Product Quality and the Demand for Food: The Case of Urban China

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Paper Presented at the 2004 Annual Meeting
American Agricultural Economics Association
August 1-4, 2004
Denver, CO

A Quadratic Almost Ideal Demand System is used to examine the structure of food demand for a sample of urban Chinese households. The dual choice of product quality and quantity is accounted for in the econometric model via the inclusion of simultaneously estimated unit-value equations.

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JEL Classification: D12, I31, O12, Q17
Keywords: China, Product Quality, QUAIDS

The authors would like to thank the Babcock Institute for International Dairy Research and Development for providing research support.

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Introduction

The Chinese population is undergoing significant change in its eating patterns resulting from a variety of factors including: change in the degree of government participation in the food system, increased affluence of urban households and China's recent admittance to the WTO (Gale, 2003; Wang, 1997). As China continues to develop there is general consensus that there will be movement of the Chinese diet away from the traditional (Gao, et al., 1996; Guo, et.al., 2000). With rising incomes it is projected that the Chinese population will diversify their diets away from staples such as rice and wheat flour, to one containing more livestock products (Shono, et al., 2000; Gale, 2003). Besides changes in the quantity of products purchases, Hsu, et.al (2001) note that it is important to recognize that the demand for product quality will become an increasingly important component of the food purchase process. For example, with higher incomes, one would anticipate an increase in the demand for Aready-to-eat@ convenience, nutritionally enhanced and/or alternatively packaged foods.

There are a variety of methods that can be used to quantify the determinants of food demand in China. Banks, et al. (1996) assert that a demand system approach based on some underlying utility function is preferred over single equation approaches given their theoretical consistency. In the present analysis we use the quadratic almost ideal demand system (QUAIDS) of Banks, et. al. (1996, 1997) and Moro and Sckokai (2000). The data which forms the foundation of our empirical model is a dataset that encompasses *yearly* food purchases by a sample of urban Chinese households. Our empirical demand system is defined over 12 aggregate commodities.

Cross-sectional surveys of food purchase behavior often contain purchase quantity and expenditure information. Division of observed expenditures by quantity (here referred to as unit-value) is often used as an estimate of a commodity=s price (Gould 1996; Yen at al, 2003). Previous analyses have recognized that this method of calculating price reflects not only differences in market prices faced by each household but also in endogenously determined commodity quality (Theil, 1953; Houthaker, 1952; Deaton, 1997, 1988; Cox and Wohlgenant, 1986; and Nelson, 1991). For example, observed differences in the price paid for cheese may be reflecting not only local market conditions but also product form. That is, households purchasing cheese in block form would be expected to pay a lower price than households purchasing cheese that is pre-sliced or shredded, ceteris paribus given the additional value-added encompassed in the latter product forms.

As Nelson (1991) notes, the portion of product price determined by market forces is obviously beyond the control of the consumer whereas the quality portion is endogenous to the purchase process. To assist in differentiating between these two forces, Nelson (1991) presents a review of the consumer purchase process from the perspective of both *elementary* goods (x_j) and *composite* commodities (Q_j) where an elementary good is relatively homogeneous while a composite commodity encompasses a set of elementary goods that vary according to characteristic(s) such as flavor, fat content, packaging, or product form. (p.1206). An example of an elementary good would be 2% milk purchased in a half gallon size package. In contrast, the commodity category *fluid milk* would represent a composite commodity that encompasses the above elementary good.

We develop a model structure where we differentiate between the market component of observed unit values and that portion that is due to endogenous quality decisions of the household. Our econometric model consists of a system of expenditure shares derived from the indirect utility function associated with the QUAIDS model specification. We augment this share system with a series of unit value equations that contain market level variables. Household characteristics which represent reduced form impacts on endogenous unit values are also included in the estimated unit value equations. We use the results of Deaton (1988, 1997) to convert the estimated "unit-value" elasticities to the traditionally interpreted price elasticities.

Section II of this manuscript presents an overview of the QUAIDS specification of Banks, et al., (1997) which is extended to incorporate demographic characteristics via the modifying cost function of Lewbel (1985). Restrictions implied by economic theory are discussed. We also provide the theoretical framework by which product quality is made part of the purchase process. Section III provides an overview of the household level survey data used in our analysis. Food categories and demographic variables are defined and descriptive statistics provided. In section IV the estimation method is discussed, estimated model parameters summarized and, based on these estimated coefficients, various elasticity measures calculated. A general discussion of the econometric findings is included within this section. The last section of this analysis provides an overview of our analysis and future research possibilities are identified.

Description of the Econometric Model

Overview of the Quadratic AIDS Model

When developing empirical models of food (and nonfood) demand, previous research has provided evidence of the importance of allowing for complex nonlinear relationships between the level of total expenditures and such demand (Atkinson, et al., 1990; Lewbel, 1991; Hausman, et al., 1995). To this end, empirical demand systems have been developed that allow for extended income effects. The QUAIDS is an example of such a system where expenditure shares are quadratic in the logarithm of total expenditures. This specification is based on a generalization of preferences represented by the Price-Independent Generalized Logarithmic (PIGLOG) structure. Under the original specification PIGLOG demand systems arise from indirect utility functions that are themselves linear in the logarithm of total expenditures (Muellbauer, 1976). An examples of these PIGLOG specifications is the ubiquitous Almost Ideal Demand System (AIDS) specification of Deaton and Muellbauer (1980).

The QUAIDS is based on the following indirect utility (IU) function:

$$\ln IU = \left\{ \left[\frac{\ln m - \ln a(p)}{b(p)} \right]^{-1} + l(p) \right\}^{-1} \qquad (1)$$

where the first term within the square brackets is the indirect utility function of a PIGLOG demand system, *m* is total expenditures, and *p*, is observed price. To assure that the homogeneity property holds for this indirect utility function, a(*p*) is homogeneous of degree 1 in *p*, and the functions b(*p*) and λ(*p*) are differentiable and homogeneous functions of degree zero in *p*.

The functions ln[a(*p*)] and b(*p*) are the translog and Cobb-Douglas price aggregator functions found in the traditional AIDS formulations:

$$\ln a(p) = a_0 + \sum_{i=1}^{n} a_i \ln p_i + \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} g_{ij} \ln p_i \ln p_j \qquad (2)$$

$$b(p) = \prod_{i}^{n} p_i^{b_i} \tag{3}$$

where a_j, b_i and g_{ij} are unknown parameters and n the number commodities in the system. To complete the specification $\lambda(p)$ is defined as:

$$l(p) = \sum_{i=1}^{n} l_i \ln p_i \text{ where } \sum_{i=1}^{n} l_i = 0 \quad \text{(Banks, et al., 1997).} \tag{4}$$

From (1)-(4) and the indirect utility function can be represented as:

$$\ln IU = \left\{ \left[\frac{\ln m - \left(a_0 + \sum_{i=1}^{n} a_i \ln p_i + \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} g_{ij} \ln p_i \ln p_j \right)}{\prod_{i}^{n} p_i^{b_i}} \right]^{-1} + \sum_{i=1}^{n} l_i \ln p_i \right\}^{-1} \tag{5}$$

Applying Roy's Identity to (5), the QUAIDS expenditure shares (w_i) can be represented via the following:

$$w_i = a_i + \sum_{j=i}^{n} g_{ij} \ln p_j + b_i \ln\left[\frac{m}{a(p)}\right] + \frac{l_i}{b(p)} \left\{ \ln\left[\frac{m}{a(p)}\right] \right\}^2 \tag{6}$$

Inclusion of Demographic Characteristics in the Demand System

Our use of household-level data requires that we recognize the heterogeneous nature of food preferences. The use of demand systems that account for such heterogeneity has had a long history starting with the efforts of Barten (1964) and extended by Pollack and Wales (1981), Heien and Pompelli (1988), Gould, et al. (1991), Blundell, et al. (1993) and Perali (1993). Lewbel (1985) provides a general conceptual framework for incorporating demographic characteristics into a demand system. As noted by Perali (1993), the use of demographic translating has the effect of impacting the underlying cost function via fixed or subsistence level costs while demographic scaling changes the relative slope of a household's budget constraint by modifying the effective prices via changes in demographic characteristics.

