0.776
Aquatic products	1.049	1.240	1.41[d]	0.699	1.315
Dairy products				1.361[f]	1.204
Fresh milk	1.190	1.000	1.40		
Vegetables	1.109		0.83	1.029	0.804
Fresh vegetables		0.872			
Fruits	0.956		0.60	1.067	0.888
Fresh fruits		0.921			
Other foods				0.184	1.081

(Continues)

Category	Zhang and Wang	Liu and Chern	Yen, Fang, and Su	Gould	This study
Own-price Elasticities					
Grain	-0.754		-0.90	-0.907	-1.204
Rice	-1.259	-0.862[b]			-1.866
Wheat	-1.901	-0.954			-2.094
Coarse grain	-0.771	-0.925			-1.073
Processed wheat	-0.534				-0.749
Oils & fats	-0.535	-0.786	-0.55		-1.201
Meats	-0.844[a]				-0.975
Pork	-0.716	-0.924	-0.21	-1.435	-1.031
Beef	-0.269[c]	-1.004[c]	-0.96[c]	-1.033[c]	-0.275
Mutton					-1.011
Processed meats	-0.439		-1.00[e]		-0.466
Poultry		-0.907	-0.75	-1.218	-0.669
Eggs	-0.846	-0.914	-0.70		-0.792
Aquatic products	-0.385	-0.828	-0.37[d]	-1.275	-0.157
Dairy products				-1.146[f]	-1.308
Fresh milk	-1.074	-1.066	-1.40		
Vegetables	-0.732		-0.72	-1.375	-0.617
Fresh vegetables		-0.832			
Fruits	-0.848		-0.76	-1.205	-0.997
Fresh fruits		-0.905			
Other foods				-1.657	-0.738

[a] Meats include meats and poultry. [b]Rice includes rice and wheat products. [c]Beef includes beef and mutton.[d]Aquatic products refers to fish.
[e]Processed meat refers to all kinds of meats except for fish, pork, beef & mutton, and poultry. [f]Dairy products include eggs and dairy products.
Source: Zhang and Wang (2003), with 3,500 households for whole China in 1998; Liu and Chern (2003), with unknown households for Shandong, Jiangsu and Guangdong in 1998; Yen, Fang, and Su (2004), with 3,715 households for entire China in 2000; and Gould, B. W. (2002), with 5,273 households between 1995 and 1997 for Jiangsu, Shandong, and Guangdong.

ESSAY II

AN ANALYSIS OF HOUSEHOLD FOOD CONSUMPTION PATTERNS BY INCOME GROUPS

Introduction

The rapid economic growth in China has been accompanied by an increase in income inequality since the late 1970s when China initiated its economic reforms. According to World Bank, the Gini index, the most commonly used measure of inequality within an income distribution, has increased from 0.26 in 1984 to 0.38 in 1992 and to 0.47 in 2004 in China, substantially above one for other Asian countries and approaching the very high values found in Latin America (table II-1). Although the high Gini index for China has been attributed in part to rural-urban income gap, it is widely acknowledged that considerable income inequality has existed and been widening within both intra-rural and intra-urban households in the past two decades (Fang, Zhang, and Fan 2002; Khan and Riskin 2005; Gale and Huang 2007). For instance, in the distribution of income among rural families, the share of the bottom 20% of households declines from 7.4% in 1995 to 6.3% in 2004, whereas the share of the top 20% of households rises from 41.7% to 43.5% (National Bureau of Statistics, China (NBS) 2005a). The similar trend occurs in the distribution of income among urban households. The share of the bottom 20% of households decreases from 11.1% in 1995 to 7.5% in 2004; the share of top 20%

of households increases from 32.6% to 40.8%; and that of top 10% from 18.8% to 25.6% (NBS 2005b).

The increase in income inequality has led to the emerging of the newly rich class, mainly including the entrepreneurs, technicians, and some government officials (Chang 2002), and of the population in poverty who mainly consists of farmers in remote mountain areas and retired and laid-off workers from state- and collective-owned enterprises (Fang, Zhang, and Fan 2002; Tang 2003). The new rich class, often referred to as an emerging “middle class,” is the focus of marketing efforts of food companies, retailers, restaurants, and product distributors in China; while the population in poverty is the target of the government’s anti-poverty policies and programs. There is a research gap in the existing literature in understanding food demand by income categories. More specifically, there is a need to investigate how the rich versus the poor respond to economic factors such as changes in price and income.

There exists a myriad of studies that focus on the effects of changing household consumption patterns resulting from rapidly increasing household income on food demand in China; however, there have been very few studies that address the impact of income inequality on price and income elasticities for household food demand in China. Han and Wahl (1998), with a data set accounting for 10% of households in the national sample for rural household survey conducted by NBS in 1993, examined rural household consumption behavior by different income groups. Cai et al. (1998) used aggregate time-series data from NBS’s urban household surveys from 1985 to 1995 to analyze urban household demand for meats by three income groups. Guo et al. (2000) with time-series of cross-sectional data for 1989, 1991, and 1993 from the China Health and Nutrition

Survey for eight provinces investigated the changing food consumption behavior of urban households resulting from changes in income. However, the general pattern that lower-income households respond more sensitively to price and income changes than higher-income families which has been shown for other countries (Alderman 1986) was not found by these studies for the Chinese households. Yet, the dramatic change in economic system and social welfare policies in China occurred in the second half of 1990s, which meat a transfer of the responsibility of education, health services and housing to individuals themselves. This transfer has caused a diversion of expenditures from consumer goods to services and from present consumption to savings for protection against future uncertainty. These changes in socioeconomic settings suggest that using the early 1990s data to measure the parameters of food demand models would not be an accurate reflection of the current situation and would have limited value for policy purpose and marketing activities.

In this light, the objective of this study is to estimate price and income elasticities for food commodities by levels of income using the 2004 NBS's urban household survey data for Jiangsu province, China. More specifically, this study estimates an incomplete demand system separately for low-, medium-, and high-income groups of Chinese urban households. The null hypothesis of this study is that urban households share a common demand function. Jiangsu province is one of China's major provinces. Its GDP shares account for more than 9 percent of national levels. Jiangsu's urban per capita disposable income was ranked seventh among thirty-one provinces in 2004 (NBS 2005b). Similar to urban China as a whole, the income distribution in urban Jiangsu is heavily skewed. In 2004, the bottom 10% of the sample population obtained less than 3% of total income, while the top 10% of the sample population obtained more than 27% of total income.[12] Hence, an understanding of urban household food consumption patterns in Jiangsu, particularly the impact of income inequality on food demand, could provide useful insights about the nation's situation.

The emerging urban middle class accounts for about 10% of urban households all over the China (Gale 2006), while the urban households in poverty make up 5% of urban households (Tang 2003). Because of the relative small size of data set used for this study, this study cannot provide estimates of demand elasticities exactly for the rich (i.e., the top 10% of households) and the poor (i.e., the bottom 5% of households). This study can, by examining food consumption patterns by low-, medium-, and high-income households, shed light on basic patterns of how low- and high-income households respond to price and income changes, respectively. Further, if the income elasticities for higher income households are significantly different than those for lower income households, food commodity demand projections in urban China, where visible changes have occurred in income distribution, should be based on estimates of demand elasticities by income strata rather than for the population as a whole. Similarly, if consumption response to food price changes depends on the household's income levels, it is possible to trace the impact of food price changes on food demand of a specific population group, say, population in poverty or "middle class" in urban China. Such information is critical both for policymakers to design a more appropriate food policy and for market strategists to develop a more suitable marketing program targeted at a specific population group.

The remainder of this study is organized as follows. The econometric model used in this study is presented in Section II. The data used for this study are described in

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[12] See table III-2 in Essay III.

Section III. Section IV discusses estimation procedures and statistical tests related to system misspecification and structure change. Section V provides estimates of price and income elasticities by income groups. A welfare analysis with respect to price changes is performed and discussed in the section VI. The summary and conclusion are in the Section VII.

Model Specification

The LINQUAD model, an incomplete demand system approach, which was developed by LaFrance (1990),[13] is used for estimating the demand systems of 10 food groups across income classes for urban households in Jiangsu, China. The LINQUAD model, which is derived from a quasi-expenditure function, is linear in income and linear and quadratic in prices. Contrary to the complete demand systems that rely on separability to analyze a subset of the total number of goods that are purchased by consumers, the incomplete demand system used in this study, the LINQUAD model, avoids the usual two-stage budgeting procedure used in many food consumption studies. Moreover, the quasi-indirect utility function that generates the LINQUAD model permits the calculation of exact welfare measures due to changes in the prices of the foods of interest. Additionally, the LINQUAD model preserves the theoretical consistency of the incomplete demand system, allows for more flexibility, and imposes less structure on the preferences underlying the demand system by including quadratic price terms in its specification (Agnew 1998; Fang and Beghin 2002).

[13] This section adapts from LaFrance and Hanemann (1989), LaFrance (1990) and Agnew (1998).

Incomplete Demand System- LINQUAD Model

Let $\mathbf{x} = [x_1,...,x_n]'$ be a vector of non-negative consumption levels of the goods of interest and $\mathbf{p} = [p_1,..., p_n]'$ be the corresponding price vector; let $\mathbf{x}^o = [x_1^0,..., x_m^0]'$ be a vector of non-negative consumption levels of all other goods and $\mathbf{q} = [q_1,..., q_m]'$ be the corresponding price vector; and let income be y. Then, the observed demand functions are given by

(1) $\mathbf{x} = \mathbf{h}(\mathbf{p}, \mathbf{q}, y)$.

Additionally, there is a set of demand functions $\mathbf{x}^{\mathbf{0}} = \hat{\mathbf{h}}(\mathbf{p}, \mathbf{q}, y)$, but these are not observed and they do not necessarily have the same functional forms as the demands for $\mathbf{x}$. If $m = 1$, the demand function for x_1^o can be derived from (1) by using the adding-up condition. If $m>1$, then (1) is an incomplete demand system; and, since the demands for the elements of $\mathbf{x}^{\mathbf{0}}$ are not known, it is not possible to recover the complete preference relation.

It is well known that maximizing an increasing, quasi-concave utility function, $u(\mathbf{x}, \mathbf{x}^{\mathbf{0}})$, subject to $\mathbf{x}\geq 0$, $\mathbf{x}^{\mathbf{0}}\geq 0$, and the budget constraint, $\mathbf{p}'\mathbf{x} + \mathbf{q}'\mathbf{x}^{\mathbf{0}} \leq y$, is identical to the following properties for a complete system of demand functions:

(a) demands are positively valued, $\mathbf{h}(\mathbf{p}, \mathbf{q}, y)\geq 0$;

(b) demands are homogeneous of degree zero in all prices and income, $\mathbf{h}(\mathbf{p}, \mathbf{q}, y) \equiv \mathbf{h}(t\mathbf{p}, t\mathbf{q}, ty)\geq 0$ for all $t \geq 0$.

(c) the $n \times n$ Slutsky matrix, $\partial\mathbf{h}/\partial\mathbf{p}' + \partial\mathbf{h}/\partial y * \mathbf{h}$, is symmetric, negative semidefinite.

(d) total expenditure is exhausted by the sum of the expenditures on the individual demands.

If a subset of this complete set of demand functions is considered separately from the whole, the four properties only change slightly. That is, for an incomplete demand system, (a') the demands in (1) are positively valued; (b') the demands in (1) are homogeneous of degree zero in all prices and income; (c') the n × n sub-matrix of Slutsky substitution terms for demands in (1) is symmetric and negative semidefinite; and (d') income is greater than total expenditures on the demands in (1). These properties of an incomplete demand system, concerned only with demand for **x**, are equivalent to the complete set of demands that would include $\mathbf{x}^{\mathbf{0}}$, except in the last property. The last property is the essence of an incomplete demand model; only part of the consumer's budget is allocated to the consumption of **x**. Hence, the main source of information loss in an incomplete demand model is because of the fact that the adding-up condition does not apply to a subset of the goods consumed.

A theoretical link between complete and incomplete system is accomplished with a composite commodity encompassing all other goods. Expenditure on this composite good is defined as $s = \mathbf{q}'\mathbf{x}^0 \equiv y - \mathbf{p}'\mathbf{h}(\mathbf{p}, \mathbf{q}, y)$. With a properly defined utility function and the price of s normalized to one, duality applies to the incomplete system just as if it were a complete system. The four properties of incomplete demands and this new budget identity are equivalent to the existence of an expenditure function, $e(\mathbf{p}, \mathbf{q}, u)$, that is increasing and concave in **p**, linearly homogenous in **p** and **q**, and satisfies the adding-up condition. That is,

(2) $$e(\mathbf{p}, \mathbf{q}, u) \equiv \mathbf{p}'\mathbf{h}[\mathbf{p}, \mathbf{q}, e(\mathbf{p}, \mathbf{q}, u)] + \sigma[\mathbf{p}, \mathbf{q}, e(\mathbf{p}, \mathbf{q}, u)]$$

where σ = s. Because the functional form for the composite commodity of other goods is unknown, this approach implicitly relaxes the assumption of uniformity of functional form that commonly holds in demand system theory. This further increases the generality of incomplete demand systems.

This relationship between an incomplete demand system with *n* goods and a complete system with *n+1* goods and a numeraire composite commodity for the last good greatly simplifies the analysis of incomplete demand systems (LaFrance 1990). If the *n* demands for **x** satisfy properties (a') to (d') then there exists the quasi-expenditure function $\epsilon[\mathbf{p}, \mathbf{q}, \theta(\mathbf{q}, u)]$ that is linearly homogenous in **p** and **q**, and increasing and concave in **p**. The quasi-expenditure function is related to the expenditure function by the identity

(3) $e(\mathbf{p}, \mathbf{q}, u) \equiv \epsilon[\mathbf{p}, \mathbf{q}, \theta(\mathbf{q}, u)]$

where $\theta(\mathbf{q}, u)$ is the arbitrary constant of integration for the partial differential equation system and is a function of the prices of the other goods, **q**, and the level of utility, *u*, but not **p** (LaFrance and Hanemann 1989). The quasi-expenditure function that generates the LINQUAD model is given by

(4) $\varepsilon(\mathbf{p}, \mathbf{q}, \theta) = \boldsymbol{\alpha}'\mathbf{p} + .5\mathbf{p}'\mathbf{B}\mathbf{p} + \delta(\mathbf{q}) + \theta(\mathbf{q}, u)\exp(\boldsymbol{\gamma}'\mathbf{p})$

where **p** is now the vector of deflated prices, i.e., $[p_1/\pi(\mathbf{q}),..., p_n/\pi(\mathbf{q})]$, where $\pi(\mathbf{q})$ is a known, twice continuously differentiable, positive valued, non-decreasing, linearly homogeneous, concave function of other prices **q**; $\delta(\mathbf{q})$ is an arbitrary real valued function of all variables in **q**; and **α**, **B**, and **γ** are the parameters to be estimated.

Applying Shepherd's lemma generates demands of form as

(5) $\mathbf{x} = \boldsymbol{\alpha} + \mathbf{B}\mathbf{p} + \boldsymbol{\gamma}[\theta(\mathbf{q}, u)\exp(\boldsymbol{\gamma}'\mathbf{p})]$.

Solving the original quasi-expenditure function (4) for [$\theta(\mathbf{q}, u)\exp(\boldsymbol{\gamma}'\mathbf{p})$], and replacing expenditure with *y* for income, results in the final LINQUAD model (LaFrance 1990; Agnew 1998) as

(6) $\mathbf{x} = \boldsymbol{\alpha} + \mathbf{Bp} + \gamma[y - \boldsymbol{\alpha}'\mathbf{p} - .5\mathbf{p}'\mathbf{Bp} - \delta(\mathbf{q})]$.

This demand model is quite flexible with respect to the price and income elasticities compared to other forms of incomplete demand system such as the linear, log-linear, and semi-log incomplete demand system models (LaFrance 1985, 1990; Haefen 2002). For instance, individual income coefficients in equation (6) may be positive, negative or zero, and the matrix of price effects in equation (6), $\partial\mathbf{x}/\partial\mathbf{p} = \mathbf{B} - \gamma[\boldsymbol{\alpha} + \mathbf{p}'\mathbf{B}]$, is not necessarily symmetric, so that there is no requirement that the demands for **x** are homothetic (LaFrance 1990).

The restriction on demand of homogeneity of degree zero in prices and income is fulfilled by deflating all prices for **x** and income by the price index - $\pi(\mathbf{q})$. Since Slutsky substitution matrix is $\mathbf{B} + [y - \boldsymbol{\alpha}'\mathbf{p} - .5\mathbf{p}'\mathbf{Bp} - \delta(\mathbf{z})]\gamma\gamma'$, symmetry of the Slutsky matrix is determined by **B**. Thus, symmetry of the Slutsky substitution terms is imposed by setting $\mathbf{B}_{ij} = \mathbf{B}_{ji}$ (Agnew 1998). The adding-up condition, that is, the sum of expenditure shares equal to one, does not apply to an incomplete demand system, for total expenditures related to goods in **x** are smaller than total income.

The LINQUAD model with quantities consumed as left-hand side variables implies that the error terms are heteroskedastic (Agnew 1998). To avoid this source of heteroskedasticity, the deflated expenditures are used as the left-hand side variable, which is accomplished by multiplying both sides of each equation by its corresponding real price (Agnew 1998). In addition, the arbitrary value function, $\delta(\mathbf{q})$[14], is set to zero and include demographic variables encompassing region, household size, ratio of the number of seniors to total household members, ratio of the number of kids to total household members, and ratio of food-away-from-home (FAFH) expenditures to total food expenditures as regressors in the expenditure equations. The system of equations to be estimated in this study is given by

(7) $e_i = p_i[\boldsymbol{\alpha}_i + \mathbf{A}_i\mathbf{z} + \mathbf{B}_i\mathbf{p} + \boldsymbol{\gamma}(y - \boldsymbol{\alpha}'\mathbf{p} - \mathbf{p}'\mathbf{A}\mathbf{z} - .5\mathbf{p}'\mathbf{B}\mathbf{p})] + u_i$, with $i = 1, \ldots, 10$,

where the subscript i refers to food group i, $\mathbf{B}_i$ and $\mathbf{A}_i$ are the corresponding row of matrices $\mathbf{A}$ and $\mathbf{B}$, z is a set of demographic variables, and u is the error term assumed to be normally distributed, $N(0, \Sigma)$. Matrix $\mathbf{A}$ contains the parameters related to shift parameters z and their interaction with prices in the quasi-expenditure function (Agnew 1998).

The Marshallian (uncompensated) own- and cross-price elasticities (η_{ii} and η_{ij}) associated with equation (7) are given by

(8) $\eta_{ii} = [\beta_{ii} - \gamma_i(\alpha_i + \mathbf{A}_i\mathbf{z} + \mathbf{B}_i\mathbf{p})]p_i/x_i$, $i = 1, \ldots, 10$,

and

(9) $\eta_{ij} = [\beta_{ij} - \gamma_i(\alpha_j + \mathbf{A}_j\mathbf{z} + \mathbf{B}_j\mathbf{p})]p_j/x_i$, $j = 1, \ldots, 10$,

where β_{ij} denotes the ijth element of matrix $\mathbf{B}$.

The income elasticities (ε_i) are given by

(10) $\varepsilon_i = \gamma_i y_i / x_i$.

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[14] $\delta(\mathbf{z})$ in the LINQUAD model is similar to α_0 in the almost ideal demand system (AIDS) developed by Deaton and Muellbauer (1980). Other values can be chosen without influencing the estimated price and income response very much (Fang and Beghin 2002).

Consistent Two-Step Procedure

The data set used for this study indicates that some food categories have missing observations. The fact that the observed expenditures cannot take on negative values means that the dependent variables are censored (Heien and Wessells 1990). Estimation techniques that fail to accommodate the censoring of the dependent variables lead to biased estimates (Park et al. 1996). In order to account for zero dependent variables, the consistent two-step (CTS) estimation procedure for systems of equations with limited dependent variables, proposed by Shonkwiler and Yen (1999), was used in this study. The CTS is computationally simple and provides consistent parameter estimates.

Drawing on the mathematical notation used by Shonkwiler and Yen (1999), the system of equations with limited dependent variables is given

(11) $$y_{ih}^{*} = f(x_{ih}, \theta_i) + \varepsilon_{ih}, \; d_{ih}^{*} = z_{ih}^{'} \tau_i + \upsilon_{ih},$$

$$d_{ih} = \begin{cases} 1 & if \quad d_{ih}^{*} > 0, \\ 0 & if \quad d_{ih}^{*} \leq 0, \end{cases} \; y_{ih} = d_{ih} y_{ih}^{*},$$

(i = 1, 2, 3, 4; h =1, 2, …, 920)

where subscripts i and h denote, respectively, equation number and household observation, y_{ih} and d_{ih} are the observed dependent variables, y_{ih}^{*} and d_{ih}^{*} are corresponding latent variables, x_{ih} and z_{ih} are vectors of exogenous variables, θ_i and τ_i are parameter vectors, and ε_{ih} and υ_{ih} are random errors. Shonkwiler and Yen (1999) proved that the system of equations (10) can be rewritten as

(12) $$y_{ih} = \Phi(z'_{ih} \tau_i) f(x_{ih}, \theta_i) + \delta_i \phi(z'_{ih} \tau_i) + \xi_{ih},$$

where $\Phi(z'_{ih}\,\tau_i)$ and $\phi(z'_{ih}\,\tau_i)$ are the standard normal cumulative distribution functions (CDF) and the standard normal probability density functions (PDF), respectively, δ_i is the parameter to be estimated, and ξ_{ih} is the error term and equals $y_{ih} - E(y_{ih} | x_{ih}, z_{ih})$.

