The Structure of Food Demand In Urban China: A Demand System Approach

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Abstract

The structure of Chinese food demand is examined using a non-homothetic translog indirect utility function. This analysis uses household level survey data for 3 urban Chinese provinces over the 1995-1997 period. We improve upon previous studies by incorporating theoretically consistent equivalence scales to account for differences in household size and composition. These scales allow us to quantify the impact of alternative types of household members on food expenditures. Similar to previous research we find little evidence of purchase economies with the addition of members although, depending on age, we find statistically significant differences in equivalence values across household member age grouping.

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With the U.S. granting China permanent normal trading status and its joining the WTO there is the possibility of dramatic increases in U.S. agricultural exports. Fuller, Hayes and Smith (2000) note that with China accounting for one fifth of the world's population and only 7% of the world's arable land, China has the potential to become a major importer of land intensive products. For example, the USDA's Foreign Agricultural Service estimates that China's participation in the World Trade Organization (WTO) could result in substantial reductions in trade barriers resulting in at least an increase of $2 billion per year in agricultural exports by 2005. Estimates are that U.S. exports of grains, oilseeds and related products and cotton alone to increase by $1.6 billion (Colby, Price and Tuan, 2000). Not only would tariffs be reduced significantly for poultry, pork, beef, fruits, forestry and fish products with China's joining the WTO but there may also be significant reductions in a variety of non-tariff barriers for a number of agricultural commodities (USDA, 2000[a]).

As China develops, there is likely to be an associated change in the diet of Chinese households (Gao, Wailes and Cramer, 1996). With rising incomes the general consensus is that the Chinese population will diversify their diets away from their dependance on staple, e.g. rice and grains, to one which contains more livestock products (Fuller, Hayes, and Smith, 2000). Using the example of other Asian economies such as Japan, Korea, Hong Kong and Singapore, most believe that consumption of beef will increase along with income. Currently, beef represents a small proportion of total meat products consumed but have been increasing in importance over the last two decades (Figure 1). A desire for diversity with higher incomes will likely lead to more rapid increases in beef consumption at the expense of pork. Also, the beef currently consumed is of low quality. Increases in demand for quality may be as important, if not more important, than quantity increases (USDA, 2000[b]).[1] Another indication of changes facing China is evidenced by its transition from being a net grain exporter to an importer during the mid-1990's, second only to Japan.[2]

Besides rising incomes, an important trend impacting Chinese food purchase is the changing age structure of the population. Due to improved living conditions, the mortality rate of the Chinese population has decreased dramatically over the last 4 decades. This situation has resulted in estimates that there will be a significant aging of the population by mid-century. By 2000, it is expected that 7.2% of the Chinese population will be aged 65 or more. This percentage will increase to 11.7% by 2020 and 20.6% by 2040 (Murray, 1998, p. 75). Concurrent with this change has been the dramatic decrease in the birth rate due in large part a government policy promoting later marriage, fewer births and a policy advocating one birth per couple in urban areas. Between 1980 and 1995 the total fertility rate decreased from 2.2 to 1.9 births per couple. This trend has resulted in forecasts of reductions in the primary school age population from 133.0 million in 1995 to 94.7 million in 2050 (Murrary, 1998, p.81-82). Both these demographic changes will impact the type and quantities of future food purchases.

With Chinese markets becoming more open to U.S. food products, it is important that U.S. manufacturers and traders obtain a better understanding of the determinants of expenditures on a variety of foods. For example, how does income impact food choice? What is the role of household composition in determining the demand for specific foods? To help answer these questions, Guo, et al. (2000) use a series of Engel curves analyze changes in the income/expenditure relationship over the 1989-1993 period for selected high-fiber and higher fat food products. They show differences in the relationship between income and the purchases of these types of foods. Information obtained from such analyses is important for potential exporters especially with the projected 7% annual GDP growth for China over the near term (USDA, 2000[a]). Such growth may result in increased demand for foods that in the past have been considered luxuries by the Chinese population.

Figure 1 provides an overview of purchases of a variety of foods over the 1981-1997 period. Over this period there has been a gradual decrease in consumption of total grains and vegetables, relatively stable pork and seafood consumption and an increase in beef and poultry purchased (Guo, et al, 2000).

The data in Figure 1 are obtained by dividing total household purchases of these foods by the number of household members. This method of standardization does not take into account differences in food consumption needs across individual household members. For example it does not recognize that the consumption needs of children can typically be met at lower cost than that of adults (Dreze and Srinivasan, 1997). The use in empirical demand analysis of a single household count variable as a deflator of food expenditures or its use as an explanatory variable is common practice. It is important to remember that such use incorporates the implicit assumption of the uniform impacts on expenditures of household members of different age and gender.

One approach that can be used to avoid the assumption of equal expenditure impacts is the use of endogenously determined *equivalence scales* which assign different weights to household members according to their age and gender (Deaton and Muellbauer, 1986).[3] Given the determination of an appropriate equivalence scale, a comparison of food expenditures for households of differing composition can be undertaken. As an example, suppose the weight given to a male adult between 25 and 45 years of age is 1.0, a female adult in the same age group a weight of .85 and a female child under 10 years of age a weight of .35, then a four-member household consisting of one male and two female adults and one female child in the above age groups would result in the household being composed of 3.05 *adult equivalents*. A single parent household with one female adult would possess the corresponding adult equivalent of 1.20. The per capita expenditures patterns of these two households can then be compared where the number of AE's are used as the expenditure deflator.

