Consumption

2/8 Preliminary Draft

CONSISTENT FAMILY AND INCOME SCALES IN ENGEL CURVE ESTIMATION

Mark Brown and S.R. Johnson*

1. Introduction

Recently, the estimation of family scales in Engel curve and demand systems has received increased attention (e.g., Kakwani [1977], McClements [1977], Muellbauer [1975, 1977, 1980]). The scaling problem is long standing in econometrics with interest stemming from the early work of Engel [1857]. Identification problems have been known for some time and there have been various methods advanced for introducing the *a priori* information necessary to estimate the scales (Stone [1954], Forsyth [1960], Cramer [1969]).

The rekindling of interest in scaling has been sparked by two developments. First, more advanced, nonlinear and iterative estimation methods have held-out the possibility of making progress on the technical identification problem. Secondly, and likely more importantly, income transfer programs like the food stamp program in the U.S. and other between country aid programs have been requiring more systematic bases for determining eligibility and the incidence of benefits stemming from these efforts (Pinstrup-Andersen and Caicedo [1978], and Pollak and Wales [1978]). Family composition (and other features of the studied groups) and its behavioral effect on consumption expenditures is central to these and related policy questions. For this reason, new data bases have been developed and explored and more modern approaches to the scaling problem have been implemented.

The present study contributes to this stream of results by synthesizing the approaches to the scaling problem and making an application of an as yet

Presented at AAEA meetings, Urbana Champaign, July 27-30, 1980.

unanalyzed data source. Results provide a basis for evaluating the more modern procedures theoretically and in terms of the impact that they have in producing improved scale estimates. At issue in the latter case is the advantage in terms of improved estimates, of the more advanced scaling methods applied in large data sets of the type used to support program implementation and policy decisions.

2. Data and Variable Definitions

Consumer unit scales were estimated using a subsample of the Department of Agriculture survey data on food consumption in the U.S., 1977-1978. The subsample consisted of 930-950 observations on individual households, depending on the model and associated missing values. The subsample employed in the analysis is for the first quarter of the annual survey.

Five aggregate commodity groups were defined for the analysis. These were 1) milk equivalent or dairy products, 2) meat, poultry, fish and shellfish, and eggs, 3) flour and cereal products, bakery products, potatoes, vegetables, and fruits, 4) other foods (fats and oils, sugars and sweets, beverages, soups, sauces, gravies, nuts, peanut butter, condiments, mixtures, and baby foods), and 5) nonfood commodities.

Expenditures on each food group were calculated, and using income net of taxes as total expenditures, nonfood expenditures were computed as a residual. This instrument for income could likely be improved by including savings. The latter was not available in the survey data.

Food expenditures are for use in the households and do not include meals and snacks eaten away from the home. This may be a significant factor considering that the male adult often eats meals on the job and that children eat regularly at school. Planned future investigations will take this factor into account.

Household members were divided into eight age-sex groups, 1) male child less than twelve, 2) female child less than twelve, 3) male adolescent between twelve and eighteen, 4) female adolescent between twelve and eighteen, 5) male adult between nineteen and sixty-four, 6) female adult between nineteen and sixty-four, 7) male adult sixty-five and over, and 8) female adult sixty-five and over. The estimated scales pertain to these groups. The choice of the upper break for age was motivated by an objective, classifying retired individuals into one group.

3. Engel Curve Specifications

Consider a consumer demand equation, $q_i = q_i(p_1, \ldots, p_n, y)$ where $i = 1, \ldots, n$, q_i and p_i are the quantity and price of commodity i, $y = \sum_{i=1}^{n} p_i q_i$ and is total expenditures, loosely termed income. For fixed prices the quantity demanded is a function of income only,

$$(1) \qquad q_i = f_i(y) \ .$$

The constant prices are reflected in the Engel relationship f_i but their absolute and relative levels obviously influence the response of consumption to income.

Although Engel curves refer to individual consumption behavior, data used to estimate them generally are for households. Cross-section sampling assures approximately constant prices. For this budget data, the model is

$$(2) \qquad q_{ih} = f_i(y_h) \ ,$$

where $h = 1, \ldots, H$, and denotes a household. Note, the constancy of the functional relationship implies all households behave uniformly with respect to income. Thus, the households represented should be homogeneous in distinguishing characteristics, e.g., cultural and ethnic backgrounds, geographic location, occupation, education, social attitudes, and most likely household size and age-sex composition.

