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Estimation of a Composite Food Demand System for the United States—A Revisit

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Introduction

The food demand system is an effective instrument to provide commodity forecasts and to conduct analysis of program effects. Because food demand is a critical component in the economic analyses of national food programs, a consistent and comprehensive description of the demand relations for major food products is a very important tool for policy makers in formulating and implementing various agricultural policies in the United States. Brandow (1961) was the first who applied a synthetic method to generate a demand elasticity matrix for food groups and nonfood sector. A similar study was conducted by George and King (1971) to create a demand matrix for 49 food groups and one nonfood sector. However, because many demand elasticities were not estimated directly from sample observations, their food demand system might not provide a reliable model for food consumption forecasting and policy analysis. Two similar studies were conducted by Court (1967) and Byron (1970), respectively, in which they generated equivalent results by imposing the restricted conditions. But all parameters in their studies must be estimated directly. Thus, the estimation of the demand systems could be time-consuming if the number of items included in the system is very large.

To overcome the major drawbacks in those earlier studies and recognizing the importance and the need for the food demand analysis, Huang and Haidacher (1983) developed an approach for estimating the parameters of a demand system based on the time-series data for the period 1950-1981. The empirical demand system in which all direct, cross-price, and income elasticities were estimated in a system framework, which gives information about the complete interdependent nature of demand for food. The complete matrix includes 12 food categories and one nonfood sector. More specifically, the food groups are (1) meat, (2) poultry, (3) fish, (4)

eggs, (5) dairy products, (6) fats and oils, (7) fresh fruits, (8) fresh vegetables, (9) processed fruits and vegetables, (10) cereal and bakery products, (11) sugar and sweeteners, and (12) nonalcoholic beverages. Their estimation of the complete demand system that incorporates the theoretical demand constraints of symmetry, homogeneity, and Engel aggregation yielded a 13×14 demand elasticity matrix. They found that, in most cases, the elasticity measures appear to have acceptable sign and magnitude as to be expected.

A better understanding and knowledge of the demand structure and its associated effects of prices and income changes on the quantity demanded is useful for forecasting future demands and in appraising the likely outcome of potential changes in national food programs. So to provide the new information about interdependent relationship among food items, the demand elasticities need to be re-examined and updated regularly based on the most recent data available. Thus, the main objective of the study is to estimate a complete system of demand interrelationships among the major food items which includes 12 food groups and one nonfood sector, and to update demand elasticities reported in Huang and Haidacher (1983).

To remain relevant, we employ the same demand system model with the same food and nonfood classifications developed in the study of Huang and Haidacher (1983) and base on the data that cover the period from 1953 through 2008. Instead of applying a constrained maximum likelihood method (Huang and Haidacher 1983), we use the iterative seemingly unrelated regression procedure for the estimation of the complete system of demand equations. The paper is organized as follows. The differential-form of the empirical demand model used in the analysis is depicted first. A brief discussion of the data utilized for the estimation of the demand system is then presented. The estimated demand elasticities for 12 food categories and one nonfood sector are presented and discussed in the Results and Implications section. Finally, the

paper concludes with some remarks regarding the important findings obtained from the estimation of the demand system.

Methodology

In general, several approaches, which are based on a specified functional form for direct utility, indirect utility, or cost function, can be applied to estimate a complete Marshallian demand system, such as: linear expenditure system (Stone 1954), the almost ideal demand system (Deaton and Muellbauer 1980), the indirect translog demand system (Christensen, Jorgenson, and Lau 1975), the Rotterdam model (Theil 1965) and differential-form demand systems (Huang and Haidacher 1983; Huang 1993). However, the application of the differential-form demand system has certain advantages compare to other methods. First of all, time series data on expenditure shares are not required by the demand system (Huang and Haidacher 1983). Secondly, the specification of the demand system yields conveniently the demand elasticities as the results of the statistical estimation. Thirdly, the demand system is linear in parameters and it can be easily estimated by using the OLS procedure.