Given the recognition of the need to obtain estimates of food adult equivalents to allow for cross-household expenditure comparison, there are a number of approaches that have been suggested for the estimation of endogenously determined adult equivalent scales. These have ranged from the use of demographically translated utility consistent demand systems suggested by Barten(1964), Gorman(1976) and Deaton and Muellbauer (1986) and implemented by Perali (1993) to the single equation approaches used by Prais and Houthakker(1955), Blokland(1976), Buse and Salathe(1978) and Muelbauer(1980). The present paper uses a demand system approach to an analysis of food purchases by Chinese households over the 1995-1997 period. In this analysis we adopt a method where the prices are scaled in such a manner that a single household food equivalent is estimated for each household. This is in contrast to previous analyses where food-specific scaling functions are estimated (Gould, Cox and Perali, 1991). Results of this analysis provides useful information to potential food exporters as to the market impacts of continued improvements in the level of Chinese income. Additional information is provided that show how food expenditure patterns differ across households of differing composition. Our analysis improves upon previous econometric analyses of Chinese food demand in that these previous studies have not included demographic impacts, have used a simple head count of household members as a measure of household size implying the same marginal impact on food expenditures of household members, have not included price effects on purchase or have not allowed for the effects of substitutability/complementarity with purchases of other food categories (Gao, Wales, and Cramer, 1996; Guo, et.al, 2000; Halbrandt, et.al, 1994; Wang and Chern, 1992).

Description of the Econometric Model

We assume that observed food purchase behavior can be represented by a household's indirect utility function (n) which represents the maximum equally distributed equivalent indirect utility for each member of a household:

$$(1)\quad n = n\left(P, y \mid A\right) = Max\left[U\left(X \mid A, PX \leq A\right)\right]$$

where U is the household's utility function, X a vector of consumed goods, A is a vector of demographic characteristics, P a vector of prices faced by the household and Y is total household income. That is, n represents the level of per capita utility which if it were shared by each household member would yield the same aggregate well-being as the actual distribution of utility within the household (Phipps, 1998). An equivalence scale, d, can then be defined using the above indirect utility function:

$$(2)\quad n = n\left(P, y \mid A\right) = n\left(P, Y/d \mid A^R\right)$$

where A^R is the vector of characteristics of an arbitrary reference household. For this analysis the reference household is assumed to be a household composed of two adults with both being between 23 and 60 years old. Given (2), members of a household with characteristic vector A, facing prices P with household income Y experience the same utility level as the reference household facing the same prices but with household income (Y/d).

As Deaton (1988) and Blundell and Lewbel(1991) show, this equivalence scale can also be derived from the households' expenditure functions via the following:

$$(3)\quad d = \frac{E\left(n, P \mid A\right)}{E\left(n, P \mid A^R\right)} = d\left(n, P \mid A\right)$$

Phipps(1998) notes that such equivalence scales are of interest in that they allow for interhousehold comparisons of utilities and a determination of income levels at which members of households with different characteristics, such as the age or gender composition of household members, are equally well off. If these equivalence scales are to be independent of the utility level at which these comparisons are made, then preferences must satisfy *independence of base* (IB) and/or equivalence scale exactness (ESE).[4] Lewbel(1989) describes the general restrictions on cost and social welfare functions required for the estimation of IB equivalence scales. Blackorby and Donaldson (1993) show that in order to recover exact equivalence scales from demand behavior it is necessary that the preferences not take a PIGLOG form.

As shown by (3) we need to specify a functional form for the equivalence scale measure. That is, we would like to define the equivalence of the reference household, n^R, such that:

$$(4)\quad V\left(P, Y \mid A^R\right) = V^R\left(P, \frac{Y}{d\left(A, P\right)}\right)$$

We can apply Roy's identity to the above indirect utility function to generate a system of demand equations. These demand equations will be functions of prices, income and demographic characteristics implying that the parameters of the equivalence scale can be obtained via the estimation of these demand equations (Blackorby and Donaldson, 1993).

In our analysis of food expenditures and similar to Phipps(1998), we assume our reference household's indirect utility can be represented by the following nonhomothetic translog function:

$$(5)\quad \ln n\left(P, Y\right) = a_0 + \sum_{i=1}^{K} a_i \ln\left(\frac{p_i}{M}\right) + \frac{1}{2}\sum_{i=1}^{K}\sum_{j=1}^{K} b_{ij} \ln\left(\frac{p_i}{M}\right)\ln\left(\frac{p_j}{M}\right)$$

where M represents total food expenditures on K foods, p_i is the i^{th} food's unit value (price) and the $a_i{'}s$ and $b_{ij}{'}s$ are estimated coefficients. With the above utility function being defined for the reference household, the implied equivalence scale value is 1 . For a non-reference household we can represent its preference structure by incorporating the exact equivalence scale measure shown in (4) into (5):

$$(6)\ \ \ln V(P,Y) = a_0 + \sum_{i=1}^{K} a_i \ln\left(\frac{p_i}{M^*}\right) + \frac{1}{2}\sum_{i=1}^{K}\sum_{j=1}^{K} b_{ij} \ln\left(\frac{p_i}{M^*}\right)\ln\left(\frac{p_j}{M^*}\right)$$

where $M^* = \dfrac{M}{d(A,P)}$ and $d(A,P) \equiv \prod_{s=1}^{S} N_s^{*g_s} \exp\left(\sum_{l=1}^{L} D_l \Gamma_l\right) \prod_{i=1}^{K} p_i^{\left(\sum_{s=1}^{S} d_{is} N_s\right)}$

S is the number of age classification of household members, L the number of demographic characteristics hypothesized to impact household food expenditures, N_s the number of household members in the s^{th} age classification other than that represented by the base household, $N^*_s = (N_s + 2)/2$, D_l is the l^{th} demographic characteristic other than member category counts, and $g_s{'}s$, $\Gamma_l{'}s$, and $d_{is}{'}s$ are parameters to be estimated.[5] Note that under this equivalence scale function specification and using the above assumed reference household definition, a household composed of only two adults between the age of 23 and 60 (e.g., $N_s = 0$, s=1,...,S) generates a scale function value of 1 . To insure symmetry, adding up, and homogeneity of degree zero in prices we are also assuming that $b_{ij} = b_{ji}$ and $\sum_{i=1}^{K} a_i = -1$ and $\sum_{i=1}^{K} d_{is} = 0$ (s = 1,…,S) (Christenson, Jorgenson and Lau, 1975). It can be shown that this formulation satisfies general IB and ESE restrictions (Phipps, 1998).

