FOOD CONSUMPTION PATTERNS: EVIDENCE FROM POOLED ORGANIZATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (OECD) DATA

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Abstract: This paper analyzes food consumption patterns across time for countries with different income levels. Utilizing multi-stage budgeting, two extended versions of the Working's model are fit to cross-country and pooled data from the Organization for Economic Co-operation and Development between 1985 and 1999. Specifically, the two models are fit to the data of individual years prior to fitting the models to the pooled cross-country data over time. The pooled data are unbalanced, and an AR(1) maximum-likelihood (ML) procedure is used to allow for preference or taste persistence over time. From pooled ML parameter estimates, income and own-price elasticites are calculated and reported for both stages. Formulas to convert the conditional elasticities in the second stage to unconditional ones are derived and presented. The estimated demand elasticities are useful for economists and policy makers in preparing demand forecasts and policy analyses.

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Introduction

This paper analyzes food consumption patterns across time for countries with different income levels. Utilizing multi-stage budgeting, two extended versions of Working's (1943) model are fit to cross-country and pooled data from the Organization for Economic Co-operation and Development between 1985 and 1999. Specifically, the two models are fit to the data of individual years prior to fitting the models to the pooled cross-country data over time. The pooled data are unbalanced, and an AR(1) maximum-likelihood (ML) procedure is used to allow for preference or taste persistence over time. From pooled ML parameter estimates, income and own-price elasticites are calculated and reported for both stages. Formulas to convert the conditional elasticities in the second stage to unconditional ones are derived and presented. The estimated demand elasticities are useful for economists and policy makers in preparing demand forecasts and policy analyses.

Data

To estimate demand systems across countries, it is necessary to convert domestic currencies into a common currency. Often exchange rates are used to convert national currencies of different countries to a common currency. However, this is a poor choice (Gilbert and Kravis, 1953; Theil, Chung and Seale, 1989; Seale and Regmi, 2006). Exchange rates are volatile and the exchange rate-converted figures are not good indicators for measuring the relative purchasing power among populations of different countries. Basically, purchasing power parities (PPPs) are defined as the conversion rates between two currencies, which would equate the purchasing power of different currencies by eliminating the differences in price levels between countries (OECD 2002, p. 10). In practice, the PPPs are more suitable for international comparison analyses than official exchange rates.

The data of this study are from Eurostat-OECD Purchasing Power Parity Programme. The Eurostat initiated the PPP programme in the late 1960s to provide estimates for the members of the European Economic Community (EEC), which is now the EU. In spite of the involvements of the OECD and the Eurostat in the PPP programme, the initiation of the ICP during the 1960s shifted its center of operations to the University of Pennsylvania. In the early 1980s, the OECD reactivated its involvement in the PPP programme so as to provide estimates for non-European member countries of the OECD. With support from Eurostat, the Eurostat-OECD PPP Programme was established to provide internationally comparable price and volume measures of GDP and its components for member states of the EU and the member countries of the OECD (OECD, 2002).

The 1980 round is the first round of the Eurostat-OECD PPP Programme and included 18 countries, all of which were OECD member countries (Ward, 1985). Because of the limitation of the data, the 1980 round will not be employed in our research. The 1985 round is the second round, and it included 12 EU countries plus 10 OECD member countries (Table 1). Eurostat collected the data and calculated the PPPs and real expenditures for the 12 EU member countries and Austria, while the OECD collected the data and calculated the results for the rest of the countries (OECD, 1987). The 1990 round is the third round and it included 12 EU countries plus 12 OECD member countries (Table 1). Eurostat was responsible for the 12 EU member countries, Austria, and Switzerland while the OECD was responsible for the remaining 10 countries (OECD, 1993). The 1993 round is the fourth round and included the same 24 OECD member countries covered in the 1990 round (Table 1).

The 1996 round is the fifth round and included 32 countries of which four were non-members of the OECD (Table 1). Eurostat provided the data for the 15 EU member countries, Iceland, Norway, Poland, and Switzerland while the OECD provided the data for the 13 remaining countries (OECD, 2000). The next round is the 1999 round that included 43 countries. The Eurostat was responsible for the data collection and the calculation of the PPPs and real expenditures of 31 countries, consisting of 15 EU member countries, three member countries of the European Free Trade (Iceland, Norway, and Switzerland), and 13 countries of the EU-candidate countries (Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovenia, the Slovak Republic, and Turkey). The OECD was responsible for the data collection and the calculation of the PPPs and the real expenditures of seven non-European countries (Australia, Canada, Japan, Korea, Mexico, New Zealand, and the United States) and five other countries (Croatia, Israel, Macedonia, the Russian Federation, and Ukraine). Finally, the OECD incorporated its results with those obtained from the Eurostat in order to acquire the final results of 43 countries (OECD, 2002).

Calculation and Aggregation of PPPs

The calculation of PPPs for the Eurostat-OECD PPP programme is divided into two main steps. For the first step, two methods of estimating the unweighted PPPs at the basic heading level are available, either the Elteto-Koves-Szulc (EKS) method or the Country-Product-Dummy (CPD) method. While the choice is arbitrary as to which method should be selected, the EKS method is chosen by the Eurostat-OECD PPP Programme. For the aggregation of PPPs from the basic heading level to the aggregate level, either the EKS method or the Geary-Khamis (GK) method can be employed. The GK method was employed to the data prior to the 1990 round. The results of the 1990 round and later were calculated using either the EKS method or the GK method.

Our research utilizes the data based on the GK aggregation method as opposed to the EK method. A major drawback of the EKS method is that the resulting data are not additive (i.e., the real values of GDPs components do not add up to the real values of total GDPs). As a result, the EKS data are not suitable cross-country demand studies. However, data resulting from the GK aggregation method are additive and therefore are suitable for cross-country demand studies. Another important issue is the fixity convention that was established during and after the 1980 round. Basically, the fixity convention ensures that the ranking of the EU member countries, in terms of GDPs, remains unchanged as the composition of the group of countries being compared changes. While the expenditures calculated from the EKS method follow the rules created by the fixity convention, the expenditures from the GK method do not.

Consumption Classification

While our study focuses on the broad category food, beverages and tobacco and eight food subcategories, in the first stage we estimate as a system the demand for nine broad categories of goods. The first of the nine broad categories is the food, beverages, and tobacco category that consists of food consumption at home; beverages and tobacco; and food consumption away from home. The latter consists of food and beverages that were previously included in the medical care category as well as food consumed in canteens, in restaurants, and in any other places that were previously included in the “other” category. The second group is the clothing and footwear category, and the third is gross rent, fuel, and power category that includes rents (rents of tenants, imputed rents of owner-occupiers); the repair and maintenance of housing, sanitary services, and water charges, and expenditures on household fuel consumption (electricity; town gas and natural gas; liquefied petroleum gas; liquid fuels for heating and lighting; and coal, coke, and other solid fuels). The other groups are house furnishings and operations; medical care; transport and communications; recreation; education; and “other” miscellaneous expenditures such as hairdressers, beauty parlors, durable and nondurable toilet articles, and repairs, jewelry, watches and their repairs, travel goods and baggage items, goods for babies, personal accessories, writing and drawing equipment and supplies, insurance charges (except for car and health insurances), fees for other services, and other lodging places.