The system (12) can be estimated by a two-step procedure using all observations. First, using the binary outcome $d_{ih} = 1$ and $d_{ih} = 0$ for each *i*, the maximum likelihood (ML) probit estimates $\hat{\tau}_i$ of τ_i were obtained. The estimated $\hat{\tau}_i's$ are then used to calculate $\Phi(z'_{ih}\,\hat{\tau}_i)$ of $\Phi(z'_{ih}\,\tau_i)$ and $\phi(z'_{ih}\,\hat{\tau}_i)$ of $\phi(z'_{ih}\,\tau_i)$ for each household. Second, the calculated $\Phi(z'_{ih}\hat{\tau}_i)$ and $\phi(z'_{ih}\hat{\tau}_i)$ in the first step are augmented in equation (12) to generate a model as

(13) $$y_{ih} = \Phi(z'_{ih}\,\hat{\tau}_i) f(x_{ih}, \theta_i) + \delta_i \phi(z'_{ih}\,\hat{\tau}_i) + \xi_{ih},$$

where $\xi_{ih} = \varepsilon_{ih} + [\Phi(z'_{ih}\tau_i) - \Phi(z'_{ih}\hat{\tau}_i)] f(x_{ih}, \theta_i) + \delta_i [\phi(z'_{ik}\alpha_i - \phi(z'_{ih}\hat{\alpha}_i)]$. Therefore, the estimated equations for the LINQUAD system for food groups that have zero observations take on the following form for each household

(14) $$e_i = \Phi_i \{p_i[\boldsymbol{\alpha}_i + \mathbf{A}_i\mathbf{z} + \mathbf{B}_i\mathbf{p} + \boldsymbol{\gamma}(y - \boldsymbol{\alpha}'\mathbf{p} - \mathbf{p}'\mathbf{A}\mathbf{z} - .5\mathbf{p}'\mathbf{B}\mathbf{p})]\} + \delta_i \phi_i + \xi_i,$$

where Φ_i, ϕ_i, and ξ_i are generalized expressions of $\Phi(z'_{ih}\hat{\tau}_i)$, $\phi(z'_{ih}\hat{\tau}_i)$, and ξ_{ih} in the equation (13), respectively.

The augmented LINQUAD model (equation (14)) is intrinsically heteroscedastic because the incorporation of Φ_i and ϕ_i from the probit model in the first-step estimation introduces heteroscedasticity into the second-step estimation (Shonkwiler and Yen 1999; Greene 2004).

Welfare Measurement

One of the most useful properties of the LINQUAD quasi-expenditure function is its complete characterization of the included goods with respect to prices and income. This result allows exact welfare measures to be obtained from the quasi-indirect utility function (LaFrance 1991). The quasi-indirect utility function corresponding to the quasi-expenditure function that generates the LINQUAD model is derived as follows,

(15) $\epsilon[\mathbf{p}, \mathbf{q}, \theta(\mathbf{q}, \mathbf{z}, \mathrm{u})] = \mathrm{y}$

where z represents demographic variables. Thus, the quasi-indirect utility function associated with the LINQUAD quasi-expenditure specification is

(16) $\theta(\mathbf{q}, \mathbf{z}, \mathrm{u}) = \varphi(\mathbf{p}, \mathbf{q}, \mathbf{z}, \mathrm{y})$.

The quasi-indirect utility function is related to the true indirect utility function, $\mathrm{v}(\mathbf{p}, \mathbf{q}, \mathrm{y})$, by identity

(17) $\mathrm{v}(\mathbf{p}, \mathbf{q}, \mathrm{y}) = \psi(\mathrm{q}, \varphi(\mathbf{p}, \mathbf{q}, \mathbf{z}, \mathrm{y})$,

where $u = \psi(\mathrm{q}, \theta)$ is the inverse of $\theta(\mathbf{q}, \mathbf{z}, \mathrm{u})$ with respect to u. Hence, the equation (17) shows that the quasi-indirect utility function contains all the information available regarding prices, **p**, of goods included in the demand system and income, y. As a result, all compensated changes in prices are fully contained in $\varphi(\mathbf{p}, \mathbf{q}, \mathbf{z}, \mathrm{y})$.

The equivalent variation (EV) that is denoted as the change in income that would generate the equivalent change in utility as the price changes is defined as

(18) $\varphi(\mathbf{p^0}, \mathbf{q}, \mathbf{z}, \mathrm{y} + ev) = \varphi(\mathbf{p^1}, \mathbf{q}, \mathbf{z}, \mathrm{y})$.

where $\mathbf{p^0}$ and $\mathbf{p^1}$ are vectors of prices of **x** before and after the price change, respectively Because

(19) $\varphi(\mathbf{p}, \mathbf{q}, \mathbf{z}, \mathrm{y}) \equiv \theta(\mathbf{q}, \mathbf{z}, \mathrm{u}) = [\mathrm{y} - (\boldsymbol{\alpha}'\mathbf{p} + \mathbf{p}'\mathbf{Az} + .5\mathbf{p}'\mathbf{Bp} + \delta(\mathbf{z}))]\exp(-\boldsymbol{\gamma}'\mathbf{p})$,

where $\delta(\mathbf{z})$ is an arbitrary real valued function of all variables in **z** and **q**. Thus, the EV identity becomes

$$(16)\quad [y + EV - \boldsymbol{\alpha}'\mathbf{p^0} - \mathbf{p^{0'}Az} - .5\mathbf{p^{0'}Bp^0} - \delta(\mathbf{z}))]\exp(-\boldsymbol{\gamma}'\mathbf{p^0})$$

$$= [y - \boldsymbol{\alpha}'\mathbf{p^1} - \mathbf{p^{1'}Az} - .5\mathbf{p^{1'}Bp^1} - \delta(\mathbf{z}))]\exp(-\boldsymbol{\gamma}'\mathbf{p^1}).$$

Solving for EV then gives

$$(17)\quad EV = [y - \boldsymbol{\alpha}'\mathbf{p^1} - \mathbf{p^{1'}Az} - .5\mathbf{p^{1'}Bp^1} - \delta(\mathbf{z})]\exp[\gamma'(\mathbf{p^0} - \mathbf{p^1})]$$

$$- [\mathbf{y} - \boldsymbol{\alpha}'\mathbf{p^0} - \mathbf{p^{0'}Az} - .5\mathbf{p^0Bp^0} - \delta(\mathbf{z})].$$

Similar to the estimation of the LINQUAD system, the arbitrary value function, $\delta(\mathbf{z})$, is also set to zero when calculating EV.

Data Source and Description

The data set used for this study is collected and provided by NBS for Jiangsu province in 2004. The NBS conducts a nationwide urban household survey annually. As an official statistical activity, the urban household survey collects extensive socio-economic information on income, consumption, employment, housing, demographics, education, and asset ownership. Essay I gives detailed introduction to the survey. Unlike most income and expenditure surveys that cover only a short period of time, China's survey captures expenditures and consumptions via a diary kept by the household over the course of an entire year. Thus, the data set used for this analysis reflects actual consumption patterns of a household during an entire year.

The sample of households selected for the survey in Jiangsu province has a total of 5,000 households, representing 0.56 percent of total urban households in the province in 2004. However, the data set used for this study has only a total of 922 households, which were drawn systematically from the 5,000 sample households. After deleting two households with missing observations for more than six food items, the data set for 920 households was actually used for this study.

Can the data set for the 920 households be used to represent the entire urban households in Jiangsu province? This question equivalently asks representation of the data set for the 920 households over the entire urban sample (i.e., 5,000 households) in Jiangsu. Table I-2 reports a comparison of per capita expenditures for each of 10 food groups examined in this study between the 920 households and the 5,000 households across seven income classes. First, comparing the means of key variables that are generated from the 920 households with the published averages based on the 5,000 sample households, it is found that most are consistent except for expenditures for dairy products. For instance, the difference in per capita expenditures for grains between the two data sets is only 1.4% (228 yuan vs. 225 yuan). The difference in expenditures for meats is almost equal. On the contrary, there is relatively a large difference in the estimate of expenditures for dairy products. The estimate of average annual per capita expenditure for dairy products based on the 920 households is 126 yuan, whereas it is 144 yuan based on the 5,000 households, a gap of 18 yuan or a difference of 12.8%. Second, while most food items across income classes are consistent between the two data sets, several food items across income classes are apparently different between the two data sets. For example, the differences in per capita expenditures for dairy products between the two data sets are more than 10% in five of seven income classes. The similar situation exists also for alcoholic products. Third, the changing trend of per capita expenditures across income classes between the two data sets is basically similar for oils & fats, poultry, aquatic products, dairy products, vegetables, and fruits, while small differences in the changing trend of per capita expenditures across income classes between the two data sets occur in grains, meats, eggs, and alcoholic products. For instance, the estimate of per capita expenditures for aquatic products presents an increasing trend as income rises. In contrast, the per capita expenditures for grains in the data set for the 5,000 households increase between the 0-10th percentile and the 40-60th percentile and then decrease as income increases; whereas the grain expenditures in the data set for the 920 households increase between the 0-10th percentile class and the 40-60th percentile and then decrease from the 40-60th class to the 80-90th percentile and finally increase in the 90-100th class. Therefore, it should take caution to apply the estimates based on the data set for 920 households to the situation in urban Jiangsu and China.

The 10 food groups that were consumed at home in this study are defined as follows: grains, including rice, wheat flour, coarse grain, and grain product (mainly including wheat products such as bread); oils and fats; meats, including pork, beef, mutton, other meats such as rabbits, and meat products; poultry, including chicken, duck, other poultry, and poultry products; eggs, including fresh eggs and egg products; aquatic products including fish, shrimp, and other aquatic products; dairy products, including fresh milk, milk-powder, and yogurt; vegetables, including fresh and dried vegetables; fruits, including fresh fruits, fresh melon, dried fruits, fruit and melon products, and nuts and fruit nuts; and alcoholic products, including Chinese liquor, wine, beer, and other alcoholic beverages. Average total expenditures for the above commodity groups account for 78.0 percent of total expenditures for food that was consumed at home and 65.5 percent of total food expenditures, respectively.

Households report their food expenditures and the physical quantities pertaining to their food consumption in the survey diary. The prices were calculated by dividing the consumer expenditure of a food category by its corresponding quantity. The data set used for this study had some missing observations. More specifically, there were no data available for oils & fats, poultry, eggs, aquatic products, dairy products, fruits, and alcoholic products for 5.9%, 1.0%, 0.4%, 0.4%, 10.9%, 0.2%, and 14.7% of households, respectively. These non-purchases could be due to no preference, but they could also be caused by infrequent food purchases by consumers and the fact that the timing of the survey may not have taken pace at the time that the consumers buy those food items. This second reason is not relevant because the data are from a household's diary for food consumption/expenditures over an entire year. These missing observations for these food groups lead to missing prices for the food groups at some data points. The missing prices arising due to zero consumption were estimated by performing a regression with the data on the price of the food category from those households who did consume it. The independent variables included in these regressions are demographic variables such as region, city size, household age structure, and ratio of FAFH expenditures to total food expenditures, as well as household income. The regressions were then used to estimate the missing prices for those households which did not consume that particular category.

The city's urban consumer price index (UCPI) in Jiangsu province was used to deflate the prices of the 10 food groups examined in this study and total living expenditure that is a measure of income in this study. Because prices for the 10 food groups considered in this study are a very small component of the UCPI, the price index for other food items and non-food items within a household budget is nearly perfectly correlated with the UCPI. The thirteen city's UCPIs, representing price indexes for 13 cities in Jiangsu province, can be functioned as $\pi(q)$ that is the price index for other goods mentioned in model section in this study. Each UCPI is normalized at one in 2003.

The principal goal was to measure the effects of income level upon household food consumption patterns. To accomplish this goal, households in the data set were regrouped into low-, medium-, and high-income groups based on per capita disposable incomes, each category accounts for 25 percent, 50 percent, and 25 percent, separately, of households used for this study. Table II-3 presents summary statistics on per capita incomes, per capita total living expenditures, and per capita quantities consumed, as well as prices of food groups examined in this study. First, income disparity among the three income groups is substantial. For example, per capita income for the high-income households is 5 times as much as the low-income families although the difference in household's total living expenditures is only 3 times between the high- and low-income groups. Second, per capita consumption of most food categories increases as per capita incomes increase except for grains, oils & fats, and alcoholic products which increase first then decrease as incomes increase. Finally, prices of the 10 food groups are higher for higher income households. For example, the price for grains for the low-income households is 3.0 yuan/kg while it becomes 3.4 yuan/kg for the high-income households. The pattern that prices of food items are higher for higher income households suggests that higher-income families tend to pay higher prices for food commodities with higher quality and services compared to lower-income families.

Demographic variables included in the LINQUAD model are as follows: *SOUTH*, a binary variable representing a household located in the south of Yangtze River;

HHSIZE, household size; *OLD*, proportion of number of family members aged 61 and above to household size; *KID*, proportion of number of kids aged 17 and below to household size; and *FAFHR*, ratio of expenditures for FAFH to total food expenditures. One category was omitted from each household characteristic to avoid singularity due to the use of binary variables. Thus, reference households correspond to those that reside in the North. In addition, household income in the LINQUAD systems is measured by total household living expenditure, i.e., household income net of savings. The summary statistics about the demographic variables are also reported in table II-3.

An analysis of the composition of the three income groups as exhibited in table II-3 revealed some differences. First, more households in higher income groups lived in the south than in the north, which is consistent with the fact that the south is more economically developed than the north in Jiangsu province. Second, more households in higher income groups lived in large- and medium-size cities, which suggests that urbanization levels are correlated positively with income levels of households in Jiangsu. Third, households in lower income group had larger family size, more kids, but fewer old people. This implies that lower income household had more people with labor age as compared to higher income households, suggesting that lower income households may be composed of mainly unemployed residents' families due to restructuring economy in recent years in China. Finally, as an important and increasing part of food expenditures, the ratio of FAFH expenditures to total food expenditures is considerably high for the high-income group, with about 12 percent points higher than one for the low-income group.

Estimation Procedure and Statistical Tests

The estimation procedures, system misspecification tests, and structural change (Chow) tests are described below separately.

Estimation Procedure

As described in section three, there are 7 food groups that have zero observations. However, the consistent two-step (CTS) estimation procedure was only used for estimating equations for oils & fats, dairy products, and alcoholic products, because the percentage of zero observations to total households in the other 4 food groups is quite low and is thus ignored.[15] Hence, the first-step probit model was estimated first separately for oils & fats, dairy products, and alcoholic products using maximum likelihood to obtain the standard normal probability density functions (PDF) and the standard normal cumulative distribution functions (CDF). The second-step LINQUAD models (equation (14)) using the estimated PDF's and CDF's from the first-step probit estimations for the three food groups, along with the LINQUAD models (equation (7)) for the other 7 food groups, were estimated using the nonlinear seemingly unrelated regressions (SUR) with imposition of symmetry. All the regressions above were run separately for the low-, medium-, and high-income groups.

[15] Additionally, ignoring zero observation problems for the 4 food groups, namely poultry, eggs, aquatic products, and fruits, increases the degrees of freedom in the second-step LINQUAD estimations using GMM. This guarantees the convergence of the non-linear LINQUAD system.

Misspecification tests

McGuirk et al. (1995) proposed system misspecification tests for multi-equation linear regression models (MLRM) to test the assumptions of normality of the error terms, joint conditional mean (no autocorrelation, appropriateness of functional form, parameter stability), and joint conditional variance (static and dynamic homoskedasticity, and variance stability). Because this study used the multi-equation non-linear regression models (MNLRM) with cross-sectional data, the system misspecification tests in this study focused on tests for normality and static homoskedasticity of error terms. The normality test for an individual equation was performed with the Shapiro-Wilk W test, and the system normality test for all the 10 equations was conducted with Mardia's skewness test and kurtosis test and the Henze-Zirkler test. The system static homoskedasticity test was performed with the modified Breusch-Pagan test. Both normality and homoskedasticity tests were conducted in Model Procedure in SAS program.

The p-values from the full-system tests are reported in tables II-4, II-5 and II-6 Results show that the assumptions of normality of error terms for all equations for the low-, medium-, and high-income groups are rejected at the 5% significance level. Moreover, results indicate that the homoskedasticity assumption of conditional variance of error terms for most equations for the low- and medium-income groups using the LINQUAD model is rejected at the 5% significance level. Yet, results indicate the failure to reject homoskedasticity assumption of conditional variance of error terms for most equations for the high-income group. Because the second-step regression is heteroscedastic in the consistent two-step procedure for a censored system (Shonkwiler and Yen 1999), the modified Breusch-Pagan tests used may have low power in detecting heteroscedasticity problem. Hence, it is concluded that at least the equations for oils & fats, dairy products, and alcoholic products are heteroscedastic because they are estimated using equation (14) which is intrinsically heteroscedastic. To correct for heteroscedasticity together with nonnormality problem, the LINQUAD models were regressed using the Generalized Method of Moments (GMM) separately for the low-, medium-, and high-income groups with imposition of symmetry. The GMM is robust to nonnormality requirement and gives consistent covariance estimates when the error terms are not homoskedastic (Greene 2004).

Structural Change Tests

The null hypothesis to be tested is that households share a common demand function. The commonly used F-test for stable parameters between the first and second half of the sample is the Chow test. An important assumption made in using the Chow test is that the disturbance variance is the same in both regressions. If the assumption does not hold, the Chow test can not be applied to the test for stable parameters. Table II-7 and II-8 report the results for the F-tests for the equal variances and the Chow tests across income groups. For the low-income group versus the higher-income group that combines the medium- and high-income groups, results indicate that the null hypothesis of equal variance for the two regressions is rejected at the 5% significance level for most equations for food groups considered. For the medium-income group versus the high-income group, results show that the null hypothesis of equal variance within the two data sets is rejected at the 5% significant level for all equations except for those for oils & fats, poultry, eggs, and vegetables. Thus it is not valid in using the Chow test for stable parameters across income groups in this study.

Thus this study turns to use a Wald test proposed by Andrews and Fair (1988) that is valid whether or not the disturbance variances are the same. Suppose that $\hat{\mathbf{A}}_1$ and $\hat{\mathbf{A}}_2$ are two consistent and asymptotically normally distributed estimators of a parameter based on independent samples, with asymptotic covariance matrices $\mathbf{U}_1$ and $\mathbf{U}_2$. Then, under the null hypothesis that the true parameters are the same, $\hat{\mathbf{A}}_1 - \hat{\mathbf{A}}_2$ has mean zero and asymptotic covariance matrix $\mathbf{U}_1 + \mathbf{U}_2$. Under the null hypothesis, the Wald statistic,

(18) $\boldsymbol{W} = (\hat{\mathbf{A}}_1 - \hat{\mathbf{A}}_2)' \times (\hat{\mathbf{U}}_1 + \hat{\mathbf{U}}_2)^{-1} \times (\hat{\mathbf{A}}_1 - \hat{\mathbf{A}}_2),$

has a limiting chi-squared distribution with K degrees of freedom (Greene 2004, p.133). Thus a test that the difference between the parameters is zero can be based on this statistic. The Wald test was performed for the low-income group versus the medium-income group, the low-income group versus the high-income group, and the medium-income group versus the high-income group, respectively. Results of the Wald test across income groups indicate that the null hypothesis in this study is rejected at the 5% significance level. Hence, it is appropriate to partition the entire households into income groups in analyzing food consumption patterns for urban households in Jiangus province of China.

Empirical Results

The first-step maximum likelihood probit estimates and log-likelihood values for oils & fats, dairy products, and alcoholic products across income groups are presented in table II-8. The second-step LINQUAD models (equation (14)) for oils & fats, dairy products, and alcoholic products, along with the LINQUAD models (equation (7)) for other seven food categories across three income groups, were estimated separately using GMM in the Model Procedure in SAS. Table II-9 presents the estimated coefficients, t-statistics associated with estimates, and adjusted R^2 of the LINQUAD demand systems across low-, medium-, and high-income groups. Notice that the R^2s for dairy products and alcoholic products for the medium- and high-income groups are negative. Since equations for these food categories are the second-step LINQUAD functions which incorporate the cdf's and pdf's obtained from the first-step probit estimations, they are transformed regressions. These regressions need not have constant terms, so the R^2s are not bounded by zero and one. Consequently, that a good fit is obtained in the transformed model such as those for dairy products and alcoholic products may be of no interest (Greene 2004).

Results in table II-9 show that the LINQUAD model fits the data well in the analysis of food demand across income classes. For the LINQUAD system for the low-income group, about 70% of demographic variables are significant at the 5% or lower levels; 68% of price variables are significant at the 5% or lower level; all the 10 income terms are significant at the 5% or lower levels. With respect to the LINQUAD system for the medium-income group, roughly 70% of demographic variables are significant at the 5% or lower levels; more than half of price variables are significant at the 5% or lower level; all the 10 income terms are significant at the 5% or lower levels. Regarding the LINQUAD system for the high-income group, about 65% of demographic variables are significant at the 5% or lower levels; more than 80% of price variables are significant at the 5% or lower level; 9 out of 10 income terms are significant at the 5% or lower levels.

To evaluate the effects of prices and incomes on food demand across income groups, the demand elasticities at the sample mean of the explanatory variables are calculated. The Marshallian own- and cross-price, and income elasticities across income groups are compared and explained separately below. Then, a comparison between this study and other studies is made in relation to own-price and income elasticity estimates. Finally, the own-price and income elasticities as estimated with the LINQUAD models are compared to those obtained using the AIDS models.