From the above, via Roy's identity we obtain the following share equations:

$$(7)\quad w_i \equiv \frac{p_i x_i}{Y} = \frac{a_i - \left(\sum_{s=1}^{S} d_{is} N_s\right) + \sum_{j=1}^{K} \ln\left(\frac{p_j}{M^*}\right) + \left(\sum_{s=1}^{S} d_{is} N_s\right) \sum_{j=1}^{K} b_j^* \ln\left(\frac{p_j}{M^*}\right)}{-1 + \sum_{j=1}^{K} b_j^* \ln\left(\frac{p_j}{M^*}\right)} \quad (i = 1,\ldots,K)$$

$$= \frac{\left[\begin{array}{c} a_i - \left(\sum_{s=1}^{S} d_{is} N_s\right) + \sum_{j=1}^{K} \ln\left(\frac{p_j}{M}\right) + b_j^* \ln d(A,P) + \left(\sum_{s=1}^{S} d_{is} N_s\right) \sum_{j=1}^{K} b_j^* \ln\left(\frac{p_j}{M}\right) + \\ \left(\sum_{s=1}^{S} d_{is} N_s\right) \sum_{j=1}^{K} b_j^* \ln d(A,P) \end{array}\right]}{-1 + \sum_{j=1}^{K} b_j^* \ln\left(\frac{p_j}{M}\right) + \sum_{j=1}^{K} b_j^* \ln d(A,P)}$$

where d(A,P) is defined via (6) and $b_j^* = \sum_{i=1}^{K} b_{ji}$. Given the above share equations, a stochastic error term (e_i) can be added to each share equation where: $e \sim N(0,\Sigma)$ and Σ is the (K x K) error term covariance matrix. Given the above, we can identify one of the error terms from the remaining and thus one share equation can be omitted from the estimation process.

Phipps(1998) uses the above to examine differences in household well-being when children are present in the household. Given the extended nature of Chinese households, we use this model as a base, but as shown by (6) we formulate a more flexible model where we examine the impact on household food expenditures of the presence of not only children but also other adults.

Data Used in the Analysis

The data used in this analysis was obtained from an annual survey conducted by the State Statistical Bureau (SSB) of the People's Republic of China encompassing 1995-1997.[6] The SSB is the sole government agency that collects basic information concerning food consumption and expenditure data in China. This agency has had a relatively long history of collecting such data and has separated its data collection efforts into rural and urban components. For this analysis we use the results of the urban survey over the above 3 year period for Jiangsu, Shandong, and Guangdong provinces. In addition to purchase quantity and value information, data as to each household member's age, gender, educational attainment and labor force participation are also included in this data set. There is also a series of questions concerning the source and amount of the income brought into the home by each household member.

The unique aspect of this expenditure survey is that households are required to keep detailed records concerning household expenditures and income over the course of the study year. The 365-day diary is then summarized by county statistical offices and the aggregate results for each expenditure item and household reported to SSB. This is in contrast to other household expenditure surveys where diaries encompassing 1-2 weeks are used implying that researchers need to account for the censored nature of commodity expenditures (Dong and Gould, 2000). The urban surveys have two geographic components. One component covers large urban cities and the other, smaller county towns.

Table 1 provides an overview of the purchase characteristics for a disaggregated list of foods based on the 1995-1997 data. There are some differences in purchase patterns across the three provinces. As will be noted in Table 2, Guangdong province is the more affluent than the other two provinces. Higher provincial income is part of the explanation for the more than twice the level of per capita food expenditures observed in Shandong province. Away-from-home expenditures (FAFH) accounts for more of total food expenditures, 23% in Guandong versus 11% in the other two provinces. In terms of the distribution of food-at-home expenditures there are some provincial differences. For example, in Guangdong, 15% of at-home per capita expenditure is for seafood. This compares to 8% for Shandong. Slightly more than 12% of Shandong at-home expenditures (FAH) is for Grains/Flour (including bread). This is in contrast to 4% observed for households in Guangdong province.

Table 2 provides an overview of household characteristics used in the application of the econometric model represented by (7) to the 1995/97 SSB data. Besides dramatic differences in income we see that there are differences in the percent of adult ($\geq$ 18 years old) household members that are in the labor force with an average 72.2% of household members in Jiangsu province versus 85% in Shandong province. There is also a difference in the percent of the sampled households where there is refrigerated storage, 78.8% of households in Shandong versus 91.2% in Guangdong province.[7]

For this analysis we estimate a 9 equation food sub-system. The foods categories included in this analysis are pork, red meat, poultry, seafood, grains, vegetables, fruits, dairy products/eggs and "other" foods. We do not include food purchased away from home (FAFH) or alcoholic beverages in this analysis. Divisia price indexes were used to generate prices for the dairy products/eggs commodity and for "other" food.

Econometric Results

As noted above we limit our analysis to households where two parents are present and whose ages are in the range of 23 and 60 years of age. Thus, for a childless couple with no other household members present the functional form adopted for the equivalence scale results in a value of 1.0 . We extend the work of Phipps(1998) by examining how individuals of differing ages impact food purchases as represented by differences in their equivalence scale values. For this analysis we examine the impacts of the presence of young children, YNGCHILD (age < 13) , teenagers, TEENS (12< age <18), young adults, YNGADLT (17 < age < 23) and other adults, OTHADLT (age > 23). With the above definition of our base household, and dropping observations due to missing data, the presence of extremely large unit values (prices), and households that fed non-residents out of home food supplies, data for 4841 households were used to obtain parameter estimates.