Following Huang and Haidacher (1983), the demand model as the functions of prices and income can be expressed as follows:

$$q_i = f_i(p, m) \quad i = 1, 2, \dots, n. \quad (1)$$

According to static demand theory and applying the first-order differential approximation of the conceptual demand model, the demand system can be expressed as follows:

$$dq_i = \sum_{j=1}^n (\partial q_i / \partial p_j) dp_j + (\partial q_i / \partial m) dm, \quad i = 1, 2, \dots, n, \quad (2)$$

where dq_i and dp_i are $n \times 1$ vectors of price and quantity differentials; $\sum_{j=1}^n (\partial q_i / \partial p_j)$ is the $n \times n$ matrix of price slope, the i^{th} row of which consists of elements $\partial q_i / \partial p_j$, $j = 1, 2, \dots, n$; $\partial q_i / \partial m$, $i = 1, 2, \dots, n$, are expenditure slopes for the i^{th} row. To express the price slopes in equation (2), we can rewrite the equation in terms of elasticities, and thus obtain the differential-form demand system:

$$dq_i/q_i = \sum_{j=1}^n e_{ij}(dp_j/p_j) + \eta_i(dm/m), \quad i = 1, 2, \dots, n, \quad (3)$$

where $e_{ij} = (\partial q_i / \partial p_j)(p_j / q_i)$ is the price elasticity of the i^{th} commodity with respect to a price change of the j^{th} commodity, and $\eta_i = (\partial q_i / \partial m)(m / q_i)$ is an income elasticity which measures the effect of changes in quantity demanded for the i^{th} commodity in response to a change in per capita expenditure. Hence, equation (3) can be compactly expressed as follow:

$$\dot{q} = E_p \dot{p} + \eta \dot{m}, \quad (4)$$

where \dot{q} , \dot{p} , and \dot{m} represent vectors of relative change in quantity, price, and expenditure, respectively, E_p is a matrix of price elasticities, and η is a vector of income elasticities. Given a demand structure consisting of $(n - 1)$ food categories and one nonfood sector, we can rewrite the complete demand system of a representative consumer as a set of linear equations with $n(n + 1)$ parameters:

$$\begin{aligned} \dot{q}_1 &= e_{11}\dot{p}_1 + e_{12}\dot{p}_2 + \dots + e_{1n}\dot{p}_n + \eta_1\dot{m} \\ &\cdot \\ &\cdot \\ &\cdot \\ \dot{q}_n &= e_{n1}\dot{p}_1 + e_{n2}\dot{p}_2 + \dots + e_{nn}\dot{p}_n + \eta_n\dot{m}. \end{aligned} \quad (5)$$

To be consistent with the demand properties derived from the classical demand theory, the theoretical demand constraints of symmetry, homogeneity, and Engel aggregation are

imposed in the estimation process. These theoretical properties expressed in elasticity terms are presented as follows:

$$\sum_{i=1}^n w_i \eta_i = 1, \quad \text{Engel aggregation} \quad (6)$$

$$\sum_{j=1}^n e_{ij} = -\eta_i, \quad \text{for } i = 1, 2, \dots, n, \quad \text{Homogeneity} \quad (7)$$

$$\left(\frac{e_{ji}}{w_i} \right) + \eta_j = \left(\frac{e_{ij}}{w_j} \right) + \eta_i, \quad \text{for } i = 1, 2, \dots, n \ (i \neq j), \quad \text{Symmetry} \quad (8)$$

where $w_i = p_i q_i / m$ is the expenditure weight of the i^{th} commodity. Instead of applying a constrained maximum likelihood method (Huang and Haidacher 1983), the demand system of equation (5) and the theoretical constraints of equations (6) - (8) are estimated by employing the iterative seemingly unrelated regression procedure (ISUR) from SAS.

As noted previously, the estimation of the demand system yields the price and income elasticities directly. The own-price and cross-price elasticities obtained are known as uncompensated price elasticities. To obtain the compensated elasticities, we apply the Slutsky equation, which states

$$e_{ij}^h = e_{ij}^m + \eta_i w_j, \quad (9)$$

where e_{ij}^h is the compensated or Hicksian price elasticity, e_{ij}^m is the uncompensated or Marshallian price elasticity, and η_i and w_j are income elasticity and budget share, respectively, as previously defined. The compensated price elasticities serve as a more accurate and appropriate measures for discussing the nature of demand in relation to cross-price effects. In other words, it would be more appropriate to classify whether two commodities are substitutes or complements based on compensated cross-price elasticities than uncompensated cross-price elasticities. Thus, it is not uncommon to observe that two commodities are found to be

substitutes based on compensated cross-price elasticity while they are considered as complements based on the uncompensated cross-price elasticity.