Following Lewbel (1985) and Perali (1993), household expenditure (m^*) can be represented as a function of household utility, *U*, prices, p, and an S-vector of demographic characteristics, *d*:

$$m^* \equiv f\left[C\left(U, h\left(p, d\right)\right), p, d\right] \tag{7}$$

where C is a well-behaved expenditure function, *h(•)* and *f* (•)are continuous functions that have first and second derivatives that exist everywhere except possibly in a set of measure zero. The modifying function *h(•)* is assumed to generate non-negative modified prices for every commodity and a positive modified price for at least one.

As noted above, there are a number of approaches that can be used in the specification of *h(•).* For the present analysis and recognizing our use of unit-values instead of market prices, we allow for demographic translating via the system outlined by Perali (1993):

$$m^* \equiv f\left[m, p, d\right] = m \prod_{i=1}^{M} p_i^{t_i(d)} \tag{8}$$

where $t_i(d)$ is a commodity specific translating function. In our analysis, these translating functions are specified as:

$$t_i(d) = \sum_{s=1}^{S} w_{is} d_s \tag{9}$$

where w_{is} is the translating parameter for the i[th] commodity and the s[th] demographic characteristic.

Substituting (8) and (9) into the indirect utility function represented in (1) and applying Roy's Identity, the resulting modified system of quadratic budget shares of the QUAIDS specification can be obtained:

$$w_i = a_i + t_i(d) + \sum_{j=i}^{n} g_{ij} \ln p_j + b_i \ln\left[\frac{m^*}{a(p)}\right] + \frac{l_i}{b(p)}\left\{\ln\left[\frac{m^*}{a(p)}\right]\right\}^2 \tag{10}$$

This specification differs from that of Abdulai (2002) in that we allow more than just share equation intercepts to vary across household.

Imposition of Theoretical Restrictions within the QUAIDS Model

As noted by Moro and Sckokai (2000), to allow for integrability e.g., to be able to derive the underlying expenditure function given utility and prices, a series of parametric restrictions need to be imposed. For example adding-up of expenditure shares implies:

$$\sum_{k=1}^{n} a_k = 1,\ \sum_{k=1}^{n} b_k = 0,\ \sum_{k=1}^{n} l_k = 0,\ \sum_{k=1}^{n} w_{ks} = 0, \text{and } \sum_{k=1}^{n} g_{kj} = 0 \tag{11}$$

The theoretical restriction of linear homogeneity with respect to price is satisfied via the following parameter restrictions:

$$\sum_{k=1}^{n} g_{jk} = 0 \qquad \text{for j=1,2,…,n} \quad . \tag{12}$$

Symmetry is satisfied provided that

$$g_{ij} = g_{ji} \qquad \text{for i,j=1,2,…,n} \; . \tag{13}$$

As shown by Banks, et al. (1997) commodity-specific expenditure elasticities, x_{i}, can be calculated as:

$$x_{\mathrm{i}} = \frac{\Gamma_{\mathrm{i}}}{\mathrm{w_i}} + 1 \quad \text{where: } \Gamma_{\mathrm{i}} \equiv \frac{\partial w_{\mathrm{i}}}{\partial \ln(\mathrm{m}^*)} = b_{\mathrm{i}} + \frac{2 l_i}{b(p)} \left\{ \ln \left[\frac{m^*}{a(p)} \right] \right\} \quad . \tag{14}$$

uncompensated unit value elasticities $\left(p_{\mathrm{ij}}^{\mathrm{U}}\right)$:

$$p_{\mathrm{ij}}^{\mathrm{U}} = \frac{\Gamma_{\mathrm{ij}}}{\mathrm{w_i}} - k_{\mathrm{ij}}$$

$$\text{where: } \Gamma_{\mathrm{ij}} \equiv g_{\mathrm{ij}} - \Gamma_i \left(a_i + \mathrm{t_i(d)} + \sum_{j=i}^{m} g_{\mathrm{ij}} \ln \mathrm{p_j} \right) - \frac{l_i b_j}{\mathrm{b(p)}} \left\{ \ln \left[\frac{\mathrm{m}^*}{\mathrm{a(p)}} \right] \right\}^2 \tag{15}$$

and k_{ij} is the Kronecker delta. From the above uncompensated elasticities, compensated elasticities $\left(p_{\mathrm{ij}}^{\mathrm{C}}\right)$ can also be evaluated:

$$p_{\mathrm{ij}}^{\mathrm{C}} = p_{\mathrm{ij}}^{\mathrm{U}} + x_{\mathrm{i}} \mathrm{w_j} \tag{16}$$

Product Quality and Food Demand

The above overview of the QUIADS model implicitly assumed that we knew market prices. In reality most expenditure surveys have information on quantities purchased and expenditures. Dividing expenditures by quantity generates estimates of household specific unit values. The empirical implementation of the QUAIDS model used in this analysis replaces commodity prices with unit values. We then adjust the calculated “unit-value” elasticities to account for the endogenous quality effects.

When using observed unit-values as a proxy for price, there is an implicit incorporation of not only the effects of exogenously determined product price but also product quality. To differentiate these effects, one can define the utility (U) maximization problem faced by a household in terms of *elementary goods*, x_i:

$$\max_{x_1,\ldots,x_{S^*}} U\left(x_1, x_2, \ldots, x_{S^*}\right) \quad s.t. \sum_{i=1}^{S^*} p_i x_i = Y \tag{17}$$

where p_i is the i^{th} elementary good's price, S^*, the number of goods and Y, household income.

As an alternative, Nelson (1991), using Hicks' composite commodity theorem, shows that if we assume that within each composite commodity, the prices of all elementary goods vary proportionally, then:

$$p_i = P_j p_i^e; \; i \in j \text{ and } Q_j = \sum_{i \in j} p_i^e x_i \tag{18}$$

where p_i^e is the base price of elementary good x_i, which Theil (1952) refers to as a *quality indicator* and P_j is the j^{th} composite good's group specific price level proportionality factor. From (17), we can represent the consumer's optimization problem in terms of composite goods as:

$$Max \; U\left(Q_1, Q_2, \ldots, Q_M\right) \; s.t. \sum_{j=1}^{M} P_j Q_j = Y \text{ where } Q_j = Q_j\left(P, Y\right) \tag{19}$$

and P is an M-vector of composite commodity prices.