We use the GAUSS software system to estimate the 9 equation system using the BHHH algorithm. Table 3 shows the estimated own and cross price elasticities evaluated at the mean values of the exogenous variables along with their standard errors.[8] All of own price elasticities are negative with the Red Meat, Grains, and Dairy/Egg commodities possessing elasticities significantly greater than one. The cross-price elasticities are of reasonable sign with a large number of estimated substitute relationships. One surprising result is the small, but significant, complementary relationship between pork and red meat. The vegetable commodity was the only one which showed a complementary relationship with all other commodities.

Table 4 shows the exact equivalence scale parameter estimates represented in (6) and (7). A majority of the demographic characteristics (e.g., the D_l's) were found to possess significant coefficients. For example, we find significant regional impacts. Approximately 15% of the households in our analysis did not have refrigerated storage. The insignificance of the associated coefficient is probably due to the significant income effect shown in this Table. There appears to be some cohort impacts on expenditure patterns, ceteris paribus, as shown by the significant AGE_D1 and AGE_D2 coefficients. Expenditure patterns do not appear to be impacted by household labor force participation decisions.

Nineteen of the 36 parameters associated with the member count variables (e.g., the N_s's) were statistically significant. The coefficients for the four modified member count variables (e.g., the N_s^*'s) were statistically significant. Using these coefficients we generate equivalent scale values using mean values of the demographic and price variables along with their approximate standard errors for various types and numbers of household members. The results of these calculations are shown in Table 5. In interpreting the scale values shown in this table it should be remembered that our reference household is a childless two-person household with both the husband and spouse between the age of 23 and 60. Thus the value of 1.361 implies that in terms of food expenditures, Chinese couples with 1 child require 1.361 times the level of food expenditures of childless couples to be equally well off.

Very few studies have examined the existence of scale economies in food expenditures. Comparing our results to that of Phipps(1998) who examined total household expenditures on food, clothing and shelter by Canadian households, our results appear to reasonable. In the above study only the impact of children on expenditures. Compared to childless couples, an equivalence scale value of children of 1.16 for one child, 1.28 for two and 1.38 for three was obtained. Phipps and Garner (1994) estimate food equivalence scales for Canada and the U.S. using a series of Engel curves. Unfortunately, they examine the impact of household size on food expenditures regardless of whether these additional members are adults or children. Using a two-person household as a base, they obtain food equivalence values of 1.33 and 1.68 for 3 and 4-person households in the U.S. and 1.36 and 1.73 for Canadian households, respectively (p.10-11). Similarly, Blaylock (1991) presents food equivalence values for different size households regardless of age of additional members. Using a 2-person household as a base, the obtain equivalence measures of 1.22 and 1.51 for 3 and 4-person households, respectively.

Similar to the above studies we find limited evidence of economies as additional members of a particular type are added to the household. For example, with the addition of a second young child, there is a relative increase of 0.344 in equivalence compared to the 0.361 increase with the addition of the first child to the household. One result that was surprising was the relatively low equivalence values for the young and ”other” adult members. It should be remembered that the foods delineated in our demand system only include food-at-home (FAH) expenditures. Any FAFH expenditures are not included. In developed and developing country settings, previous research has shown a positive relationship between FAFH expenditures and labor force participation (Manrique and Jensen, 1998; Sabates and Gould, 2000). As shown in Table 2, on average, more than 15% of total food expenditures originates from FAFH. One explanation for the low equivalence values for the other adults relative to the children category may be evidence of this phenomenon. In addition, the other adult age category includes household members more than 60 years of age. These seniors may have reduced nutritional needs and again have a relatively smaller impact on food expenditures.

Summary

Our analysis of the impacts of household composition on Chinese household food expenditures has used equivalence scales whose values are defined relative to a two-adult household. These theoretically consistent exact equivalence scales were obtained from the estimation of share equations derived from a non-homothetic translog indirect utility function. From our econometric results we are able to evaluate the impacts of having additional household members on food expenditures where these members are differentiated by age. For example, a simple head count of individuals in our estimation sample shows a mean household size of 3.25 . Using our equivalence scale parameter estimates and evaluating the scaling function at the mean values of all price, demographic and member count variables results in a equivalent size of 2.80 (remembering our base household is composed of two adults). These results imply that the frequency distribution of per capita food expenditures will be shifted to the right given our scaling down of the number of household members.

Given the strict population controls in place for the urban Chinese population, our ability to extend our model to allow for gender differences proved unsuccessful. We were also not able to break out directly the impacts of having household members over the age of 60 on household food expenditures. We intend to undertake additional analyses using the above model structure in specific country settings where households of larger size are more common. This will allow us to directly analyze the impacts of seniors on food expenditures as well as allowing us to test for gender specific impacts on food expenditures.

References

Blackorby, C., and D. Donaldson, 1993. "Adult Equivalence Scales and the Economic Implementation of Interpersonal Comparisons of Well-Being", *Social Choice and Welfare*, 10(4):335-361.

Barten, A.P., 1964. "Family Composition, Prices and Expenditure Patterns," in P.Hart, G. Mills, and J.K. Whittaker (eds.), *Econometric Analysis for National Economic Planning*, 16th Symposium of the Calston Society, London, Butterworths, 1964.

Blaylock, J., 1991. "The Impact of Equivalence Scales on the Analysis of Income and Food Spending Distributions", *Western Journal of Agricultural Economics*, 16(1):11-20.

Blokland, J., 1976. *Continuous Consumer Equivalence Scales*, The Hague: Martinas Nijhoff.

Blundell, R. and A. Lewbel, 1991. The Information Content of Equivalence Scales", *Journal of Econometrics*, 50:49-68.

Buse, R. and L. Salathe, 1978. "Adult Equivalence Scales: An Alternative Approach", *American Journal of Agricultural Economics*, 60:460-468.

Chern, W.S., 1994. "Consumption and Demand Data in the People's Republic of China", in *China as a Market and Competitor*, eds. T.I. Wahl and A.D. O'Rourke, Proceedings of Regional Committee WRCC-101, Reno NV, Nov. 1994.