One approach to estimating Engel curves is to divide the households into homogeneous groups and estimate separate equations for each group. A drawback is that extensive data are needed for reliable parameter estimators. As well, it is difficult to draw general inferences about consumption behavior from such results as they are specialized to the groups.

An alternative is to scale the model to the special characteristics of the groups. The development of this approach has a long history, especially in relation to family size. Engel [1857], Sydenstricker and King [1921], Prais and Houthakker [1955], Barten [1964], Singh and Nagar [1973], and Muellbauer [1974] are a few who have investigated scaling problems. These models incorporate household size and age-sex (or other) composition effects using two scales; a specific scale which weighs each family member according to particular commodity requirements, and a general scale which weighs each family member according to overall need for family income. From these two scales household Engel curves can be expressed in per capita or more accurately, per unit basis.

4. Scaling

The main features of the consumer unit scale model can be developed within the following general framework.

$$\frac{c_{ih}}{m_h} = g_i \left(\frac{y_h}{m_h}, m_h\right) \tag{3}$$

where i, h and y are as earlier defined, $c_{ih} = p_i q_{ih}$ (i.e., expenditures on commodity i by household h), m_h is the family size and composition parameter for household h, and g_i is the assumed functional form. For expository purposes consider the simple linear form of this equation, i.e.,

$$\text{(3a)} \qquad \frac{c_{ih}}{m_h} = \frac{\beta'_{oi}}{m_h} + \beta''_{oi} + \beta_{1i}\frac{y_h}{m_h}$$

or equivalently

$$\text{(3b)} \qquad c_{ih} = \beta'_{oi} + \beta''_{oi}m_h + \beta_{1i}y_h$$

where β'_{oi}, β''_{oi}, and β_{1i} are parameters.

Ignoring household size and composition effects set $m_h = 1$, for all h, and define $\beta_{oi} = \beta'_{oi} + \beta''_{oi}$. Equation (3b) then is

$$\text{(4)} \qquad c_{ih} = \beta_{oi} + \beta_{1i}y_h$$

This is the linear counterpart of equation (2), although now in expenditure form. A graphical representation is given in Figure 1 by AA'.

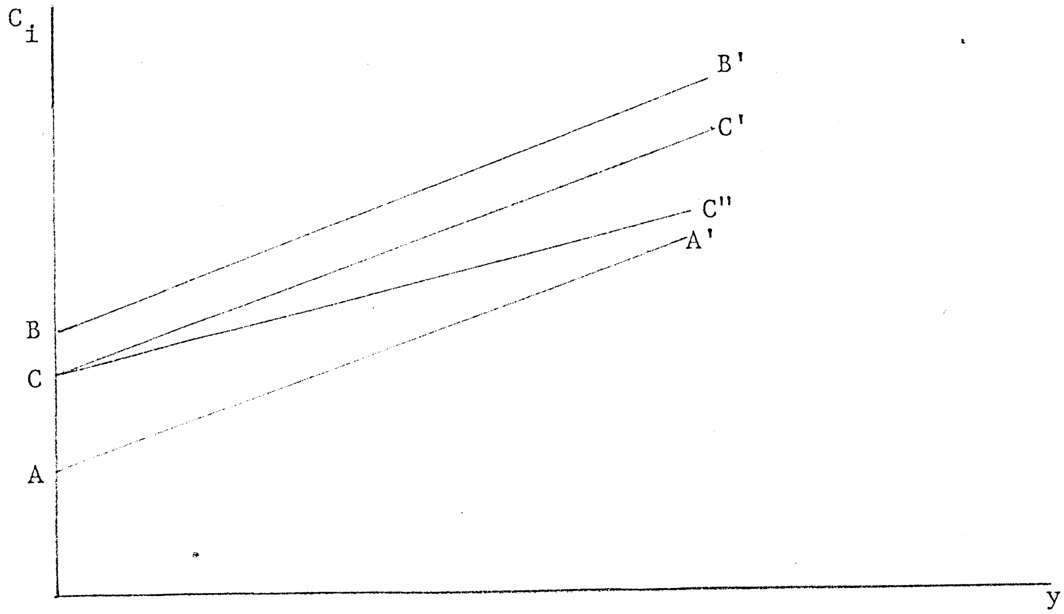

Figure 1.