Data source

Estimation of the composite food demand system for the United States is based on time series data of food prices, quantities, per capita total expenditure and expenditure weights. The basic data that are applied in the estimation of the composite food system is the time series data of food prices, quantities, and per capita total expenditure for the period from 1953 through 2008. We obtained the food quantities from several sources such as the U.S. Department of Agriculture, Economic Research Service, Food Availability (Per Capita) Data System; Agricultural Statistics; Fruit and Tree Nut Yearbook; Food Consumption, Prices, and Expenditures (Putnam and Allshouse 1999). Per capita total expenditure was calculated by dividing the personal consumption expenditures (obtained from the U.S. Department of Commerce) by the civilian population (obtained from the U.S. Census Bureau) of the United States on July 1 from 1953 through 2008.

Since most of time series data on retail price are not available, we use the mean value of per capita total expenditure, food quantity for period 1982-1984 and CPI for period 1953-2008 to compute them. We obtained the price data in two steps. First, we compute the average price for those food groups which time series data on their retail price are unavailable by taking the ratio of mean value of per capita total expenditure and food quantity for period 1982-1984. Second, we obtained the price data by multiplying the average price by CPI (obtained from the U.S. Department of Labor, Bureau of Labor Statistics) and then dividing the product of average price and CPI by 100. Other sources that we obtained food retail prices are the U.S. Department of

Commerce, Bureau of Economic Analysis; the U.S. Department of Labor, Bureau of Labor Statistics; Agricultural Prices Summary; Vegetables and Melons; Fruit and Tree Nuts Yearbook; Tree Nuts; Frozen Fruits and Vegetables Expenditure; Food Consumption, Prices, and Expenditures (Putnam and Allshouse 1999).

The nonfood quantity is computed from the current value of per capita expenditure on nonfood divided by CPI of all items less food. The time series data on personal consumption expenditures on food published by U.S. Department of Commerce, Bureau of Economic Analysis include food at home and food away from home. Thus, we calculate composite food expenditure weights for food at home first. Then, personal consumption expenditures on food away from home are proportionally allocated to each individual food group according to the expenditure weight for food at home. Given the expenditure weight for total food, the weight is proportionally allocated to each composite food category. The expenditure weights used for the estimation of the empirical model based on period 1953-1981 are obtained from Huang and Haidacher (1983) to provide a more compatible level for comparison or results. For the demand system based on period 1982-2008, we use the average proportions of personal consumption expenditures for the period as the weights in the estimation process.

Specifically, the detailed food classification and disaggregate food items consisting of the aggregate food groups are:

- (1) Meat: beef & veal, pork, and other meats.
- (2) Poultry: chicken, and turkey.
- (3) Fish: fresh & frozen fish, and canned & cured fish.
- (4) Eggs: eggs.
- (5) Dairy: cheese, milk, evaporated & dry milk, ice cream, and other frozen dairy products.

- (6) Fats: butter, margarine, and other fats & oils.
- (7) Fresh fruits: apples, oranges, bananas, grapes, grapefruits, and other fresh fruits.
- (8) Fresh vegetables: lettuce, tomatoes, celery, onions, carrots, and other fresh vegetables.
- (9) Processed fruits and vegetable: frozen fruits & juice, canned tomatoes, canned peas, canned fruits cocktail, peanuts, and tree nuts.
- (10) Cereal: wheat flour, rice, and potatoes.
- (11) Sugar: sugar, and sweeteners.
- (12) Nonalcoholic Beverages: coffee & tea.
- (13) Nonfood: all items less food.