The food, beverages, and tobacco category is further disaggregated into eight food subgroups. These subgroups are cereals and bread including rice, flour and other cereals, bread, other bakery products, pasta products, and other cereal products; meat and fish; dairy including fresh milk, pasteurized milk, sterilized milk, condensed milk, evaporated milk, powdered milk, other milk products, excluding cheese, processed and unprocessed cheese, and eggs and egg product; fats and oil includes butter, margarine, edible oils, and other animal and vegetable fats; fruit and vegetables includes fresh fruit, dried fruit and nuts, frozen and preserved fruit and juices, fresh vegetables, dried vegetables, frozen vegetables, preserved vegetables, juices, soups, potatoes and other tuber vegetables, and potato products; other foods include raw and refined sugars, coffee and instant coffee, tea and other infusions, cocoa excluding cocoa preparations, jams, jellies, honey and syrups, chocolate and cocoa preparations, confectioneries, edible ice and ice-cream, salt, spices, sauces, and condiments; beverages and tobacco includes mineral water, other soft drinks, spirits and liqueurs, wine (not fortified or sparkling), beer, other wines and alcoholic beverages, cigarettes, and other tobacco products; and food consumed away from home includes consumption of food and beverages in medical and healthcare, restaurants and take-aways, pubs, cafes, bars, tea rooms, and staff canteens.

Analysis of Broad Category Budget Shares

Based upon country real income per capita with respect to that of the United States, we divide countries into two distinct groups (the higher income group and the lower income group). The higher income group consists of countries with real income per capita with respect to that of the United States greater than 0.50, while the lower income group consists of the rest of the countries not included in the higher income group. These budget shares for the years 1985, 1990, 1993, 1996, and 1999 are reported in Table 2. Consumers on average in the higher income group spend a smaller proportion of their total income on food than do consumers in the lower income group in every year. They also spend a slightly smaller proportion of their total income on clothing and footwear than do consumers in the lower income group between 1985 and 1996. In contrast, higher income consumers spend a larger proportion of their total income on gross rent, fuel, and power; medical care; transport and communications; recreation; and other expenditures than do consumers in the lower income group in every year. The allocation of total income to house furnishings and operations is approximately the same for both groups during the period 1985-1993, but the shares become larger for consumers in the higher income group in 1996 and 1999.

The budget shares of food, beverages and tobacco are averaged over 1985, 1990, 1993, 1996, and 1999 for the higher and lower income groups. The resulting average budget shares are plotted in Figure 1. For all years, the average food budget shares of the lower income countries are higher than the corresponding ones for the higher income countries.

Analysis of Food Subgroup Budget Shares

As before, countries are divided into higher income and lower income Next, the average budget shares for the eight food subcategories conditional on total food expenditure are calculated and reported in Table 3. Consumers in the lower income group allocate a larger proportion of their total food expenditure to consumption of meat and fish; fats and oil; and fruit and vegetables in every year. In addition, consumers in the lower income group allocate a larger proportion of their food expenditure to consumption of cereals and bread (1985, 1996, and 1999) and other foods (1996 and 1999). Although consumers in both groups allocate about the same proportion of their total food expenditure to dairy in 1985 and 1990, consumers in the lower income groups allocate a larger proportion than do consumers in the higher income group since 1993. On the other hand, consumers in the higher income group spend a larger proportion of their total food expenditure on beverages and tobacco (1985, 1990, 1996, and 1999) and food away from home (1985, 1996, and 1999) than do consumers in the lower income group.

Unconditional budget shares for the food subcategories are also calculated and averaged over all five rounds (Figure 2). From this, it is clear that the lower income group of countries spends a larger proportion of total expenditure on all eight food subcategories.

Empirical Models

The analysis in our research utilizes two versions of the Florida model, the Florida Slutsky and Florida PI models. Both models are extensions of Working's (1943) model (Theil, Chung, and Seale, 1989).

Working's Model

Working (1943) developed a demand model by analyzing data on U.S. household expenditures in the mid-1930s under the condition that all households faced the same prices. For *n* goods, Working's model can be expressed as

$$w_i = \alpha_i + \beta_i \log E + \varepsilon_i \qquad i = 1, \ldots, n, \tag{1}$$

where $w_i = E_i / E$ is the budget share of good *i*, $E_i = p_i q_i$ is expenditure on good i, $E = \sum_{i=1}^{n} p_i q_i$ is total consumption expenditure, p_i is the price of good i, q_i is the quantity of good i, and ε_i is a residual term. The model also satisfies the additivity constraints, which are

$$\sum_{i=1}^{n} \alpha_i = 1, \text{ and } \quad \sum_{i=1}^{n} \beta_i = 0. \tag{2}$$

Multiplying both sides of equation (2) by E and differentiating with respect to *E* gives the marginal share of good *i* (θ_i), which can be written as

$$\theta_i = \frac{dE_i}{dE} = w_i + \beta_i. \tag{3}$$

The marginal share of good *i* measures changes in the expenditure of good *i* when total expenditure increases by one dollar, given that prices $(p_1, \ldots, p_n)$ are constant.

The income elasticity is simply the product of (dE_i / dE) and (E/E_i) or the ratio of the marginal share of good *i* to the budget share of good *i*, that is,

$$\frac{\theta_i}{w_i} = \frac{dE_i}{dE}\frac{E}{E_i} = 1 + \frac{\beta_i}{w_i}. \tag{4}$$

As such, good *i* is a luxury good if $\beta_i > 0$ such that income elasticity measure is greater than unity. In contrast, good *i* is a necessity if $\beta_i < 0$ such that income elasticity measure is less than unity. If $\beta_i = 0$, good i has unitary elasticity.

Florida Slutsky Model

Working's model is only applicable when all countries face the same price data. Arguing that this is not generally the case, Theil, Chung, and Seale (1989) extended Working's model by incorporating prices into the model.

Following Theil, Chung, and Seale (1989), let $\tilde{w}_{ic}$ be the budget share of good *i* at the geometric mean price $\overline{p}_i$ for $i = 1,\ldots, n$, and at the observed real income per capita of country *c* (Q_c) where c represents country (c=1,…,N). Accordingly, equation (1) is modified as

$$\tilde{w}_{ic} = \alpha_i + \beta_i \log Q_c + \varepsilon_{ic}, \tag{5}$$

where ε_{ic} is the residual term. Therefore, the observed budget share of good *i* in country *c* can be written as

$$w_{ic} = \alpha_i + \beta_i \log Q_c + (w_{ic} - \tilde{w}_{ic}) + \varepsilon_{ic}, \tag{6}$$

where $w_{ic} - \tilde{w}_{ic}$ represents the move from the price vector $[\overline{p}_i]$ to the observed price vector $[p_{ic}]$. The next step is to find the difference $w_{ic} - \tilde{w}_{ic}$ and then substitute the result back into equation (6) so as to obtain the final form of the extended model.