Own-Price Elasticities

The full matrix of the Marshallian (uncompensated) demand elasticities for the 10 food groups for the low-, medium-, and high-income groups are reported in table II-10, II-11, and II-12, respectively. Consistent with economic theory, all own-price elasticities across income groups are negative. With an exception of aquatic products for the medium-income group, all own-price elasticities across income groups are significant at the 5% or lower levels. Moreover, all own-price elasticities across income groups are less than one in absolute values, indicating they are inelastic in response to price changes. Among the price elasticities for all food groups across income groups, the meat category for the low-income group is the most price-responsive, having price elasticity at – 0.98; whereas the aquatic product category for the high-income group has the lowest price elasticity at – 0.11.[16]

A comparison of own-price elasticities across income groups indicates small differences for most food groups across income groups. More specifically, the absolute

[16] Own-price elasticity for aquatic products for the medium-income group is -0.07, the smallest value in absolute terms among the own-price elasticities across income groups. However, it is not significant at the 5% level.

price elasticities for most food groups for lower income households are greater than those for higher income families. The price elasticities for seven food groups for the low-income group are greater than or equal to those for the medium-income group in absolute terms. Similarly, the price elasticities for seven food groups for the medium-income groups are greater than or equal to those for the high-income group in absolute values. Of which, the absolute price elasticities for meats, poultry, aquatic products, vegetables, and fruits for the low-income group are higher than those for the medium- and high-income groups. Thus, food price changes in urban Jiangsu would lead to greater adjustments in the consumption patterns of the lower income households.

In contrast to the patterns for most food groups, the absolute price elasticities for oils & fats and eggs are consistently higher for higher income groups. More important, oils & fats and eggs are the most price-responsive to price changes among the 10 food groups for the high-income group, being -.65 and -.81, respectively. Is this because Chinese wealthier urban households tend to consume oils & fats and eggs with high-quality such as organic oils and eggs? A further study is needed to make clear what causes such a phenomenon.

Cross-Price Elasticities

Most Marshallian cross-price elasticities are significant at the 10% or lower levels. The Marshallian cross-price elasticities suggest a slight change in mix of gross substitutes and complements across income groups. That is, cross-price relationship for food groups changed slightly at different income levels. Among the 270 Marshallian cross-price elasticities, roughly 20% changed from a gross substitute (or gross complement) of a commodity to a gross complete (or gross substitute) across income groups. For instance, meat category is a gross substitute of grains for the low-income group, whereas it becomes a gross complement of grains for the high-income group. On the contrary, poultry is a complement of grains for the low-, medium-, and high-income groups. Relative to the own-price and income elasticities, the cross-price effects are less pronounced, with the largest elasticity being oils & fats with respect to meat price for the medium-income group at 0.57.

Income Elasticities

As shown in tables II-10, II-11, and II-12, all income elasticities are positive, and nearly all income elasticities are significantly at the 1% level, with an exception of the income elasticities for grains and oils & fats for the high-income group that are significant at the 8% and 23% levels, respectively. Thus, all the 10 food groups examined in this study at different income levels are classified as normal goods.

A comparison of the income elasticities indicates a clear pattern across income groups. First, the income elasticities of the 10 food groups for the high-income group are significantly lower than those for the low- and medium-income groups. Second, the income elasticities for grains, oils & fats, meats, eggs, and dairy products, accounting for a half of food groups examined in this study, are significantly lower for the low-income group than for the medium-income group, which is contrary to the expectation that lower income households respond sensitively to income changes than higher income families. However, just as Alderman (1986) notes, Engel's law – proportion of total food expenditure to total expenditure or income declines as income rises – does not mean that it holds also for a specific food item. Finally, the income elasticities for the 10 food groups are substantially small for the high-income group, and some elasticities are even close to zero. For example, income elasticity for grains is 0.06, implying that high-income households are approaching saturation level of quantity consumed of grains. The income elasticity for alcoholic products is substantially high among the 10 food groups for the high-income group, suggesting that consumption of alcoholic products grow rapidly for the high-income households compared to other food categories as household incomes increase.

Comparisons with Other Studies

Few previous studies report income (unconditional expenditure) and price (unconditional price) elasticities for Chinese urban households. The own-price and income elasticities as estimated by this study are compared with those reported by Fan, Wailes, and Cramer (1995), Wu, Li, and Samuel (1995), Gao, Wailes, Cramer (1996), Zhang, Mount, and Boisvert (2001), and Fang and Beghin (2002). The former four studies are presented in table II-15. Fang and Beghin (2002) focused on their study on demand for disaggregate oils & fats for Chinese urban households. The income elasticity estimates for aquatic products as estimated by this study fall within the range of estimates reported by the previous studies; however, the income elasticities for other food groups including grains, meats, poultry, eggs, dairy products, vegetables, fruits, and alcoholic products as reported by this study are lower than those found by the previous studies. For example, the income elasticity coefficient for aquatic products estimated by this study ranges between 0.13 and 0.45 across three income groups, falling within the range of

0.08-0.89 as reported by the previous studies. On the contrary, the income elasticity coefficients of 0.09-0.33 for vegetables estimated by this study are much lower than the estimates of 0.38-1.26 reported by the previous studies. The price elasticity coefficients for grains, meats, and vegetables estimated by this study fall within the range of estimates reported by the previous studies; whereas the price elasticity coefficients for poultry, eggs, aquatic products, fruits, and alcoholic products estimated by this study are much lower in absolute terms than those of the previous studies. For oils & fats, the price and income elasticities as reported by this study are consistent with those reported by Fang and Beghin (2002) who also use the LIQNAUD model.

Fan, Wailes, and Cramer (1995), Wu, Li, and Samuel (1995), Gao, Wailes, and Cramer (1996), and Zhang, Mount, and Boisvert (2001) analyzed food demand for Chinese households in the 1990s, the period when people's living standards were much lower than current levels. Moreover, Fan, Wailes, and Cramer (1995), Gao, Wailes, and Cramer (1996), and Zhang, Mount, and Boisvert (2001) focused on food demand of Chinese rural households which have much lower per capita incomes than urban households. The relatively low price and income elasticities as estimated by this study may be partially explained because this study focuses on urban households in 2004. Urban residents may have become less responsive to the price and income changes when they became wealthier.

Comparisons with Results Based on the AIDS Model

The AIDS models for low-, medium-, and high-income groups were estimated separately using GMM. The estimated coefficients, t-statistics associated with estimates, and adjusted R^2 of the AIDS models across low-, and medium-, and high-income groups are not reported.[17] The income elasticities for the 10 food groups in the table are transformed from the estimated total food expenditure elasticities. That is, an auxiliary linear regression of total expenditures for the 10 food groups considered in this study on total living expenditures is estimated. The income (total living expenditure) elasticity for total expenditure for the 10 food groups derived from this auxiliary regression can then be used to calculate income elasticities for food groups examined in this study as follows:

(18) $e_i = \varepsilon_i \varepsilon_y$

where e_i is income elasticity for the *i*th food group, ε_i is the total food expenditure elasticity for food group *i*, and ε_y is the income elasticity of expenditures for the 10 food groups as a whole, respectively.

The aforementioned auxiliary regression was run separately for low-, medium-, and high-income group using OLS. From these regressions income elasticities for total expenditure for the 10 food groups were calculated at the means of data. For low-income group this value was 0.566, for medium-income group this value was 0.537, and for high-income group this value was 0.346. These income elasticities for foods in this study were directly applied to equation (18) to convert all expenditure elasticities into the corresponding income elasticities.

Own-price, expenditure, and income elasticities for the 10 food groups for urban households in Jiangsu for low-, medium-, and high-income groups as estimated by the AIDS models are reported in table II-14. Similar to those based on the LINQUAD models, the income elasticties for the 10 food groups as estimated using the AIDS models

[17] However, similar results can be found in Essay III.

are significantly lower for the high-income group than for the low- and medium-income groups. However, the income elasticities for the 10 food groups as estimated using the AIDS models do not show significant differences between the low- and medium-income groups. Moreover, the income elasticities across income groups estimated using the AIDS models are consistently larger compared to those estimated with the LINQUAD models. This is particularly obvious for the estimates for the high-income group. The income elasticity estimates for all food groups except for alcoholic products with the LINQUAD models range between 0.06 and 0.13 for the high-income group, whereas the corresponding estimates with the AIDS models are between 0.28 and 0.42. For alcoholic products the income elasticity estimated with the LINQUAD model is at 0.30 while it is at 0.53 as estimated using the AIDS model.

The price elasticities derived from the AIDS models are conditional elasticities, which can not be compared with the unconditional price elasticies generated with the LINQUAD models in terms of magnitude. Thus, price elasticity comparisons are made to focus on the changing patterns of price elasticities across income groups. First, similar to the patterns as estimated with the LINQUAD models, the absolute price elasticities for most food groups with the AIDS models are greater for the low-income households than for the medium- and high-income groups. More specifically, except for the price elasticities for oils & fats, vegetables, and alcoholic products, the price elasticity estimates for other food groups are significantly larger in absolute values for the low-income group than the medium- and high-income groups. However, the pattern does not exist between the medium- and high-income groups. In other words, there are no obvious differences in price elasticity between the medium- and high-income households. Second, similar to the result based on the LINQUAD models the price elasticity for oils & fats as estimated using the AIDS models is consistently higher for higher income households in absolute values.

In conclusion, the AIDS models generate main results which are consistent with those as estimated by the LINQUAD models as follows. First, the high-income households are less sensitive to income changes for the 10 food groups than the low- and medium-income families. And second, the low-income households are more responsive to price changes for most food groups considered in this study than the medium- and high-income families.

Welfare Analysis

This study provides parameter estimates across income groups. These estimates may be used to determine the impact of changes in income distribution and in price on food demand, respectively. To illustrate, the LINQUAD estimates across income groups are used in quantifying welfare effects of changes in prices of food commodities on households that consume these commodities across income groups. The equivalent variation, EV, is reported as the yearly change in income that a consumer is willing to accept in lieu of experiencing the price changes. Consumer benefit from the price changes when the equivalent variation is positive and suffer a loss when the equivalent variation is negative. Thus, the welfare analysis based on the LINQUAD models for low-, medium-, and high-income groups can trace out the impact of food price changes on household incomes and, consequently, on food demand of households across income groups.

Two scenarios of simulation experiments are used in this study. The first scenario is to measure the per capita welfare effects of an increase in price of each food group independently. The second scenario is to estimate the per capita total welfare effects of an increase in prices of 10 food groups simultaneously. An arbitrarily selected 10% of the average price of each food group for the low-income households is used as the amount available for all cases.

Table II-16 reports per capita EVs for the two scenarios. As shown in the table, shares of welfare loss to total living expenditures are consistently higher for lower income households, although higher income households suffer more absolute welfare losses compared to lower income families as food prices increase. An increase in price of meat, for example, would lead to the per capita welfare loss equivalent to 0.86%, 0.66%, and 0.35%, respectively, of total living expenditures for the low-, medium-, and high-income households (table II-16, column 3). On the contrary, the per capita welfare loss for an increase in price of meats reaches 28 yuan for the low-income households, 40 yuan for the medium-income households, and 43 yuan for the high-income families. This is also clearly exhibited in the total welfare effects due to increases in prices. The per capita total welfare loss because of increases in prices of the 10 food groups is 123 yuan for the low-income group, 169 yuan for the medium-income group, and 190 yuan for the high-income group, respectively (table II-16, column 11). In contrast, share of welfare loss to total living expenditures due to a rise in prices for all the 10 food groups is 3.72%, 2.77%, and 1.54%, respectively, for the low-, medium-, and high-income households. Since the poor spend a larger percentage of their income on food, higher food prices have a disproportionately large impact on the poor (Timmer 1980).

Further, the welfare analysis above helps identify the food groups that are more essential in the Chinese diets. It is shown in the table that demands for grains, meats, and vegetables are easily affected by food price changes for the three income groups alike. However, the low-income households are more easily influenced by changes in these food prices compared to the medium- and high-income families, because the low-income households devoted more to these three food groups relatively to both the medium- and high-income households. The result is helpful in designing an effective food price policy or a marketing strategy aimed at a specific population group.

The results of the welfare analysis as simulated above may be used in making or assessing food policy decisions in China. Since the late 2007, inflation in China has continues to hit Chinese consumers. China's consumer price index in February 2008 increased by 8.7 percent on average over the same month in 2007. Average food prices increased by 23.3 percent specifically, average meat and poultry prices 45.3 percent (pork, 63.4 percent), edible oils 41 percent, fresh vegetables 46 percent, grain and aquatic products 13.8 percent, dairy products 16.4 percent, fresh fruits 8.7 percent, and fresh eggs 6 percent.[18] High food price benefits those farmers who produce significant market surpluses while hurting urban consumers, particularly the poor in urban areas, and farmers who must purchase most of their food from the market. Thus, the direct effect of higher food prices will tend to skew further the urban and rural income distribution in China. Therefore, the estimated welfare effects due to food price changes in this study may be used in designing food assistance program for the poor in urban areas which was initiated by some lawmakers currently in China.

[18] As reported by the United States of Agriculture ((USDA) 2008).

Summary and Conclusions

This study estimates the differences in price and income elasticities for foods at different income levels using the 2004 urban household survey data for Jiangsu, China. An incomplete demand system for 10 food groups was estimated using the LINQUAD model separately for low-, medium-, and high-income groups which are segmented based on per capita disposable incomes. Moreover, the consistent two-step (CTS) estimation procedure proposed by Shonkwiler and Yen (1999) was used to account for zero dependent variables resulting from missing values for several dependent variables.

To assure that the system specification and estimation procedures were correct, the hypotheses of homoskedaticity and normality of error terms in the LINQUAD model are tested. Results of the system misspecification tests show that normality and homoskedasticity are rejected at the 5% significance level, respectively. Thus, the models were estimated using the generalized methods of moments (GMM) which is robust to nonnormality requirement and gives consistent covariance estimates when the error terms are not homoskedastic. To test the null hypothesis of this study that households share a common demand function, the Wald statistic suggested by Andrews and Fair (1988) was used in this study. Results of the Wald test show that null hypothesis is rejected at the 5% significance level.

The major findings of this study are summarized as follows. First, results of this study show that the high-income households are less responsive to price and income changes for most food groups examined in this study compared to the low- and medium-income households in urban Jiangsu, which is consistent with the Wald test results. Hence, the empirical results also reject the null hypothesis of constant elasticities of demand for foods in urban Jiangsu, China. If the emphasis of policy analysis is focused on a specific population group, then researchers and policy-makers should use demand parameter estimates with the data set indigenous to the targeted population group, and not average estimates for the population as a whole.

Second, results of this study reveal that the income elasticities for the 10 food groups considered in this study are larger for both the low- and high-income households compared to those for the high-income households. The finding suggests that food demand in urban Jiangsu is expected to grow rapidly as the low- and medium-income household incomes increase. Hence, individual commodity demand projections should be based on income elasticities by income strata rather than those for a population as a whole in urban Jiangsu as well as in urban China, where significant changes have occurred in income distribution.

Finally, results of the welfare analysis based on the LINQUAD estimates across income groups show that higher food prices have a disproportionately large impact on the poor, which is consistent with the pattern that lower income households respond more responsively to price changes than higher income families in terms of the estimated own-price elaticities for most food groups considered in this study. The finding has an important implication in the formulation of economic development strategies targeted at raising the income of the poor in China. China needs higher food prices as an incentive to millions of small farmers to raise their agricultural productivity through adoption of modern technology. But those same higher incentive food prices will have a disproportionate impact on food consumption of the poor in the cities in China. The dilemma may be resolved through an introduction of the food assistance program for the urban poor aimed at easing the burden incurred by the high food prices. Results of the welfare analysis for urban households across income groups may be used in designing such a program for the urban poor in current China.

This study opens up discussion on the important issue of food consumption patterns for different income classes, particularly for the poor and the rich. It could be enhanced by a further partitioning of income groups with longer data set.

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Table II-1. Comparative International Income Inequality, as Measured by the Gini Index

Country	Gini Index	
	2000	2004
Asia		
Bangladesh	0.318	0.334
Korea	0.316 (1998)	-
India	0.325	0.368
Indonesia	0.342 (2002)	-
China	0.447 (2001)	0.469
Latin America		
Costa Rica	0.465	0.498 (2003)
Argentina	0.522 (2001)	0.513
Chile	0.571	0.549
Brazil	0.585 (2001)	0.570
United States	0.408	-

Note:
1. The Gini Index in 2000 is the year 2000 unless otherwise indicated.
2. Source: World Bank, World Development Indicators, 2004 and 2007, respectively. Of which, data for 2000 are directly taken from Khan and Riskin (2005).

Table II-2. Per Capita Expenditures by Income Classes in Urban Jiangsu, China, 2004

	Average	Bottom 10%	Next 10%	Next 20%	Middle 20%	Next 20%	Next 10%	Top 10%
Households in the Data Set for 920 Households								
Grains	228.2	198.5	199.4	228.8	246.6	236.1	226.5	239.2
Oils & Fats	83.4	72.0	72.4	84.1	93.0	90.2	82.4	72.0
Meats	425.1	255.4	329.1	414.8	463.6	479.8	480.8	492.5
Poultry	167.5	75.8	111.6	140.0	186.8	204.8	213.9	230.0
Eggs	73.2	55.5	64.9	72.3	78.9	78.7	74.9	78.7
Aquatic	252.9	105.5	152.3	225.6	276.8	303.5	306.4	386.7
Dairy	125.7	34.9	60.0	102.3	129.8	162.6	191.8	202.2
Vegetables	251.8	177.9	183.4	235.1	276.9	282.7	277.0	305.9
Fruits	171.3	73.2	89.2	138.8	172.5	211.1	262.6	271.4
Alcoholics	70.1	29.0	50.0	65.1	74.5	93.7	70.1	88.5
Households in the Data Set for 5,000 Households								
Grains	225.0	203.4	211.3	220.7	234.6	234.6	233.4	229.5
Oils & Fats	81.0	66.9	75.0	84.0	84.3	84.3	85.3	76.6
Meats	423.0	262.2	330.7	398.8	451.6	451.6	505.4	502.6
Poultry	165.6	71.8	105.6	147.5	177.3	177.3	220.7	226.5
Eggs	73.8	57.1	62.4	69.6	74.9	74.9	88.6	87.1
Aquatic	263.5	115.5	156.7	212.1	271.1	271.1	368.8	423.9
Dairy	144.2	39.1	77.6	109.5	148.7	148.7	223.0	228.4
Vegetables	263.7	174.4	197.6	238.9	273.8	273.8	325.8	342.0
Fruits	175.5	65.7	94.9	136.0	178.3	178.3	260.7	299.5
Alcoholics	72.0	26.4	42.1	58.41	74.84	95.49	92.34	114.0

Note:
1. Unit of expenditures is Yuan/year/capita.
2. Values for households in the data set for 920 households are calculated in light of tabulation formula.
3. Data for households in the data set for 5,000 households are from Jiangsu Statistical Yearbook, 2005.

Table II-3. Summary Statistics for Urban Households by Income Classes, Jiangsu, China, 2004

Items	Low-income	Medium-income	High-income
Per-Capita Quantities Consumed (Kg)			
Grains	71.32	76.94	73.57
Oils & fats	8.98	9.91	9.20
Meats	19.86	27.92	29.23
Poultry	7.67	12.49	13.73
Eggs	10.72	12.17	12.79
Aquatic products	14.32	20.44	23.25
Dairy products	8.92	22.60	31.77
Vegetables	103.27	115.63	121.66
Fruits	35.24	56.50	73.97
Alcoholic products	5.28	7.36	6.89
Unit Values (yuan/kg)			
Grains	2.99	3.17	3.42
Oils & fats	8.11	8.97	9.76
Meats	15.11	15.77	16.47
Poultry	12.08	13.58	14.56
Eggs	5.76	6.03	6.13
Aquatic products	9.20	12.47	14.64
Dairy products	7.47	6.91	6.81
Vegetables	1.79	2.21	2.39
Fruits	2.71	3.03	3.41
Alcoholic products	12.57	15.54	18.71
Demographic Variables			
Households in south	0.27	0.48	0.60
Large-city	7.55	11.95	11.56
Medium-city	15.56	25.66	39.56
Small-city	38.22	34.29	31.11
County-level City	38.67	28.10	17.78
Household size	3.35	2.99	2.68
OLD[a]	0.11	0.21	0.29
KID	0.18	0.14	0.11
FAFH ratio[b]	0.09	0.13	0.20
Income and Expenditures (yuan)			
Per household living expenditures	11056.75	18198.24	33079.68
Per-capita income	3984.06	8547.85	20234.56

[a] OLD and KID refer to percentage of household members aged 61 and above and aged 17 and below to total sample population, respectively,
[b] FAFH ratio refers to the ratio of expenditure on FAFH total food expenditure computed at mean within the sample households.
Source: Calculated based on the 920 households in urban Jiangsu, China, 2004.

Table II-4. System Misspecification Tests for Food Demand Model for Low-Income Group (the bottom 25% households)

Hypotheses Tested	P-value
Normality Tests	
Grains	0.0002
Oils & fats	0.7307
Meats	<.0001
Poultry	<.0001
Eggs	<.0001
Aquatic products	<.0001
Dairy products	<.0001
Vegetables	0.4389
Fruits	<.0001
Alcoholic products	<.0001
Overall test	<.0001
Homoskedasticity Test	
Grains	0.0280
Oils & fats	0.0448
Meats	0.0038
Poultry	<.0001
Eggs	0.0179
Aquatic products	<.0001
Dairy products	0.0061
Vegetables	0.0003
Fruits	<.0001
Alcoholic products	0.0002

Note:

1. Normality tests for an individual equation are conducted with the Shapiro-Wilk W test, and system test is performed with Mardia's skewness test and kurtosis test (Mardia 1980) and the Henze-Zirkler test (Henze and Zirkler 1990). Detailed introduction see "SAS help and documentation."