One may introduce household size effects by defining $m_h = N_h$ where N is the number of household members. Equation (3a) then is expressed in per capita terms, i.e., (5a) $$\frac{c_{ih}}{N_h} = \frac{\beta'_{oi}}{N_h} + \beta''_{oi} + \beta_{1i}\frac{y_h}{N_h}$$

Note, the inclusion of N as an explanatory variable allows for economies of scale in the consumption of commodity i. Equivalently, equation (3b) is

(5b) $$c_{ih} = \beta'_{oi} + \beta''_{oi}N_h + \beta_{1i}y_h .$$

Defining $\beta_{oi} = \beta'_{oi} + \beta''_{oi}N_h$, equation (5b) can be viewed as a variational parameters model. Graphically, this is shown in Figure 1 by line AA', for N = 1, and by BB', for N = 2. Here, the effect of an additional family member, whether an adult or child, male or female, etc. involves the same upward shift of the line with the slope remaining constant.

The scale used in the per capita formulation implicitly gives each family member a weight of 1, and thus ignores family composition effects. The arbitrariness of this was recognized early. In fact, Engel [1857] attempted to deal with this problem. He proposed a scale based on a "quet", the food requirement of a baby. Weights for family members would be expressed in "quets" depending on individual needs, and the family size, the sum of its members' weights. Similarly, nutritional scales have been advanced (Stone [1953]). According to these scales, a normal young man might require 3,000 calories per day and given a weight of 1 while a normal child might require 1,000 calories per day and given a weight of 1/3.

Models of this type are defined by specifying $m_h = \sum_{g=1}^{G} w_g n_{gh}$ where n_{gh} is the number of persons in household h of class g, g = 1, ..., G (note, although classes are often based on age and sex other criteria might be used depending on the composition effects hypothesized), w_g is the weight for a person in class g, and the term $\sum_{g=1}^{G} w_g n_{gh}$ is the weighted household size (and when the adult male is given a weight of 1 this is called the number of equivalent adult males in household h). Also, observe that if the weighted household size is generally defined as $m_h = m_h(n_1, \ldots, n_G)$, then m_h can be specified such that economies of scale can be alternatively introduced through it.

Equation (3b) for this specification is

$$\text{(6b)} \qquad c_{ih} = \beta'_{oi} + \beta''_{1i} \sum_{g=1}^{G} w_g n_{gh} + \beta_{1i} y_h .$$

Again, by defining $\beta_{oi} = \beta'_{oi} + \beta''_{oi} \sum_{g=1}^{G} w_g n_{gh}$ equation (6b) can be viewed as a variational parameters model. Graphically, this is shown in Figure 1 by line AA' for $n_1 = 1$, $n_2 = n_3 = \ldots = n_G = 0$, by line CC' for $n_1 = 1$, $n_2 = 1$, $n_3 = \ldots = n_G = 0$, and by line BB' for $n_1 = 1$, $n_3 = 1$, $n_2 = n_4 = \ldots = n_G = 0$. Here it is assumed that members of class 3 are given a bigger weight than those in class 2. Thus, the effect of an additional family member involves a constant slope shift which depends on the class of the additional individual.

This model is less restrictive than the per capita model by allowing different weights for different people. However, note that there is one scale for all commodities, i.e., the shift factor $\sum_{g=1}^{G} w_g n_g$ is invariant across i. This implies a child has the same requirements relative to an adult male for milk, beer, clothing, etc. In view of this and other limitations (such as scales based on energy or caloric needs measure only one dimension of need and nutritional scales are not behavioral) several alternative approaches are considered.

First, addressing the latter limitations the weights, w_g's, can be determined from household behavior by estimating them from revealed expenditure patterns of households of various incomes and compositions. Estimates of this type are presented in the table of weights under Engel's model.

Second, different scales for different commodities might be assumed and estimated behaviorally. Formally, the model is defined by specifying $m_h = \sum_{g=1}^{G} w_{ig} n_{gh}$ where w_{ig}, called a specific weight, is the weight of a person in class g for commodity i, and the term $\sum_{g=1}^{G} w_{ig} n_{gh}$ is the weighted household size of household h for commodity i (and again, the number of equivalent adult males when the adult male is given a weight of 1).