First, totally differentiate $w_i = p_i q_i / E$ and obtained

$$dw_i = w_i d(\log p_i) + w_i d(\log q_i) - w_i d(\log E). \tag{7}$$

This equation indicates that a change in the budget share is the sum of a price component, a quantity component, and an income component. By adding and subtracting $w_i d(\log P)$ to the right-hand side of equation (7), we obtain

$$dw_i = w_i[d(\log p_i) - d(\log P)] + w_i d(\log q_i) - w_i[d(\log E) - d(\log P)]. \quad (8)$$

where $d(\log P)$is the Divisia price index,

$$d(\log P) = \sum_{i=1}^{n} w_i d(\log p_i)\,. \quad (9)$$

Noting that $d(\log E) - d(\log P) = d(\log Q)$, replace $d(\log E) - d(\log P)$ in equation (8) by $d(\log Q)$, which is the Divisia volume index,

$$d(\log Q) = \sum_{i=1}^{n} w_i d(\log q_i)\,. \quad (10)$$

Further, the term $w_i d(\log q_i)$ is the dependent variable of the general differential demand equation (Theil, Chung, Seale, 1989, p. 157),

$$w_i d(\log q_i) = \theta_i d(\log Q) + \sum_{j=1}^{n} \pi_{ij} d(\log p_j)\,, \quad (11)$$

where π_{ij} is the Slutsky price coefficient. The Slutsky matrix $[\pi_{ij}]$ is an $n \times n$ matrix, which is negative semi definite of rank n-1. The term π_{ij} is the (i, j) component of the Slutsky matrix. In addition, the matrix $[\pi_{ij}]$ satisfies both the Slutsky symmetry property, $\pi_{ij} = \pi_{ji}$, and the demand homogeneity property, $\sum_{j=1}^{n} \pi_{ij} = 0$ for $i = 1,\ldots, n$.

After further substitution of equation (11) into equation (8), we obtain

$$dw_i = w_i[d(\log p_i) - d(\log P)] + \theta_i d(\log Q) + \sum_{j=1}^{n} \pi_{ij} d(\log p_j) - w_i d(\log Q)\,. \quad (12)$$

In the present case, real income is fixed at Q_c so that $d(\log Q)$ vanishes leaving us

$$dw_i = w_i[d(\log p_i) - d(\log P)] + \sum_{j=1}^{n} \pi_{ij} d(\log p_j)\,. \tag{13}$$

By replacing w_i with $\alpha_i + \beta_i \log Q_c$, by interpreting $d(\log p_i)$ as the difference between $\log p_{ic}$ and $\log \bar{p}_i = \frac{1}{N}\sum_{c=1}^{N} \log p_{ic}$, the log of the geometric mean price of good i, and by applying the mean value theorem of calculus, we can substitute equation (13) into equation (6) to obtain the Florida-Slutsky model,

$$w_{ic} = \alpha_i + \beta_i q_c + (\alpha_i + \beta_i q_c)\left[\log\left(\frac{p_{ic}}{\bar{p}_i}\right) - \sum_{j=1}^{n}(\alpha_j + \beta_j q_c)\log\left(\frac{p_{jc}}{\bar{p}_j}\right)\right]$$
$$+ \sum_{j=1}^{n} \pi_{ij} \log\left(\frac{p_{jc}}{\bar{p}_j}\right) + \varepsilon_{ic}\ , \tag{14}$$

where $q_c = \log Q_c$. The Florida Slutsky model is the sum of a linear real income term, a quadratic pure price term, and a linear substitution term under the assumption of weak separability. To estimate the model, $\alpha_i, \beta_{\mathrm{i}}$, and π_{ij} are treated as constants.

Florida PI Model

The Florida Slutsky model can be simplified to the Florida PI model by assuming that preferences are independent. Under preference independence, the total utility function can be written as the sum of *n* subutility functions, where *n* represents *n* individual goods. This means that the Hessian of the total utility function and its inverse are both diagonal matrices. Additionally, because $\theta_{ij} = \mu p_i u^{ij} p_j / \phi E$, the matrix $[\theta_{ij}]$ is also diagonal matrix, where ϕ is the income flexibility or the reciprocal of the income elasticity of the marginal utility of income and

u^{ij} is the i,jth element of the Hessian of the total utility function. This means that $\theta_{ij} = \theta_i$, when $i = j$, and $\theta_{ij} = 0$, when $i \neq j$. The resulting restriction simplifies the term $\pi_{ij} = \phi(\theta_{ij} - \theta_i\theta_j)$ in the Florida-Slutsky model. As a result, under preference independence, π_{ij} takes the form

$$\pi_{ij} = \begin{cases} \phi\theta_i(1-\theta_i) & ; i = j \\ -\phi\theta_i\theta_j & ; i \neq j \end{cases}.$$

Thus, the simplification of the Slutsky matrix of the Florida-Slutsky model leads us to

$$\begin{aligned} w_{ic} = \alpha_i + \beta_i q_c + (\alpha_i + \beta_i q_c)\left[\log\left(\frac{p_{ic}}{\overline{p}_i}\right) - \sum_{j=1}^{n}(\alpha_j + \beta_j q_c)\log\left(\frac{p_{jc}}{\overline{p}_j}\right)\right] \\ + \phi\theta_i \log\left(\frac{p_{ic}}{\overline{p}_i}\right) - \phi\theta_i \sum_{j=1}^{n}\theta_j \log\left(\frac{p_{jc}}{\overline{p}_j}\right) + \varepsilon_{ic} \ . \end{aligned} \tag{15}$$

Given that the marginal share of good i of country c (θ_{ic}) in the Florida model is the sum of w_{ic} and β_i, it can be verified that (Theil, Chung, and Seale, 1989)

$$\theta_{ic} = \alpha_i + \beta_i q_c^*, \tag{16}$$

where $q_c^* = 1 + q_c$. As such, the final functional form of the Florida PI model is

$$\begin{aligned} w_{ic} = \alpha_i + \beta_i q_c + (\alpha_i + \beta_i q_c)\left[\log\left(\frac{p_{ic}}{\overline{p}_i}\right) - \sum_{j=1}^{n}(\alpha_j + \beta_j q_c)\log\left(\frac{p_{jc}}{\overline{p}_j}\right)\right] \\ + \phi(\alpha_i + \beta_i q_c^*)\left[\log\left(\frac{p_{ic}}{\overline{p}_i}\right) - \sum_{j=1}^{n}(\alpha_j + \beta_j q_c^*)\log\left(\frac{p_{jc}}{\overline{p}_j}\right)\right] + \varepsilon_{ic}, \end{aligned} \tag{17}$$

Unlike the Florida Slutsky model, the Florida PI model is the sum of a linear real income term, a quadratic pure price term, and a cubic substitution term under the assumption of preference independence. To estimate the model, α_i, β_i, and ϕ are treated as constants.