Expenditures on the j^{th} composite commodity (E_j) and resulting unit values, V_j can be related to expenditures on the associated elementary goods via the following:

$$E_j = \sum_{i \in j} p_i x_i = \sum_{i \in j} P_j \; p_i^e x_i = P_j \sum_{i \in j} p_i^e x_i = P_j Q_j, \text{ where } V_j = \frac{P_j Q_j}{q_j}, \tag{20}$$

and $q_j = \sum_{i \in j} x_i$, the observed physical quantity of composite commodity j. These unit values will not be exogenous given that they depend on the endogenously determined quality of each composite commodity (Deaton, 1997, 1988). As shown by Nelson (1991) and by Dong, Shonkwiler and Capps (1998), a quantity-weighted sum of elementary goods base prices can be used as a measure of average quality of a particular composite commodity (? $_j$). That is:

$$y_j = \sum_{i \in j} \left(\frac{x_i}{q_j} \right) \mathrm{p}_{\mathrm{i}}^{\mathrm{e}} = \frac{Q_j}{q_j} \tag{21}$$

Combining (20) and (21) the relationship between unit value (V_j), market price (P_j) and quality (? $_j$) is:

$$\ln V_j = \ln P_j + \ln y_j . \tag{22}$$

Using the results of (22), Deaton (1988, 1997) shows that

$$p_{jj}^{\Psi} \equiv \frac{\partial \ln \Psi_j}{\partial \ln P_j} = h_j \frac{p_{jj}^{p}}{x_j} \quad \text{and} \quad p_{jj}^{V} \equiv \frac{\partial \ln V_j}{\partial \ln P_j} = 1 + \frac{\partial \ln \Psi_j}{\partial \ln P_j} \tag{23}$$

where p_{jj}^{p} is the own-price elasticity, x_j is the j[th] commodity expenditure elasticity, and ?$_j$ is the j[th] quality elasticity of expenditure $\left(\partial \ln \Psi_j / \partial \ln E\right)$. As Deaton (1988) notes, we would expect that with should market prices increase consumers can be expected to adjust both the quantities purchase and the quality of their purchases (e.g., the composition of the underlying goods that make up a particular composite commodity will be adjusted). We therefore would expect to see a degredation in product quality, that is, $\frac{\partial \ln \Psi_j}{\partial \ln P_j} < 0$ (p.420).

The above implies that if the researcher uses calculated unit-values obtained from an expenditure survey in the estimation of commodity demand elasticities and interprets them as such this demand elasticity incorporates both exogenous price and quality effects. Under the most usual conditions, such elasticities tend to overstate the price elasticity in absolute magnitude if the product of the price and quality elasticities is smaller than the expenditure elasticity. The above relationships provide the framework for adjusting these “demand” elasticities to control for such quality effects.

From (23) the relationship between the own unit-value elasticity $\left(p_{jj}^{U} \equiv \frac{d \ln\left(Q_j\right)}{d \ln\left(V_j\right)} \right)$ and own-price elasticity $\left(p_{jj}^{p} \equiv \frac{d \ln\left(Q_j\right)}{d \ln\left(P_j\right)} \right)$ is (Deaton, 1997, p.299):

$$p_{jj}^{U} = \frac{p_{jj}^{p}}{1+h_j p_{jj}^{p} / x_j} \rightarrow p_{jj}^{p} = \frac{p_{jj}^{U}}{1-p_{jj}^{U} h_j / x_j} \tag{24}$$

Dong, Shonkwiler and Capps (1998) and Dong and (2000) incorporate the above into a model originally formulated by Wales and Woodland (1980) to account for selectivity bias in estimating a conditional commodity expenditure equation for a composite good while at the same time endogenizing unit-value. Under their two-equation model, a unit value regression equation is formulated along with conditional expenditure functions where expenditure and unit-value equation error terms are assumed to be normally distributed and correlated. Parameters of the expenditure and price equations are estimated within a single likelihood function encompassing all observations.

Deaton (1997) provides a general framework for incorporating product quality within an empirical demand system. His methodology involves augmenting a system of utility-based share equations with an associated set of unit-value equations. In his original specification, both sets of dependent variables (i.e., expenditure shares and commodity unit values) are dependent on unobserved prices. Given the size of our empirical model and the complexity of the functional form used, instead of using his method for solving for unobserved prices, we use observed unit-values in the share equations and a set of market level variables in the unit value equations as instrumental variables for unobserved market prices. We then use the relationships shown in (24) to transform the estimated unit-value elasticities $\left(p_{ij}^{U}\right)$ to price elasticities $\left(p_{ij}^{P}\right)$.

We augment the QUAIDS share equations with the following unit value equations:

$$\ln V_j = t_{0j} + \sum_{r=1}^{R} t_{rj}^{*} R_r + \sum_{d=1}^{D} t_{dj} D_d + u_j \tag{25}$$

where the t^*'s and t's are coefficients to be estimated and R_r is the r[th] regional dummy variable used to capture the exogenous market price effects on observed unit values. The vector of variables represented by D_d correspond to the set of demographic characteristics (including the logarithm of total FAH expenditures) used as instruments for the unobserved product quality.

The share equations represented by (10) and the unit value equations represented by (25) represent our complete simultaneous system. It should be noted that only the expenditure share equations have endogenous variables as arguments (i.e., $\ln V_j$). As noted by Greene (2003) expressing all equations in a reduced form results in a likelihood function that is the same as the seemingly unrelated regression equation where we assume all error terms to be related via a multivariate normal distribution (p.407). A Full-Information Maximum Likelihood estimator is used to obtain parameter values.

Brief Description of the Chinese Urban Household Food Expenditure Data

We evaluate the structure of food demand in China using data obtained from an annual household expenditure survey conducted by the State Statistical Bureau (SSB) for the year 2001. This data encompasses household expenditures for urban households in the provinces of Jiangsu, Shandong, Guangdong, Heilongjiang and Henan. We use an urban sample to avoid issues associated with the consumption of home produced foods. The first three provinces are located on the China Sea. Jiangsu and Quangdong are the most prosperous provinces given their location close to Shanghai and Hong Kong, respectively (Table 1). The latter two provinces are the poorest of the five. Both are located in the interior with Heilongjiang being the most north and east and Henan located west of Shandong. In addition to food purchase quantity and value, household and member demographic characteristics are also included in this data set. A total of 3,650 households were used to estimate the parameters of our food system (Table 2).

The unique aspect of this expenditure survey is that households are required to maintain detailed daily expenditure diaries related to the purchase of food and nonfood items over the entire survey year. The daily diaries are then summarized by county statistical offices and aggregate results for each expenditure item and household reported to the SSB. The annual nature of these diaries is in contrast to other developing country surveys that typically encompass 1-2 weeks of purchases (Dong, et al., 2004; Sabates, et al., 2001). The brevity of the data collection period in these other setting usually result in the censoring of food expenditures. Such censoring represents a significant econometric problem when estimating disaggregated food demand systems (Dong, et al., 2004; Perali and Chavas, 2000; Yen, et al., 2003). Given the annual nature of the expenditure diaries used here, even with the development of our 12 food demand system, commodity censoring was not a significant problem. For most commodities less than 5% of the households did not report purchasing a particular commodity group.

For our analysis we adopt commodity group definitions similar to the categories used by Gao, et al. (1996) in their analysis of Chinese household food purchase behavior. These food categories include beef/mutton (BF), pork (PK), poultry (PLT), fish/seafood (SFD), vegetables (VEG), fruits (FRT), rice (RIC), other grain products (OGR), dairy products (DA), eggs (EGG), food fats and oils (FAT), and other foods for at-home consumption (OTH).

Table 2 provides an overview of food purchase patterns of our sampled households. Mean annual household income ranges from 15,884 yuan/household in Henan province to 47,446 yuan in Guongdong. In spite of this wide range there is little variation in the mean share of household income allocated to food. The minimum mean food share is 24.6% for households in Shandong province. This compares to 28.0% for households in Jiangsu province. In contrast, there are some significant differences in the allocation of average household food budgets across specific food categories. For example, Guongdong, the more affluent province, relies the least on grain-based commodities (7.0% of total food expenditures) while households in Henan rely the most (17.0% of expenditures). For the 5 provinces included in this analysis, the sample mean income is 16.1% greater than the mean household income across all urban Chinese households. Again the relative value of this value varies across province, from slightly more than 66% for our sample of households from Henan province to more than 230% for our sample of urban Guangdong households.