Equation (3b) for this model is

$$(7b) \qquad c_{ih} = \beta'_{oi} + \beta''_{oi} \sum_{g=1}^{G} w_{ig} n_{gh} + \beta_{1i} y_h \, .$$

The variational parameters interpretation now involves $\beta_{oi} = \beta'_{oi} + \beta''_{oi} \sum_{g=1}^{G} w_{ig} n_{gh}$, and the graphics are the same as for equation (6b) except that the shift factor $\sum_{g=1}^{G} w_{ig} n_{gh}$ now varies across i reflecting the different requirements that individuals have for different commodities. Estimates of this type are presented in the table of weights for foods.

Third, in addition to allowing different scales for different commodities, a general or income scale which weights each family member according to overall need for family income might be assumed. Following Prais and Houthakker [1955] the model for this case (and earlier referred to as the consumer unit scale model) is defined by specifying $m_h = \sum_{g=1}^{G} w_{ig} n_{gh}$ for adjustment of c_{ih} and $m_h = \sum_{g=1}^{G} w_{og} n_{gh}$ for adjustment of y_h where w_{og}, called an income or general weight, is the weight of a person in class g on the income scale, and the term $\sum_{g=1}^{G} w_{og} n_{gh}$ is the weighted household size of household h with respect to income (and the number of equivalent male adults when the adult male is given a weight of 1).

Equation (3b) for the Prais and Houthakker model is

$$(7b) \qquad c_{ih} = \beta'_{oi} + \beta''_{oi} \sum_{g=1}^{G} w_{ig} n_{gh} + \beta_{1i} \frac{\sum_{g=1}^{G} w_{ig} n_{gh}}{\sum_{g=1}^{G} w_{og} n_{gh}} y_h .$$

Note that the variational parameters interpretation now involves two variables, i.e., $\beta_{oi} = \beta'_{oi} + \beta''_{oi} \sum_{g=1}^{G} w_{ig} n_{gh}$ and $\beta^*_{1i} = \beta_{1i}(\sum_{g=1}^{G} w_{ig} n_{gh})/(\sum_{g=1}^{G} w_{og} n_{gh})$. Graphically, this is shown in Figure 1 by line AA', for $n_1 = 1$, $n_2 = \ldots n_G = 0$, and by line CC" for $n_1 = 1$, $n_2 = 1$, $n_2 = \ldots n_G = 0$. Thus, the effect of an additional family member depends on the type of individual and the commodity and results in a shift in the expenditure line and a change in slope.

Estimates of the specific and income weights of this model are presented in the table of weights along with the previously mentioned scale estimates. Before proceeding with a discussion of these estimates two noteworthy comments concerning the Prais-Houthakker consumer unit scale model are given.

First, the Prais-Houthakker model which has been the traditional way of introducing household size and composition effects directly adjusts the Engel (or demand) curves to per unit relationships. This may be satisfactory for empirical work, but is it compatible with the theory? Consumer demand theory suggests that we begin with a utility function, maximize it subject to a budget constraint, and derive demand curves. This procedure ensures satisfaction of the general demand restrictions, and also allows for specific restrictions peculiar to assumed utility functions. Using the utility maximization approach, Barten [1964] and later Muellbauer [1974] have investigated household composition effects. Their results show that the Prais-Houthakker model is not, in general, compatible with the one derived from utility maximization.[1]

Second, identification of the specific and income scales is a long standing problem. Prais and Houthakker [1955], Forsyth [1960], and Cramer [1969] have provided insight for this problem, and Barten [1964] and Muellbauer [1975] have shown that the consumer scales are not identifiable.[2] The difficulty results from the imposition of the budget constraint, causing linear dependencies that make the identification of the scales impossible without *a priori* restrictions.

5. Results

A linear form of the Prais and Houthakker [1955] model was estimated using an iterative method similar to that suggested by Singh and Nagar [1973] and with appropriate prior restrictions. Additionally, and for comparison, linear Engel functions were estimated on the assumption of a single scale for all commodities, and for each food group separately under the assumption of identical specific and general weights. The latter functions were estimated directly, using ordinary least squares.