Maximum Likelihood Procedure for the Florida PI Model

For estimation purposes, it is necessary to eliminate one equation from the demand systems (Barten, 1969). Disregarding the *n*th equation, the Florida PI model from Equation (17) can be rewritten for $i = 1,\ldots, n$-1 as

$$w_{ic} = \alpha_i + \beta_i q_c + (\alpha_i + \beta_i q_c)\left[x_{ic} - \sum_{j=1}^{n-1} (\alpha_j + \beta_j q_c) x_{jc} \right] + \phi(\alpha_i + \beta_i q_c^*)\left[x_{ic} - \sum_{j=1}^{n-1} (\alpha_j + \beta_j q_c^*) x_{jc} \right] + \varepsilon_{ic} \qquad (18)$$

where $x_{ic} = \log(p_{ic} / \bar{p}_i) - \log(p_{nc} / \bar{p}_n)$, w_{ic} is the budget share of good *i* in country *c*, $q_c = \log Q_c$, p_{ic} is the price of good *i* in country *c*, $\bar{p}_i$ is the geometric mean prices of good *i* across countries, ϕ is the income flexibility, $q_c^* = 1 + q_c$, and ε_{ic} is the residual term of good *i* in country *c*. A simple matrix notation of the Florida PI model can be expressed as

$$w_c = f_c(\theta) + \varepsilon_c, \qquad (18)$$

where θ is the parameter vector of 2*n*-1 elements that consist of *n*-1 elements of subvector α, *n*-1 elements of subvector β, and one element of subvector ϕ. The terms w_c and ε_c are column vectors of *n*-1 elements. It is noted that $f_c(\theta)$ is defined as

$$f_c(\theta) = \alpha + q_c\beta + X_c(\alpha + q_c\beta) - (\alpha + q_c\beta)x_c^T(\alpha + q_c\beta) + \phi X_c(\alpha + q_c^*\beta) - \phi(\alpha + q_c^*\beta)x_c^T(\alpha + q_c^*\beta), \qquad (19)$$

where X_c is the diagonal matrix of order *n*-1 with x_{ic} as the *i*th diagonal element, and x_c is the column vector (x_c^T is its transpose) with x_{ic} as its *i*th element ($i = 1,\ldots, n$-1).

For $c = 1,\ldots, N$ and $\varepsilon_c \sim N(0, \Sigma)$, the log-likelihood function of the Florida PI model is

$$L = \text{constant} + \frac{1}{2} N \log\left|\Sigma^{-1}\right| - \frac{1}{2}\sum_{c=1}^{N}[w_c - f_c(\theta)]^T \Sigma^{-1}[w_c - f_c(\theta)]. \qquad (20)$$

Due to the presence of unknown parameters (θ and Σ) in the log-likelihood function, it is worthwhile to transform the log-likelihood function to the concentrated log-likelihood function so that the solution of the optimization problem can be written as an explicit function of the other solution of the problem. In other words, the concentrated log-likelihood function can be derived by calculating the first-order derivatives of the log-likelihood function with respect to Σ given θ and setting the equation to zero. This gives the solution for Σ which can be written as a function of θ. Let $R(\theta)$ be the solution for Σ as a function of θ, thus the concentrated log-likelihood function of the Florida PI model is

$$L^* = \text{constant} + \frac{1}{2} N \log\left|R(\theta)^{-1}\right|, \text{ where} \tag{21}$$

$$R(\theta) = \frac{1}{N}\sum_{c=1}^{N}[w_c - f_c(\theta)][w_c - f_c(\theta)]^T \,. \tag{22}$$

The first-order derivatives of the concentrated log-likelihood function of the Florida PI model with respect to θ are

$$\frac{dL^*}{d\theta} = \sum_{c=1}^{N}\left[\frac{df_c(\theta)}{d\theta^T}\right]^T R(\theta)^{-1}[w_c - f_c(\theta)], \tag{23}$$

where $df_c(\theta)/d\theta^T$ consists of three submatrices. Three submatrices of $df_c(\theta)/d\theta^T$ can be expressed as

$$\frac{df_c(\theta)}{d\alpha^T} = A + B\,, \tag{24}$$

$$\frac{df_c(\theta)}{d\beta^T} = q_c A + q_c^* B\,, \text{ and} \tag{25}$$

$$\frac{df_c(\theta)}{d\phi} = X_c(\alpha + q_c^*\beta) - (\alpha + q_c^*\beta)x_c^T(\alpha + q_c^*\beta) \tag{26}$$

where $A = X_c - (\alpha + q_c\beta)x_c^T + [1 - (\alpha + q_c\beta)^T x_c]I_{n-1}$, and

$$B = \phi X_c - \phi(\alpha + q_c^*\beta)x_c^T - \phi(\alpha + q_c^*\beta)^T x_c I_{n-1}$$

with I_{n-1} as the identity matrix of order n-1. The Hessian matrix or the second-order derivatives of L^* with respect to θ is

$$\frac{d^2L^*}{d\theta d\theta^T} = K(\theta) + J(\theta), \text{ where} \tag{27}$$

$$K(\theta) = -\sum_{c=1}^{N}\left[\frac{df_c(\theta)}{d\theta^T}\right]^T R(\theta)^{-1}\left[\frac{df_c(\theta)}{d\theta^T}\right], \text{ and} \tag{28}$$

$J(\theta)$ is a matrix that is linear in $w_c - f_c(\theta)$ for c = 1,…, N. The asymptotic covariance matrix of the maximum likelihood estimator of θ is $-K(\theta)^{-1}$. The maximum likelihood estimates $\hat{\theta}$ can be obtained using the method of scoring. The asymptotic standard errors are the square root of the diagonal elements of the asymptotic covariance matrix.

ML Estimator for Pooled Data

Pooling cross-country and time-series data have become more common practice in the demand analysis. The reason is pooling the data provides information and permits estimates of demand system parameters for the cross-country and the time series data, given that the character of relationship under study does not change from time to time (Nuamah, 1986). In our study, we assume that if the error term of the food budget share of country c is positive and large in period t, it is likely that this country will have a positive error term for food in the next period (Theil, Chung, and Seale, 1989). This is to account for preference or taste persistence over time. One way to impose this assumption is through an introduction of the AR(1) process with parameter τ.

AR(1) process

There exist five phases in our study. Each phase represents data from five different reference years (1985, 1990, 1993, 1996, and 1999). In the case when different time periods are involved, the general form of the Florida PI model can be written as

$$w_{ct} = f_{ct}(\theta) + \varepsilon_{ct}, \tag{29}$$

where subscript t indicates different reference years or phases (t = 1, 2, 3, 4, or 5). In this case, the first phase (t = 1) represents reference year 1985. The second phase (t = 2) represents reference year 1990. The third phase (t = 3) represents reference year 1993. The fourth phase (t = 4) represents reference year 1996. Finally, the fifth phase (t = 5) represents reference year 1999. The term w_{ct} is the budget share of country c at time t, $f_{ct}(\theta)$ is a functional form of the Florida PI model at time t, and ε_{ct} is the disturbance term of country c at time t. Therefore, using the error term of equation (29), the AR(1) process can be written as

$$\varepsilon_{ct} = \tau\varepsilon_{c,t-1} + \nu_{ct}, \tag{30}$$

where t-1 and t are two successive phases (i.e., phases 1 and 2, or phases 2 and 3, or phases 3 and 4, or phases 4 and 5), ν_{ct} is independent, identically distributed $N(0, \Sigma_\nu)$, and $-1 < \tau < 1$.

Let h be the number of phases in which country c participates. After excluding outlying observations by the method of information inaccuracy measures (Seale and Regmi, 2006), 11 countries participate in one phase, eight countries participate in two phases, two countries in four phases, and 21 countries in five phases. It should be noted that no country participates in three phases because reference years 1990 and 1993 have the same number of countries. Let Ω_h be the covariance matrix of ε_c when country c participates in h phases, where h equals 1, 2, 4, or 5.