Besides data sorted by region of residence, we also present food purchase characteristics for households contained in the highest and lowest total food expenditure deciles. Not surprisingly, the most significant difference can be seen with respect to the importance of FAFH as a food source. Slightly less than one-third of total food expenditures by households in the highest expenditure decile is spent on FAFH. This compares to only 7% for households in the lowest expenditure decile. More than 35% of FAH expenditures is associated with beef, pork or poultry for the highest decile households. This compares to less than 23% for households in the lowest decile. The lowest decile households also spend relatively more on vegetables compared to high decile households.

We account for household heterogeneity in the estimated expenditure share equations by including a set of demographic characteristics in the translating functions, $t_i(p)$. Table 2 provides an overview of these characteristics along with the household characteristics used in the unit value equations. Besides the wide range in household income across region noted in Table 1, there is a parallel pattern obtained with respect to the percent of households owning refrigerators and/or freezer appliances (D_REFRIG) and meal planner education (D_ADV, D_LHS).

Application of the Econometric Model to Chinese Urban Households

Given expenditure share adding-up and theoretical symmetry conditions, estimation of the share equation parameters was achieved by dropping one share equation e.g., other food, from the estimation process. Parameters for this omitted category were recovered from these conditions. We assume that the share equation and unit value error terms are distributed multivariate normal. We use the following log-likelihood function to obtain parameter estimates:

$$\ln L = -\frac{(2M-1)T}{2}\ln(2p) - \frac{T}{2}\ln|\Omega| - \frac{1}{2}\sum_{t=1}^{T}\begin{pmatrix} e_t^* \\ u_t \end{pmatrix}' \Omega^{-1} \begin{pmatrix} e_t^* \\ u_t \end{pmatrix} \qquad (26)$$

where M is the number of aggregate commodities included in the system, T the number of households in the sample, e_t^* is the ([M-1] x 1) expenditure share error terms used in estimation, $?_t$ is the (M x 1) unit value error terms and O is the ([2M-1] x 1) error term covariance matrix. As noted above, after expressing the share equations in reduced form a Full Information Maximum Likelihood estimator was used within the GAUSS software system to obtained parameter estimates. In order to estimate the large system included in the present application we assumed that the covariance of the share and unit-value equation error terms are zero. Even with this assumption we were still required to estimate 519 parameters which included the remaining error covariance matrix elements.

Overview of Estimated Share Equation Coefficients

Appendix A contains a listing of the estimated coefficients, associated standard errors and equation R^2 values for the 12 expenditure share equations. Appendix B contains similar results for the unit value equations. The share equation R^2 values were of reasonable size given our use of cross-sectional data ranging from 0.029 for pork to 0.436 for other grains. It was not surprising that the R^2 values for the unit value equations tended to be larger than the share equation values given the use of lnV as the dependent variable. The range in unit value R^2 values was from 0.082 for dairy products to 0.688 for the fruit commodity.

As shown in Appendix A, there are 11 demographic-related coefficients in each share equation resulting in a of 132 share equation demographic related parameters. Approximately two-thirds of these coefficients were statistically significant at the 0.01 level. There appears to be significant regional differences in the structure of food demand as 40 of the 48 provincial dummy variable coefficients were statistically significant. Compared to the impact of region on food demand structure we found less of an impact of household age composition. Less than a third of the age related dummy variable coefficients were found to be statistically significant. Not surprisingly, for dairy products we see that having children in the household positively impacts the share of total expenditures allocated to dairy products. Having adults over the age of 65 in the household only impacted expenditures on fruits (-) and rice (+).

We included household head age (AGE) as an explanatory variable in the share equations to capture some of the age-related cohort effects in food choice. From Appendix A, we see that head age is negatively related to the share of total food expenditures allocated to beef, poultry, fruits and dairy products. We also find some evidence that household income impacts food choice. The estimated coefficients associated with household income in the share equation were statistically significant except in for the poultry equations. The level of food expenditure shares associated with beef, fruit, and dairy products were positively related to household income.

We hypothesized that refrigerator ownership would have a positive impact on the share of relative expenditures spend on commodities considered to be perishable. Except for the other foods category, the commodities where a positive impact of refrigerator ownership was for commodity groups that could be considered being composed of perishable foods (e.g., beef, seafood, fruit, and dairy products).

From Appendix A we see that a majority of price related coefficients are significantly different from zero (i.e., 65 out of 78). The beef and poultry commodities had the least number of statistically significant price coefficients. The price coefficients associated with the dairy products (10 out of 12) and other food categories (12 out of 12) had the largest number of statistically significant coefficients.

Overview of the Estimated Coefficients in the Unit Value Equations

Appendix B contains the estimated coefficients associated with the unit value equations. As noted above in (22) we use the regional dummy variables to provide an estimated of exogenous market prices (i.,.e, $\ln P_j$). There are significant regional differences in commodity prices as reflected in 40 of the 48 estimated regional dummy coefficients being statistically significant from the base region, Shandong. Market prices in Guangdong and Jiangsu provinces are tend to be higher versus those in Henan and Heilongjiang provinces.

We initially hypothesize a negative relationship between household size and observed unit values reflecting a household's ability to obtain economies of scale when purchasing larger quantities. Dong and Gould (2000) found such an effect in their analysis of purchases of pork and poultry purchases. We do not find evidence of this in the present application with significant negative values obtained in the fats and oils and other food commodity groupings.

There appears to be some relationship between education level and unit value. This suggests that more educated households exhibited an increased demand for quality, ceteris paribus. Household composition appears to matter in terms of the demand for food quality. Unit-values for 5 of the 12 commodities are impacted by the percentage of household members that are older than 65 years. The beef commodity shows a positive unit value relationship compared to negative values obtained in the vegetable, fruit, other grain and dairy product unit value equations. All of the unit value coefficients associated with the PER_LT_6 and PER_6_14 variables were positive, indicating increased demand for quality. Again, this may be reflecting a cohort effect where younger households being accustomed to purchasing better quality food.

Evaluation of the Structure of Food Demand

Form (14) and (15) expenditure ($?_j$) and "unit value" elasticities $\left(p_{ij}^{U}\right)$ are calculated using the mean values of the exogenous variables. The resulting elasticity estimates are displayed in Table 3. Banks, et al. (1997) note that given the expression for the expenditure elasticities shown in (14) a positive b_i coefficient in combination with a negative l_i value implies for relatively low expenditure levels, the ith commodity could be considered a luxury and a necessity for relatively high expenditure levels (p.534). Only the pork commodity exhibits this structure. It was surprising that dairy products did not fall into this category given the historically low levels of dairy product expenditures in the past and rapid increases in such expenditures recently. When evaluated at these mean values of the exogenous variables we find that beef, pork, dairy products and fats and oils have expenditure elasticities significantly greater than 1.0 . Given the relative increase in per capita fruit consumption in recent history, it is surprising that the estimated fruit expenditure elasticity is significantly less than 1.0 .