2. Heteroskedasticity test is performed with the modified Breusch-Pagan test in Model procedure in SAS program.

Table II-5. System Misspecification Tests for the Food Demand Model for Medium-Income Group (the middle 50% households)

Hypotheses Tested	P-value
Normality Tests	
Grains	<.0001
Oils & Fats	<.0001
Meats	<.0001
Poultry	<.0001
Eggs	<.0001
Aquatic products	<.0001
Dairy products	<.0001
Vegetables	<.0001
Fruits	<.0001
Alcoholic products	<.0001
Overall test	<.0001
Homoskedasticity Test	
Grains	0.0726
Oils & fats	0.0134
Meats	<.0001
Poultry	0.0002
Eggs	0.1036
Aquatic products	0.0022
Dairy products	<.0001
Vegetables	0.0016
Fruits	<.0001
Alcoholic products	0.0093

Note:
1. Normality tests for an individual equation are conducted with the Shapiro-Wilk W test, and system test is performed with Mardia's skewness test and kurtosis test (Mardia 1980) and the Henze-Zirkler test (Henze and Zirkler 1990). Detailed introduction see "SAS help and documentation."
2. Heteroskedasticity test is performed with the modified Breusch-Pagan test in Model procedure in SAS program.

Table II-6. System Misspecification Tests for the Food Demand Model for High-Income Group (the top 25% households)

Hypotheses Tested	P-value
Normality	
Grains	<.0001
Oils & Fats	<.0001
Meats	<.0001
Poultry	<.0001
Eggs	<.0001
Aquatic products	<.0001
Dairy products	<.0001
Vegetables	<.0001
Fruits	<.0001
Alcoholic products	<.0001
Overall test	<.0001
Homoskedasticity	
Grains	0.2837
Oils & Fats	0.2131
Meats	0.2144
Poultry	0.4818
Eggs	0.0754
Aquatic products	0.4950
Dairy products	0.3123
Vegetables	0.1572
Fruits	0.0110
Alcoholic products	0.1863

Note:

1. Normality tests for an individual equation are conducted with the Shapiro-Wilk W test, and system test is performed with Mardia's skewness test and kurtosis test (Mardia 1980) and the Henze-Zirkler test (Henze and Zirkler 1990). Detailed introduction see “SAS help and documentation.”

2. Heteroskedasticity test is performed with the modified Breusch-Pagan test in Model procedure in SAS program.

Table II-7. Structure Change Tests for the Food Demand Model for the Entire Sample

Hypotheses Tested	F-value
Equal Variance Tests	
Grains	1.1938*
Oils & fats	2.1686**
Meats	2.1804**
Poultry	2.0206**
Eggs	1.1166
Aquatic products	3.7976**
Dairy products	3.0448**
Vegetables	1.7967**
Fruits	2.4708**
Alcoholic products	3.3163**
Chow F-tests	
Grain	5.3425**
Oils & fats	0.2989
Meats	4.2718**
Poultry	2.3242**
Eggs	1.5930*
Aquatic products	2.2008**
Dairy products	9.5338**
Vegetables	1.5886*
Fruits	3.2050**
Alcoholic products	4.8654**

Note:

1. The tests are for the low-income households (the bottom households) and the higher-income households (690 households) that combines both medium- (the middle households) and high-income households (the top 25% households).
2. The "*" and "**"indicate that null hypothesis of constant variance or no structure change is rejected at the 10% and 5% significance level, respectively.

Table II-8. Structure Change Tests on the Food Demand Model for the Higher-Income Households

Hypotheses Tested	F-value
Equal Variance Tests	
Grains	1.1881*
Oils & fats	1.0731
Meats	1.1977*
Poultry	1.1237
Eggs	1.1102
Aquatic products	1.5722**
Dairy products	1.4817**
Vegetables	1.0108
Fruits	2.6249**
Alcoholic products	3.5386**
Chow F-tests	
Grains	2.1672**
Oils & fats	1.4048
Meats	6.2101**
Poultry	1.6615**
Eggs	.0193
Aquatic products	2.4451**
Dairy products	1.8668**
Vegetables	3.0001**
Fruits	1.0718
Alcoholic products	-1.3269

Note:

1. The tests are for the medium-income households (460 households) and the high-income households (230 households) within the remaining 690 households after deleting 230 low-income households.
2. The "*" and "**" indicate that null hypothesis of constant variance or no structure change is rejected at the 10% and 5% significance level, respectively.

Table II-9. First-Step Probit Estimates for LINQUAD System

Items	Low-Income Group		Medium-Income Group		High-Income Group	
	Coefficient	T-statistic	Coefficient	T-statistic	Coefficient	T-statistic
Oils & Fats						
Constant	-2.482	-0.02	7.356	1.14	-1.788	-0.31
South	-1.229	-1.70	-0.062	-0.18	0.533	1.02
Large-size city	-	-	0.395	0.80	0.092	0.14
Medium-size city	-1.182	-1.42	0.903	2.14	0.211	0.49
Small-size city	-	-	0.712	1.92	1.222	2.10
Aged between 18 and 30	-	-	0.401	0.95	0.639	1.42
Aged between 31 and 40	0.220	0.55	-0.110	-0.40	-0.001	0.00
Aged between 41 and 50	0.465	1.13	-0.282	-1.17	0.329	1.07
Aged over 61	-	-	0.381	1.42	0.532	1.88
Children between 6 and 12	-1.047	-1.94	-0.508	-1.07	0.069	0.13
Children between 13 and 17	-		0.069	0.18	0.002	0.00
Edu1	-3.361	-0.03	-0.109	-0.21	0.949	1.96
Edu2	-2.965	-0.02	-0.292	-0.59	0.937	2.00
FAFHR	-3.129	-2.08	-2.715	-3.07	-0.417	-0.39
Log price of grains	-0.781	-0.67	-0.573	-1.01	-1.250	-1.91
Log price of oils	-0.738	-0.37	0.864	1.55	-0.271	-0.40
Log price of meats	-1.144	-0.60	-0.699	-0.56	-0.173	-0.16
Log price of poultry	0.812	0.61	-0.378	-0.45	2.123	1.92
Log price of eggs	2.636	0.95	-1.731	-1.75	-0.548	-0.51
Log price of aquatic prod.	0.450	0.45	-0.106	-0.19	0.376	0.61
Log price of dairy prod.	0.993	0.99	1.384	2.38	0.107	0.25
Log price of vegetables	1.385	1.14	1.121	1.58	-0.629	-0.75
Log price of fruits	-0.099	-0.13	-0.813	-1.70	-0.680	-1.17
Log price of alcoholics	-0.568	-1.17	0.186	1.09	0.318	1.51
Log Income	0.610	1.03	-0.290	-0.55	-0.122	-0.27
Log-likelihood		-18.97		-60.94		-46.15

Source: Estimated.

(continues)

Item	Low-Income Group		Medium-Income Group		High-Income Group	
	Coefficient	T-statistic	Coefficient	T-statistic	Coefficient	T-statistic
Dairy Products						
Constant	-10.394	-2.09	-5.263	-1.07	-1.055	-0.11
South	0.227	0.56	-0.211	-0.68	-0.783	-1.22
Large-size city	-0.428	-0.74	-0.017	-0.04	-0.872	-0.98
Medium-size city	-0.232	-0.54	0.916	2.45	-0.427	-0.50
Small-size city	-0.307	-1.18	0.480	1.77	-1.044	-1.23
Aged between 18 and 30	-0.137	-0.68	0.217	0.77	0.182	0.31
Aged between 31 and 40	0.248	1.18	-0.299	-1.26	-0.368	-0.86
Aged between 41 and 50	0.105	0.66	-0.300	-1.87	-0.396	-1.31
Aged over 61	-0.303	-1.60	-0.183	-1.19	0.333	1.03
Children under 5	0.296	0.77	0.263	0.47	3.853	0.02
Children between 6 and 12	0.404	1.14	0.986	1.91	0.214	0.31
Children between 13 and 17	-0.218	-0.94	0.730	2.25	4.133	0.10
Edu1	-0.264	-0.47	-0.049	-0.10	0.275	0.40
Edu2	-0.454	-0.80	-0.067	-0.15	0.608	0.89
FAFHR	2.390	1.62	-0.110	-0.11	-1.432	-0.96
Log price of grains	1.028	1.69	2.048	2.14	4.540	2.19
Log price of oils	1.056	1.06	0.805	1.73	-1.084	-1.47
Log price of meats	0.701	0.56	0.262	0.23	-0.110	-0.05
Log price of poultry	0.066	0.10	0.816	1.59	-0.748	-0.47
Log price of eggs	-0.263	-0.21	-0.694	-0.73	0.931	0.56
Log price of aquatic prod.	0.993	1.85	-0.263	-0.55	0.985	0.91
Log price of dairy prod.	0.153	0.56	0.037	0.14	0.256	0.44
Log price of vegetables	0.647	1.11	0.472	0.80	-0.150	-0.13
Log price of fruits	-0.855	-2.57	-0.332	-1.04	-0.114	-0.17
Log price of alcoholics	-0.345	-2.35	0.115	0.82	-0.097	-0.38
Log Income	0.570	1.88	0.154	0.41	-0.063	-0.08
Log-likelihood		-96.34		-94.12		-29.17

Source: Estimated.

(continues)

Item	Low-Income Group		Medium-Income Group		High-Income Group	
	Coefficient	T-statistic	Coefficient	T-statistic	Coefficient	T-statistic
Alcoholic Products						
Constant	-3.192	-0.75	-5.037	-1.32	0.145	0.03
South	-0.105	-0.31	0.512	1.95	-0.459	-1.23
Large-size city	-0.299	-0.65	-0.552	-1.65	-0.213	-0.41
Medium-size city	0.308	0.79	0.021	0.08	-0.672	-1.69
Small-size city	0.000	0.00	0.019	0.08	-0.910	-2.06
Aged between 18 and 30	-0.105	-0.51	-0.021	-0.09	0.258	0.87
Aged between 31 and 40	-0.033	-0.16	-0.047	-0.27	0.299	1.24
Aged between 41 and 50	0.033	0.21	0.114	0.81	0.040	0.21
Aged over 61	-0.015	-0.08	-0.027	-0.21	0.093	0.57
Children under 5	0.648	1.39	-0.301	-0.82	-0.211	-0.38
Children between 6 and 12	0.364	1.08	-0.041	-0.12	-0.997	-2.34
Children between 13 and 17	0.111	0.46	-0.371	-1.49	-0.700	-1.72
Edu1	0.478	1.14	-0.300	-0.74	0.629	1.65
Edu2	0.196	0.46	-0.577	-1.47	0.646	1.76
FAFHR	-0.815	-0.92	-0.224	-0.32	-0.563	-0.70
Log price of grains	0.786	1.18	0.234	0.49	0.314	0.51
Log price of oils	-0.034	-0.05	-0.516	-1.48	-0.331	-0.77
Log price of meats	0.180	0.19	1.265	1.69	-1.143	-1.33
Log price of poultry	0.292	0.47	0.402	0.93	0.160	0.20
Log price of eggs	-0.499	-0.43	1.211	1.63	-1.009	-1.21
Log price of aquatic prod.	-0.413	-0.90	-0.783	-2.11	0.542	1.15
Log price of dairy prod.	0.186	0.72	-0.192	-0.93	0.013	0.04
Log price of vegetables	-0.573	-1.01	-0.501	-1.21	-0.621	-0.95
Log price of fruits	0.289	0.86	0.028	0.10	0.223	0.48
Log price of alcoholics	0.085	0.54	0.067	0.59	0.033	0.22
Log Income	0.327	1.11	0.331	1.05	0.464	1.35
Log-likelihood		-103.33		-150.03		-88.39

Source: Estimated.

Table II-10. Second-Step Estimates of the LINQUAD Systems

Items	Low-Income Group		Medium-Income Group		High-Income Group	
	Coefficient	T-statistic	Coefficient	T-statistic	Coefficient	T-statistic
Grains						
Intercept	325.1249	12.41	304.3712	8.70	248.4485	8.46
SOUTH	-19.9101	-1.80	2.3694	0.25	15.8577	1.57
HHSIZE	36.9803	6.59	45.0200	5.96	38.4952	4.27
KID	-0.9246	-0.05	87.1638	6.25	61.5041	4.28
OLD	-94.3701	-2.54	-126.3560	-3.93	-85.1794	-2.79
FAFHR	-271.0410	-11.83	-275.1130	-6.46	-174.9300	-7.16
Price of grains	-38.3414	-25.43	-46.2609	-9.08	-15.4043	-7.05
Price of oils & fats	-3.7293	-8.79	-2.3979	-3.48	-2.0849	-3.44
Price of meats	1.2274	2.15	-0.3595	-0.35	-1.1802	-2.08
Price of poultry	-2.1670	-5.51	-0.8863	-1.36	-2.1203	-4.44
Price of eggs	-3.4337	-5.65	-2.2585	-3.18	-0.6423	-0.99
Price aquatic products	-0.8662	-2.28	0.5178	0.74	-1.5772	-4.22
Price of dairy products	-0.6234	-1.10	0.2265	0.30	2.7720	3.15
Price of vegetables	-33.7179	-10.58	-17.3612	-5.44	-2.3126	-0.72
Price of fruits	15.3340	12.94	-2.0500	-0.79	-5.9415	-2.56
Price of alcoholic products.	0.6511	4.60	-0.2843	-1.45	0.2701	2.72
Expenditure	0.0036	4.46	0.0048	5.81	0.0003	1.76
Adjusted R^2		0.1209		0.2040		0.0126

Source: Estimated.

(Continues)

Items	Low-Income Group		Medium-Income Group		High-Income Group	
	Coefficient	T-statistic	Coefficient	T-statistic	Coefficient	T-statistic
Oils & Fats						
Φ *Intercept	29.5366	4.70	53.4128	9.55	26.5857	4.26
Φ *SOUTH	0.3033	0.20	1.4807	0.84	-0.1314	-0.07
Φ *HHSIZE	4.1612	4.82	3.2697	3.24	4.6993	4.06
Φ *KID	0.0742	0.03	7.4737	2.61	0.8440	0.34
Φ *OLD	-9.3812	-1.81	6.5520	1.14	-3.4414	-0.62
Φ *FAFHR	-40.9995	-8.44	-51.9675	-5.86	-15.6277	-3.43
Φ *price of grains	-3.7293	-8.79	-2.3979	-3.48	-2.0849	-3.44
Φ *price of oils & fats	-1.3419	-7.57	-1.6418	-13.92	-1.7920	-12.10
Φ *price of meats	0.8112	3.67	-1.0244	-4.81	-0.2135	-1.21
Φ *price of poultry	0.1190	0.60	0.0754	0.51	0.6195	4.31
Φ *price of eggs	-0.0244	-0.10	0.2626	1.50	-0.8496	-4.44
Φ *price aquatic products	-0.2070	-1.28	-0.4193	-3.23	-0.3852	-3.69
Φ *price of dairy products	0.1580	2.16	-0.2863	-2.71	1.0696	4.95
Φ *price of vegetables	-3.9650	-3.38	-1.1532	-1.90	1.4372	1.81
Φ *price of fruits	0.8300	1.75	2.6374	4.43	2.1737	4.64
Φ *price of alcoholic products.	0.0997	1.82	-0.0354	-0.94	0.0701	2.74
Φ *expenditure	0.0007	5.56	0.0008	5.25	0.0000	1.21
ϕ	103.8455	2.38	-129.2990	-3.17	-41.6260	-1.33
Adjusted R^2		0.2511		0.1869		0.0664

Note: Φ 's and ϕ 's indicate the standard normal cumulative distribution function (cdf) and the standard normal probability density functions (pdf) estimated in the first-step regressions.
Source: Estimated.

(Continues)

Items	Low-Income Group		Medium-Income Group		High-Income Group	
	Coefficient	T-statistic	Coefficient	T-statistic	Coefficient	T-statistic
Red Meats						
Intercept	57.7280	6.14	69.9338	7.18	85.8001	10.02
SOUTH	5.5002	1.93	0.1354	0.04	-2.2022	-0.59
HHSIZE	9.6558	7.55	15.5229	8.42	8.1862	4.48
KID	15.3985	2.75	11.6885	2.77	6.2528	1.43
OLD	-14.8900	-1.81	-23.9107	-2.57	-7.2716	-0.73
FAFHR	-87.8064	-12.19	-156.2340	-12.62	-90.9579	-11.86
Price of grains	1.2274	2.15	-0.3595	-0.35	-1.1802	-2.08
Price of oils & fats	0.8112	3.67	-1.0244	-4.81	-0.2135	-1.21
Price of meats	-4.2352	-12.40	-2.3238	-5.81	-2.1670	-8.46
Price of poultry	1.0848	4.46	-0.3908	-1.60	0.5891	3.10
Price of eggs	0.4913	1.60	0.6617	2.31	-0.6212	-2.11
Price aquatic products	1.2309	6.38	0.5664	2.55	-0.4701	-3.56
Price of dairy products	-0.2037	-1.08	-0.3092	-1.62	-0.7984	-3.92
Price of vegetables	0.2603	0.16	-0.5520	-0.47	-4.6661	-5.54
Price of fruits	-0.8425	-1.50	0.7494	0.94	12.2265	13.21
Price of alcoholic products.	-0.0002	0.00	0.1139	1.72	-0.0240	-0.54
Expenditure	0.0019	8.82	0.0021	8.00	0.0003	4.60
Adjusted R^2		0.3382		0.3946		0.3026

Source: Estimated.

(Continues)

Items	Low-Income Group		Medium-Income Group		High-Income Group	
	Coefficient	T-statistic	Coefficient	T-statistic	Coefficient	T-statistic
Poultry						
Intercept	5.1229	0.87	30.7571	4.85	14.5880	2.08
SOUTH	12.5068	5.82	16.1641	6.93	9.1066	3.47
HHSIZE	3.4667	4.01	7.4299	7.33	8.0436	6.72
KID	0.4703	0.18	7.6757	3.01	6.2719	2.13
OLD	2.8552	0.56	-4.6749	-0.82	-12.1769	-2.14
FAFHR	-52.7188	-11.27	-47.9720	-8.40	-45.5503	-8.08
Price of grains	-2.1670	-5.51	-0.8863	-1.36	-2.1203	-4.44
Price of oils & fats	0.1190	0.60	0.0754	0.51	0.6195	4.31
Price of meats	1.0848	4.46	-0.3908	-1.60	0.5891	3.10
Price of poultry	-1.4327	-6.52	-1.7152	-5.46	-0.7764	-2.34
Price of eggs	-0.3373	-1.29	-0.2621	-1.05	-0.4295	-1.55
Price aquatic products	0.6795	3.35	-0.1376	-0.89	-0.6524	-5.83
Price of dairy products	0.0530	0.62	0.4051	1.77	-0.3681	-2.60
Price of vegetables	2.3240	1.94	1.4227	1.79	2.3363	2.23
Price of fruits	0.5192	1.23	-0.0758	-0.14	2.9485	5.78
Price of alcoholic products.	0.1072	2.46	0.1247	2.44	0.1108	2.39
Expenditure	0.0006	3.93	0.0007	4.82	0.0001	3.98
Adjusted R^2		0.2474		0.2581		0.2572

Source: Estimated.

(Continues)

Items	Low-Income Group		Medium-Income Group		High-Income Group	
	Coefficient	T-statistic	Coefficient	T-statistic	Coefficient	T-statistic
Eggs						
Intercept	59.0031	8.51	45.0237	7.06	73.6673	10.47
SOUTH	2.6331	1.79	-1.6785	-1.00	2.0276	1.11
HHSIZE	5.3860	6.59	5.3394	4.80	7.4827	7.32
KID	2.6984	0.94	11.5340	5.14	6.5998	2.78
OLD	-0.9108	-0.18	-11.2521	-2.48	-7.0818	-1.28
FAFHR	-32.0474	-6.67	-58.7666	-8.96	-31.2488	-5.78
Price of grains	-3.4337	-5.65	-2.2585	-3.18	-0.6423	-0.99
Price of oils & fats	-0.0244	-0.10	0.2626	1.50	-0.8496	-4.44
Price of meats	0.4913	1.60	0.6617	2.31	-0.6212	-2.11
Price of poultry	-0.3373	-1.29	-0.2621	-1.05	-0.4295	-1.55
Price of eggs	-4.3281	-4.84	-3.5887	-9.36	-4.5210	-8.84
Price aquatic products	1.1645	6.22	0.1123	0.65	0.4965	3.21
Price of dairy products	0.0974	0.78	-0.5830	-4.31	-0.0047	-0.04
Price of vegetables	-9.8140	-5.41	-5.6667	-5.68	-3.3530	-2.76
Price of fruits	-1.8575	-3.41	2.1951	3.25	-1.4845	-2.72
Price of alcoholic products.	-0.0153	-0.39	0.0147	0.35	0.0485	1.98
Expenditure	0.0006	3.32	0.0008	6.56	0.0001	4.43
Adjusted R^2		0.1521		0.2018		0.0792

Source: Estimated.