Given the relationship in equation (30), the form of Ω_h depends on the value of h or the number of phases in which countries participate. This can be defined as

$$\Omega_1 = \Sigma, \tag{31}$$

$$\Omega_2 = \begin{bmatrix} \Sigma & \tau\Sigma \\ \tau\Sigma & \Sigma \end{bmatrix}, \tag{32}$$

$$\Omega_4 = \begin{bmatrix} \Sigma & \tau\Sigma & \tau^2\Sigma & \tau^3\Sigma \\ \tau\Sigma & \Sigma & \tau\Sigma & \tau^2\Sigma \\ \tau^2\Sigma & \tau\Sigma & \Sigma & \tau\Sigma \\ \tau^3\Sigma & \tau^2\Sigma & \tau\Sigma & \Sigma \end{bmatrix}, \text{ and} \tag{33}$$

$$\Omega_5 = \begin{bmatrix} \Sigma & \tau\Sigma & \tau^2\Sigma & \tau^3\Sigma & \tau^4\Sigma \\ \tau\Sigma & \Sigma & \tau\Sigma & \tau^2\Sigma & \tau^3\Sigma \\ \tau^2\Sigma & \tau\Sigma & \Sigma & \tau\Sigma & \tau^2\Sigma \\ \tau^3\Sigma & \tau^2\Sigma & \tau\Sigma & \Sigma & \tau\Sigma \\ \tau^4\Sigma & \tau^3\Sigma & \tau^2\Sigma & \tau\Sigma & \Sigma \end{bmatrix}. \tag{34}$$

AR(1) corrected ML estimator

With the additional parameter τ, the log-likelihood function takes a new form. In this case, our AR(1) corrected maximum likelihood function takes the form

$$L = \text{constant} + \frac{1}{2}\sum_{h=1,2,4,5} N_h \log\left|\Omega_h^{-1}\right| - \frac{1}{2}\left[\sum_{c=1}^{11}\varepsilon_c^T\Omega_1^{-1}\varepsilon_c + \sum_{c=12}^{19}\varepsilon_c^T\Omega_2^{-1}\varepsilon_c + \sum_{c=20}^{21}\varepsilon_c^T\Omega_4^{-1}\varepsilon_c + \sum_{c=22}^{42}\varepsilon_c^T\Omega_5^{-1}\varepsilon_c\right] \tag{35}$$

where N_h is the number of countries that participate in h phases. By substituting Ω_h (h = 1, 2, 4, or 5) and $\Sigma = (1-\tau^2)^{-1}\Sigma_\nu$ into equation (35), the log-likelihood function under AR(1) can be written as

$$L = \text{constant} + \frac{1}{2}(n-1)N\log(1-\tau^2) + \frac{1}{2}N^*\log\left|\Sigma_\nu^{-1}\right|$$
$$-\frac{1}{2}\left[(1-\tau^2)\sum_{c=1}^{42}\varepsilon_{c1}^T\Sigma_\nu^{-1}\varepsilon_{c1} + \sum_{c=12}^{42}(\varepsilon_{c2}-\tau\varepsilon_{c1})^T\Sigma_\nu^{-1}(\varepsilon_{c2}-\tau\varepsilon_{c1}) + \sum_{c=20}^{42}(\varepsilon_{c3}-\tau\varepsilon_{c2})^T\Sigma_\nu^{-1}(\varepsilon_{c3}-\tau\varepsilon_{c2})\right]$$

$$-\frac{1}{2}\left[\sum_{c=20}^{42}(\varepsilon_{c4}-\tau\varepsilon_{c3})^T\Sigma_v^{-1}(\varepsilon_{c4}-\tau\varepsilon_{c3})+\sum_{c=22}^{42}(\varepsilon_{c5}-\tau\varepsilon_{c4})^T\Sigma_v^{-1}(\varepsilon_{c5}-\tau\varepsilon_{c4})\right] \quad (36)$$

where $N = N_1 + N_2 + N_3 + N_4 + N_5$, and $N^* = N_1 + 2N_2 + 3N_3 + 4N_4 + 5N_5$. The AR(1) corrected log-likelihood function is maximized with respect to the three unknown parameters (θ, Σ_v, and τ). The concentrated AR(1) corrected log-likelihood function can be obtained by maximizing the AR(1) corrected log-likelihood function in equation (36) with respect to Σ_v given θ and τ. The solution of Σ_v is expressed as a function of θ and τ. Let $R(\theta, \tau)$ be the solution for Σ_v.

Substituting $R(\theta, \tau)$ for Σ_v in the AR(1) corrected log-likelihood function in equation (36) gives the concentrated AR(1) corrected log-likelihood function,

$$L^* = \text{constant} + \frac{1}{2}(n-1)N\log(1-\tau^2)+\frac{1}{2}N^*\log\left|R(\theta,\tau)^{-1}\right| \quad (37)$$

where θ is a vector of α, β, and ϕ, respectively, and

$$R(\theta,\tau)=\left(\frac{1}{N^*}\right)\left[(1-\tau^2)\sum_{c=1}^{42}\varepsilon_{c1}\varepsilon_{c1}^T+\sum_{c=12}^{42}(\varepsilon_{c2}-\tau\varepsilon_{c1})(\varepsilon_{c2}-\tau\varepsilon_{c1})^T\right]$$
$$+\left(\frac{1}{N^*}\right)\left[\sum_{c=20}^{42}(\varepsilon_{c3}-\tau\varepsilon_{c2})(\varepsilon_{c3}-\tau\varepsilon_{c2})^T+\sum_{c=20}^{42}(\varepsilon_{c4}-\tau\varepsilon_{c3})(\varepsilon_{c4}-\tau\varepsilon_{c3})^T+\sum_{c=22}^{42}(\varepsilon_{c5}-\tau\varepsilon_{c4})(\varepsilon_{c5}-\tau\varepsilon_{c4})^T\right]$$

. (38)

Defining $df_{ct}(\theta)/d\theta^T$ as the first-order derivative of the functional form of the Florida PI model at time t with respect to parameter θ (θ is a vector of α, β, and ϕ), the first-order derivatives of the concentrated likelihood function with respect to θ and τ are as follows:

$$\frac{dL^*}{d\theta}=(1-\tau^2)\sum_{c=1}^{42}\left[\frac{df_{c1}(\theta)}{d\theta^T}\right]R(\theta,\tau)^{-1}\varepsilon_{c1}+\sum_{c=12}^{42}\left[\frac{df_{c2}(\theta)}{d\theta^T}-\tau\frac{df_{c1}(\theta)}{d\theta^T}\right]R(\theta,\tau)^{-1}(\varepsilon_{c2}-\tau\varepsilon_{c1})$$
$$+\sum_{c=20}^{42}\left[\frac{df_{c3}(\theta)}{d\theta^T}-\tau\frac{df_{c2}(\theta)}{d\theta^T}\right]R(\theta,\tau)^{-1}(\varepsilon_{c3}-\tau\varepsilon_{c2})+\sum_{c=20}^{42}\left[\frac{df_{c4}(\theta)}{d\theta^T}-\tau\frac{df_{c3}(\theta)}{d\theta^T}\right]R(\theta,\tau)^{-1}(\varepsilon_{c4}-\tau\varepsilon_{c3})$$

$$+\sum_{c=22}^{42}\left[\frac{df_{c5}(\theta)}{d\theta^T}-\tau\frac{df_{c4}(\theta)}{d\theta^T}\right]R(\theta,\tau)^{-1}(\varepsilon_{c5}-\tau\varepsilon_{c4})\,, \tag{39}$$