Table 3 also contains a summary of the estimated uncompensated (Marshallian) unit value elasticities. All own unit-value elasticities were found to be significantly less than zero and all except for the other grains commodity were inelastic. Surprisingly, dairy products exhibited the most own unit-value inelastic structure. In terms of the cross price effects we found a mixture of gross complements and substitutes. Of the 132 cross unit-value elasticities, 77 were found to be statistically different from 0. The large number of significant relationships reinforces the need for us to disaggregate our analysis of food purchases versus the more ad hoc single equation approaches. Of the statistically significant cross unit-value elasticities all exhibit inelastic relationships. The relationship between demand for other food commodities due to a change in unit-value of the other grains commodity shows the largest substitution relationship with a cross-price elasticity of 0.436. The next largest substitute relationship was between the demand for rice in reaction to changes in the egg unit value. An example of a complementary relationship can be seen for the impact on other food demand resulting from the pork unit value, -0.515.

Differentiation of Unit Value and Price Elasticities

Deaton (1988, 1997) provides the theoretical framework for differentiating the effects on food choice of changes in endogenously determined unit values versus exogenous market prices. As noted above, Table 3 contains elasticity measures that incorporate quality effects. To isolate the quality effects of price changes, Table 4 provides a summary of alternative elasticity measures used to correctly evaluate the own-price impacts on commodity demand.

Similar to the interpretations of Prais and Houthaaker (1955), Cramer (1973) and Deaton (1997) we interpret the elasticity of unit value to a change in total expenditures (FAH) , as a measure of the quality elasticity, e.g. $h \equiv \frac{\partial \ln \Psi_j}{\partial \ln E} = \frac{\partial \ln V_j}{\partial \ln FAH}$. These elasticity values are displayed in the first column of Table 4. They are relatively small but much larger than those obtained by Myrland et al. (2003) in their analysis of the demand for salmon (0.002) which was based on a similar methodology as used here but applied to single commodity. Dong and Gould (2000) in their double-hurdle model of pork and poultry purchases by Mexican households obtain similar values as those reported in Table 4, 0.060 and 0.10, respectively. In the analysis of food demand in urban households in Pakistan (1984-85), Deaton (1997) obtained a relatively large value for his aggregate meat category, 0.242 when compared to the estimated values obtained for our beef, pork and poultry commodities.

The second column of Table 4 repeats the value of the own unit value elasticities previously reported in Table 3. The next 3 columns use the results of (24) to summarize our estimates of the own-price elasticities, p_{jj}^{P} under alternative expenditure elasticity scenarios. Similar the results of Deaton (1997) the relatively small quality elastities result in small differences in p_{jj}^{U} versus p_{jj}^{P} values. The p_{jj}^{P} values shown under the Base column correspond to the values obtained using the quality elasticities obtained from the estimated unit value equations. Only for the fruit and other grains commodities do we see a major difference between the unit-value versus price based elasticity measures. Next to the *Base* model we present our estimates of the own price elasticity if the quality elasticity had been double (2X) or triple (3X) the estimated value.

Given our estimates of p_{jj}^{P} we (23) to generate estimates of the relationship between observed unit values and unobserved market prices, e.g., $p_{jj}^{V} \equiv \frac{\partial \ln V_j}{\partial \ln p_j}$. These estimates are provided in columns 7-9 of Table 4 using the same quality elasticity values used in the evaluation of the price elasticities. We would expect the following range of values:

$0 < p^V_{jj} < 1$. The higher the number the lower the role quality plays in determining observed unit values. The range in values was from 0.975 for eggs to 0.817 and 0.802 for the other grains and fruit categories, respectively. The relatively large value for eggs is not surprising given the egg commodity is composed of mostly a single fundamental good, chicken eggs which is fairly standardized. In contrast, the other grains category is composed of a number of different types of fundamental goods some with very little valued added characteristics such as raw small grains versus others that embody significant value added such as breads and bakery items that are grain based. The relatively high p^V_{jj} values for the meat categories and for dairy products were surprisingly given the variety of product forms and degree of processing associated with composite commodities. Similar to the analysis of p^P_{jj} we also examine the sensitivity of p^V_{jj} to alternative quality elasticity values.

Given the definition of unit values and the relationship between observed unit values, product price and quality noted in (22), the quality own price elasticity $\left(p^{\Psi}_{jj} \equiv \frac{\partial \Psi_j}{\partial p_{jj}} \right)$ exhibits the opposite pattern of the above unit-value own price elasticities. That is, the quality of the Other Grain and Fruit commodities responded the most to changes in unit values. We verify the theoretical results of Deaton (1988, 1997) by finding that for all commodities, a price increase ceteris paribus will result not only reduction in quantity purchased but also a reduction in the quality of the composite commodity bundle. If the quality elasticity for the Fruit commodity had been 0.508 versus the actual value of 0.254, the quality own-price elasticity is projected to increase in abosolute value from 0.198 to 0.331 .

Summary

This research utilizes a generalization of the Quadratic Almost Ideal Demand System (QUAIDS) to quantify the structure of food demand of urban households in 5 Chinese provinces. We extend previous research via the estimation of a disaggregated demand system while at the same time accounting for the endogenous decision as to product quality. By capturing the joint nature of the quantity and quality decisions we are able to examine the impact of quality when market prices change. As predicted, increases in market prices result in changes in purchase patterns such that overall commodity quality is reduced.

This paper found that there exist statistically significant substitution effects between foods. The utilization of the QUAIDS specification was important as a likelihood ratio test indicated that this specification added significant explanatory power to the model versus the traditional AIDS specification. Using the QUAIDS specification we obtain reasonable unit value and price elasticity estimates when compared to other analyses of food demand by Chinese households.

Our method for examining the impacts of product quality results in a set of elasticity measures that indicate that product quality is relatively inelastic with respect to changes in market prices. The analysis presented here is based on demand characteristics for the sample as a whole. A more detailed analysis should examine how the demand for quality varies across households in different income deciles, expenditure deciles, region of residence, etc. We also need to provide estimated cross-price elasticities using the estimated cross unit-value elasticities. These values will enable use to answer the question as to whether the similarity of the own price and own unit-value elasticities carries over to cross price effects.

An extension of the current model would be to examine the sensitivity of our results to changes in the method by which we endogenize product quality. That is, in the estimated QUAIDS share equations we use predicted simultaneously determined unit values instead of unobserved commodity market prices as explanatory variables. This is in contrast to the methodology proposed by Deaton (1997) whereby both the system of share equations and unit value equations use the unobserved commodity market prices as explanatory variables. He applies this methodology to a Linear Approximate AIDS-based system. Our use of the much more nonlinear QUAIDS model greatly complicates the implementation of Deaton's (1997) framework. In the future, we will undertake the task of incorporating his methodology within the QUAIDS structure.