(Continues)

Items	Low-Income Group		Medium-Income Group		High-Income Group	
	Coefficient	T-statistic	Coefficient	T-statistic	Coefficient	T-statistic
Aquatic Products						
Intercept	-5.5277	-0.67	11.1621	1.29	52.1710	6.10
SOUTH	1.1308	0.49	-7.6415	-2.13	-5.8987	-1.36
HHSIZE	6.8714	5.21	8.9559	5.38	10.7194	6.44
KID	18.6821	4.02	13.7225	3.11	3.7781	0.78
OLD	-7.7265	-0.98	-17.6276	-2.05	-52.9966	-5.68
FAFHR	-92.2602	-12.44	-110.0870	-10.00	-72.3928	-9.56
Price of grains	-0.8662	-2.28	0.5178	0.74	-1.5772	-4.22
Price of oils & fats	-0.2070	-1.28	-0.4193	-3.23	-0.3852	-3.69
Price of meats	1.2309	6.38	0.5664	2.55	-0.4701	-3.56
Price of poultry	0.6795	3.35	-0.1376	-0.89	-0.6524	-5.83
Price of eggs	1.1645	6.22	0.1123	0.65	0.4965	3.21
Price aquatic products	-1.7526	-10.55	0.0395	0.17	-0.4485	-4.66
Price of dairy products	0.2709	1.87	0.5780	2.26	0.4803	1.76
Price of vegetables	2.8874	2.57	0.2553	0.27	0.6551	0.93
Price of fruits	2.3366	5.65	3.6370	6.79	6.9761	8.59
Price of alcoholic products.	-0.0590	-0.86	-0.0493	-0.87	-0.0518	-2.49
Expenditure	0.0020	6.81	0.0015	7.22	0.0002	5.11
Adjusted R^2		0.4558		0.3736		0.3133

Source: Estimated.

(Continues)

Items	Low-Income Group		Medium-Income Group		High-Income Group	
	Coefficient	T-statistic	Coefficient	T-statistic	Coefficient	T-statistic
Dairy products						
Φ *Intercept	14.5532	1.94	74.6449	5.58	62.7243	4.01
Φ *SOUTH	8.5213	2.00	8.8227	1.84	25.9928	3.97
Φ *HHSIZE	1.9711	1.39	-0.0711	-0.03	3.3472	0.78
Φ *KID	-1.8397	-0.24	12.1541	1.87	-0.0379	-0.01
Φ *OLD	25.8683	2.94	8.4020	0.54	99.7416	4.21
Φ *FAFHR	22.8614	2.40	-80.1077	-5.21	-63.0928	-3.19
Φ *price of grains	-0.6234	-1.10	0.2265	0.30	2.7720	3.15
Φ *price of oils & fats	0.1580	2.16	-0.2863	-2.71	1.0696	4.95
Φ *price of meats	-0.2037	-1.08	-0.3092	-1.62	-0.7984	-3.92
Φ *price of poultry	0.0530	0.62	0.4051	1.77	-0.3681	-2.60
Φ *price of eggs	0.0974	0.78	-0.5830	-4.31	-0.0047	-0.04
Φ *price aquatic products	0.2709	1.87	0.5780	2.26	0.4803	1.76
Φ *price of dairy products	-1.0829	-7.13	-3.6931	-13.40	-3.3690	-10.09
Φ *price of vegetables	0.9235	1.15	-0.2713	-0.30	-3.8516	-4.13
Φ *price of fruits	0.7193	1.54	-2.4424	-3.39	2.6708	3.41
Φ *price of alcoholic products.	0.0734	0.76	0.0256	0.31	0.0011	0.02
Φ *expenditure	0.0014	5.73	0.0027	7.28	0.0003	2.67
ϕ	-85.3184	-2.24	-421.2790	-4.54	156.2945	1.12
Adjusted R^2		-0.0292		-0.1292		-0.1446

Note: Φ 's and ϕ 's indicate the standard normal cumulative distribution function (cdf) and the standard normal probability density functions (pdf) estimated in the first-step regressions.

Source: Estimated.

(Continues)

Items	Low-Income Group		Medium-Income Group		High-Income Group	
	Coefficient	T-statistic	Coefficient	T-statistic	Coefficient	T-statistic
Vegetables						
Intercept	460.8639	9.41	354.1122	10.06	390.2976	11.45
SOUTH	42.5940	2.96	17.2955	1.32	26.9578	1.94
HHSIZE	40.9751	7.22	46.4811	6.68	45.9147	7.45
KID	55.4760	2.27	116.7253	6.76	45.8299	3.07
OLD	-71.2115	-1.74	-136.4090	-3.84	-270.2910	-7.89
FAFHR	-504.8830	-14.71	-541.4380	-13.11	-450.6580	-17.62
Price of grains	-33.7179	-10.58	-17.3612	-5.44	-2.3126	-0.72
Price of oils & fats	-3.9650	-3.38	-1.1532	-1.90	1.4372	1.81
Price of meats	0.2603	0.16	-0.5520	-0.47	-4.6661	-5.54
Price of poultry	2.3240	1.94	1.4227	1.79	2.3363	2.23
Price of eggs	-9.8140	-5.41	-5.6667	-5.68	-3.3530	-2.76
Price aquatic products	2.8874	2.57	0.2553	0.27	0.6551	0.93
Price of dairy products	0.9235	1.15	-0.2713	-0.30	-3.8516	-4.13
Price of vegetables	-101.5730	-9.23	-40.9823	-12.89	-39.7292	-7.05
Price of fruits	10.1857	3.00	-1.3310	-0.48	13.1049	4.51
Price of alcoholic products.	0.7704	3.13	0.3586	1.72	0.1167	0.83
Expenditure	0.0079	8.42	0.0063	7.19	0.0009	4.76
Adjusted R^2		0.4054		0.4291		0.4447

Source: Estimated.

(Continues)

Items	Low-Income Group		Medium-Income Group		High-Income Group	
	Coefficient	T-statistic	Coefficient	T-statistic	Coefficient	T-statistic
Fruits						
Intercept	14.0213	0.71	136.3111	5.64	-130.6200	-4.09
SOUTH	7.2522	1.25	2.8627	0.43	-12.1244	-0.97
HHSIZE	15.4873	5.76	5.5134	1.25	26.3894	3.98
KID	35.7887	3.65	-22.1774	-2.67	5.7291	0.42
OLD	48.5245	2.81	-48.0032	-2.30	-88.5491	-2.34
FAFHR	-154.6270	-11.65	-161.7650	-6.59	-189.1840	-5.86
Price of grains	15.3340	12.94	-2.0500	-0.79	-5.9415	-2.56
Price of oils & fats	0.8300	1.75	2.6374	4.43	2.1737	4.64
Price of meats	-0.8425	-1.50	0.7494	0.94	12.2265	13.21
Price of poultry	0.5192	1.23	-0.0758	-0.14	2.9485	5.78
Price of eggs	-1.8575	-3.41	2.1951	3.25	-1.4845	-2.72
Price aquatic products	2.3366	5.65	3.6370	6.79	6.9761	8.59
Price of dairy products	0.7193	1.54	-2.4424	-3.39	2.6708	3.41
Price of vegetables	10.1857	3.00	-1.3310	-0.48	13.1049	4.51
Price of fruits	-25.5986	-20.45	-26.2476	-11.85	-27.4026	-12.13
Price of alcoholic products.	-0.0345	-0.26	-0.1106	-0.72	-0.0510	-0.29
Expenditure	0.0047	10.46	0.0046	7.97	0.0006	2.67
Adjusted R^2		0.2093		0.2697		0.1497

Source: Estimated.

(Continues)

Items	Low-Income Group		Medium-Income Group		High-Income Group	
	Coefficient	T-statistic	Coefficient	T-statistic	Coefficient	T-statistic
Alcoholic Products						
Φ *Intercept	-10.2442	-2.11	13.7956	3.24	21.1970	5.08
Φ *SOUTH	3.9954	2.26	-0.4859	-0.36	1.8760	0.96
Φ *HHSIZE	4.5020	5.54	-0.4114	-0.49	-0.5575	-0.45
Φ *KID	1.0311	0.34	2.0579	0.87	0.8908	0.25
Φ *OLD	-2.4810	-0.43	1.7403	0.33	13.2697	1.90
Φ *FAFHR	-17.6841	-3.77	-16.9167	-2.72	-22.2086	-4.06
Φ *price of grains	0.6511	4.60	-0.2843	-1.45	0.2701	2.72
Φ *price of oils & fats	0.0997	1.82	-0.0354	-0.94	0.0701	2.74
Φ *price of meats	-0.0002	0.00	0.1139	1.72	-0.0240	-0.54
Φ *price of poultry	0.1072	2.46	0.1247	2.44	0.1108	2.39
Φ *price of eggs	-0.0153	-0.39	0.0147	0.35	0.0485	1.98
Φ *price aquatic products	-0.0590	-0.86	-0.0493	-0.87	-0.0518	-2.49
Φ *price of dairy products	0.0734	0.76	0.0256	0.31	0.0011	0.02
Φ *price of vegetables	0.7704	3.13	0.3586	1.72	0.1167	0.83
Φ *price of fruits	-0.0345	-0.26	-0.1106	-0.72	-0.0510	-0.29
Φ *price of alcoholic products.	-0.2114	-4.34	-0.2345	-6.11	-0.1354	-7.27
Φ *expenditure	0.0008	5.03	0.0005	4.11	0.0002	3.82
ϕ	140.0614	2.27	84.0337	0.97	-256.3420	-4.75
Adjusted R^2		0.0919		-0.1764		-0.0521

Note: Φ ’s and ϕ ’s indicate the standard normal cumulative distribution function (cdf) and the standard normal probability density functions (pdf) estimated in the first-step regressions.
Source: Estimated.

Table II-11. Estimated Marshallian Price and Income Elasticities for Low-Income Groups

	Grains	Oils & Fats	Meats	Poultry	Eggs	Aquatic Products	Dairy Products	Vegetable	Fruits	Alcoh. Products
Price Elasticities										
Grains	-0.491**	-0.126**	0.069*	-0.114**	-0.085**	-0.038**	-0.016	-0.262**	0.172**	0.029**
	0.020	0.014	0.036	0.020	0.015	0.015	0.014	0.025	0.014	0.006
Oils & fats	-0.388**	-0.355**	0.395**	0.042	-0.009	-0.071	0.028**	-0.250**	0.072*	0.035**
	0.042	0.046	0.111	0.080	0.048	0.050	0.014	0.070	0.043	0.019
Meats	0.034	0.088**	-0.979**	0.189**	0.038	0.161**	-0.020	-0.011	-0.038*	0.002
	0.025	0.026	0.078	0.044	0.027	0.027	0.016	0.043	0.023	0.010
Poultry	-0.271**	0.030	0.624**	-0.680**	-0.080	0.235**	0.009	0.147*	0.052	0.044**
	0.046	0.060	0.143	0.103	0.059	0.072	0.019	0.084	0.045	0.017
Eggs	-0.297**	-0.009	0.198	-0.118	-0.697**	0.294**	0.014	-0.499**	-0.142**	-0.003
	0.052	0.054	0.129	0.088	0.144	0.048	0.020	0.091	0.041	0.011
Aquatic products	-0.084**	-0.045*	0.365**	0.161**	0.133**	-0.349**	0.028*	0.083*	0.127**	-0.010
	0.024	0.026	0.061	0.051	0.023	0.032	0.017	0.042	0.024	0.015
Dairy products	-0.098*	0.029	-0.130	0.009	0.010	0.068	-0.210**	0.026	0.059	0.028
	0.058	0.020	0.095	0.035	0.024	0.045	0.029	0.049	0.043	0.033
Vegetables	-0.308**	-0.096**	-0.001	0.075*	-0.167**	0.070**	0.013	-0.540**	0.077**	0.024**
	0.028	0.027	0.070	0.042	0.030	0.030	0.013	0.057	0.027	0.007
Fruits	0.359**	0.044	-0.130*	0.043	-0.098**	0.170**	0.031	0.130**	-0.593**	0.000
	0.030	0.032	0.072	0.043	0.027	0.033	0.022	0.052	0.029	0.012
Alcoholic products	0.075**	0.031	-0.027	0.061**	-0.013	-0.046	0.019	0.049*	-0.011	-0.118**
	0.026	0.024	0.056	0.029	0.013	0.034	0.030	0.026	0.020	0.029
Income Elasticities										
Income	0.164**	0.246**	0.323**	0.277**	0.157**	0.452**	0.404**	0.253**	0.438**	0.423**
	0.037	0.044	0.037	0.070	0.047	0.066	0.071	0.030	0.042	0.084

Note: Numbers in the first row of a good are the estimated elasticities, and numbers in the second row of a good are associated standard errors. Single and double asterisks (*) denote significance at the 10% and 5% levels, respectively.

Table II-12. Estimated Marshallian Price and Income Elasticities for Medium-Income Groups

	Grains	Oils & Fats	Meats	Poultry	Eggs	Aquatic Products	Dairy Products	Vegetable	Fruits	Alcoh. Products
Price Elasticities										
Grains	-0.651**	-0.094**	-0.046	-0.064*	-0.063**	0.015	-0.002	-0.184**	-0.032	-0.021*
	0.070	0.026	0.071	0.039	0.019	0.038	0.021	0.031	0.034	0.012
Oils & fats	-0.274**	-0.477**	-0.572**	0.020	0.048	-0.193**	-0.072**	-0.107**	0.263**	-0.021
	0.074	0.034	0.113	0.068	0.036	0.054	0.023	0.046	0.061	0.018
Meats	-0.030	-0.111**	-0.465**	-0.078*	0.043**	0.069**	-0.033**	-0.035	0.021	0.015
	0.039	0.022	0.076	0.040	0.021	0.034	0.015	0.032	0.029	0.011
Poultry	-0.087	0.012	-0.184*	-0.634**	-0.046	-0.057	0.062	0.069	-0.011	0.043**
	0.056	0.034	0.104	0.114	0.040	0.052	0.039	0.048	0.043	0.019
Eggs	-0.212**	0.055	0.263**	-0.111	-0.600**	0.024	-0.111**	-0.363**	0.177**	0.002
	0.062	0.041	0.125	0.093	0.063	0.059	0.024	0.061	0.056	0.016
Aquatic products	0.011	-0.065**	0.121**	-0.044	0.006	-0.007*	0.051	-0.010	0.174**	-0.015
	0.037	0.018	0.058	0.035	0.017	0.048	0.027	0.036	0.027	0.013
Dairy products	-0.016	-0.047**	-0.114**	0.059	-0.060**	0.082*	-0.365**	-0.042	-0.119**	-0.002
	0.036	0.013	0.046	0.046	0.012	0.048	0.027	0.030	0.033	0.017
Vegetables	-0.171**	-0.033**	-0.044	0.046	-0.103**	-0.002	-0.012	-0.277**	-0.016	0.011
	0.029	0.015	0.055	0.032	0.017	0.035	0.017	0.021	0.025	0.008
Fruits	-0.056	0.125**	0.042	-0.022	0.073**	0.251**	-0.103**	-0.040	-0.478**	-0.014
	0.049	0.030	0.075	0.043	0.024	0.040	0.028	0.036	0.040	0.013
Alcoholic products	-0.056*	-0.020	0.058	0.064**	-0.001	-0.042	-0.001	0.017	-0.021	-0.151**
	0.029	0.015	0.049	0.032	0.012	0.033	0.024	0.022	0.021	0.025
Income Elasticities										
Income	0.377**	0.449**	0.451**	0.328**	0.416**	0.433**	0.673**	0.331**	0.497**	0.370**
	0.065	0.085	0.056	0.068	0.064	0.060	0.092	0.046	0.062	0.090

Note: Numbers in the first row of a good are the estimated elasticities, and numbers in the second row of a good are associated standard errors. Single and double asterisks (*) denote significance at the 10% and 5% levels, respectively.

Table II-13. Estimated Marshallian Price and Income Elasticities for High-Income Groups

	Grains	Oils & Fats	Meats	Poultry	Eggs	Aquatic Products	Dairy Products	Vegetable	Fruits	Alcoh. Products
Price Elasticities										
Grains	-0.268**	-0.094**	-0.100**	-0.157**	-0.020	-0.118**	0.091**	-0.029	-0.103**	0.021**
	0.038	0.027	0.047	0.035	0.020	0.028	0.029	0.039	0.040	0.008
Oils & fats	-0.290**	-0.645**	-0.144	0.365**	-0.211**	-0.230**	0.282**	0.139*	0.301**	0.044**
	0.084	0.053	0.118	0.085	0.048	0.062	0.057	0.077	0.065	0.016
Meats	-0.053**	-0.025	-0.459**	0.108**	-0.049**	-0.090**	-0.068**	-0.144**	0.532**	-0.005
	0.025	0.020	0.054	0.035	0.023	0.025	0.017	0.026	0.040	0.009
Poultry	-0.198**	0.149**	0.261**	-0.309**	-0.072	-0.261**	-0.066**	0.151**	0.273**	0.047**
	0.044	0.035	0.085	0.132	0.046	0.045	0.025	0.068	0.047	0.020
Eggs	-0.065	-0.221**	-0.302**	-0.184	-0.809**	0.210**	-0.002	-0.235**	-0.148**	0.022**
	0.065	0.050	0.142	0.118	0.092	0.066	0.024	0.085	0.054	0.011
Aquatic products	-0.088**	-0.056**	-0.128**	-0.154**	0.049**	-0.107**	0.049*	0.024	0.382**	-0.013**
	0.021	0.015	0.035	0.026	0.015	0.023	0.029	0.027	0.045	0.005
Dairy products	0.110**	0.111**	-0.157**	-0.064**	-0.001	0.081*	-0.259**	-0.109**	0.107**	0.000
	0.036	0.023	0.040	0.024	0.009	0.047	0.026	0.026	0.031	0.012
Vegetables	-0.025	0.039*	-0.238**	0.103**	-0.063**	0.028	-0.078**	-0.292**	0.137**	0.006
	0.034	0.022	0.043	0.047	0.023	0.032	0.019	0.041	0.030	0.007
Fruits	-0.103**	0.097**	1.014**	0.215**	-0.046**	0.514**	0.087**	0.157**	-0.472**	-0.004
	0.040	0.021	0.077	0.038	0.017	0.060	0.026	0.035	0.039	0.014
Alcoholic products	0.047**	0.032**	-0.030	0.083**	0.015*	-0.047**	-0.004	0.012	-0.011	-0.113**
	0.018	0.012	0.040	0.037	0.008	0.017	0.022	0.018	0.032	0.016
Income Elasticities										
Income	0.057*	0.041	0.119**	0.102**	0.139**	0.132**	0.105**	0.090**	0.099**	0.301**
	0.033	0.034	0.026	0.026	0.032	0.026	0.040	0.019	0.037	0.079

Note: Numbers in the first row of a good are the estimated elasticities, and numbers in the second row of a good are associated standard errors. Single and double asterisks (*) denote significance at the 10% and 5% levels, respectively.

Table II-14. Estimated Marshallian Own-Price, Expenditure, and Income Elasticities Using the AIDS System

	Conditional			Unconditional		
	Low-Income Group	Medium- Income Group	High- Income Group	Low- Income Group	Medium- Income Group	High- Income Group
Expenditure Elasticities						
Grains	0.977	0.899	1.021	0.553	0.483	0.353
Oils & fats	0.883	1.007	1.129	0.499	0.541	0.391
Meats	1.258	1.128	0.975	0.712	0.606	0.337
Poultry	1.107	1.181	1.149	0.626	0.634	0.398
Eggs	0.956	0.757	0.939	0.541	0.406	0.325
Aquatic products	1.071	1.269	1.223	0.606	0.681	0.423
Dairy products	0.629	0.816	0.857	0.356	0.438	0.297
Vegetables	0.939	0.964	0.845	0.531	0.518	0.292
Fruits	0.666	0.553	0.793	0.377	0.297	0.274
Alcoholics	0.790	1.149	1.534	0.447	0.617	0.531
Own-price Elasticities						
Grains	-1.495	-1.150	-0.951	-	-	-
Oils & fats	-0.577	-1.108	-1.519	-	-	-
Meats	-1.396	-0.921	-1.073	-	-	-
Poultry	-1.278	-1.057	-1.089	-	-	-
Eggs	-1.397	-1.172	-1.228	-	-	-
Aquatic products	-0.505	-0.249	-0.282	-	-	-
Dairy products	-1.558	-1.340	-1.456	-	-	-
Vegetables	-0.606	-0.851	-0.449	-	-	-
Fruits	-1.159	-0.906	-0.965	-	-	-
Alcoholics	-0.648	-0.821	-0.621	-	-	-

Note: Conditional elasticities are calculated directly using the formulae for the AIDS model. The unconditional expenditure elasticities, i.e., income elasticities, are estimated using the formulae in Section V, i.e., the product of the expenditure elasticities and elasticities of total expenditure on the 10 food groups with respect to total living expenditures. The latter according to the estimations are 0.566, 0.537, and 0.346, respectively for the low-, medium-, and high-income groups. In addition, all the conditional elasticity estimates above are significantly at the 1% level.