Christensen, L.R., D.W. Jorgenson, and L.J.Lau, 1975. "Transcendental Logarithmic Utility Functions", *The American Economic Review*, 65(3):367-383.

Colby, H, J.M. Price, and F.C. Tuan, 2000, "China's WTO Accession Would Boost U.S. Agricultural Exports and Farm Income", *Agricultural Outlook*, USDA, Economic Research Service, March, Washington, D.C.

Deaton, A., and J. Muellbauer, 1986. "On Measuring Child Costs: With Applications to Poor Countries", *Journal of Political Economy*, 94:

Dong, D. and B.W. Gould, 2000. "Quality Versus Quantity in Mexican Household Poultry and Pork Purchases", *Agribusiness*, 16(3):333-356.

Drez, J., and P.V. Srinvasan, 1997. "Widowhood and Poverty in Rural India, Sime Inferences from Household Survey data", *Journal of Development Economics*, 54(2):217-234.

Fuller, F., D. Hayes and D. Smith, 2000. "Reconciling Chinese Meat Production and

Consumption Data”, *Economic Development and Cultural Change*, 49(1):23-43.

Gao, X.M., E.J. Wailes and G.L. Gramer, 1996. “A Two-Stage Rural Household Demand Analysis: Microdata Analysis from Jiangsu Province, China”, *American Journal of Agricultural Economics*, 78(Aug.):604-613.

Gorman, W.M., 1976. “Tricks with Utility Functions”, in *Essays in Economic Analysis: Proceedings of the 1975 AUTE Conference, Sheffield*, M.J. Artis and A.R. Nobay (eds), Cambridge, Cambridge University Press.

Gould, B.W., T.L. Cox, and F. Perali, 1991. “Determinants of the Demand for Food Fats and Oils: The Role of Demographic Variables and Government Donations”, *American Journal of Agricultural Economics*, Vol. 73(1):212-221, February.

Guo, X., T. A. Mroz, B.M.Popkin and F. Zhai, 2000. “Structural Change in the Impact of Income on Food Consumption in China, 1989-1993", *Economic Development and Cultural Change*, 48(4):737-760.

Halbrednt, C., F. Tuan, C. Gempesaw, and D. Dolk-Etz, 1994. “Rural Chinese Food Consumption: The Case of Guangdong”, *American Journal of Agricultural Economics*, 76(4):794-799.

Huang, J. S. Rozelle, and M.W. Rosegrant, 1999. “China’s Food Economy to the Twenty-First Century: Supply, Demand and Trade”, *Economic Development and Cultural Change*, 47(4):737-766.

Lazear, E.P. and R.T. Michael, 1980. “Family Size and the Distribution of Real Per Capita Income”, *American Economic Review*, 70(March):91-107.

Lewbel, A., 1989. “Household Equivalence Scales and Welfare Comparisons”, *Journal of Public Economics*, 39:377-391.

Manrique, J., H. and H. Jensen, 1998. “Working Women and Expenditures on Food Away-From-Home and At-Home in Spain, *Journal of Agricultural Economics*, 49(3), 321-33.

Muelbauer, D., 1980. “The Estimation of the Prais-Houthakker Model of Equivalence Scales”, *Econometrica*, 48:153-76.

Murray, G., 1998. *China: The Next Superpower*, Curzon Press Ltd, Surray.

Perali, C.F., 1993. *Consumption, Demographics and Welfare Measurement: Metric and Policy*

Implications to Columbia, Unpublished Ph.D. Dissertation, Department of Agricultural and Applied Economics, University of Wisconsin-Madision.

Phipps, S.A., 1998. What is the Income "Cost of a Chile"? Exact Equivalence Scales for Canadian Two-Parent Families, *Review of Economics and Statistics*, 80(1):157-164.

Phipps, S.A. and T.Garner, 1994. "Are Equivalence Scales the Same for the United States and Canada?", *Review of Income and Wealth*, 40(1):1-18.

Prais, S.J., and H.S. Houthakker, 1955. *The Analysis of Family Budgets*, Cambridge: Cambridge University Press.

Sabates R. and B.W. Gould, 2000 "Characteristics of Food Expenditures in Argentina: Implications for the U.S. Dairy Industry", Babcock Institute Discussion Paper 2000-5, Babcock Institute for International Dairy Development, University of Wisconsin-Madison.

USDA, 2000(a). "The U.S. – China WTO Accession Deal: A Strong Deal in the Best Interests of U.S. Agriculture", *FAS Online*, February, www.http://www.fas.usda.gov/itp/china/deal.html

USDA, 2000(b). *Peoples Republic of China, Livestock and Products Annual, 2000,* U.S. Department of Agriculture-Foreign Agricultural Service, GAIN Report CH0030.

Veeck, A. and G. Veeck, 2000. "Consumer Segmentation and Changing Food Purchase Patterns in Nanjing, PRC", *World Development*, 28(3):457-471.

Wang, Z. and W.S. Chern, 1992. "Effects of Rationing on the Consumption Behavior of Chinese Urban Households During 1981-1987", *Journal of Comparative Economics*, 16:1-26.

Footnotes

1. Veeck and Veeck (2000) also note the following food purchase behavior changes by Chinese households: an increasing demand for convenience foods, an increase in the importance of meals purchased away from home, increased use of retail food stores, changes in the amount of time spent shopping and the changing frequency of food shopping trips.

2. Huang, Rozell and Rosegrant (1999) forecast a steady increase in China's grain imports over the next decade to an anticipated level of 28 MMT by 2010.

3. When applied to household income, adult equivalence scales are employed to adjust household budgets to permit welfare comparisons across households differing in size and composition (Lazear and Michael, 1980). For a review of the methodological issues involved with the estimation of adult equivalence scales for welfare evaluation refer to Blaylock (1991).

4. The assumption of equivalence scale exactness implies that this measure is only a function of the demographic characteristics and prices and is independent of the level of utility.