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Table 1. Allocation of Food Expenditures Across Food Commodity Group, Expenditure Decile and Region

	Entire Sample	*Lowest Decile*	*Highest Decile*	*Jiangsu*	*Shandong*	*Guangdong*	*Henan*	*Heilongjiang*
Beef	8.6	7.1	11.4	8.4	8.0	11.4	7.6	9.4
Pork	10.4	11.7	9.5	10.9	9.5	10.2	12.7	11.1
Poultry	5.7	3.9	14.5	6.3	6.0	9.7	5.7	3.0
Seafood/Fish	7.9	4.5	11.3	11.1	7.3	14.1	3.0	5.8
Vegetables	11.3	13.8	4.5	10.8	9.8	11.4	12.6	13.6
Rice	5.0	6.9	8.8	6.3	2.0	4.9	4.4	7.1
Other Grain	7.6	13.4	5.9	3.4	9.2	4.2	14.1	9.6
Fruit	7.8	7.8	4.2	5.7	7.9	7.9	7.6	10.6
Dairy	5.0	3.2	5.9	5.3	6.9	4.6	4.1	4.8
Eggs	4.1	6.6	1.9	3.4	5.4	1.7	6.2	4.9
Fats/Oils	3.4	5.1	2.5	3.1	2.7	2.4	5.4	4.3
Other Food	15.4	16.1	15.8	16.3	17.7	13.6	16.6	15.8
Total Food Expend. (Yuan)	6,356	2,043	16,476	6,426	5,071	13,083	4,128	4,435
Food-at-Home (FAH) Expend. (Yuan)	5,135	1,790	11,604	5,335	4,242	9,234	3,660	3,983
Household Income(Yuan)	23,661	10,931	56,990	22,961	20,588	47,446	15,884	16,612
Income as % of All Urban Chinese	116.1	53.6	279.7	112.7	101.0	232.8	67.1	70.2
Food Expend. As % of Income	26.8	18.7	28.9	28.0	24.6	27.6	26.0	26.7
FAH* as % of Income	21.7	17.4	19.7	23.2	20.6	19.5	23.0	24.0
Sample Size	3650	365	365	800	650	600	600	1000

*Note: During June 2001, 1 $U.S.=8.28 Yuan. In 2001, the average urban household income across all Chinese provinces was 20,378 yuan (National Bureau of Statistics, 2003). The decile categories in the above table are defined relative to total food expenditures.

Table 2. Summary of Household Characteristics Used in the Demand System

Variable	*Description*	*Unit*	*Equation*	*Entire Sample*	*Bottom Decile*	*Top Decile*	*Jiangsu*	*Shandong*	*Guangdong*	*Henan*	*Heilongjiang*
HH_INC	Total Household Income	Yuan	S	23,661 (18,546)	10,931 (5,795)	56,990 (30,163)	22,961 (13,575)	20,588 (10,336)	47,446 (28,630)	15,884 (8,393)	16,612 (8,579)
HH_SIZE[a]	Number of Resident Members	#	S,V	3.1 (0.83)	2.9 (0.86)	3.5 (0.92)	2.9 (0.92)	3.1 (0.64)	3.3 (0.77)	3.2 (0.93)	3.0 (0.79)
D_REFRIG	Own Refrigerator/Freezer	0/1	V	0.83	0.57	0.97	0.90	0.90	0.92	0.79	0.70
AGE	Age of Household Head	Year	S	47.4	45.7	46.0	51.3	43.7	44.3	48.1	48.3
	Meal Planner Education Status										
D_ADV	Completed More Than High School	0/1	V	0.26	0.17	0.36	0.18	0.38	0.32	0.19	0.24
D_LHS	Completed Less Than High School	0/1	V	0.46	0.57	0.28	0.57	0.37	0.28	0.54	0.50
	Household Composition										
D_LT_6	Child < 6 Years Old Present	0/1	S	0.11	0.12	0.13	0.08	0.12	0.12	0.17	0.09
D_6_14	Child Between 6-14Years Old	0/1	S	0.28	0.32	0.33	0.21	0.31	0.32	0.33	0.26
D_SENIOR	Adult > 65 Years Old Present	0/1	S	0.26	0.19	0.28	0.33	0.14	0.22	0.30	0.27
PER_LT_6	% Members <6 Yrs. Old	%	V	3.1	3.7	3.4	2.3	3.7	3.3	4.6	2.5
PER_6_14	% Members Between 6-14 Yrs. Old	%	V	8.7	10.8	10.0	6.4	9.8	10.1	10.5	8.1
PER_SENIOR	% Members > 65 Yrs. Old	%	V	14.7	12.3	10.1	21.8	7.2	8.6	16.4	16.3
	Household Province										
D_JS	Jiangsu*	0/1	S,V	0.23	0.13	0.11	1.0	-----	-----	-----	-----
D_SD	Shandong	0/1	S,V	0.18	0.13	0.02	-----	1.0	-----	-----	-----
D_GD	Guangdong	0/1	S,V	0.16	0.00	0.85	-----	-----	1.0	-----	-----
D_HN	Henan	0/1	S,V	0.16	0.33	0.01	-----	-----	-----	1.0	-----
D_HLJ	Heilongjiang	0/1	S,V	0.27	0.41	0.01	-----	-----	-----	-----	1.0
	Sampled Households			3650	365	365	800	650	600	600	1000

Note: The values in parentheses are standard deviations. The symbol * identifies the omitted region. The meal planner is assumed to be the female head, if present, otherwise it is the male head. The "S" and "V" symbols identify use of the associated variable in the expenditure share and unit value equations respectively.

[a]In the share equations, the inverse of household size is used as an explanatory variable. In the unit value equations, the natural logarithm of household size is used.

Table 3. Uncompensated Unit-Value and Expenditure Elasticities

		Quantity Change											
		BF	PK	PLT	SFD	VEG	FRT	RI	OG	DA	EG	FAT	OTH
Price Change	BF	-0.968	0.095	-0.008	0.022	-0.012	-0.015	0.014	-0.022	-0.042	-0.013	-0.026	-0.167
	PK	0.071	-0.579*	0.018	-0.110	0.053	-0.094	-0.022	-0.026	-0.126	0.041	0.013	-0.515
	PLT	-0.011	0.045	-0.876*	0.021	0.020	-0.040	-0.160	0.011	0.045	0.063	-0.037	-0.211
	SFD	0.027	-0.140	0.017	-0.608*	-0.075	0.044	-0.122	0.041	-0.022	-0.073	-0.009	-0.057
	VEG	-0.005	0.056	0.013	-0.052	-0.678*	-0.046	0.010	-0.124	-0.040	-0.063	0.023	-0.049
	FRT	0.001	-0.104	-0.017	0.048	-0.063	-0.704*	-0.126	0.033	0.066	-0.094	-0.040	0.277
	RI	0.021	-0.058	-0.183	-0.193	0.025	-0.185	-0.603*	0.126	-0.116	0.285	0.153	-0.241
	OG	0.001	0.000	0.026	0.046	-0.180	0.029	0.074	-1.019	0.096	-0.061	-0.087	0.436
	DA	-0.067	-0.235	0.054	-0.040	-0.101	0.070	-0.114	0.102	-0.405*	-0.065	-0.049	-0.339
	EG	-0.020	0.114	0.090	-0.138	-0.171	-0.180	0.338	-0.117	-0.070	-0.737*	0.002	-0.052
	FAT	-0.073	0.037	-0.066	-0.023	0.069	-0.102	0.225	-0.209	-0.081	-0.001	-0.713*	-0.275
	OTH	-0.036	-0.216	-0.043	-0.037	-0.058	0.043	-0.085	0.093	-0.064	-0.025	-0.028	-0.510*
Exp.Elas.		1.142	1.277	1.130	0.977	0.954	0.722	0.968	0.639	1.191	0.941	1.215	0.966

Note: The above elasticities were evaluated at the mean values of the exogenous variables. For the unit value elasticities, shaded values identify those statistically different from 0 at the 0.01 level of significance. For expenditure elasticities a shaded value identifies elasticities statistically different from 1.0. For own unit value elasticities, a "*" indicates a value statistically different from -1.0 at the 0.01 significance level.