Estimates

Scale estimates for the Prais and Houthakker model under selected restrictions, Engel's model, and the individual food groups are presented in the table of weights. In this table, the various versions of the income-consumption models used are indicated in the first column. These, together with the identifying restrictions (if any) specified in the final column, give the *a priori* information underlying the family scale estimates. The remainder of the table includes the commodity groups, estimated scales and average and average weighted family sizes.

The first set of estimates presented is for the Prais and Houthakker model with restrictions on w_{5g} for g = 1, 2, ..., 8, i.e., the weight for nonfood, 1, for all g. These estimates are comparable to the second set for which the Prais and Houthakker model was iterated four times. The iterations are listed in the final column of table of weights. Only the results of the fourth iteration are given. Finally, the two more *ad hoc* model results are given; one model with all weights the same and one with the specific scales estimated separately.

The estimated weights for all models are statistically significant at the .05 level. As this is the case the standard errors are not shown. Intuitively, all of the models seem to give both the male and female sixty-five and over too much weight. This is probably due to the omission of expenditure outside the household on meals and snacks. One would anticipate that this is an important component of food consumption for adult males. Otherwise, the general trend in the weights seems plausible (lower weights for children and higher weights for adults).

From the comparison of estimated scales, observe that the isolated food models which can be directly estimated with significantly less cost (in both time and dollars) seem to capture the basic trends of the Prais and Houthakker model. This would suggest that from a practical viewpoint, the more consistent estimation of the scales does not add significantly to the richness of the empirical results. Further research on other functional forms of the Prais and Houthakker model, more basically other conceptually different household composition models (e.g., those based more directly on utility theory), and additional empirical work with other data sets is required to determine more predictably the implications of such a short cut approach.

6. Conclusions

These results though preliminary suggest several tentative conclusions. First, the specific scales within the food group are more nearly of the same magnitude than suggested by other studies.[3] This may be a data problem, food away from home and savings, or imply a shifting or different set of expenditure patterns between countries and time periods. Whatever the case, the results require further investigation for their robustness, which if it holds has implications for numerous nutritional assistance programs.

Secondly, the similarity of the results from the simple and more complex models is interesting. The so-called consistent scales models require iteration and are expensive and complicated. The similarity of results obtained with these and simpler models may mean that the prior information in the more restrictive models is not adding much to the data or that the data are not rich enough in variation to discriminate among the models. If this is true then production oriented large scale estimation projects can use the simpler computational methods without significant losses of information.

Finally, the consistency of scales across models and data bases may be indicative of the fact that other characteristics of the households should be receiving more attention. We are all guilty of focusing much attention on household size and composition while including in an *ad hoc* manner other possibly equally important characteristics.

FOOTNOTES

*Respectively, Graduate Research Assistant and Professor, Economics and Agricultural Economics Departments, University of Missouri. Research supported by USDA/SEA-53-32U4-9-188 research grant.

[1]Barten, A.P.: "Family Composition, Prices and Expenditure Patterns," in Economic Analysis for National Economic Planning, ed. by P. Hart, G. Mills, and J. Whittaker, 16th Symposium of the Colston Society. London: Butterworth, 1964.

Muellbauer, J.: "Household Composition, Engel Curves and Welfare Comparisons Between Households," European Economic Review, 5 (1974), 103-122.

[2]Ibid. Also, see Muellbauer, J.: "Identification and Consumer Unit Scales," Econometrica, 43 (1975), 807-809.

Singh, B., and A.L. Nagar: "Identification and Estimation of Consumer Unit Scales," Econometrica, 46 (1978), 231-233.

[3]Prais, S.J.: "The Estimation of Equivalent Adult Scales from Family Budgets," Economic Journal, 63 (1953), 791-810.

Singh, B., and A.L. Nagar: "Determination of Consumer Unit Scales," Econometrica, 41 (1973), 347-356.

Kakwani, N.C.: "On the Estimation of Consumer Unit Scales," The Review of Economics and Statistics (November 1977), 507-510.

McClements, L.: "Equivalence Scales for Children," Journal of Public Economics, 8 (1977), 191-210.

Muellbauer, J.: "The Estimation of the Prais-Houthakker Model of Equivalence Scales," Econometrica, 48 (1980), 153-176.

REFERENCES

Barten, A.P.: "Family Composition, Prices and Expenditure Patterns," in Economic Analysis for National Economic Planning, ed. by P. Hart, G. Mills, and J. Whittaker, 16th Symposium of the Colston Society. London: Butterworth, 1964.