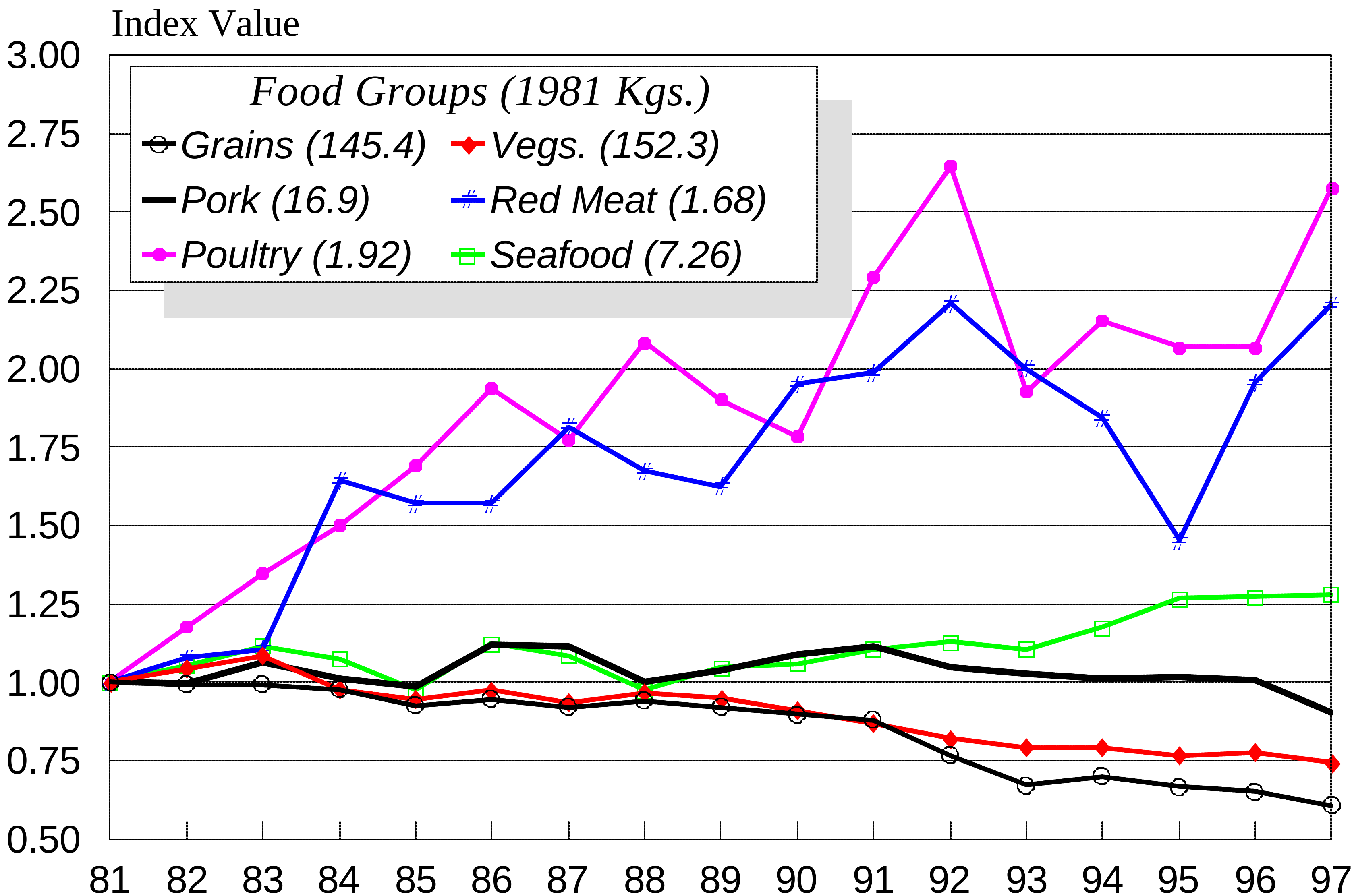
5. This form is used so as to allow for the use of logarithms even with zero valued member count variables.

6. For a discussion of the availability of food consumption data for China, refer to Chern(1994). All expenditures have been deflated to $1995 yuan.

7. As Veeck and Veeck (2000) note, in contrast to the high percentage of refrigerator/freezer ownership, these units tend to be relatively small and generally used to accommodate meat, beverages and leftovers, but not fruits and vegetables.

8. Approximate standard errors are derived from the estimated parameter variance-covariance matrix: $\text{Var}\left(d\left(\Theta\right)\right) \approx C\,\Sigma_{\Theta}C'$ where $C = \frac{\partial d\left(\Theta\right)}{\partial \Theta'}$, Θ is the vector of estimated coefficients $d\left(\Theta\right)$ is the estimated equivalence scale and Σ_{Θ} is the coefficient covariance matrix. For space reasons, the complete listing of the 99 estimated coefficients are not presented here. A complete listing of these coefficients can be obtained from the authors upon request.

Figure 1: Indices of Annual Per Capita Consumption of Selected Foods: Urban Households: 1981-1997



Source: SSB, various years. 1981 index =1.00, 1981 amounts in parentheses

Table 1. Annual Per Capita Food Purchase Characteristics of Surveyed Households (1995-1997, 1995 Yuan)