$$\frac{dL^*}{d\tau}=\frac{-(n-1)N\tau}{1-\tau^2}+\tau\sum_{c=1}^{42}\varepsilon_{c1}^T R(\theta,\tau)^{-1}\varepsilon_{c1}+\sum_{c=12}^{42}\varepsilon_{c1}^T R(\theta,\tau)^{-1}(\varepsilon_{c2}-\tau\varepsilon_{c1})$$
$$+\sum_{c=20}^{42}\varepsilon_{c2}^T R(\theta,\tau)^{-1}(\varepsilon_{c3}-\tau\varepsilon_{c2})+\sum_{c=20}^{42}\varepsilon_{c3}^T R(\theta,\tau)^{-1}(\varepsilon_{c4}-\tau\varepsilon_{c3})+\sum_{c=22}^{42}\varepsilon_{c4}^T R(\theta,\tau)^{-1}(\varepsilon_{c5}-\tau\varepsilon_{c4})\,. \tag{40}$$

Define H as the Hessian of the concentrated log-likelihood function with respect to θ and τ. Therefore, the matrix of the second-order derivative or the Hessian of the concentrated log-likelihood function with respect to θ and τ takes the form

$$H=\begin{bmatrix}\frac{d^2L^*}{d\theta d\theta^T} & \frac{d^2L^*}{d\theta d\tau}\\ \frac{d^2L^*}{d\theta d\tau} & \frac{d^2L^*}{d\tau^2}\end{bmatrix}. \tag{41}$$

The estimated asymptotic covariance matrix of the maximum likelihood estimators ($\hat{\theta}$ and $\hat{\tau}$) can be derived by taking negative value of the inverse of the expectation of the Hessian matrix. In other words, the estimated asymptotic covariance matrix of the maximum likelihood estimators is

$$-[E(H)]^{-1}=-\begin{bmatrix}E\left(\frac{d^2L^*}{d\theta d\theta^T}\right) & E\left(\frac{d^2L^*}{d\theta d\tau}\right)\\ E\left(\frac{d^2L^*}{d\theta d\tau}\right) & E\left(\frac{d^2L^*}{d\tau^2}\right)\end{bmatrix}^{-1}. \tag{42}$$

Recall that the error terms have zero expectation, therefore the expectation of the second-order derivatives of the concentrated log-likelihood function with respect to θ and τ or $E\left(d^2L^*/d\theta d\tau\right)$ equal zero. As such, the estimated asymptotic covariance matrix of the maximum likelihood estimators can be simplified as

$$-[E(H)]^{-1}=-\begin{bmatrix} E\left(\dfrac{d^2L^*}{d\theta d\theta^T}\right) & 0 \\ 0 & E\left(\dfrac{d^2L^*}{d\tau^2}\right)\end{bmatrix}^{-1}, \tag{43}$$

where

$$E\left(\frac{d^2L^*}{d\theta d\theta^T}\right)=-(1-\tau^2)\sum_{c=1}^{42}\left[\frac{df_{c1}(\theta)}{d\theta^T}\right]R(\theta,\tau)^{-1}\left[\frac{df_{c1}(\theta)}{d\theta^T}\right]$$
$$-\sum_{c=12}^{42}\left[\frac{df_{c2}(\theta)}{d\theta^T}-\tau\frac{df_{c1}(\theta)}{d\theta^T}\right]R(\theta,\tau)^{-1}\left[\frac{df_{c2}(\theta)}{d\theta^T}-\tau\frac{df_{c1}(\theta)}{d\theta^T}\right]$$
$$-\sum_{c=20}^{42}\left[\frac{df_{c3}(\theta)}{d\theta^T}-\tau\frac{df_{c2}(\theta)}{d\theta^T}\right]R(\theta,\tau)^{-1}\left[\frac{df_{c3}(\theta)}{d\theta^T}-\tau\frac{df_{c2}(\theta)}{d\theta^T}\right]$$
$$-\sum_{c=20}^{42}\left[\frac{df_{c4}(\theta)}{d\theta^T}-\tau\frac{df_{c3}(\theta)}{d\theta^T}\right]R(\theta,\tau)^{-1}\left[\frac{df_{c4}(\theta)}{d\theta^T}-\tau\frac{df_{c3}(\theta)}{d\theta^T}\right]$$
$$-\sum_{c=22}^{42}\left[\frac{df_{c5}(\theta)}{d\theta^T}-\tau\frac{df_{c4}(\theta)}{d\theta^T}\right]R(\theta,\tau)^{-1}\left[\frac{df_{c5}(\theta)}{d\theta^T}-\tau\frac{df_{c4}(\theta)}{d\theta^T}\right], \text{ and} \tag{44}$$

$$E\left(\frac{d^2L^*}{d\tau^2}\right)=-\left(\frac{(n-1)N(1+\tau^2)}{(1-\tau^2)^2}\right). \tag{45}$$

The asymptotic standard errors of the maximum likelihood estimators are simply the square root of the diagonal elements of equation 43.

Maximum Likelihood Procedure for the Florida Slutsky Model

The Florida Slutsky model from equation (14) can be rewritten in terms of a conditional demand system for item $i = 1,\ldots, n\text{-}1$ within group S_g as

$$w_{ic}^*=\alpha_i+\beta_i q_{gc}+(\alpha_i+\beta_i q_{gc})\left[x_{ic}-\sum_{j=1}^{n-1}(\alpha_j+\beta_j q_{gc})x_{jc}\right]+\sum_{j=1}^{n-1}\pi_{ij}^* x_{jc}+\varepsilon_{ic}\ , \tag{46}$$

where $w_{ic}^*=w_{ic}/W_{gc}$ is the conditional budget share of good $i\in S_g$ in country *c* given group expenditure; w_{ic} is the unconditional budget share of good $i\in S_g$ in country *c;* W_{gc} is the group budget share in country *c*;, $q_{gc}=\log Q_{gc}$ is the natural logarithm of total real group expenditure of country c, π_{ij}^* is the conditional Slutsky price parameter, and $x_{ic} = \log(p_{ic}/\overline{p}_i) - \log(p_{nc}/\overline{p}_n)$ for $i, j \in S_g$.

In matrix notation, the Florida Slutsky model for i = 1,…, n-1 takes the form

$$w_c^* = f_c^*(\theta) + \varepsilon_c, \qquad (47)$$

where θ is the parameter vector that consists of n-1 elements of subvector α, n-1 elements of subvector β, and subvector π^*. Note that subvector π^* has been transformed from a $(n-1)\times(n-1)$ matrix. The terms w_c^* and ε_c are column vectors of n-1 elements. It is noted that $f_c^*(\theta)$ is defined as

$$f_c^*(\theta) = \alpha + q_{gc}\beta + X_c(\alpha + q_{gc}\beta) - (\alpha + q_{gc}\beta)x_c^T(\alpha + q_{gc}\beta) + X_d\pi^*, \qquad (48)$$

where X_c is the diagonal matrix of order n-1 with x_{ic} as the ith diagonal element, and x_c is the column vector (x_c^T is its transpose) with x_{ic} as its ith element ($i \in S_g$ and i = 1,…, n-1). The term X_d is constructed to ensure the imposition of the symmetry restriction on the conditional Slutsky price matrix (π^*).