Brown, A., and A. Deaton: "Surveys of Applied Economics: Models of Consumer Behaviour," Economic Journal, 82 (1972), 1145-1236.

Cramer, J.S.: Empirical Econometrics. Amsterdam: North Holland, 1969.

Engel, E.: "Die Productions-und Consumptionsverhaltnisse des Konigreichs Sachsen," Zeitschrift des Statischen Bureaus des Konlglich Sachsischen Ministerium des Inneren, Nos. 8 and 9, 1857.

Engel, E.: "Der Werth des Menschen; I. Teil: Der Kostenwerth des Menschen," in Volkswirtschaftliche Zeitfragen, Vol. 37-38, Berlin: I. Simion, 1883, 1-74.

Engel, E.: "Die Lebenskosten Belgischer Arbeitter--Familien Fruher and Jetzt," International Statistical Institute, Bulletin 9, Rome, 1895, 1-124.

Forsyth, F.G.: "The Relationship Between Family Size and Family Expenditure," Journal of the Royal Statistical Society, Series A, 123 (1960), 367-397.

Kakwani, N.C.: "On the Estimation of Consumer Unit Scales," The Review of Economics and Statistics, (November 1977), 507-510.

McClements, L.: "Equivalence Scales for Children," Journal of Public Economics, 8 (1977), 191-210.

Muellbauer, J.: "Household Composition, Engel Curves and Welfare Comparisons Between Households," European Economic Review, 5 (1974), 103-122.

Muellbauer, J.: "Identification and Consumer Unit Scales," Econometrica, 43 (1975), 807-809.

Muellbauer, J.: "Testing the Barten Model of Household Composition Effects and the Cost of Children," Economic Journal, 87 (1977), 460-487.

Muellbauer, J.: "The Estimation of the Prais-Houthakker Model of Equivalence Scales," Econometrica, 48 (1980), 153-176.

Nicholson, J.L.: "Variations in Working Class Family Expenditure," Journal of the Royal Statistical Society, Series A, 112 (1949), 359-411.

Pinstrup-Andersen, Per, and Elizabeth Caiciedo: "The Potential Impact of Changes in Income Distribution on Food Demand on Human Nutrition," American Journal of Agricultural Economics, 60 (1978), 402-415.

Pollak, R.A., and T.J. Wales: "Estimation of Complete Demand Systems From Household Budget Data," The American Economic Review 68(3) (1978), 348-359.

Prais, S.J.: "The Estimation of Equivalent Adult Scales from Family Budgets," Economic Journal, 63 (1953), 791-810.

Prais, S.J., and H.S. Houthakker: The Analysis of Family Budgets, Department of Applied Economics Monograph 4. Cambridge: Cambridge University Press, 1955 (2nd edition 1971).

Singh, B., and A.L. Nagar: "Determination of Consumer Unit Scales," Econometrica, 41 (1973), 347-356.

Singh, B., and A.L. Nagar: "Identification and Estimation of Consumer Unit Scales," Econometrica, 46 (1978), 231-233.

Stone, J.R.N.: The Measurement of Consumers' Expenditure and Behavior in the United Kingdom, 1920-1938, Vol. 1. Cambridge: Cambridge University Press, 1953.

Sydenstricker, E., and W.I. King: "The Measurement of Relative Economic Status of Families," Quarterly Publication of the American Statistical Association, 17 (1921), 842-857.

Table of Weights

ESTIMATES FOR SPECIFIC AND GENERAL SCALES USING THE ENGEL MODEL AND PRAIS-HOUTHAKKER MODEL UNDER ALTERNATIVE IDENTIFYING RESTRICTIONS; 1977-1978 HOUSEHOLD SURVEY DATA