Table II-15. Comparisons with Other Studies

	Fan, Wailes, and Cramer (1995)	Gao, Wailes, and Cramer (1996)	Zhang, Mount, and Boisvert (2001)	Wu, Li, and Samuel (1995)	This study	Fan, Wailes, and Cramer (1995)	Gao, Wailes, and Cramer (1996)	Zhang, Mount, and Boisvert (2001)	This study
	-----------------Expenditure Elasticities---------------------------					------------------Own-Price Elasticities------------------------			
Grain		0.52	0.20		0.06-0.38			-0.31	-0.27- -0.65
Rice	0.50			0.37		-0.63	-0.99		
Wheat	0.77					-0.54			
Coarse grain	0.26					-0.24			
Oils & fats					0.04-0.45				-0.35- -0.64
Meats	0.90		0.672		0.12-0.45	-0.31		-0.28	-0.46- -0.98
Pork		1.15		0.44			-0.98		
Beef & mutton		0.78					-1.04		
Poultry		0.28			0.10-0.33		-0.53		-0.31- -0.68
Eggs		0.91		0.21	0.14-0.42		-0.90		-0.60- -0.80
Aquatic products		0.89	0.85	0.08	0.13-0.45		-0.81	-0.84	-0.01- -0.35
Dairy products					0.10-0.67				-0.21- -0.36
Vegetables	0.67	1.26	0.381	0.45	0.09-0.33	-0.35	-0.83	-0.15	-0.28- -0.54
Fruits		0.72		0.55	0.10-0.50		-0.96		-0.47- -0.59
Alcoholic products	1.16				0.30-0.42	-0.34			-0.11- -0.15

Table II-16. Per Capita EV for an Increase in Prices of Food Groups across Income Groups in Urban Jiangsu, China

	Grains	Oils & Fats	Meats	Poultry	Eggs	Aquatic Products	Dairy Products	Veg.	Fruits	Alcoholic Products	Total
Equivalent Variation (yuan/household)											
Low-income	-20.05	-7.18	-28.22	-8.79	-5.93	-13.45	-7.95	-17.84	-8.59	-4.49	-122.82
Medium-income	-21.92	-8.43	-40.31	-14.62	-6.71	-18.64	-18.65	-20.17	-14.76	-6.66	-168.57
High-income	-21.00	-7.71	-43.08	-15.97	-6.79	-20.97	-21.71	-21.49	-19.49	-10.96	-190.49
Share of EV to Total Living Expenditures											
Low-income	0.61	0.22	0.86	0.27	0.18	0.41	0.24	0.54	0.26	0.14	3.72
Medium-income	0.36	0.14	0.66	0.24	0.11	0.31	0.31	0.33	0.24	0.11	2.77
High-income	0.17	0.06	0.35	0.13	0.06	0.17	0.18	0.17	0.16	0.09	1.54

Note:
1. Per capita EV of an increase in price of a specific food group across income groups was calculated holding prices of other food groups constant. Of which, the amount of an increase in price of a specific food group is equal to a 10% increase in price of the food group for low-income group.
2. Per capita total EV was calculated based on an increase in prices of 10 food groups simultaneously across income groups.

ESSAY III

THE IMPACT OF CHANGES IN INCOME DISTRIBUTION ON FOOD DEMAND

Introduction

China has been one of the most rapidly developing economies in the world since the late 1970s when China initiated its economic reforms. Per capita gross domestic products (GDP) in China have grown at an annual rate of 9-10 percent in the past two decades and, consequently, the living standards of the Chinese people as a whole have improved considerably. However, the rapid economic growth has been accompanied by significant rises in income inequality. According to World Bank, the Gini coefficient, the most commonly used measure of inequality within an income distribution, has increased from 0.257 in 1984 to 0.378 in 1992 and to 0.469 in 2004,[19] approaching the very high values found in Latin America. Although the high Gini coefficient for China as a whole has been attributed partly to rural-urban income gap, it is widely acknowledged that the relative distribution of income has been moving toward inequality across both intra-rural and intra-urban households (Chang 2002; Fang, Zhang, and Fan 2002; Khan and Riskin 2005). In the distribution of income among rural families, the share of the bottom 20% of households declines from 7.4% in 1995 to 7.0% in 2000 and to 6.3% in 2004, whereas

[19] The Gini coefficient for China in 1984 and 1992 are drawn from Li and Zou (1998). The Gini coefficient in 2004 is directly from World Bank. Detailed introduction is reported in table II-1.

the share of the top 20% of households rises from 41.7% to 42.7% and to 43.5% (NBS, 2005a). The similar trend occurs in the distribution of income among urban households. The share of the bottom 20% of households decreases from 11.1% in 1995 to 9.7% in 2000 and to 7.5% in 2004; the share of top 20% of households increases from 32.6% to 35.0% and to 40.8%; and that of top 10% from 18.8% to 20.5% and to 25.6% (NBS, 2005b).

The increase in income inequality has drawn attention of researchers, international organizations, China's government, and China's society as a whole. While much research has been devoted to analyzing the causes and characteristics of income inequality (e.g., Chang 2002; Fang, Zhang, and Fan 2002; Khan and Riskin 2005) as well as the relationship between economic growth and income inequality (e.g., Li and Zou 1998), a great deal less attention has been paid to studying the potential impact of changes in income distribution on food demand. In general, income and price elasticities of demand, particularly income elasticities of demand, tend to be inversely correlated with income levels. Hence, a shift in the structure of the income distribution, with more rapid increases for the low (high) income groups than for the high (low), would generally lead to greater increases (decreases) in demand for food commodities (FAO 1972; Saleh and Sisler 1977). However, little previous literature of food commodity demand projections in China has taken into account the income distribution as a factor influencing demand. The previous studies have focused on changes in population and level of income, with the implicit assumption that the income distribution will remain stable. While this assumption may be feasible in the 1980s or the early 1990s when income distribution in China was relatively stable, it becomes questionable when China is experiencing significant changes in income distribution. If the change in income distribution affects consumption behavior and if forecasts are based on estimates of income and price elasticities which do not account for changes in income distribution, then these forecasts might give rise to incorrect predictions for economies where the distribution of income is changing rapidly. In this light, the result of this study could be very useful to policy-makers and markets interested in knowing China's future consumption needs and patterns.

Most of previous work related to the relationship between food consumption and income redistribution took place prior to the 1980s and mainly focused on Latin American countries where income distribution was seriously unequal at the time. The previous work has found that a drive toward a more equal distribution of income would lead to a substantial increase in consumer expenditures for food. In a study based on data for eleven Latin American countries in 1970 and for a selected number of agricultural commodities, FAO (1972) found that a "moderate" shift in the income distribution toward a more equal income distribution would generate an additional food demand in 1980 of 9-9.5% or 13-14% under the "drastic" hypothesis. Pinstrup-Andersen and Caicedo (1978) estimated the potential impact of changes in income distribution on food demand and human nutrition for Cali, Colombia. They indicated that changes in income distribution can effectively improve human nutrition and have a large impact on the demand for individual food commodities. For instance, the demand for cassava would increase by about 0.1% if all five income classes uniformly increase income by 1%. However, if an equal amount of income was received totally by the lowest income group, the demand for cassava would increase by more than 1%. Saleh and Sisler (1977) estimated the impact of income inequality on the demand for mutton in urban Iran at the time when Iran was experiencing changes in income distribution resulting from a rapid rise in per capita income. They found that long-term projections of demand for mutton based on average estimates of income elasticity will over-estimate future consumption as a result of failure to consider deterioration in income distribution. Their study implies that an increase in income inequality would lead to a considerable decrease in total consumer expenditures for foods. “This clearly points out the need for including changes in income distribution in demand forecasting if any such changes are expected” (Pinstrup-Andersen and Caicedo 1978, p. 412).

The overall goal of this study is to fill the gap in the literature of food demand in China and to increase understanding of the relationship between food consumption and income distribution. More specifically, this study is to estimate the impact of changes in income distribution on food demand in urban Jiangsu, China. To achieve this objective, two goals were set. The first goal is to estimate the response of food demand to household income changes across low-, medium-, and high-income groups which are segmented on the basis of per capita incomes. The second goal is to use the estimated models to project food demands across income groups under scenarios of changes in income and /or income distribution. In the next section, the general approach is outlined. Following this, the data used for this study are described. Then, the estimated response of food demand to income changes is explained. Finally, these responses are then used as a predictive device in determining the impact of changes in income distribution on food demand, followed by summary remarks and policy implications.

Methodology

The first goal of this study is to estimate the effect of household income changes on food demand. A double-log function is used to estimate the response of demand for food away from home (FAFH) and for grains, oils & fats, meats, poultry, eggs, aquatic products, dairy products, vegetables, fruits, and other foods that were consumed at home[20] that were consumed at home, respectively, to changes in income across three income groups. FAFH is an important component of increased demand for food in China as household incomes grow. More important, FAFH spending increases more rapidly than expenditures for food that was consumed at home (FAH). Ma et al. (2006) indicates that income elasticity of demand for FAFH is greater than one and increases with income levels. Thus, inclusion of FAFH in this study helps gain more knowledge on the impact of income redistribution on food demand in China..

The double-log form used in this study is defined as:

$$(1) \qquad \log(\exp_t) = f(y_t, z_t) + \mu_t$$

where $\exp_t$ represents tth household's total expenditure for FAFH; y_t is logged total disposable income of household t; z_t is the vector of demographic variables, including region, city size, household size, the proportion of number of kids aged 17 and below to total number of family members, and the proportion of number of seniors aged 61 and above to total number of family members; and μ_t is the error term.

The quadratic almost ideal demand system (QUAIDS) developed by Banks, Blundell, and Lewbel (1997) is chosen for estimating the response of demand for the 10

[20] Average expenditures for the 10 food groups account for 82.6 percent of total FAH expenditures and 69.4 percent of total food expenditures in the data set used, respectively.

food groups to expenditure changes across income groups. In addition to having the same degree of price flexibility as the usual AIDS and translog models and having the AIDS model nested within it as a special case, the QUAIDS model has the income flexibility–having leading terms that are linear in logarithmic income while including the empirically necessary rank 3 quadratic term, which provides a sufficiently general approximation to the Engel relationship in the raw micro-data (Banks, Blundell, and Lewbel 1997). The QUAIDS model is defined as

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

where subscripts *i* and *j* indicate goods, γ_{ij}, β_i, and λ_i are parameters to be estimated, p_{jt} is the price of *j*th category of household *t* in the demand system, m_t indicates *t*th household expenditure on commodity items in the system, u_{it} is the error term, the $a(p)_t$ is the price index in household *t* and defined as

$$(3) \qquad \ln a(p)_t = \alpha_0 + \sum_j \alpha_j \ln p_{jt} + \frac{1}{2}\sum_i \sum_j \gamma_{ij} \ln p_{it} \ln p_{jt},$$

the *b(p)* is the Cobb-Douglas price aggregator for household *t* and defined as

$$(4) \qquad b(p)_t = \prod_{i=1}^{n} p_{it}^{\beta_i}, \text{ and}$$

$$(5) \qquad \alpha_i = \rho_{i0} + \sum_{k=1}^{8} \rho_{ik} d_k,$$

where ρ_{i0} and ρ_{ik} are parameters to be estimated, and d_k represents *k*th household demographic variable, including those augmented in the equation (1) and the ratio of expenditures for FAFH to total food expenditures.

The second goal is to use the estimated models to project expenditures for FAFH and for each of the10 food groups across income groups under hypothetical changes in incomes and / or income distribution. To perform these projections, several assumptions are employed. First, preferences are assumed to be constant across a specific income group. Second, relative prices are held constant across a specific income group. This assumption may be interpreted as a situation where the supply elasticity is perfectly elastic or a situation where the shifts in the demand curve caused by changes in income distribution are matched by equal shifts in the supply curve. Finally, population is assumed to be unchanged. Thus, changes in expenditures for FAFH and for each of the 10 food groups are virtually assumed to be only brought by changes in incomes and/ income distribution.

Levels of total demand in each income group were then derived by multiplying the demand of each household by the number of households in each of income groups. Aggregate demand for each item was calculated as a summation of the demand for the three income groups. The impact of changes in income distribution on food demand was finally estimated via a comparison of aggregate demand between the **predicted values** that are calculated based on hypothetical changes in incomes and /or income distribution and the **fitted values** which are on the basis of estimated average consumption levels of each household with the data set for urban Jiangsu, 2004. Note that both the predicted and fitted values are a summation of the demand for the three income groups.

Data Source and Description

The data set used for this study is collected and provided by NBS for Jiangsu province in 2004. The NBS conducts a nationwide urban household survey annually.

Essay-1 gives detailed introduction to the survey. The uniqueness of this survey is that the survey data are compiled from diaries of income and expenditures kept by sample households over the course of an entire year. Thus, the data set used for this study reflects actual consumption patterns of a household during the entire year in 2004.

The sample of households selected for the survey in Jiangsu province has a total of 5,000 households. However, the data set used for this study has only a total of 902 households, which were drawn systematically from the 5,000 sample households. Comparing the means of key variables that are generated from the 902 households with the published averages based on the 5,000 sample households, it is found that most are consistent except those for FAFH spending and expenditures for dairy products (table I-3). For instance, the difference in per capita disposable incomes between the two data sets is only 2.6% (10,203 yuan and 10,481 yuan). The difference in total expenditures for the 10 food groups is almost equal. On the contrary, there is relatively a large difference in the estimate of FAFH spending and expenditures for dairy products. The estimate of average annual per capita expenditures for FAFH based on the 902 households is 455 yuan, whereas it is 524 yuan based on the 5,000 households, a gap of 69 yuan or a difference of 13.2%. The estimate of average annual per capita expenditures for dairy products based on the 902 households is 135 yuan, whereas it is 144 yuan based on the 5,000 households, a gap of 9 yuan or a difference of 6.2%. However, the averages based on the 902 households show consistency with the published averages as to relative values between urban Jiangsu and urban China as a whole. For example, average per capita FAFH spending based on the 902 households and the 5,000 households, respectively, are less than the national average, while average values for dairy products from both data sources are greater than the national average. From this point, the data set for 902 households can be used to represent the 5,000 sample households in urban Jiangsu in 2004.

Households report their food expenditures and the physical quantities pertaining to their food consumption in the survey diary. The prices were calculated by dividing the consumer expenditure of a food group by its corresponding quantity. The price calculated in this way is household specific, representing household purchase decisions. In most instances, consumers choose both the quantity and the quality of consumption simultaneously. Therefore, the calculated price should be adjusted to reflect quality variations before it can be used to estimate commodity demand functions from cross-sectional data. The quality and price adjustment follows the procedure discussed by Cox and Wohlgenant (1986). The definition of and procedure to obtain quality-adjusted prices, as well as the definition and coverage of the 10 food groups examined in this study, are explained in the Essay-I.

Table III-1 reports summary statistics in urban Jiangsu. As would be expected from casual observation, the income distribution is relatively heavily skewed. Hence, the poorest 27.8% of the sample population (low-income group) obtained only 11.2% of total income, whereas the 22.2% of population with highest incomes (the high-income group) obtained 45.5% of total incomes. The distribution of expenditures for FAFH was also found to be more skewed in favor of higher incomes compared to the corresponding income distribution. The poorest 27.8% of the sample population spent 9.3% of total expenditures for FAFH, whereas the wealthiest 22.2% of the sample population spent more than 44%. However, total food expenditures and expenditures for the 10 food groups are relatively more equally distributed across population compared with the distribution of income and of FAFH spending. For instance, the poorest 27.8% of the sample population spent 17.2% of total food expenditures, while the wealthiest 22.2% of the sample population spent 30.1%. This is expected because of subsistence requirements and government efforts focusing on providing an adequate diet.

Estimation and Results

This section briefly explains estimation procedures, presents and discusses goodness-of-fit and income elasticity estimates across income groups.

Estimation Procedure

The double-log function (1) for FAFH spending and for expenditures for the 10 food groups that were consumed at home was estimated with maximum likelihood separately for the entire sample, low-, medium-, and high-income groups.[21] As to the double-log function for expenditure for the 10 food groups that were consumed at home, the main intent is to establish a relationship of changes between in income and in the expenditure for the 10 food groups considered in this study, which is used directly for estimating the impact of income redistribution on the demand for each of the 10 food groups. Thus, there are a total of eight equations estimated in this study. Heteroskedasticity problems found in the data set were corrected with the maximum likelihood correspondingly. The estimated parameters, the associated t-statistics, and log

[21] There are 6 and 4 households that did not consume FAFH for low- and medium-income groups, respectively. Because the small number of zero observations cannot substantially bias estimates of parameters, this study directly estimate households consuming food away from home without correction zero observation problem.

likelihood for FAFH spending for the entire sample, low-, medium-, and high-income groups are presented in table III-7.

The demand system of 10 food groups, namely grains, oils & fats, meats, poultry, eggs, aquatic products, dairy products, vegetables, fruits, and other foods was estimated with the QUAIDS model using the nonlinear iterative seemingly unrelated regressions (ITSUR) with imposition of homogeneity and symmetry. The demand systems for the entire sample, low-, medium-, and high-income groups were estimated separately. The heteroskedasticities found in the data were remedied with the second modified White's heteroscedastic consistent-covariance matrix estimator (HCCME=2) in the Model Procedure in SAS. The estimated parameters, the associated t-statistics, and adjusted R^2 for 10 food groups for the entire sample, low-, medium-, and high-income groups are reported in table III-6. Notice that the coefficients for dairy-products for the entire sample, low-, medium-, and high-income groups were retrieved from the other equations using the properties of adding up, homogeneity and symmetry.

Goodness-Of-Fit

The goodness-of-fit measure used for this study is the second Theil-U statistic, i.e., Theil-U_1. The smaller the Theil-U_1 statistic, the bigger the forecasting power the model has. The detailed explanation of Theil-U_1 may be seen in Appendix-I. The Theil-U_1 statistics are reported in table III-2. As shown in the table, the Engel equations for FAFH spending have Theil-U_1 statistic between 0.18 and 0.27, much less than those for the QUAIDS models for the 10 food groups. Consequently, the Engel equations for FAFH spending perform better than the QUAIDS models for the 10 food groups in simulating endogenous variables. Additionally, the models for the entire sample generally have similar Theil-U_1 statistics to the models based on income groups, suggesting the models based on the entire sample and income groups perform equally well in simulating their corresponding values of endogenous variables.

To further examine the forecasting power of the estimated models based on income groups in simulating endogenous variables of entire sample, a comparison of difference between actual and fitted values derived from the models for entire sample and for income groups, respectively, was performed. As shown in table III-3, the difference between the actual and the fitted values based on models for entire sample (table III-3, column "a-b") is basically similar to those derived from the models (table III-3, column "a-c") for income groups. For instance, for grains, oils & fats, eggs, aquatic products, vegetables, and other foods, the models based on income groups performed better in simulating the endogenous variables for entire sample than did the models based on entire sample; on the other hand, for meats, poultry, dairy products, and fruits, the models for the entire sample are better. Thus, the weighted averages calculated using the models based on income groups are equivalent to the values as estimated by the model based on the entire sample.

Income Elasticity

The income elasticities in this study are either parameter estimates (e.g., in the double-log functions) or closely correlated with estimates of expenditure parameters (e.g., in the QUAIDS model). Thus, their magnitudes are directly related to estimation of the impact of income redistribution on food demand. Table III-4 presents income elasticities for FAFH spending and for each of the 10 food groups. Of which, the income elasticity for a specific food group is derived by multiplying the total expenditure elasticity for the 10 food groups and the corresponding expenditure elasticity for the specific food group.[22] Several findings are summarized as follows. First, the income elasticities for the 10 food groups are consistently higher for lower income groups. For instance, the income elasticities for the low-income group are between 0.31 and 0.58, while these values for the medium- and high-income groups are 0.16- 0.33 and 0.11-0.16, respectively. Thus, lower-income households respond more sensitively to income changes than high-income households, suggesting that changes in income distribution will have a significant impact on demand for foods that were consumed at home.

Second, the income elasticity for FAFH spending for the medium-income group (1.35) is larger than unity and substantially higher than those for the low- and high-income groups, whereas the elasticity of FAFH spending for the high-income group (0.90) is less than unity and significantly higher than that for the low-income group (0.59). Thus, FAFH is a luxury item for the medium-income households, while it is a necessity for both the low- and high-income families. The low-income households devoted relatively small share of their food spending to meals away from home compared to the medium- and high-income families and, consequently, their response of demand for FAFH to income growth may not be strong. The income elasticity for FAFH spending for the entire sample estimated by this study is 1.04, consistent with the findings of Ma et al. (2006) and Gale and Huang (2007). However, the income elasticities across income groups as estimated by this study differ from those reported by Ma et al. (2006) and Gale

[22] Detailed explanation on how a conditional expenditure elasticity of a commodity is transformed into the corresponding unconditional expenditure (or income) elasticity see Essay-II.

and Huang (2007). Ma et al. (2006) found that the elasticities for FAFH spending in urban China increase as household incomes increase. Gale and Huang (2007) reported that the elasticity for FAFH spending is constant across income classes.

Projection Results

This section presents and discusses scenarios for food demand projections and the impact of income redistribution on demands for FAFH spending and for each of the 10 food groups that were consumed at home.

Scenarios for Food Demand Projections

Five scenarios of hypothetically changing existing income distribution are considered: (a) increasing incomes of all three groups at a same rate, maintaining current income distribution constant; (b) increasing the incomes of the low-income group, maintaining the incomes of other income groups constant; (c) increasing the incomes of the medium-income group, maintaining the incomes of other income groups constant; (d) increasing incomes of the high-income group, maintaining the incomes of other income groups constant; and (e) redistributing current incomes from the high-income group to the low-income group, maintaining total incomes constant.