For c = 1,…, N and $\varepsilon_c \sim N(0, \Sigma)$, the log-likelihood function is

$$L = \text{constant} + \frac{1}{2}N\log\left|\Sigma^{-1}\right| - \frac{1}{2}\sum_{c=1}^{N}[w_c^* - f_c^*(\theta)]^T\Sigma^{-1}[w_c^* - f_c^*(\theta)] \qquad (49)$$

where N is the number of countries. The unknown parameters are θ and Σ. The concentrated log-likelihood function can be derived by calculating the first-order derivatives of the log-likelihood function with respect to Σ, given θ, and setting the equation to zero. Let $R(\theta)$ be the solution for Σ as a function of θ, thus

$$R(\theta) = \frac{1}{N}\sum_{c=1}^{N}[w_c^* - f_c^*(\theta)][w_c^* - f_c^*(\theta)]^T . \tag{50}$$

Substituting $R(\theta)$ for Σ in the log-likelihood function gives the concentrated log-likelihood function. The concentrated log-likelihood function is

$$L^* = \text{constant} + \frac{1}{2} N \log\left|R(\theta)^{-1}\right| . \tag{51}$$

The first-order derivatives of L^* with respect to θ are

$$\frac{dL^*}{d\theta} = \sum_{c=1}^{N}\left[\frac{df_c^*(\theta)}{d\theta^T}\right]^T R(\theta)^{-1}[w_c^* - f_c^*(\theta)], \tag{52}$$

where $df_c^*(\theta)/d\theta^T$ consists of three submatrices:

$$\frac{df_c^*(\theta)}{d\alpha^T} = A, \tag{53}$$

$$\frac{df_c^*(\theta)}{d\beta^T} = q_c A, \text{ and} \tag{54}$$

$$\frac{df_c^*(\theta)}{d\pi^*} = X_d , \tag{55}$$

where $A = X_c - (\alpha + q_{gc}\beta)x_c^T + [1 - (\alpha + q_{gc}\beta)^T x_c] I_{n-1}$, and $I_{n\text{-}1}$ is the identity matrix of order n-1.

The Hessian matrix or the second-order derivatives of L^* with respect to θ is

$$\frac{d^2 L^*}{d\theta d\theta^T} = K(\theta) + J(\theta), \text{ where} \tag{56}$$

$$K(\theta) = -\sum_{c=1}^{N}\left[\frac{df_c^*(\theta)}{d\theta^T}\right]^T R(\theta)^{-1}\left[\frac{df_c^*(\theta)}{d\theta^T}\right], \text{ and} \tag{57}$$

$J(\theta)$ is a matrix that is linear in $w_c^* - f_c^*(\theta)$ for $c = 1,\ldots, N$. The asymptotic covariance matrix of the maximum likelihood estimator of θ is equal to minus the inverse of the expectation of the second derivatives of L^* with respect to θ. Because $J(\theta)$ has zero expectation, and $K(\theta)$ is nonrandom, the asymptotic covariance matrix of the maximum likelihood estimator of θ is $-K(\theta)^{-1}$. The maximum likelihood estimates $\hat{\theta}$ can be obtained by using the method of scoring. The asymptotic standard errors are the square root of the diagonal elements of the asymptotic covariance matrix.

AR(1) process and AR(1) corrected ML estimator

Parameters are estimated using the AR(1) corrected ML procedure described above. The general form with AR(1) of the Florida Slutsky model at time t (for good $i = 1,\ldots, n$-1 and $i \in S_g$) can be written as

$$w_{ct}^* = f_{ct}^*(\theta) + \varepsilon_{ct}, \text{ and} \tag{58}$$

$$\varepsilon_{ct} = \tau\varepsilon_{c,t-1} + \nu_{ct}, \tag{59}$$

where subscript t indicates different reference years or phases (i.e., t = 1, 2, 3, 4, or 5 for reference years 1985, 1990, 1993, 1996, or 1999, respectively); w_{ct}^* is the conditional budget share of country c at time t, given food expenditure; $f_{ct}^*(\theta)$ is a conditional functional form of the Florida Slutsky model at time t (equation (48)); θ is the parameter vector that consists of n-1 elements of subvector α, n-1 elements of subvector β, and subvector π^*; ε_{ct} is the disturbance term of country c at time t; ν_{ct} is independent, identically distributed $N(0, \Sigma_\nu)$; and $-1 < \tau < 1$. Given the relationships in equations (58) and (59), we form the covariance matrix of ε_c when country c participates in h phases (Ω_h), where h equals 1, 2, 4, or 5. The term Ω_h is used to formulate the concentrated AR(1) corrected log-likelihood function (equation (52)). Finally, the first- and second-order derivatives of the concentrated AR(1) corrected log-likelihood function are used as part of an updating process in the method of scoring to estimate the unknown parameters.

Multi-Stage Budgeting

Given the budget constraint, consumers allocate their income through a multi-stage budgeting procedure (Barten, 1977). Our study will focus on the two-stage budgeting process. In the first stage, consumers allocate total expenditure among broad consumption groups under the separability condition of block independence (Theil, Chung, and Seale, 1989, p. 130-132). In the second stage, group expenditures are allocated among individual commodities within the group under weak separability conditions. Conditional elasticities calculated from parameter estimates of the second stage estimation of the food group will be combined with the food group elasticities in order to calculate unconditional elasticities for the food subcategory items.

Estimation Procedure for Broad Consumption Groups

Prior to estimation of final parameter estimates for the individual years, outlier countries are identified by simple plots of Workings (1943) model for food and by calculation of information inaccuracy measure and Stroebel measures (Stroebel, 1982; Seale and Regmi, 2006). The analyses indicate that Turkey is an outlier country in 1985, 1993, and 1996. The Strobel measures reveal that medical care is the major source of the lack of fit. In 1990, although the information inaccuracy measure did not identify Turkey as an outliers, a is less than 0.10, a scatter plot of Working's model (1943), that is, between the budget share of food, beverages, and tobacco and the natural logarithm of real income per capita (Figure 3) suggests that Turkey is an outlier and be omitted from the final parameter estimation. In 1999, Malta is the only outlying observation with its approximate information inaccuracy measure equal to 0.15 (1,454 out of

10,000). The gross rent, fuel, and power category as well as the other expenditures category are the major sources of lack of fit.

The Florida PI model is refitted to the data of the individual years and the pooled data after omitting the outliers. Parameter estimates are estimated with ML based on the procedures discussed above using the method of scoring (Harvey, 1990, p. 134-135). To allow for preference or taste persistence over time in the pooled data, we extend the likelihood function to allow for first-order autocorrelation of the error terms, and we also estimate the pooled parameters with ML using the method of scoring. We call this estimation procedure the first-order-autoregressive-maximum-likelihood estimator (AR(1) MLE). The resulting parameter estimates with associated asymptotic standard errors are reported in Table 4.