To estimate a composite food demand system, we need to calculate the composite food prices and quantities. We obtained the composite food quantities by compute the summation of the disaggregate food quantity. The composite food prices were calculated in three steps. First, we computed the quantity weights for each disaggregate food items by taking the ratio of disaggregate food quantities and aggregate food quantities. Second, we multiplied price by quantity weight for disaggregate items. Third, we obtained the composite food price by computing the sum of products described in the second step.

Results and Implications

To investigate if there has been a structural change in the demand for food since the report of the earlier study by Huang and Haidacher (1983), a preliminary analysis was conducted to estimate the demand system with a dummy variable that identify the two time periods for 1953-1981 and 1982-2008. The results show that time has statistically significant effect only on dairy, fresh vegetables and nonfood products. In order to compare the results in our study and those in the

earlier study we decided to estimate the demand system separately and the results obtained from the two time period estimations are presented in table 1 (Model I) and table 2 (Model II), respectively.

Overall, the statistical results obtained based on the two time periods suggest the data fit the model quite well with the system weighted R^2 being 0.998 and 0.999 for Model I and Model II, respectively. As shown in the diagonal entries of table 1, most of the estimated own-price elasticities are negative and less than one indicating the demand for food is price inelastic as might be expected. The estimated own-price elasticities for fats, processed fruits and vegetables, sugar and nonalcoholic beverages are found to be positive but not statistically significant. We found the performance of these four food groups to be least satisfactory. The poor statistical performances may account for the results of getting the wrong positive signs for own price elasticities. Furthermore, there are statistical evidences suggesting that changes in the price of these three food groups had little or no effects on the demand for other food commodities. In fact, the price of nonalcoholic beverages was found to have no statistical significant effects on the demand for any of the other food groups included in the study. Overall, the estimated own-price elasticities are quite different in terms of magnitude from that reported in Huang and Haidacher (1983), except for nonfood. Among food groups, we find the demand for fish (-.8444) and fresh vegetables (-.6130) to be most responsive to their own price changes, while Huang and Haidacher (1983) show poultry (-.6753) and meat (-.5259) to be most price responsive.

The estimated cross-price elasticities also exhibit considerable differences in the complementary and substitution relationships among food groups (table 1). Taking meat category for example, we find poultry and fish are significant substitutes for meat and dairy and processed fruits and vegetables are significant complements. In contrast, Huang and Haidacher

(1983) show poultry, fresh fruits and cereal as being significant substitutes for meat, while sugar is a significant complement to meat. Furthermore, we find that the demand for poultry and fish are more responsive to changes in meat price than the other way around. Similarly, Huang and Haidacher (1983) also show that meat is a more significant substitute for poultry, eggs, fresh fruits and cereal than they are for meat. It should be noted that the own-price and cross-price elasticities reported in both Model I and Huang and Haidacher (1983) are uncompensated elasticities. Thus, the cross-price relationships among food products are considered as either gross substitution or gross complement, while the Hicksian or compensated elasticities represent a net substitution or complement relationship.

With respect to income elasticities, the results of Model I (table 1) show that all estimated elasticities for food products are positive and less than one suggesting that most food items are normal goods with the exception poultry and fresh fruits, which are found to be negative but not statistically significant. We are somewhat disappointed with the estimation of income elasticities in the sense that only meat, fresh vegetables, and nonfood are found to be statistically significantly different from zero, although most of them are positive as expected. In comparison, the earlier study shows that consumers will significantly consume more meat, dairy, fats, processed fruits and vegetables, sugar and nonfood while consume less fresh fruits and cereal if their income or total expenditure increases. In fact, according to Huang and Haidacher (1983), fresh fruits and cereal are considered as inferior goods because their income elasticities were estimated to be negative and statistically significant. Their results also show negative income elasticities for fish and eggs, but the estimates are not statistically significant.

Our results suggest that fresh vegetables are most responsive to changes in income followed by meat, while Huang and Haidacher (1983) shows fats & oils have a largest positive

response to income changes followed by sugar. If consumers are conscientious and concerned about their diets and health, one would not expect those two food products to have the largest positive income elasticities among the food groups. The finding of a very large magnitude of income elasticity for nonalcoholic beverage was unexpected (table 1). Again, we can only attribute the seemingly unreasonable result to the poor performance related to the estimation of the beverages equation. However, our study of Model I and Huang and Haidacher (1983) are consistent in finding nonfood to be a luxury goods with an estimated income elasticity of 1.1446 and 1.2035, respectively.