Table 4. Comparison of Various Elasticity Measures

Commodity	Quality (?$_j$) [1]	Unit Value $\left(p_{jj}^{U}\right)$ [2]	Own Price $\left(p_{jj}^{P}\right)$ Base [3]	2X [4]	3X [5]	Unit-Value Own Price $\left(p_{jj}^{V}\right)$ Base [6]	2X [7]	3X [8]	Quality Own Price $\left(p_{jj}^{\Psi}\right)$ Base [9]	2X [10]	3X [11]
BF	0.093	-0.968	-0.898	-0.837	-0.784	0.927	0.864	0.810	-0.073	-0.136	-0.190
PK	0.059	-0.579	-0.564	-0.550	-0.536	0.974	0.949	0.926	-0.026	-0.051	-0.074
PLT	0.139	-0.88	-0.794	-0.723	-0.664	0.902	0.822	0.754	-0.098	-0.178	-0.246
SFD	0.250	-0.608	-0.526	-0.464	-0.414	0.865	0.763	0.682	-0.135	-0.237	-0.318
VEG	0.287	-0.678	-0.563	-0.482	-0.421	0.831	0.710	0.621	-0.169	-0.290	-0.379
FR	0.254	-0.704	-0.564	-0.471	-0.404	0.802	0.669	0.574	-0.198	-0.331	-0.426
RIC	0.071	-0.603	-0.577	-0.554	-0.532	0.957	0.918	0.882	-0.043	-0.082	-0.118
OGR	0.140	-1.019	-0.833	-0.704	-0.610	0.817	0.691	0.598	-0.183	-0.309	-0.402
DA	0.180	-0.405	-0.382	-0.361	-0.342	0.942	0.891	0.845	-0.058	-0.109	-0.155
EGG	0.032	-0.737	-0.719	-0.702	-0.685	0.975	0.952	0.930	-0.025	-0.048	-0.070
FAT	0.113	-0.713	-0.669	-0.630	-0.595	0.938	0.883	0.835	-0.062	-0.117	-0.165
OTH	0.311	-0.510	-0.438	-0.384	-0.342	0.859	0.753	0.670	-0.141	-0.247	-0.330

Note: The terms “2X” and “3X” refer to estimates based on values of the Quality Elasticity being 2 and 3 times as large as the values displayed in column (1).

Appendix A. Summary of Share Equation Estimated Coefficients, Associated Standard Errors and Equation R^2

Variable	BF		PK		PLT		SFD		VEG		FR		RIC	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
	Price Coefficients (g_{ij})													
BF	0.0033	0.0020	0.0086	0.0021	-0.0005	0.0013	0.0023	0.0017	-0.0007	0.0015	-0.0004	0.0015	0.0011	0.0017
PK			0.0469	0.0068	0.0026	0.0029	-0.0119	0.0032	0.0070	0.0032	-0.0081	0.0029	-0.0031	0.0041
PLT					0.0077	0.0028	0.0014	0.0020	0.0015	0.0020	-0.0018	0.0018	-0.0099	0.0022
SFD							0.0335	0.0024	-0.0065	0.0022	0.0036	0.0021	-0.0104	0.0025
VEG									0.0392	0.0027	-0.0061	0.0019	0.0013	0.0024
FR											0.0231	0.0028	-0.0101	0.0021
RIC													0.0215	0.0047
	Expenditure Coefficients $(b_i,\ l_i)$													
ln(m)	0.0147	0.0064	0.0370	0.0074	0.0083	0.0051	-0.0074	0.0057	-0.0063	0.0045	-0.0276	0.0045	-0.0028	0.0044
$(\ln(m))^2$	-0.0014	0.0014	-0.0058	0.0016	-0.0004	0.0011	0.0056	0.0011	0.0007	0.0010	0.0043	0.0010	0.0011	0.0010

(continued)

Appendix A. Summary of Share Equation Estimated Coefficients, Associated Standard Errors and Equation R^2 (continued)

Variable	OGR		DA		EGG		FAT		OTH	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
	Price Coefficients (g_{ij})									
BF	-0.0005	0.0017	-0.0034	0.0015	-0.0010	0.0009	-0.0026	0.0011	-0.0062	0.0020
PK	0.0007	0.0031	-0.0129	0.0024	0.0052	0.0031	0.0012	0.0029	-0.0362	0.0033
PLT	0.0016	0.0019	0.0031	0.0017	0.0040	0.0014	-0.0023	0.0015	-0.0073	0.0022
SFD	0.0032	0.0021	-0.0020	0.0020	-0.0063	0.0014	-0.0007	0.0016	-0.0062	0.0022
VEG	-0.0158	0.0020	-0.0051	0.0017	-0.0078	0.0016	0.0028	0.0017	-0.0099	0.0022
FR	0.0000	0.0021	0.0045	0.0018	-0.0084	0.0014	-0.0032	0.0014	0.0068	0.0022
RIC	0.0066	0.0026	-0.0063	0.0018	0.0153	0.0025	0.0083	0.0024	-0.0142	0.0023
OGR	-0.0050	0.0030	0.0067	0.0017	-0.0056	0.0016	-0.0069	0.0016	0.0149	0.0024
DA			0.0323	0.0029	-0.0033	0.0011	-0.0027	0.0013	-0.0110	0.0021
EGG					0.0118	0.0033	0.0001	0.0017	-0.0042	0.0016
FAT							0.0107	0.0024	-0.0046	0.0018
OTH									0.0782	0.0036
	Expenditure Coefficients $(b_i,\ l_i)$									
ln(m)	-0.0344	0.0049	0.0125	0.0059	-0.0028	0.0032	0.0087	0.0041	0.0001	0.0061
$(\ln(m))^2$	0.0048	0.0012	-0.0024	0.0013	0.0002	0.0007	-0.0007	0.0009	-0.4644	0.0140

(Continued)

Appendix A. Summary of Share Equation Estimated Coefficients, Associated Standard Errors and Equation R^2 (continued)

Variable	BF		PK		PLT		SFD		VEG		FR		RIC	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
	Demographic Characteristics (a_i, Γ_{is})													
Intercept	0.0619	0.0106	0.0421	0.0117	0.0451	0.0084	0.0003	0.0106	0.0688	0.0091	0.0768	0.0097	0.0419	0.0094
1/HH_SIZE	0.0076	0.0062	0.0279	0.0071	0.0051	0.0050	0.0062	0.0060	-0.0038	0.0048	0.0040	0.0050	-0.0143	0.0046
Ln(HH_INC)	0.0026	0.0010	-0.0047	0.0012	-0.0007	0.0008	-0.0040	0.0010	-0.0033	0.0008	0.0082	0.0009	-0.0095	0.0008
D_SENIOR	-0.0020	0.0013	0.0015	0.0013	0.0004	0.0009	-0.0005	0.0011	0.0007	0.0010	-0.0040	0.0012	0.0035	0.0010
D_LT_6	-0.0008	0.0017	-0.0026	0.0018	-0.0035	0.0013	-0.0008	0.0017	-0.0051	0.0014	-0.0001	0.0016	-0.0043	0.0016
D_6_14	0.0012	0.0011	-0.0003	0.0012	-0.0017	0.0009	-0.0018	0.0011	-0.0022	0.0010	0.0009	0.0011	-0.0026	0.0010
D_REFRIG	0.0039	0.0012	-0.0018	0.0014	-0.0008	0.0010	0.0019	0.0015	-0.0021	0.0010	0.0036	0.0012	-0.0021	0.0010
D_GD	0.0072	0.0022	-0.0075	0.0028	0.0142	0.0017	0.0188	0.0019	0.0078	0.0020	-0.0096	0.0022	0.0176	0.0027
D_JS	0.0013	0.0017	0.0005	0.0020	0.0003	0.0013	0.0143	0.0015	0.0045	0.0015	-0.0075	0.0016	0.0214	0.0021
D_HN	-0.0029	0.0016	0.0083	0.0018	-0.0027	0.0012	-0.0188	0.0025	0.0109	0.0014	0.0031	0.0016	0.0058	0.0021
D_HLJ	0.0057	0.0016	0.0014	0.0020	-0.0169	0.0014	-0.0091	0.0018	0.0148	0.0014	0.0118	0.0015	0.0221	0.0020
Ln(AGE)	-0.0099	0.0027	0.0053	0.0027	-0.0073	0.0021	0.0032	0.0026	0.0093	0.0022	-0.0074	0.0023	0.0064	0.0022
R^2	0.088		0.029		0.291		0.385		0.081		0.195		0.231	