Based on work of Pinstrup-Andersen and Caicedo (1978), an arbitrarily selected 1% of total incomes is used as the amount available for distribution in all cases so as to compare the results. Because the relationship considered here are linear, the impact of changes in the income distribution of magnitudes different from 1% of total incomes may be estimated by simple extrapolation. 1% of total incomes is equal to 8.9% of incomes of the low-income group, 2.3% of those of the medium-income group, and 2.2% of incomes of the high-income group, respectively. Table III-5 presents the estimates on the present income distribution pattern and the income distribution patterns as a result of the hypothetical change in incomes and income distribution. Generally speaking, the income distribution patterns under scenarios (b) - (e) above change little compared to the actual pattern of income distribution. For instance, if an amount of 1% of total income in the data set is transferred from the high-income group to the low-income group (i.e., scenario (e)), the shares of total incomes by the low- and high-income groups rise only +1 and -1 percentage points, respectively, while the share by the medium-income group remains unchanged. However, because the major concern of this study is to examine the sensitivity of food demand to alternative income patterns, such small changes in income distribution patterns are sufficiently to determine the changes in food demand resulting from hypothetical changes in incomes and /or income distribution.

Impacts of Changes in Income Distribution on Demand for Food Groups

This part estimated the impact of changes in incomes and their distribution on demand for each of the 10 food groups that were consumed at home. This goal was accomplished first to estimate the changes in total expenditure for the 10 food groups as a result of changes in incomes and income distribution. Then, the estimated total expenditure for the 10 food groups was used to estimate the expenditure share for each of the 10 food groups using the QUAIDS model. Finally, the predicted value of the expenditure for each of the 10 food groups was derived by multiplying the predicted total expenditure for the 10 food groups and the corresponding expenditure shares for each of the food groups.

Table III-8 reports the results of the simulation in this study. First, a drive toward a more equal distribution of income would lead to an increase in demand for each of the 10 food groups in urban Jiangsu. The increase in the demand for all 10 food groups would be from 0.24 to 0.61 times higher if the total income increase was received by the low-income households rather than a uniform percentage distribution of the additional income across income-groups (table III-8, column- “All to I”). For example, the demand for meats would increase by 0.52% if all incomes were increased by 1%. However, if an equal amount of income was received totally by the low-income households, the demand for meats would increase by more than 1.13%.

Second, distribution-neutral income growth (i.e. a uniform increase in household incomes holding the current income distribution constant) would increase food demand much larger than did income growth favored higher income households. The increase in the demand for food groups would be from 0.65 to 0.85 times lower if the total income increase was received by the high-income households instead of a uniform percentage distribution of the additional income across income-groups (table III-8, column- “All to III”). For instance, the demand for meats would increase by 0.52% if all incomes were increased by 1%. Yet, if an equal amount of income was received totally by the high-income households, the demand for meats would increase by only 0.08%, a decrease of about 0.85 percentage points.

Third, income transfer from higher to lower income households have also great impacts on expenditures for food groups that were consumed at home. Hence, the transfer of an amount of income equal to 1% of total household incomes from the high-income group to the low-income group, maintaining total household incomes constant, would increase the demand for meats and eggs by about 1%; grains, oils & fats, and vegetables by more than 0.9%; and poultry, aquatic products, dairy products, fruits, and other food by 0.3% (table III-8, column- "Transfer III to I").

Impact of Changes in Income Distribution on Demand for FAFH

Changes in FAFH spending caused by the previously mentioned changes in incomes and income distribution were estimated in this part. First, different from the impact of income redistribution on expenditures for each of the 10 food groups that were consumed at home, a drive toward a more equal income distribution would lead to a slow growth in demand for FAFH. As exhibited in table III-8, a uniform 1% of increase in all household incomes, maintaining the present income distribution constant, would lead to 1.22% of rise in total FAFH spending (table III-8, column 3 and row 1); however, if this 1% of total incomes was totally received by the low-income group, the expenditures would increase by only 0.52%, a decrease of 0.70% compared with the result due to the uniform 1% of increase in incomes.

Second, distribution-neutral income growth would increase food demand much larger than did income growth favored either the high-income households or the low-income households. More specifically, a uniform 1% of increase in all household incomes, maintaining the present income distribution constant, would lead to 1.22% of rise in total FAFH spending; whereas if this 1% of total incomes was totally received by the low-income group and the high-income group, the expenditures would increase by only 0.52% and 1.05%, respectively.

Third, redistribution of income favored higher income families would give rise to a considerable increase in total FAFH spending. Compared with the income distribution in favor of the low-income households, redistribution of income favored the high-income families would result in a greater growth of total FAFH spending, although it would generate a slower growth of FAFH spending. For instance, if the 1% of total incomes was totally received by the high-income group, the expenditures would increase by 1.05% (table III-8, column 9 and row 1), an increase of 0.52% if this 1% of total incomes was totally received by the low-income group. Moreover, redistribution of income favored the medium-income families would give rise to a considerable increase in total FAFH spending. For example, if the 1% of total incomes was totally given to the medium-income group, the expenditures would increase by 1.57% (table III-8, column 7 and row 1), much higher those in other scenarios of changes in incomes and income redistribution.

Finally, the transfer of an amount of income equal to 1% of total household incomes from the high-income group to the low-income group, maintaining total household incomes constant, would decrease the demand for FAFH by 0.52% (table III-8, column 11 and row 1). Thus, the impact of changes in income distribution on demand for FAFH is different from that on demand for food that was consumed at home.

The finding could be explained because the income elasticity for FAFH spending is greater in the medium-income group than in the high- and low-income groups following in order (table III-5). Higher income elasticities here are translated into corresponding higher marginal propensity to consume (MPC). MPC refers to the increase in personal consumer spending that occurs with an increase in disposable income. Mathematically, the MPC function is expressed as the derivative of the consumption (C) function with respect to disposable income (Y), i.e., $MPC = \partial C / \partial Y = e_i * (C/Y)$, where e_i is income elasticity (FAO 1972). The estimated MPCs for FAFH spending in this study are 0.046, 0.021, 0.064, and 0.038 for entire sample, low-, medium-, high-income groups, respectively. Because each increment of income transferred will increase demand in the medium-income households by a greater amount than it will reduce demand in the low- or high-income households, an income distribution favored to the medium-income households will increase demand for FAFH. Thus, the greater the difference between the MPCs in the medium-group and low- or high-income group, the greater will be the change in demand caused by income redistribution. Thus, a uniform increase in household incomes or an income distribution in favor of the medium-income households would increase FAFH spending substantially.

Conclusions and Policy Implications

This study estimates the impact of changes in income distribution on food demand in urban Jiangsu, China. To accomplish this objective, the responses of food demand to changes in household income were estimated. The estimated models were then used to project food demand under several scenarios on changes in incomes and income distribution. Major findings for food that was consumed at home are: (1) a drive toward a more equal income distribution would increase demand for each of food groups that were consumed at home considerably; (2) distribution-neutral income growth would increase food demand much larger than did income growth favored higher income households;

and (3) income transfer from higher to lower income households have also great impacts on expenditures for food groups that were consumed at home.

Results of this study indicate that the impact of changes in income distribution on demand for food away from home differs from that for food that was consumed at home. First, a drive toward a more equal income distribution would lead to a slow growth in demand for FAFH. Second, distribution-neutral income growth would increase food demand much larger than did income growth favored either the high-income households or the low-income households. Third, redistribution of income favored higher income families would give rise to a considerable increase in total FAFH spending. Finally, the income transfer from higher to lower income households would decrease demand for FAFH considerably. However, FAFH spending accounts for relatively a small share in total food expenditures in urban Jiangsu and urban China. The data set used for this study shows that shares of FAFH spending to total food expenditures are 8%, 14%, and 22%, respectively, for the low-, medium-, and high-income households. Consequently, aggregate food demand is mainly dependent upon demand for food that was consumed at home.

The findings in this study have several implications. First, food projections based on average estimates of parameters will bias estimates in urban China, where income distribution has rapidly changed toward the income distribution favored higher income families. Second, an increase in incomes specifically for the poor is the key of government's policies to improve household standard of living of the poor. Because income elasticities for food usually is less than one, only a part of the income transfer from higher to lower income groups would be spent on food. Hence, in addition to increased food demand, such transfer would influence the relative purchasing power for other goods (Pinstrup-Andersen and Caicedo 1978).

Finally, the potential growth in food demand is substantial. Given that the income growth in China is expected to continue in the future, if the income distribution improves toward a more equal income distribution across households, demand for food would increase considerably in the future. Therefore, both the income growth and the income distribution in China are two important factors to which researchers and policy-makers need to pay an attention in developing effective trade policies and marketing programs for trade with China.

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Appendix: Theil-Inequality Coefficient (or Theil-U_1)

The Theil-U statistic is one of the goodness-of-fit measures. Theil first defined a statistic measuring the accuracy of forecasts by

$$(1) \qquad U = \frac{\sqrt{\frac{1}{N}\sum_{t=1}^{N}\left(Y_t - \hat{Y}_t\right)^2}}{\sqrt{\sum Y_t^2 / N} + \sqrt{\sum \hat{Y}_t^2 / N}}$$

This statistic equals to zero if $\hat{Y}_t$ is a perfect forecast for Y_t, and it equals one if $\hat{Y}_t = -bY_t$, where b is positive. In addition, it penalizes systematic linear bias. However, it does not provide a good ranking for forecasts (Maddala, 1977). Due to this problem, Theil later suggests the use of

$$(2) \qquad U_1 = \sqrt{\frac{\frac{1}{N}\sum_{t=1}^{N}\left(Y_t - \hat{Y}_t\right)^2}{\sum\left(Y_t^2 / N\right)}}$$

This statistic equals zero for a perfect forecasts and does not display the problems associated with U. A value $U_1 = 1$ results from a naïve model where $\hat{Y}_t = Y_{t-1}$. Values of $U_1 \succ 1$ results from a model that predicts less precisely compared to a model where "$\hat{Y}_t = Y_{t-1}$". Thus, the Theil-U_1 statistics can be greater than Theil-U values.

Table III-1. Estimated Cumulative Distribution of Households, Population, Incomes, and Food Expenditures, in Percentages

Cumulative Distribution	Income Strata		
	Low-income	Medium-income	High-income
Households	25.0	75.0	100.0
Population	27.8	77.8	100.0
Incomes	11.2	54.5	100.0
Total food expenditures	17.2	69.9	100.0
Expenditures for FAFH	9.3	55.9	100.0
Expenditures for the 10 goods[a]	19.2	71.9	100.0

Note: [a] refers to expenditures for the 10 food groups considered in this study, which is slightly less than total expenditures for food that was consumed at home (FAH).
Source: Estimated based on the sample of 902 urban households in Jiangsu, China.

Table III-2. Theil-U1 Statistics for Models

Items	Low	Medium	High	Average
FAFH expenditures	0.274	0.194	0.178	0.210
Grains[a]	0.410	0.394	0.383	0.420
Oils & Fats	0.386	0.479	0.516	0.480
Meats	0.252	0.278	0.304	0.287
Poultry	0.494	0.432	0.425	0.456
Eggs	0.394	0.419	0.444	0.434
Aquatic products	0.446	0.353	0.400	0.394
Dairy products	--	--	--	--
Vegetables	0.281	0.295	0.272	0.294
Fruits	0.466	0.447	0.434	0.467
Other foods	0.465	0.483	0.490	0.497

Note: [a]food groups take form of budget shares.
Source: Estimated.

Table III-3. Actual and Fitted Values

Items	Actual	Fitted	Summation	Difference	Difference
	a	b	c	a-b	a-c
FAFH expenditures	6.221	6.285	6.235	-0.064	-0.013
Grains	0.124	0.120	0.124	0.003	0.000
Oils & Fats	0.047	0.047	0.047	0.001	0.000
Meats	0.219	0.220	0.219	0.000	0.001
Poultry	0.081	0.081	0.082	0.000	-0.001
Eggs	0.041	0.040	0.040	0.000	0.000
Aquatic products	0.120	0.124	0.120	-0.004	0.000
Dairy products	0.060	0.059	0.062	0.001	-0.002
Vegetables	0.130	0.132	0.129	-0.002	0.001
Fruits	0.087	0.087	0.086	0.000	0.001
Other foods	0.091	0.091	0.091	0.000	0.000

Note:

1. Actual values refer to average values of each household in the sample of 902 households in urban Jiangsu, China. Of which, FAFH expenditures represent logarithm of total expenditures for food-away-from-home; values of food groups refer to budget shares within the expenditures for the 10 food groups.
2. Fitted values refer to estimates of each household level based on the model for entire sample.
3. Summation refers to a weighted average value of a summation of fitted values based on the models for the low-, medium-, and high-income groups.

Source: Estimated.

Table III-4. Income Elasticities by Income Groups

Items	Low	Medium	High	Average
Expenditures for FAFH	0.59	1.35	0.90	1.05
Grains[a]	0.38	0.23	0.13	0.21
Oils & Fats	0.31	0.20	0.12	0.18
Meats	0.56	0.28	0.13	0.29
Poultry	0.47	0.28	0.14	0.30
Eggs	0.37	0.20	0.11	0.21
Aquatic products	0.52	0.33	0.17	0.35
Dairy products	0.58	0.24	0.13	0.33
Vegetables	0.40	0.22	0.11	0.22
Fruits	0.39	0.16	0.12	0.23
Other foods	0.34	0.25	0.16	0.28

Note: [a]income elasticities for food groups are derived by multiplying the income elasticity of total expenditure for the 10 food groups and the corresponding expenditure elasticities of food groups.
Source: Estimated.

Table III-5. Estimated Distribution of Households, Population, and Incomes in Urban Jiangsu, 2004

Category	Income Groups		
	Low-income	Medium-income	High-income
Households	25.00	50.00	25.00
Population	27.82	50.00	22.20
Incomes	11.22	43.29	45.49
Scenario-b			
Incomes	12.10	42.86	45.04
Scenario-c			
Incomes	11.11	43.85	45.04
Scenario-d			
Incomes	11.11	42.86	46.03
Scenario-e			
Income	12.22	43.29	44.49

Source: Estimated based on the sample of 902 urban households in Jiangsu, China.

Table III-6. Estimated Parameters in the QUAIDS Models for Food Groups That Were Consumed at Home across Income Groups

	Low-Income		Medium-Income		High-Income		Average	
Items	Coefficient	T-statistic	Coefficient	T-statistic	Coefficient	T-statistic	Coefficient	T-stat.
Grains								
Constant	0.585	3.10	0.410	3.66	-0.409	-1.95	0.757	7.85
SOUTH	-0.024	-1.38	-0.009	-1.28	0.003	0.33	-0.014	-2.44
CITYSIZE1	0.018	0.72	0.026	2.60	-0.006	-0.50	0.019	2.27
CITYSIZE2	0.017	0.91	0.026	3.27	0.011	1.16	0.023	3.60
CITYSIZE3	0.019	1.44	0.023	3.33	0.009	0.84	0.018	3.13
HHSIZE	0.009	1.33	0.006	1.76	0.002	0.35	0.011	4.33
KID	-0.076	-2.05	-0.059	-3.17	-0.040	-1.71	-0.055	-3.67
OLD	0.014	0.62	0.014	1.76	0.019	2.25	0.013	2.02
FAFHR	-0.131	-1.87	-0.084	-3.66	-0.053	-2.44	-0.132	-7.79
Log price of grains	-0.194	-1.47	-0.084	-1.95	-0.053	-1.21	-0.217	-3.04
Log price of oils & fats	-0.011	-0.35	-0.042	-2.14	-0.014	-0.95	-0.050	-2.20
Log price of meats	0.163	1.86	-0.026	-0.87	0.037	1.03	0.066	1.40
Log price of poultry	0.074	1.12	0.035	1.34	-0.013	-0.52	0.001	0.02
Log price of eggs	-0.046	-1.44	-0.029	-1.74	0.000	-0.02	-0.026	-1.44
Log price of aquatic products	-0.075	-1.60	0.179	2.28	0.079	1.69	0.241	4.38
Log price of dairy products	0.084	2.10	0.036	2.67	-0.066	-2.16	-0.023	-1.20
Log price of vegetables	-0.107	-1.86	0.008	0.39	0.071	2.08	0.041	1.31
Log price of fruits	-0.006	-0.16	-0.058	-2.13	-0.060	-2.36	-0.034	-1.16
Log price of other foods	0.117	1.82	-0.020	-1.94	0.019	1.10	0.000	0.02
Linear log of expenditures	-0.184	-2.25	-0.115	-2.68	0.134	2.53	-0.216	-5.58
Quadratic log of expenditures	0.015	1.72	0.009	2.26	-0.009	-2.74	0.016	4.22
Adjusted R^2		0.1448		0.1846		0.1798		0.2047

(Continues)

Items	Low-Income		Medium-Income		High-Income		Average	
	Coefficient	T-statistic	Coefficient	T-statistic	Coefficient	T-statistic	Coefficient	T-stat.
Oils & Fats								
Constant	0.081	0.81	0.279	3.58	-0.018	-0.14	0.224	3.49
SOUTH	-0.011	-1.62	-0.006	-1.66	-0.006	-1.25	-0.008	-3.09
CITYSIZE1	0.031	3.45	0.015	2.94	0.007	1.04	0.016	4.38
CITYSIZE2	0.029	4.02	0.010	2.64	-0.001	-0.22	0.011	3.78
CITYSIZE3	0.019	3.93	0.014	4.01	0.001	0.10	0.012	4.67
HHSIZE	0.003	1.46	0.001	0.74	0.000	-0.11	0.003	2.98
KID	-0.014	-1.07	0.008	0.89	-0.014	-1.14	-0.003	-0.42
OLD	-0.004	-0.42	0.005	1.29	-0.005	-1.06	-0.001	-0.50
FAFHR	-0.073	-2.83	-0.040	-3.53	-0.021	-1.75	-0.054	-7.17
Log price of grains	-0.011	-0.35	-0.042	-2.14	-0.014	-0.95	-0.050	-2.20
Log price of oils & fats	0.010	0.98	-0.035	-1.99	-0.017	-2.62	-0.021	-2.14
Log price of meats	0.031	1.31	-0.034	-1.70	0.013	1.23	0.021	1.65
Log price of poultry	-0.007	-0.43	0.024	1.43	0.006	0.73	0.003	0.40
Log price of eggs	0.014	1.26	-0.016	-1.49	-0.006	-1.22	-0.004	-0.69
Log price of aquatic products	-0.022	-1.44	0.130	2.81	0.008	0.28	0.052	1.83
Log price of dairy products	0.006	0.42	0.014	1.65	-0.006	-0.31	-0.005	-0.77
Log price of vegetables	-0.026	-1.31	0.010	0.73	0.020	1.15	0.010	1.07
Log price of fruits	0.004	0.58	-0.038	-2.24	-0.006	-0.56	-0.006	-0.84
Log price of other foods	0.001	0.02	-0.013	-1.87	0.003	0.50	0.000	-0.02
Linear log of expenditures	-0.002	-0.06	-0.077	-2.90	0.021	0.63	-0.049	-2.13
Quadratic log of expenditures	-0.001	-0.42	0.006	2.53	-0.002	-0.76	0.003	1.44
Adjusted R^2		0.2605		0.0829		0.0805		0.1507

(Continues)

Items	Low-Income Coefficient	Low-Income T-statistic	Medium-Income Coefficient	Medium-Income T-statistic	High-Income Coefficient	High-Income T-statistic	Average Coefficient	Average T-stat.
Meats								
Constant	-0.170	-0.97	0.509	2.82	0.432	1.43	0.110	0.81
SOUTH	0.004	0.23	0.010	1.14	-0.014	-1.00	0.001	0.16
CITYSIZE1	-0.026	-1.19	-0.054	-4.15	-0.001	-0.05	-0.032	-3.46
CITYSIZE2	-0.028	-1.63	-0.031	-3.04	-0.023	-1.53	-0.028	-3.79
CITYSIZE3	0.003	0.22	-0.018	-2.01	-0.008	-0.51	-0.009	-1.39
HHSIZE	-0.009	-1.52	0.006	1.32	-0.002	-0.31	0.002	0.87
KID	0.003	0.08	-0.024	-1.01	0.038	1.10	-0.004	-0.27
OLD	0.009	0.41	-0.006	-0.62	-0.003	-0.19	-0.006	-0.81
FAFHR	0.071	1.12	-0.079	-2.71	-0.065	-1.97	-0.050	-2.68
Log price of grains	0.163	1.86	-0.026	-0.87	0.037	1.03	0.066	1.40
Log price of oils & fats	0.031	1.31	-0.034	-1.70	0.013	1.23	0.021	1.65
Log price of meats	-0.118	-1.31	-0.042	-0.75	-0.008	-0.25	-0.008	-0.39
Log price of poultry	-0.045	-0.97	0.026	0.89	0.017	0.92	-0.002	-0.24
Log price of eggs	0.034	1.09	-0.022	-1.25	0.021	2.05	0.023	2.47
Log price of aquatic products	0.006	0.12	0.152	1.68	-0.064	-1.06	-0.084	-1.43
Log price of dairy products	-0.054	-1.80	0.015	0.98	0.016	0.32	-0.001	-0.08
Log price of vegetables	0.073	1.34	0.006	0.28	-0.032	-0.79	-0.009	-0.64
Log price of fruits	0.009	0.30	-0.062	-2.15	0.023	0.83	0.003	0.28
Log price of other foods	-0.099	-1.81	-0.014	-1.16	-0.023	-1.87	-0.009	-2.09
Linear log of expenditures	0.122	1.57	-0.123	-2.30	-0.039	-0.49	0.034	0.68
Quadratic log of expenditures	-0.006	-0.74	0.013	3.01	0.002	0.39	-0.001	-0.28
Adjusted R^2		0.0340		0.0837		0.0823		0.0602

(Continues)