The estimated demand elasticities for Model II (1982-2008) are presented in table 2. We also computed the Hicksian or compensated price elasticities using equation (9) and the results are presented in parentheses beneath the uncompensated elasticities. In general, most of the estimated own-price elasticities are negative as expected and statistically significantly different from zero with the exception of fats & oils and nonalcoholic beverages. It is bothersome to find that own-price elasticity for fats & oils and nonalcoholic beverages are both positive and statistically significant. For dairy products, fresh fruits, fresh vegetables, and sugar and sweeteners, they have the correct sign but statistically insignificant. All food demand is inelastic with respect to its own price except for fish, which is found to be price elastic (-1.446). Similar to the result obtained from Model I, demand for fish is most responsive to price changes among the food products followed by meat (-.4276) and processed fruits and vegetables (-.3915).

Overall, the estimated own-price elasticities appear to be smaller in magnitude as compared with Huang and Haidacher (1983) as well as Model I results. With respect to cross-price elasticities, we note in particular that demand for nonfood is a significant gross complement but net substitute for fish products and nonalcoholic beverages. On the other hand,

meat, poultry, eggs, fresh vegetables, and cereal are significant complement but net substitute for nonfood products. As shown in table 2, all income elasticities are positive except for meat which is negative but statistically insignificant. Unlike the Model I results, we find most of the estimated income elasticities to be statistically significantly different from zero. However, the results also suggest that many food products, e.g., fish, fresh fruits, processed fruits and vegetables, and sugar, are considered to be luxury goods and highly responsive to income changes. It is reasonable to expect food products such as fish and fresh fruits to be relatively more responsive to income than other foods, the large magnitude of the income elasticities obtained for these products are somehow incongruent with our expectation.

To facilitate comparison of own-price elasticities and income elasticities between the earlier study and present study, the estimated elasticities are reproduced and summarized in table 3. It is obvious that considerable variations in estimated elasticities are observed between Huang and Haidacher (1983) and our study. One might expect the results based on Model II (1982-2008) to be largely different from the earlier time period used in Huang and Haidacher (1983), the substantial differences based on similar time period (Model I), however, is somewhat unexpected. Although the time period covered in the studies is not exactly the same due to some data unavailability in our study, we have tried to match the food items included in their study as close as possible. Thus, it seems reasonable to speculate that the use of different estimation procedures is most likely the major factor contributing to the different estimates obtained in the two studies. Unfortunately, we are not able to verify that this is indeed the case because we do not have the software available to replicate Huang and Haidacher's (1983) estimation procedure. However, we also could not rule out any possible incompatibility of data used in the analyses.

Another factor that may contribute to the differences in estimated elasticities is the change of expenditure weights used for the later time period, Model II (1982-2008). As compared with Huang and Haidacher's (1983) study, the total expenditure weight of food decreased from 20.2% to 13.65% and the expenditure weight of nonfood increased from 79.8% to 86.35%. In general, all food groups experienced a decrease in expenditure weight except for poultry, cereal, and nonalcoholic beverages, which show some slight increases in their expenditure weights. The decrease in proportion of income expended on food relative to nonfood is reasonable and to be expected.

Conclusions

The main objectives of the study are twofold. First, we attempt to duplicate the study conducted by Huang and Haidacher (1983) by using their model and collecting the data matching the same food groups as closely as possible. Second, we extend the data set to include the most recent data available with the purpose of providing more updated elasticity estimates. Information about food demand and their interdependent relationships among different food groups are important to the policy-makers in aiding their understanding of the nature of demand for food, and to other researchers who apply various demand elasticity measures in their studies. The demand elasticities provided by Huang and Haidacher (1983) are considered outdated and need to be re-estimated based on more recent data that may reflect changes in consumers' consumption behavior and patterns.