Model	Commodity	i	Male Child w_{i1}	Male Adolescent w_{i2}	Male Adult w_{i3}	Male 65 and Over w_{i4}	Female Child w_{i5}	Female Adolescent w_{i6}	Female Adult w_{i7}	Female 65 and Over w_{i8}	Average Family Size	Average Weighted Family Size	Identifying Restrictions
Prais-Houthakker $\frac{C_{ih}}{\sum_{g=1}^{8} w_{ig} n_{gh}} = \beta_{0i}+\beta_{1i} \frac{y_h}{\sum_{g=1}^{8} w_{og} n_{gh}}$	milk equivalent	1	0.61819	1.16882	1	1.08272	0.61919	1.40883	0.97078	0.98773	2.9	2.8	$w_{5g} = 1$, for $g=1,2,\ldots, 8$
	meat, poultry, fish, eggs	2	0.47076	0.89046	1	1.13987	0.50393	0.92680	1.14316	0.97964	2.9	2.7	
	flour, bakery, veg., pot., fruit	3	0.78267	0.90315	1	0.98457	0.59383	0.74256	0.90582	1.18149	2.9	2.5	
	other foods	4	0.54230	0.73442	1	0.94073	0.76022	0.64140	1.00082	0.96517	2.9	2.5	
	nonfoods	5	1.00000	1.00000	1	1.00000	1.00000	1.00000	1.00000	1.00000	2.9	2.8	
	income	0	0.903326	0.979033	1	1.01752	0.903575	0.971606	1.01155	1.01693	2.9	2.8	
Prais-Houthakker $\frac{C_{ih}}{\sum_{g=1}^{8} w_{ig} n_{gh}} = \beta_{0i}+\beta_{1i} \frac{y_h}{\sum_{g=1}^{8} w_{og} n_{gh}}$	milk equivalent	1	0.58632	1.11248	1	1.04529	0.585183	1.34188	0.91098	0.94455	2.9	2.7	1st Iteration: $w_{5g} = 1$, for $g=1,\ldots, 8$
	meat, poultry, fish, eggs	2	0.47727	0.87954	1	1.16186	0.491663	0.93959	1.14486	0.97351	2.9	2.7	2nd Iteration: $w_{2g} = \hat{w}_{2g}$, $g = 1,\ldots, 8$
	flour, bakery, veg., pot., fruit	3	0.71273	0.82073	1	0.92229	0.534396	0.67132	0.79874	1.08705	2.9	2.4	
	other foods	4	0.48104	0.65288	1	0.87215	0.673645	0.56614	0.86990	0.87604	2.9	2.3	
	nonfoods	5	1.08965	0.85409	1	1.31921	0.763249	1.12435	1.12811	0.93247	2.9	2.9	3rd Iteration: $w_{5g} = 1$, for $g=1, \ldots, 8$
	income	0	0.96367	0.862155	1	1.25441	0.718712	1.05779	1.09578	0.960441	2.9	2.8	4th Iteration: $w_{2g} = \hat{w}_{2g}$, $g = 1, \ldots, 8$ where the (^) denotes the estimate from the previous iteration

Table of Weights--Continued

Model	Commodity	i	Male Child w_{i1}	Male Adolescent w_{i2}	Male Adult w_{i3}	Male 65 and Over w_{i4}	Female Child w_{i5}	Female Adolescent w_{i6}	Female Adult w_{i7}	Female 65 and Over w_{i8}	Average Family Size	Average Weighted Family Size	Identifying Restrictions
Engel's $\frac{C_{ih}}{\sum_{g=1}^{8} w_g n_{gh}} = \beta_{0i}+\beta_{1i} \frac{y_h}{\sum_{g=1}^{8} w_g n_{gh}}$	all commodities and income	1 2 3 4 5 0	.648	.955	1	1.097	.586	1.066	1.077	1.046	2.9	2.7	none--the model is identified
Isolated Food Models $\frac{C_{ih}}{\sum_{g=1}^{8} w_{ig} n_{gh}} = \beta_{0i}+\beta_{1i} \frac{y_h}{\sum_{g=1}^{8} w_{ig} n_{gh}}$ or $C_{ih} = \beta_{0i}(\sum_{g=1}^{8} w_{ig} n_{gh})+\beta_{1i} y_h$	milk equivalent	1	.50	.98	1	.97	.50	1.20	.75	.83	2.9	2.4	none--derivation of weights – $\frac{\beta_{0i} w_{ig}}{\beta_{0i} w_{i3}}$, g = 1, ..., 8
	meat, poultry, fish, eggs	2	.33	.71	1	.97	.35	.70	.79	.77	2.9	2.2	
	flour, bakery, veg., pot., fruit	3	.84	.97	1	1.06	.63	.79	.99	1.28	2.9	2.7	
	other foods	4	.42	.62	1	.88	.63	.49	.91	.91	2.9	2.3	