Food Type	Entire Sample			Provincial Means								
				Jiangsu			Shandong			Guangdong		
	Quantity (KG)	Expenditure		Quantity (KG)	Expenditure		Quantity (KG)	Expenditure		Quantity (KG)	Expenditure	
		Yuan	%		Yuan	%		Yuan	%		Yuan	%
All Food	-------	2407	100	-------	2120	100	-------	1522	100	-------	3747	100
Food At Home (FAH)	-------	2015	83.7	-------	1887	89.1	-------	1358	89.2	-------	2897	77.3
Pork	18.0	263	13.1	21.2	285	15.1	12.9	157	11.6	19.0	349	12.0
Red Meat	5.3	102	5.1	4.3	78	4.1	5.3	77	5.7	6.7	161	5.6
Seafood	17.4	246	12.2	16.8	213	11.3	10.8	108	8.0	25.3	440	15.2
Poultry	10.3	170	8.4	10.1	140	7.4	5.4	76	5.6	16.1	310	10.7
Rice	49.4	143	7.1	73.0	184	9.8	14.9	40	2.9	55.6	201	6.9
Other Grains	35.2	115	5.7	21.2	75	4.0	63.5	169	12.4	15.6	109	3.8
Vegetables	116.3	244	12.1	123.0	233	12.3	110.5	155	11.4	113.7	354	12.2
Legumes	5.0	35	1.7	6.6	50	2.6	4.7	24	1.8	3.2	26	0.9
Fats and Oils	7.1	69	3.4	8.5	72	3.8	5.5	51	3.8	6.9	85	2.9
Dairy Products	4.3	52	2.6	5.4	49	2.6	4.5	41	3.0	2.6	68	2.3
Eggs	13.7	88	4.4	13.8	90	4.8	18.3	104	7.7	8.7	69	2.4
Fruits	54.1	152	7.5	55.6	116	6.1	65.6	113	8.3	39.5	242	8.4
Other Food	------	336	16.7	------	302	16.0	------	243	17.9	------	483	16.7

Source: SSB, 1995-1997 Note: The percentages for specific foods are percent of the FAH expenditures.

Table 2. Variables Used in the Food Demand System

Variable Name	**Description**	**Units**	**Entire Sample**	**Provincial Means**		
				Jiangsu	**Shandong**	**Guangdong**
TOTINC	Total household annual income	Yuan	19,823 (11,705)	16,853 (7,231)	15,007 (6,115)	31,284 (15,210)
PERINLF	% of adult household members in the labor force	%	78.2 (31.3)	72.2 (35.7)	85.4 (26.8)	77.0 (28.3)
HHSIZE	Number of household members	#	3.25 (0.74)	3.18 (0.80)	3.20 (0.64)	3.42 (0.75)
REFRIG_D	A refrigerator/freezer in the household	0/1	0.833	0.826	0.788	0.912
AGE_D1*	Male head age $\leq$ 35	0/1	0.167	0.133	0.242	0.110
AGE_D2*	Male head age $\geq$ 50	0/1	0.279	0.364	0.192	0.277
YNGCHILD	Number of children <13 years old	#	0.41 (0.52)	0.36 (0.49)	0.46 (0.54)	0.40 (0.52)
TEENS	Number of children between 13 and 17 years old	#	0.32 (0.49)	0.28 (0.47)	0.35 (0.50)	0.34 (0.50)
YNGADLT	Number of adults between 18 and 22 years old	#	0.28 (0.60)	0.32 (0.65)	0.18 (0.48)	0.36 (0.68)
OTHADLT	Number of adults (not heads) with age > 22 years	#	0.22 (0.48)	0.20 (0.45)	0.19 (0.45)	0.30 (0.57)
G_DONGCTY	Household in large city in Guangdong province	0/1	0.209	-----	-----	0.830
G_DONGCNT	Household in small city/town in Guangdong province	0/1	0.043	-----	-----	0.170
JIANGCTY	Household in large city in Jiangsu province	0/1	0.291	0.761	-----	-----
JIANGCNT	Household in small city/town in Jiangsu province	0/1	0.092	0.239	-----	-----
S_DONGCTY	Household in large city in Shandong province	0/1	0.284	-----	0.777	-----
S_DONGCNT	Household in small city/town in Shandong province	0/1	0.081	-----	0.223	-----

(Continued)

Table 2. Variables Used in the Food Demand System (continued)

Variable Name	Description	Units	Entire Sample	Provincial Means		
				Jiangsu	Shandong	Guangdong
FOOD_EXP	Total FAH expenditures	Yuan	4,967 (2,366)	4,621 (1,578)	3,466 (1,360)	7,661 (2,246)
	Allocation of Food Expenditures					
PORK_SHR	Pork products	%	15.3 (6.5)	17.3 (6.2)	14.0 (6.2)	14.4 (6.5)
REDMT_SHR	Beef and other red meat products	%	6.2 (4.0)	5.1 (3.4)	6.8 (4.6)	6.7 (3.4)
POULT_SHR	Poultry	%	9.0 (5.3)	8.6 (4.7)	6.8 (4.5)	12.8 (5.2)
SEAFD_SHR	Seafood	%	12.3 (7.1)	12.4 (5.8)	8.5 (6.0)	17.7 (6.6)
GRAIN_SHR	Grains and grain-based products	%	19.0 (7.7)	19.8 (7.5)	21.5 (8.0)	14.2 (4.8)
VEG_SHR	Vegetables	%	14.3 (4.3)	14.3 (4.3)	14.1 (4.5)	14.5 (3.9)
FRUIT_SHR	Fruits	%	8.9 (5.0)	7.7 (4.1)	10.1 (5.3)	9.2 (5.3)
D/EGG_SHR	Dairy products/Eggs	%	8.4 (5.1)	8.0 (4.4)	11.2 (5.2)	4.8 (3.4)
OTHR_SHR	Other Foods (for at-home consumption)	%	6.2 (3.8)	6.5 (3.4)	6.6 (4.5)	5.3 (3.1)

Note: *The mean values are for households with both male and female heads present. Sample size: 4841 households.