Our efforts to duplicate the elasticities reported by Huang and Haidacher (1983) are not very successful considering the substantial differences in the magnitudes of demand elasticities that we obtained based on the earlier time period of 1953-1981 (Model I). We attribute this

inability to obtain similar elasticity estimates largely to the use of different econometric methods and possibly of different data quality. Overall, we consider the estimation of the demand system based on the data post Huang and Haidacher (1983) period (Model II) to be satisfactory with certain degree of success. Our results suggest that, in general, demand for food has become more inelastic in recent years as own-price elasticities are smaller in magnitudes in comparison with earlier estimates reported in Huang and Haidacher (1983). We also found the own-price elasticity for nonfood has decreased from $-.9955$ to $-.9476$. The finding of a more inelastic own-price elasticities for most food products and nonfood category is reasonable and to be expected.

Our results show that most food items are considered as normal goods except for fish, fresh fruits, processed fruits and vegetables, and sugar. According to Huang and Haidacher (1983), their income elasticities for food vary from $-.6343$ (fruits) to $.5748$ (fats). In comparison, we find the demand for food tends to become more responsive to income changes with significant income elasticities vary from $.5172$ (dairy) to 4.6687 (fish). The estimated income elasticity for nonfood appears to be fairly close between the two studies of different time periods. Overall, the differences observed in income elasticities reflect the changes in consumption behavior or lifestyle that may affect the allocation of food dollars to different food groups or items as consumer's income increases over time.

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Table 1. Results based on nominal price and personal consumption expenditures, Model I (1953-1981)

Quantity	Price													Expend
	Meat	Poult	Fish	Eggs	Dairy	Fats	Fruits	Vegeta	Pro.fv	Cereal	Sugar	Bevera	N Food	
Meat	-.4512*	.0290*	.0354*	-.0012	-.0805*	-.0076	.0049	.0142	-.1204*	-.0637	-.0130	-.0091	.1664	.4968*
Poult	.2217*	-.3772*	.0486	.0768*	.0601	.1111	.1030	.0378	-.0454	.1285	-.0713*	-.0269	-.0262	-.2407
Fish	.5086*	.1046	-.8444*	-.3091*	1.0510*	-.2634*	-.5588*	-.3382*	1.1217*	.7427*	.4544*	-.1271	-1.9311*	.3890
Eggs	.0111	.0707*	-.1311*	-.1665*	.2290*	.0392	-.1025*	.0246	.0208	.0667	.0722*	-.0560	-.2404	.1620
Dairy	-.1049*	.0116	.1154*	.0587*	-.2368*	.0096	.0572*	-.0033	-.0986*	-.0545*	-.0279*	-.0226	.1646	.1314
Fats	-.0350	.1110	-.1200	.0414	.0368	.2323	.1916	-.1073	.1613	-.7605*	-.2882*	.0285	.2724	.2359
Fruits	.0843	.0968	-.2224*	-.0908*	.2357*	.1756	-.1228*	-.1612	.0036	.2978*	-.0381	.0921	.1892	-.5398
Vegeta	.0478	.0186	-.1115*	.0129	-.0339	-.0810	-.1423*	-.6130*	.1892	.2679*	.1260*	-.0441	-.4586	.8221*
Pro.fv	-.3041	-.0234	.2049*	.0043	-.1723*	.0646	-.0061	.1138	.1973	-.1964	-.0379	-.0759	-.0514	.2825
Cereal	-.1842	.0556	.1559*	.0308	-.1141*	-.3500*	.1459*	.1782*	-.2257	-.4881*	.0315	-.0614	.4345	.3911
Sugar	-.0172	-.0371*	.0976*	.0365*	-.0528*	-.1324*	-.0259	.0909*	-.0396	.0374	.0092	.0071	-.0608	.0869
Bevera	-.3617	-.0899	-.1019	-.1333	-.3265*	-.0049	.0884	-.1441	-.3756	-.2837	-.0782	.7729	-4.6172	5.6556
N Food	-.0237*	-.0122*	-.0121*	-.0114*	-.0282*	-.0047	-.0136*	-.0105*	-.0191	-.0038	-.0203*	-.0075	-.9776*	1.1446*
Weight	.0540	.0086	.0038	.0089	.0349	.0083	.0094	.0117	.0206	.0181	.0179	.0059	.7980	

NOTE: The entries represent the uncompensated elasticities. The abbreviated notations are Poult – poultry, Vegeta – vegetables, Pro.fv – processed fruits and vegetables, Bevera – nonalcoholic beverages, N Food – nonfood, Expend – total expenditure, and Weight – expenditure weights.
 * Indicates statistical significance at least at the 90% level of statistical certainty.