Items	Low-Income Coefficient	Low-Income T-statistic	Medium-Income Coefficient	Medium-Income T-statistic	High-Income Coefficient	High-Income T-statistic	Average Coefficient	Average T-stat.
Poultry								
Constant	-0.152	-1.07	-0.139	-1.21	-0.125	-0.62	0.023	0.21
SOUTH	0.037	3.69	0.036	6.20	0.029	3.33	0.033	7.85
CITYSIZE1	-0.013	-0.92	-0.003	-0.36	0.027	2.30	0.002	0.33
CITYSIZE2	-0.015	-1.35	-0.015	-2.29	0.004	0.40	-0.012	-2.64
CITYSIZE3	-0.009	-1.18	-0.004	-0.78	0.017	1.70	-0.003	-0.68
HHSIZE	-0.003	-0.89	0.002	0.58	0.003	0.72	-0.001	-0.39
KID	0.015	0.73	-0.007	-0.46	0.022	1.01	0.007	0.70
OLD	-0.019	-1.40	-0.007	-1.14	0.010	1.19	-0.002	-0.42
FAFHR	-0.049	-1.22	-0.008	-0.43	-0.010	-0.48	-0.009	-0.74
Log price of grains	0.074	1.12	0.035	1.34	-0.013	-0.52	0.001	0.02
Log price of oils & fats	-0.007	-0.43	0.024	1.43	0.006	0.73	0.003	0.40
Log price of meats	-0.045	-0.97	0.026	0.89	0.017	0.92	-0.002	-0.24
Log price of poultry	-0.036	-0.79	0.019	0.76	0.012	0.62	0.029	3.58
Log price of eggs	0.011	0.52	0.012	0.83	0.005	0.62	-0.003	-0.52
Log price of aquatic products	0.039	1.21	-0.143	-2.05	0.007	0.16	-0.023	-0.52
Log price of dairy products	-0.032	-1.32	-0.008	-0.92	-0.026	-0.80	-0.002	-0.26
Log price of vegetables	0.049	1.23	0.000	0.03	0.014	0.45	0.006	0.55
Log price of fruits	0.012	0.61	0.021	0.89	-0.023	-1.29	-0.009	-1.28
Log price of other foods	-0.064	-1.52	0.013	1.65	0.001	0.12	0.001	0.42
Linear log of expenditures	0.091	1.56	0.064	1.55	0.034	0.64	-0.001	-0.03
Quadratic log of expenditures	-0.008	-1.38	-0.005	-1.29	-0.002	-0.54	0.001	0.32
Adjusted R^2		0.1180		0.1553		0.0767		0.1235

(Continues)

Items	Low-Income		Medium-Income		High-Income		Average	
	Coefficient	T-statistic	Coefficient	T-statistic	Coefficient	T-statistic	Coefficient	T-stat.
Eggs								
Constant	0.147	1.61	0.244	3.88	-0.043	-0.43	0.135	2.51
SOUTH	-0.002	-0.38	-0.003	-1.30	-0.008	-1.97	-0.005	-2.40
CITYSIZE1	-0.003	-0.35	0.003	0.80	0.002	0.33	0.002	0.67
CITYSIZE2	0.003	0.52	0.002	0.61	0.001	0.24	0.002	1.02
CITYSIZE3	-0.003	-0.73	-0.003	-1.02	-0.005	-1.09	-0.004	-1.85
HHSIZE	0.001	0.43	0.001	0.89	0.002	1.31	0.002	2.63
KID	-0.009	-0.76	-0.008	-1.28	-0.009	-0.95	-0.007	-1.34
OLD	0.003	0.40	0.009	3.03	0.004	1.18	0.005	2.32
FAFHR	0.014	0.66	-0.030	-3.61	-0.010	-1.09	-0.024	-4.15
Log price of grains	-0.046	-1.44	-0.029	-1.74	0.000	-0.02	-0.026	-1.44
Log price of oils & fats	0.014	1.26	-0.016	-1.49	-0.006	-1.22	-0.004	-0.69
Log price of meats	0.034	1.09	-0.022	-1.25	0.021	2.05	0.023	2.47
Log price of poultry	0.011	0.52	0.012	0.83	0.005	0.62	-0.003	-0.52
Log price of eggs	0.021	1.01	-0.009	-0.61	-0.010	-1.14	0.004	0.50
Log price of aquatic products	-0.019	-1.09	0.107	2.75	0.009	0.40	0.031	1.32
Log price of dairy products	0.018	1.22	0.009	1.21	-0.014	-0.88	-0.006	-1.29
Log price of vegetables	-0.051	-2.29	-0.005	-0.37	0.004	0.25	-0.007	-0.97
Log price of fruits	-0.017	-1.45	-0.035	-2.38	-0.008	-0.87	-0.010	-1.78
Log price of other foods	0.035	1.41	-0.012	-2.07	-0.001	-0.15	-0.002	-0.62
Linear log of expenditures	-0.048	-1.38	-0.068	-3.09	0.021	0.81	-0.032	-1.63
Quadratic log of expenditures	0.004	1.12	0.005	2.65	-0.002	-1.08	0.002	1.14
Adjusted R^2		0.2206		0.1838		0.1198		0.2031

(Continues)

Items	Low-Income Coefficient	Low-Income T-statistic	Medium-Income Coefficient	Medium-Income T-statistic	High-Income Coefficient	High-Income T-statistic	Average Coefficient	Average T-stat.
Aquatic Products								
Constant	0.292	1.53	-1.148	-8.99	0.978	4.45	-0.801	-7.61
SOUTH	0.007	0.60	0.000	0.04	-0.005	-0.37	0.006	1.11
CITYSIZE1	-0.034	-2.00	-0.044	-4.52	-0.043	-2.43	-0.043	-5.66
CITYSIZE2	-0.046	-3.38	-0.046	-5.81	-0.050	-3.45	-0.048	-7.97
CITYSIZE3	-0.018	-2.04	-0.018	-2.58	-0.021	-1.43	-0.017	-3.27
HHSIZE	-0.004	-0.83	-0.004	-1.44	-0.001	-0.19	-0.006	-2.51
KID	0.009	0.36	-0.029	-1.58	-0.064	-1.89	-0.026	-1.92
OLD	0.005	0.30	-0.003	-0.43	-0.017	-1.36	-0.003	-0.45
FAFHR	-0.011	-0.22	0.062	2.74	0.045	1.41	0.051	3.29
Log price of grains	-0.075	-1.60	0.179	2.28	0.079	1.69	0.241	4.38
Log price of oils & fats	-0.022	-1.44	0.130	2.81	0.008	0.28	0.052	1.83
Log price of meats	0.006	0.12	0.152	1.68	-0.064	-1.06	-0.084	-1.43
Log price of poultry	0.039	1.21	-0.143	-2.05	0.007	0.16	-0.023	-0.52
Log price of eggs	-0.019	-1.09	0.107	2.75	0.009	0.40	0.031	1.32
Log price of aquatic products	0.031	0.68	-0.590	-5.64	-0.103	-1.31	-0.248	-3.45
Log price of dairy products	0.030	1.20	-0.059	-1.56	0.160	3.72	0.057	2.33
Log price of vegetables	-0.040	-1.18	-0.068	-1.05	-0.152	-3.80	-0.084	-2.23
Log price of fruits	-0.008	-0.42	0.240	3.90	0.104	2.35	0.070	1.80
Log price of other foods	0.059	1.37	0.052	1.65	-0.047	-1.66	-0.013	-0.56
Linear log of expenditures	-0.090	-1.45	0.412	14.71	-0.254	-4.85	0.289	9.85
Quadratic log of expenditures	0.010	1.81	-0.032	-9.65	0.019	5.88	-0.021	-7.65
Adjusted R^2		0.1178		0.3360		0.1919		0.2764

(Continues)

Items	Low-Income		Medium-Income		High-Income		Average	
	Coefficient	T-statistic	Coefficient	T-statistic	Coefficient	T-statistic	Coefficient	T-stat.
Dairy Products								
Constant	-0.195	-	-0.039	-	-0.633	-	0.144	-
SOUTH	0.007	-	-0.021	-	-0.003	-	-0.009	-
CITYSIZE1	-0.004	-	0.041	-	0.014	-	0.023	-
CITYSIZE2	-0.002	-	0.028	-	0.021	-	0.019	-
CITYSIZE3	0.000	-	0.002	-	0.009	-	0.003	-
HHSIZE	-0.004	-	-0.003	-	-0.004	-	-0.007	-
KID	0.059	-	0.099	-	0.111	-	0.090	-
OLD	-0.015	-	0.005	-	0.003	-	0.003	-
FAFHR	0.109	-	0.112	-	0.015	-	0.105	-
Log price of grains	0.084	-	0.036	-	-0.066	-	-0.023	-
Log price of oils & fats	0.006	-	0.014	-	-0.006	-	-0.005	-
Log price of meats	-0.054	-	0.015	-	0.016	-	-0.001	-
Log price of poultry	-0.032	-	-0.008	-	-0.026	-	-0.002	-
Log price of eggs	0.017	-	0.009	-	-0.014	-	-0.006	-
Log price of aquatic products	0.030	-	-0.059	-	0.160	-	0.057	-
Log price of dairy products	-0.049	-	-0.020	-	-0.125	-	-0.026	-
Log price of vegetables	0.051	-	-0.001	-	0.094	-	0.016	-
Log price of fruits	0.006	-	0.008	-	-0.061	-	-0.014	-
Log price of other foods	-0.059	-	0.007	-	0.028	-	0.003	-
Linear log of expenditures	0.085	-	0.035	-	0.186	-	-0.048	-
Quadratic log of expenditures	-0.007	-	-0.003	-	-0.012	-	0.005	-
Adjusted R^2		-		-		-		-

(Continues)

Items	Low-Income		Medium-Income		High-Income		Average	
	Coefficient	T-statistic	Coefficient	T-statistic	Coefficient	T-statistic	Coefficient	T-stat.
Vegetables								
Constant	0.553	4.08	0.146	1.24	0.836	5.05	0.117	1.13
SOUTH	-0.009	-0.83	0.016	2.78	0.027	3.53	0.013	3.02
CITYSIZE1	0.044	3.03	0.018	2.30	-0.002	-0.15	0.020	3.45
CITYSIZE2	0.008	0.74	-0.002	-0.28	0.005	0.54	0.003	0.68
CITYSIZE3	0.016	2.09	0.012	2.11	0.015	1.76	0.014	3.49
HHSIZE	-0.003	-0.66	0.001	0.20	0.001	0.25	0.003	1.55
KID	-0.026	-1.21	-0.033	-2.33	-0.053	-2.77	-0.036	-3.50
OLD	0.001	0.11	0.019	3.06	0.003	0.49	0.011	2.55
FAFHR	-0.126	-3.06	-0.078	-4.39	-0.081	-4.44	-0.104	-8.98
Log price of grains	-0.107	-1.86	0.008	0.39	0.071	2.08	0.041	1.31
Log price of oils & fats	-0.026	-1.31	0.010	0.73	0.020	1.15	0.010	1.07
Log price of meats	0.073	1.34	0.006	0.28	-0.032	-0.79	-0.009	-0.64
Log price of poultry	0.049	1.23	0.000	0.03	0.014	0.45	0.006	0.55
Log price of eggs	-0.051	-2.29	-0.005	-0.37	0.004	0.25	-0.007	-0.97
Log price of aquatic products	-0.040	-1.18	-0.068	-1.05	-0.152	-3.80	-0.084	-2.23
Log price of dairy products	0.051	1.89	-0.001	-0.16	0.094	2.63	0.016	1.85
Log price of vegetables	-0.016	-0.28	0.039	2.87	-0.031	-0.61	0.028	1.68
Log price of fruits	-0.008	-0.33	0.012	0.55	0.035	1.09	0.005	0.46
Log price of other foods	0.075	1.74	-0.003	-0.47	-0.024	-1.36	-0.007	-1.40
Linear log of expenditures	-0.120	-2.18	0.030	0.78	-0.153	-3.35	0.056	1.67
Quadratic log of expenditures	0.009	1.74	-0.004	-1.15	0.009	2.69	-0.007	-2.51
Adjusted R^2		0.1421		0.2167		0.2726		0.2185

(Continues)

Items	Low-Income		Medium-Income		High-Income		Average	
	Coefficient	T-statistic	Coefficient	T-statistic	Coefficient	T-statistic	Coefficient	T-stat.
Fruits								
Constant	0.159	1.38	0.541	5.84	-0.263	-1.23	0.214	2.45
SOUTH	0.007	0.78	-0.001	-0.12	0.007	0.63	0.004	0.85
CITYSIZE1	-0.013	-1.10	0.006	0.69	0.015	1.02	0.001	0.14
CITYSIZE2	0.013	1.40	0.024	3.28	0.028	2.38	0.021	4.11
CITYSIZE3	-0.013	-2.14	0.006	0.97	0.011	0.83	0.002	0.44
HHSIZE	0.001	0.41	-0.001	-0.43	-0.002	-0.36	-0.005	-2.30
KID	0.030	1.73	0.022	1.30	0.038	1.36	0.026	2.25
OLD	0.012	1.10	-0.022	-2.97	-0.001	-0.09	-0.010	-1.94
FAFHR	0.068	2.00	0.059	2.77	0.037	1.38	0.090	6.79
Log price of grains	-0.006	-0.16	-0.058	-2.13	-0.060	-2.36	-0.034	-1.16
Log price of oils & fats	0.004	0.58	-0.038	-2.24	-0.006	-0.56	-0.006	-0.84
Log price of meats	0.009	0.30	-0.062	-2.15	0.023	0.83	0.003	0.28
Log price of poultry	0.012	0.61	0.021	0.89	-0.023	-1.29	-0.009	-1.28
Log price of eggs	-0.017	-1.45	-0.035	-2.38	-0.008	-0.87	-0.010	-1.78
Log price of aquatic products	-0.008	-0.42	0.240	3.90	0.104	2.35	0.070	1.80
Log price of dairy products	0.006	0.37	0.008	0.63	-0.061	-1.81	-0.014	-1.77
Log price of vegetables	-0.008	-0.33	0.012	0.55	0.035	1.09	0.005	0.46
Log price of fruits	-0.014	-1.07	-0.070	-1.97	-0.023	-0.72	-0.009	-0.79
Log price of other foods	0.021	0.65	-0.017	-1.64	0.019	1.41	0.004	1.00
Linear log of expenditures	-0.026	-0.59	-0.126	-3.79	0.092	1.72	-0.038	-1.20
Quadratic log of expenditures	0.002	0.39	0.008	2.60	-0.007	-2.09	0.002	0.84
Adjusted R^2		0.1801		0.0768		0.2323		0.1027

(Continues)

Items	Low-Income		Medium-Income		High-Income		Average	
	Coefficient	T-statistic	Coefficient	T-statistic	Coefficient	T-statistic	Coefficient	T-stat.
Other Foods								
Constant	-0.299	-2.15	0.199	3.58	0.247	1.83	0.078	1.40
SOUTH	-0.017	-1.69	-0.022	-3.45	-0.030	-2.58	-0.021	-4.32
CITYSIZE1	0.001	0.04	-0.008	-0.85	-0.013	-0.77	-0.008	-1.10
CITYSIZE2	0.020	1.74	0.004	0.51	0.003	0.25	0.008	1.42
CITYSIZE3	-0.013	-1.67	-0.015	-2.15	-0.027	-1.90	-0.016	-3.26
HHSIZE	0.008	2.15	-0.007	-2.26	0.001	0.22	-0.003	-1.48
KID	0.009	0.39	0.031	1.70	-0.031	-0.95	0.007	0.55
OLD	-0.007	-0.49	-0.013	-1.64	-0.014	-1.23	-0.011	-1.93
FAFHR	0.127	2.96	0.087	3.93	0.143	4.75	0.126	8.61
Log price of grains	0.117	1.82	-0.020	-1.94	0.019	1.10	0.000	0.02
Log price of oils & fats	0.001	0.02	-0.013	-1.87	0.003	0.50	0.000	-0.02
Log price of meats	-0.099	-1.81	-0.014	-1.16	-0.023	-1.87	-0.009	-2.09
Log price of poultry	-0.064	-1.52	0.013	1.65	0.001	0.12	0.001	0.42
Log price of eggs	0.035	1.41	-0.012	-2.07	-0.001	-0.15	-0.002	-0.62
Log price of aquatic products	0.059	1.37	0.052	1.65	-0.047	-1.66	-0.013	-0.56
Log price of dairy products	-0.059	-2.41	0.007	1.40	0.028	1.28	0.003	0.72
Log price of vegetables	0.075	1.74	-0.003	-0.47	-0.024	-1.36	-0.007	-1.40
Log price of fruits	0.021	0.65	-0.017	-1.64	0.019	1.41	0.004	1.00
Log price of other foods	-0.086	-2.10	0.009	1.48	0.025	2.28	0.022	8.44
Linear log of expenditures	0.172	5.82	-0.033	-1.86	-0.042	-1.24	0.004	0.23
Quadratic log of expenditures	-0.017	-5.99	0.003	1.67	0.004	1.69	0.000	0.02
Adjusted R^2		0.1609		0.2178		0.1055		0.2160

Note: The AIDS models were estimated using the iterative seemingly unrelated regressions (ITSUR) separately for entire sample, low-income group, medium-income group, and high-income group which were segmented in light of per capita incomes.
Source: Estimated.

Table III-7. Estimated Parameters in the Models for FAFH Expenditures

	Low-Income Group		Medium-Income Group		High-Income Group		Average	
	Coefficient	T-statistics	Coefficient	T-statistics	Coefficient	T-statistics	Coefficient	T-statistics
Intercept	-1.103	-0.40	-6.960	-2.56	-3.516	-1.00	-4.615	-5.42
SOUTH	0.454	1.38	0.278	1.79	0.804	3.15	0.489	3.93
CITYSIZE1	0.537	0.91	0.394	1.42	0.422	0.89	0.403	1.80
CITYSIZE2	0.810	2.39	0.086	0.48	0.636	2.53	0.379	2.93
CITYSIZE3	0.506	2.05	0.213	1.32	0.432	1.67	0.326	2.70
HHSIZE	0.055	0.37	-0.198	-2.05	-0.062	-0.34	-0.105	-1.98
KID	1.687	2.38	1.395	2.96	0.794	1.12	1.293	3.97
OLD	-0.945	-2.11	-0.412	-2.07	-0.216	-0.90	-0.390	-2.73
Log of income	0.586	1.82	1.347	4.59	0.903	2.63	1.053	12.03
LogLikelihood	-401.825		-741.214		-373.028		-1535.732	

Source: Estimated.

Table III-8. Estimated Increase in the Demand for Expenditures for FAFH and Each of the 10 Food Groups Consumed at Home under Alternative Changes in Household Incomes and Their Distribution

	Fitted Value	Estimated Demand Increase								Transfer III to I	
		Unchanged Distr.		All to I[b]		All to II		All to III			
	(yuan)[a]	(yuan)	(% inc.)	(yuan)	(% incr.)	(yuan)	(% incr.)	(yuan)	(% incr.)	(yuan)	(% incr.)
FAFH Exp.	572	579	1.22	575	*0.52*	581	*1.57*	578	*1.05*	569	-0.52
Grains	573	575	0.42	578	0.91	574	0.28	573	0.08	577	0.83
Oils & Fats	217	218	0.36	219	0.78	218	0.25	217	0.07	219	0.72
Meats	1031	1036	0.52	1042	1.13	1035	0.36	1032	0.08	1042	1.05
Poultry	397	398	0.43	400	0.78	398	0.36	397	0.10	399	0.68
Eggs	187	187	0.38	188	0.87	187	0.24	187	0.07	188	0.81
Aquatic products	581	583	0.47	585	0.76	583	0.45	581	0.11	585	0.65
Dairy products	308	309	0.36	310	0.61	309	0.32	309	0.11	310	0.50
Vegetables	607	609	0.39	612	0.82	608	0.29	607	0.07	611	0.76
Fruits	423	424	0.27	425	0.53	424	0.19	423	0.10	425	0.44
Other foods	437	439	0.35	440	0.60	438	0.31	438	0.11	439	0.48

Note:

[a]unit of measure is 1,000 yuan in Chinese currency.

[b]I, II, and III refers to the low-, medium-, and high-income groups.

Source: Estimated.

VITA

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Scope and Method of Study: This study is composed of three essays. The objective of the first essay is to estimate the impacts of economic and non-economic factors on food consumption patterns in urban China. A complete food demand system of households is estimated using a two-stage budgeting procedure which incorporates both an almost ideal demand system (AIDS) and a quadratic almost ideal demand system (QUAIDS) in each stage. The purpose of the second essay is to determine the differences in price and income elasticities across income classes in urban China. An incomplete demand system for 10 major food commodity groups is estimated using the LINQUAD model, which is defined as being linear in income and linear and quadratic in prices, for low-, medium-, and high-income groups, respectively. The third essay estimates the impact of changes in income distribution on food demand in urban China. This essay is based on the estimates as obtained in the second essay. All the three essays use the 2004 China's urban household survey data for Jiangsu province.

Findings and Conclusions: The results of the first essay show that the demand for animal products is significantly more sensitive to consumer food expenditure changes than other food categories, while the demand for grains and oils & fats depends more on price changes than income changes. Moreover, the demographic profile of urban consumers in Jiangsu does have a significant impact on the food demand. Finally, the AIDS and the QUAIDS models yield very similar results in this application. The results of the second essay show that the high-income households in urban Jiangsu are less responsive to price and income changes for most food groups considered in this study compared to the low- and medium-income families. The results of experiment simulation in the third essay show that a drive toward a more equal distribution of income would increase expenditures for food groups that were consumed at home.

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