Table 3. Estimated Own and Cross Price Elasticities

	Pork	Red Meat	Poultry	Seafood	Grains	Vegetable	Fruits	Dairy/Egg	Other Foods
Pork	-1.084 (0.068)	-0.050 (0.014)	-0.006 (0.018)	-0.047 (0.015)	-0.143 (0.020)	-0.022 (0.018)	-0.144 (0.012)	0.088 (0.020)	-0.018 (0.022)
Red Meat	-0.085 (0.037)	-1.319* (0.066)	-0.012 (0.026)	0.028 (0.024)	0.337 (0.033)	-0.017 (0.025)	0.061 (0.018)	-0.158 (0.027)	-0.120 (0.026)
Poultry	0.020 (0.031)	-0.005 (0.017)	-1.120 (0.066)	0.021 (0.018)	-0.080 (0.026)	-0.039 (0.021)	0.069 (0.015)	-0.083 (0.023)	-0.146 (0.023)
Seafood	-0.038 (0.019)	0.014 (0.012)	0.006 (0.009)	-1.026 (0.063)	-0.216 (0.019)	-0.072 (0.013)	0.058 (0.012)	-0.049 (0.014)	-0.067 (0.013)
Grains	-0.144 (0.016)	0.067 (0.010)	-0.080 (0.012)	-0.181 (0.012)	-1.320* (0.061)	-0.109 (0.011)	-0.006 (0.009)	0.199 (0.017)	0.074 (0.012)
Vegetable	-0.030 (0.019)	-0.031 (0.011)	-0.049 (0.013)	-0.086 (0.011)	-0.114 (0.015)	-0.975 (0.062)	-0.060 (0.008)	-0.050 (0.014)	-0.034 (0.014)
Fruits	-0.236 (0.021)	0.025 (0.013)	0.040 (0.015)	0.063 (0.016)	0.056 (0.019)	-0.075 (0.013)	-1.075 (0.062)	-0.103 0.017	-0.026 (0.008)
Dairy/Eggs	0.170 (0.037)	-0.136 (0.020)	-0.113 (0.025)	-0.064 (0.012)	0.418 (0.031)	-0.069 (0.025)	-0.112 (0.018)	-1.238* (0.071)	-0.119 (0.029)
Other Foods	-0.004 (0.055)	-0.117 (0.026)	-0.214 (0.033)	-0.132 (0.026)	0.353 (0.037)	-0.025 (0.033)	-0.132 (0.038)	-0.132 (0.038)	-1.010 (0.080)

Note: The shaded cells indicate significance at the .05 level. The own-price elasctities with the “*” indicate that these are significantly different than -1.0 . Approximate standard errors are obtained using the procedure noted in Footnote 8.

Table 4. Estimated Equivalence Scale Parameters

Variable	Coefficient	Std. Error	Variable	Coefficient	Std. Error
Member Count Variables					
Pork			Red Meat		
YNGCHILD	-0.0001	0.0021	YNGCHILD	0.0080	0.0013
TEEN	-0.0028	0.0021	TEEN	0.0065	0.0013
OTHADLT	0.0001	0.0017	OTHADLT	0.0005	0.0010
YNGADLT	-0.0032	0.0022	YNGADLT	0.0018	0.0013
Poultry			Seafood		
YNGCHILD	0.0055	0.0012	YNGCHILD	-0.0053	0.0029
TEEN	0.0009	0.0019	TEEN	-0.0047	0.0028
OTHADLT	-0.0070	0.0017	OTHADLT	-0.0017	0.0022
YNGADLT	-0.0014	0.0021	YNGADLT	-0.0091	0.0029
Grain			Vegetables		
YNGCHILD	0.0039	0.0026	YNGCHILD	-0.0023	0.0014
TEEN	0.0141	0.0024	TEEN	-0.0001	0.0014
OTHADLT	0.0090	0.0020	OTHADLT	0.0029	0.0012
YNGADLT	0.0174	0.0023	YNGADLT	0.0054	0.0014
Fruit			Dairy/Egg		
YNGCHILD	-0.0034	0.0018	YNGCHILD	-0.0058	0.0019
TEEN	-0.0062	0.0019	TEEN	-0.0066	0.0019
OTHADLT	-0.0072	0.0015	OTHADLT	0.0010	0.0016
YNGADLT	-0.0050	0.0017	YNGADLT	-0.0067	0.0021
Other Foods					
YNGCHILD	-0.0005	0.0013	OTHADLT	0.0025	0.0010
TEEN	-0.0010	0.0013	YNGADLT	0.0008	0.0012

(Continued)

Table 4. Estimated Equivalence Scale Parameters (continued)

Variable	Coefficient	Std. Error	Variable	Coefficient	Std. Error
Modified Member Count Variables					
YNGCHILD*	0.7029	0.2267	YNGADLT*	0.5748	0.2106
TEEN*	0.8111	0.2224	OTHADLT*	0.3235	0.1720
Demographic Characteristics					
GDONG_CTY	-4.3569	0.4079	REFRIG	-0.0513	0.0680
GDONG_CNT	-4.2071	0.4065	LN(INC)	0.1879	0.0515
JIANG_CTY	-3.0117	0.3221	PERINLF	-0.1091	0.0862
JIANG_CNT	-3.5667	0.3561	AGE_D1	0.1467	0.0746
SHAN_CNT	-0.6235	0.2494	AGE_D2	0.1335	0.0657

Note: The parameters for the Other Foods commodity is obtained from the homogeneity restrictions. Refer to Footnote 8 for the method used to estimate their standard errors. The shaded cells indicate statistically significant coefficient values.

Table 5. Price Sensitive Equivalence Scales
Evaluated at Sample Mean Prices

Member Type	Number of Members	Scale Value	Standard Error
Couple	2	1.000	------
Young Children	1	1.361	0.133
	2	1.705	0.288
Teenager	1	1.403	0.134
	2	1.790	0.296
Young Adult	1	1.251	0.115
	2	1.463	0.233
Other Adult	1	1.128	0.084
	2	1.224	0.159
Young Child and Teenager		1.910	0.324
Teenager and Young Adult		1.756	0.267
Young and Other Adult		1.411	0.173
Mean Values of All Member Count Variables		1.404	0.117

Note: The shaded cells identify equivalence scale values significantly different than 1.0 . Refer to Footnote 8 for a description of the method used to obtain approximate standard errors.