Table 2. Results based on nominal price and personal consumption expenditures, Model II (1982-2008)

Quantity	Price													Expend
	Meat	Poult	Fish	Eggs	Dairy	Fats	Fruits	Vegeta	Pro.fv	Cereal	Sugar	Bevera	N Food	
Meat	-.4276* (-.4319)	.0127 (.0108)	.1237* (.1231)	.0300* (.0297)	-.0014 (-.0041)	.0163 (.0156)	-.0296 (-.0307)	-.0244 (-.0260)	.0667 (.0655)	.0331 (.0281)	.0692 (.0672)	.0903 (.0864)	2.248 (.0660)	-1.839
Poult	.0077 (.0248)	-.1861* (-.1786)	.0959 (.0983)	.0704* (.0717)	-.0405 (-.0298)	.0756* (.0784)	.1035 (.1078)	.0964 (.1029)	-.1587* (-.1539)	-.2069* (-.1873)	.1429 (.1508)	-.3358* (-.3202)	-4.000 (.2353)	.7357*
Fish	.7600 (.8688)	.2563 (.3039)	-1.4460* (-1.4306)	-.2800* (-.2721)	-.2041 (-.1364)	-.7409* (-.7232)	-.3714 (-.3443)	.4170* (.4581)	-.0334 (-.0031)	.7258* (.8500)	-1.4341* (-1.3841)	.2808 (.3798)	-2.5987* (-1.4327)	4.6687*
Eggs	.3875* (.4071)	.4216* (.4302)	-.5309* (-.5281)	-.2670* (-.2656)	-.0273 (-.0151)	-.2918* (-.2886)	-.0856 (-.0807)	.0535 (.0609)	.1117 (.1172)	.3685* (.3909)	-.6746* (-.6656)	.2512* (.2690)	-.5572 (.1685)	.8404
Dairy	-.0186 (-.0065)	-.0263 (-.0210)	-.0328 (-.0311)	-.0027 (-.0018)	-.0182 (-.0107)	-.0335 (-.0315)	.0293 (.0323)	.0002 (.0048)	-.0658* (-.0624)	.0204 (.0342)	-.0776* (-.0721)	-.0290 (-.0180)	-2.628 (.1838)	.5172*
Fats	.0726 (.0959)	.2002* (.2104)	-.6313* (-.6280)	-.1308* (-.1291)	-.1347 (-.1202)	.3210* (.3248)	-.1963* (-.1905)	.1131 (.1219)	-.0366 (-.0301)	-.1338 (-.1073)	-.5693* (-.5586)	-.0766 (-.0554)	.2045 (1.0663)	.9980
Fruits	-.1552 (-.1232)	.1754 (.1894)	-.2005 (-.1960)	-.0260 (-.0237)	.0607 (.0806)	-.1301* (-.1249)	-.1965 (-.1885)	.0276 (.0397)	-.1135 (-.1046)	-.1056 (-.0690)	-.3583* (-.3436)	-.1936* (-.1645)	-1.592 (1.0277)	1.3745*
Vegeta	-.0834 (-.0689)	.1129 (.1192)	.1697 (.1717)	.0107 (.0118)	-.0013 (.0077)	.0503 (.0527)	.0226 (.0262)	-.1685 (-.1630)	.1382 (.1423)	-.3551* (-.3386)	.1006 (.1072)	-.4275* (-.4143)	-1.896 (.3462)	.6205
Pro.fv	.1965 (.2348)	-.2584* (-.2416)	-.0200 (-.0146)	.0277 (.0305)	-.1631* (-.1393)	-.0239 (-.0177)	-.1028 (-.0933)	.1780 (.1925)	-.3915* (-.3808)	-.0770 (-.0333)	.2494 (.2670)	-.3137* (-.2788)	-9.454 (.4742)	1.6440*
Cereal	.0100 (.0247)	-.0783* (-.0719)	.1034* (.1055)	.0239* (.0250)	.0095 (.0186)	-.0177 (-.0153)	-.0187 (-.0150)	-.1176* (-.1121)	-.0122 (-.0081)	-.1926* (-.1758)	.0530 (.0597)	-.2204* (-.2070)	-1.726 (.3716)	.6302*
Sugar	.1217 (.1463)	.1329 (.1437)	-.4304* (-.4269)	-.1075* (-.1057)	-.1130* (-.0977)	-.2024* (-.1984)	-.1924* (-.1863)	.0789 (.0882)	.1554 (.1623)	.1205 (.1486)	-.0917 (-.0804)	-.0879 (-.0655)	-4.391 (.4718)	1.0549*
Bevera	.0754 (.0950)	-.1626* (-.1540)	.0563 (.0591)	.0201* (.0215)	-.0245 (-.0123)	-.0131 (-.0099)	-.0499 (-.0450)	-.1794* (-.1720)	-.0910* (-.0855)	-.2822* (-.2598)	-.0421 (-.0331)	.6042* (.6220)	-7.529* (-.0262)	.8416*
N Food	-.0225* (.0017)	-.0078* (.0028)	.0020 (.0054)	-.0014* (.0004)	-.0120* (.0031)	.0007 (.0047)	.0009 (.0069)	-.0056* (.0036)	-.0032 (.0036)	-.0162* (.0115)	-.0053 (.0058)	-.0227* (-.0006)	-9.476* (-.0490)	1.0407*
Weight	.0233	.0102	.0033	.0017	.0145	.0038	.0058	.0088	.0065	.0266	.0107	.0212	.8635	