(Continued)

Appendix A. Summary of Share Equation Estimated Coefficients, Associated Standard Errors and Equation R^2 (continued)

Variable	OGR		DA		EGG		FAT		OTH	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
	Demographic Characteristics (a_i, Γ_{is})									
Intercept	0.0285	0.0099	0.0171	0.0105	0.0382	0.0054	0.0162	0.0063	0.5632	0.0132
1/HH_SIZE	-0.0488	0.0058	0.0294	0.0062	0.0001	0.0031	-0.0008	0.0035	-0.0125	0.0067
Ln(HH_INC)	-0.0070	0.0009	0.0117	0.0010	-0.0021	0.0005	-0.0066	0.0006	0.0154	0.0011
D_SENIOR	0.0009	0.0012	-0.0003	0.0013	0.0005	0.0006	0.0007	0.0007	-0.0015	0.0015
D_LT_6	-0.0028	0.0014	0.0101	0.0016	-0.0002	0.0008	0.0002	0.0009	0.0099	0.0019
D_6_14	0.0012	0.0011	0.0037	0.0012	0.0001	0.0006	-0.0014	0.0006	0.0030	0.0013
D_REFRIG	-0.0068	0.0010	0.0042	0.0015	-0.0017	0.0006	-0.0031	0.0006	0.0047	0.0014
D_GD	-0.0087	0.0025	-0.0201	0.0023	-0.0120	0.0016	0.0010	0.0015	-0.0089	0.0025
D_JS	-0.0252	0.0018	-0.0076	0.0015	-0.0079	0.0008	0.0031	0.0010	0.0027	0.0017
D_HN	0.0156	0.0014	-0.0120	0.0018	-0.0025	0.0006	0.0087	0.0008	-0.0134	0.0018
D_HLJ	-0.0046	0.0015	-0.0090	0.0016	-0.0045	0.0008	0.0057	0.0010	-0.0174	0.0018
Ln(AGE)	0.0110	0.0024	-0.0099	0.0024	0.0011	0.0013	0.0018	0.0015	-0.0036	0.0031
R^2	0.436		0.144		0.332		0.186		0.073	

Note: The values that are shaded identify coefficients that are statistically significant at the 0.01 level.

Appendix B. Summary of Unit Value Estimated Coefficients, Associated Standard Errors and Equation R^2

Variable	BF		PK		PLT		SFD		VEG		FR		RIC	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
	Demographic Characteristics													
Intercept	2.9264	0.082	2.1889	0.0191	2.1824	0.0515	1.4680	0.0602	-0.4922	0.0496	-0.2459	0.0598	0.5713	0.0289
Ln(HH_SIZE)	0.0444	0.0349	0.0232	0.009	0.0368	0.0235	0.0967	0.0284	0.0785	0.0228	0.0327	0.0254	-0.0095	0.0130
Ln(FAH)	0.0925	0.0213	0.0589	0.0048	0.1394	0.0127	0.2501	0.0150	0.2868	0.0126	0.2538	0.0150	0.0713	0.0074
ADVANCE	0.0417	0.0232	0.0171	0.0053	0.0271	0.0139	0.0583	0.0167	0.0159	0.0141	0.0518	0.0167	-0.0057	0.007
LHS	0.0228	0.0207	-0.0137	0.0049	-0.0629	0.0126	-0.0855	0.0158	-0.1047	0.0134	-0.0761	0.0145	-0.0277	0.0069
PER_6_14	0.0357	0.0632	0.0144	0.0147	0.1282	0.0361	0.1049	0.0454	0.2692	0.0394	0.2186	0.0454	0.0259	0.0196
PER_SENIOR	0.0813	0.0294	-0.0112	0.008	-0.0276	0.0204	0.0091	0.0251	-0.1019	0.0205	-0.0979	0.0226	-0.0138	0.0137
PER_LT_6	0.1981	0.1041	0.0039	0.0227	0.0299	0.0580	0.1891	0.0779	0.3602	0.0572	0.4665	0.0743	0.0714	0.0316
D_GD	0.5244	0.0323	0.3159	0.0078	0.1452	0.0264	0.2228	0.0267	0.5178	0.0282	1.0053	0.0270	0.3383	0.0105
D_JS	0.4695	0.0260	0.0352	0.0070	-0.1192	0.0204	0.1196	0.0207	0.1887	0.0210	0.0253	0.0212	-0.0612	0.0137
D_HN	-0.1713	0.0317	0.0075	0.0074	-0.1402	0.0187	-0.1525	0.0224	-0.2152	0.0227	-0.2704	0.0236	-0.0108	0.0110
D_HLJ	-0.2442	0.0287	-0.0223	0.0063	-0.2170	0.0156	-0.0807	0.0196	0.0074	0.0181	0.3117	0.0216	-0.0151	0.0108
R^2	0.373		0.624		0.295		0.356		0.599		0.688		0.527	

(Continued)

Appendix B. Summary of Unit Value Estimated Coefficients, Associated Standard Errors and Equation R^2 (continued)

Variable	OGR		DA		EGG		FAT		OTH	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
	Demographic Characteristics									
Intercept	0.6386	0.0633	4.1023	0.0704	1.3766	0.0236	1.7807	0.0385	3.8278	0.0562
Ln(HH_SIZE)	-0.0353	0.0284	-0.0315	0.0287	0.0134	0.0102	-0.0107	0.0165	-0.1433	0.0243
Ln(FAH)	0.1403	0.0157	0.1798	0.0174	0.0322	0.0059	0.1125	0.0106	0.3106	0.0139
ADVANCE	0.0440	0.0159	0.0254	0.0195	0.0138	0.0060	0.0249	0.0106	0.0740	0.0147
LHS	-0.1265	0.0149	-0.0598	0.0171	-0.0002	0.0058	-0.0326	0.0097	-0.0071	0.0134
PER_6_14	0.3443	0.0439	0.1388	0.0468	-0.0039	0.0169	0.0126	0.0275	-0.0009	0.0425
PER_SENIOR	-0.1310	0.0255	-0.0503	0.0245	-0.0119	0.0098	-0.0023	0.0146	0.0365	0.0207
PER_LT_6	0.3410	0.0695	0.3258	0.0761	0.0648	0.0259	0.0370	0.0471	0.1610	0.0655
D_GD	0.8306	0.0276	-0.1597	0.0306	0.3160	0.0096	0.1965	0.0154	-0.2222	0.0221
D_JS	0.3246	0.0216	-0.0314	0.0285	0.1086	0.0092	-0.1777	0.0117	-0.1423	0.0186
D_HN	-0.1289	0.0283	-0.0085	0.0265	0.0287	0.0102	-0.0493	0.0123	0.0639	0.0224
D_HLJ	0.0989	0.0221	-0.0782	0.023	0.0196	0.0093	-0.3862	0.0136	-0.0095	0.0187
R^2	0.567		0.082		0.484		0.556		0.265	

Note: The values that are shaded identify coefficients that are statistically significant at the 0.01 level