NOTE: The upper part of the entries is the uncompensated elasticities and the lower part of numbers in parentheses represents the Hicksian or compensated price elasticities. The abbreviated notations are Poultry - poultry, Vegeta - vegetables, Pro.fv - processed fruits and vegetables, Bevera - nonalcoholic beverages, N Food - nonfood, Expend - total expenditure, and Weight - expenditure weights. * Indicates statistical significance at least at the 90% level of statistical certainty.

Table 3. Comparison of own-price elasticity and income elasticity between earlier study and present study.

Food Category	Own-Price Elasticity (Uncompensated)			Income Elasticity		
	Huang and Haidacher (1983)	Model I (1953-1981)	Model II (1982-2008)	Huang and Haidacher (1983)	Model I (1953-1981)	Model II (1982-2008)
Meat	-.5259*	-.4512*	-.4276*	.3589*	.4968*	-.1839
Poult	-.6753*	-.3772*	-.1861*	.1363	-.2407	.7357*
Fish	.0600	-.8444*	-1.4460*	-.0648	.3890	4.6687*
Eggs	-.1429*	-.1665*	-.2670*	-.0694	.1620	.8404
Dairy	-.3046*	-.2368*	-.0182	.1832*	.1314	.5172*
Fats	-.1458*	.2323	.3210*	.5748*	.2359	.9980
Fruits	-.3739*	-.1228*	-.1965	-.6343*	-.5398	1.3745*
Vegeta	-.2066*	-.6130*	-.1685	.2083	.8221*	.6205
Pro.fv	-.3926*	.1973	-.3915*	.4279*	.2825	1.6440*
Cereal	-.3539*	-.4881*	-.1926*	-.2893*	.3911	.6302*
Sugar	-.1144*	.0092	-.0917	.4386*	.0869	1.0549*
Bevera	-.3275*	.7729	.6042*	.1438	5.6556	.8416*
N Food	-.9955*	-.9776*	-.9476*	1.2035*	1.1446*	1.0407*

Note: The abbreviated notations are Poult – poultry, Vegeta - vegetables, Pro.fv - processed fruits and vegetables, Bevera – nonalcoholic beverages, and N Food - nonfood.

* Indicates statistical significance at least at the 90% level of statistical certainty.