The β coefficient is a quick indicator of whether a particular category is a necessity, a luxury, or has unitary income elasticity. A negative β coefficient indicates that a particular category is a necessity. Conversely, a particular category is a luxury when its β coefficient is positive. A unitary income elasticity is obtained when the β coefficient equals zero. Overall, parameter estimates indicate that the food, beverages, and tobacco, and the clothing and footwear categories are necessities in every round. The β coefficient for food, beverages, and tobacco ranges from -0.189 in 1985 to -0.105 in 1996, while the β coefficient for clothing and footwear ranges from -0.016 in 1985 to -0.002 in 1999.

Prior to fitting the Florida PI model to the pooled data, real incomes per capita of the pooled data are converted to 1999 dollars using the consumer price index. We normalize such that the consumer price index of the United States in 1999 equals one. The resulting parameter estimates with associated asymptotic standard errors are reported in the last two column of Table 4. In most cases, pooled estimates fall within the values of the estimates obtained from the individual phases (Table 4). For instance, the β coefficient of the demand for food, beverages, and tobacco, obtained by fitting the Florida PI model to each round of data individually, ranges from -0.189 in 1985 to -0.105 in 1996, while the β coefficient of the demand for food, beverages, and tobacco, obtained by fitting the Florida PI model to the pooled data, equals -0.115. Similarly, the β coefficient of the demand for medical care, obtained by fitting the Florida PI model to each round of data individually, ranges from 0.019 in 1999 to 0.113 in 1993, while the β coefficient of the demand for medical care, obtained by fitting the Florida PI model to pooled data, equals 0.037.

The negative and statistically significant β parameter estimate of food, beverages, and tobacco indicates that this category is a necessity. While the β parameter estimates of the clothing and footwear; and gross rent, fuel, and power categories are negative, these estimates are not statistically different from zero indicating unitary elasticities. All other β parameter estimates are positive indicating that these categories are luxuries. The autoregressive parameter equals 0.410 and is statistically different from zero (α = .05). The pooled parameter estimates for food, beverages and tobacco will be used later to calculate income and own-price elasticities for the category food, beverages and tobacco. Additionally, they will be combined with the parameter estimates of the eight food subcategories to calculate unconditional income and own-price elasticities for these subcategories.

Estimation Procedure for the Food Subcategories

In a two-stage budgeting process, consumers allocate group expenditures among the commodities within each group. In this paper, we focus on the allocation of food, beverage and tobacco expenditure among eight subcategories of food: cereals and bread; meat and fish; fats and oil; fruit and vegetables; other foods; beverages and tobacco; and food consumed away from home. Specifically, the Florida Slutsky model is fitted to each round of the OECD data for the eight disaggregated food, beverages, and tobacco categories. These parameters and associated asymptotic standard errors are estimate with ML using the procedures discussed above and the method of scoring. The results are reported in Table 5. As with the Florida PI model, the sign (and significance) of the β coefficient indicates whether a particular food item is conditionally expenditure elastic or inelastic. A negative β coefficient indicates that a particular food item is conditionally income inelastic, while a positive β coefficient indicates that a particular food item is conditionally income elastic. Our results suggest that the cereals and bread and the fats and oil subgroups are conditionally income inelastic food items in every round. The β coefficient of the demand for cereals and bread ranges from -0.100 in 1985 to -0.039 in 1990, while β coefficient of the demand for fats and oil ranges from -0.051 in 1985 to -0.008 in 1993. Food consumed away from home is a conditionally expenditure elastic food item in every round. The β coefficient of the demand for food away from home ranges from 0.161 in 1999 to 0.333 in 1985. The diagonal of the Slutsky coefficients of the demand for all food items are also with the correct negative signs.

As with the aggregate categories, real food expenditures per capita of the pooled data are converted to the 1999 dollars using consumer price index. We normalize such that the consumer price index of the United States in 1999 equals one. Our pooled estimates show that two of the food subgroups (i.e., beverages and tobacco and food away from home) are conditionally income elastic. The β coefficients for beverages and tobacco and food away from home equal 0.005 and 0.135, respectively. The rest of the food subgroups (i.e., cereals and bread; meat and fish; dairy; fats and oil; fruit and vegetables; and other foods) have negative β coefficients, indicating that they are conditionally income inelastic. In most cases, pooled estimates for eight food subgroups fall within the values of the estimates obtained from the individual phases (Table 5). For instance, the β coefficient of the demand for cereals and bread, obtained by fitting the Florida Slutsky model to each round of data individually, ranges between -0.100 in 1985 and -0.039 in 1990, while the β coefficient of the demand for cereals and bread, obtained by fitting the Florida Slutsky model to the pooled data, equals -0.046. The diagonal of the Slutsky coefficients of the demand for all food items are also with the correct negative signs. The autoregressive parameter equals 0.842 and is statistically different from zero (α=.05). These pooled estimates are used in the following subsections to obtain income and own-price elasticities for the pooled data.

Income and Price Sensitivity

In this section, unconditional income and own-price elasticities of demand for food, beverage and tobacco category are calculated and reported as well as unconditional income and own-price elasticities of demand for the eight food subcategories. In all cases, elasticities are calculated using parameter estimates of the pooled data at observed real income per capita and at the geometric mean prices. This means that the budget share of good *i* for country *c* will be represented by $\tilde{w}_{ic}$.

Group Income and Own-Price Elasticities

First, rewrite the Florida PI model to indicate group demand for the nine broad categories. In this case the model may be written as

$$w_{gc} = \alpha_g + \beta_g q_c + (\alpha_g + \beta_g q_c)\left[\log\left(\frac{p_{gc}}{\bar{p}_g}\right) - \sum_{h=1}^{G}(\alpha_h + \beta_h q_c)\log\left(\frac{p_{hc}}{\bar{p}_h}\right)\right]$$

$$+\phi(\alpha_g + \beta_g q_c^*)\left[\log\left(\frac{p_{gc}}{\bar{p}_g}\right) - \sum_{h=1}^{G}(\alpha_h + \beta_h q_c^*)\log\left(\frac{p_{hc}}{\bar{p}_h}\right)\right] + \varepsilon_{gc}, \qquad (60)$$

where W_g is the group budget share,

$$W_g = \sum_{i \in S_g} w_i \ . \tag{61}$$

Denote the group marginal share as

$$\Theta_g = \sum_{i \in S_g} \theta_i \tag{62}$$

where w_i and θ_i are the budget share and marginal share of good i within group S_g, respectively.

The income elasticity for the group measure the percent change in the quantity demanded of group g when total real expenditure changes by 1%. The group income elasticity for the Florida PI model can be expressed as

$$\eta_g^U = \frac{\Theta_g}{\tilde{W}_g} = 1 + \frac{\beta_g}{\tilde{W}_g} \tag{63}$$

where $\tilde{W}_g = \alpha_g + \beta_g q_c$ being measure at geometric mean prices.

The Frisch own-price elasticity is the own-price elasticity when there is an income compensation that keeps the marginal utility of income constant. This is simply the elasticity with respect to the Frisch-deflated price of group *g*. The group Frisch own-price elasticity for the Florida PI model can be expressed as

$$F_{gg}^U = \phi \frac{\Theta_g}{\tilde{W}_g} = \phi \eta_g^U \ . \tag{64}$$

The group Slutsky own-price elasticity measures the percent change in the demand of group *g* when its price changes by 1% while real income remains unchanged. The group Slutsky own-price elasticity for the Florida PI model is

$$S_{PI} = \frac{\phi \Theta_g (1 - \Theta_g)}{\tilde{W}_{gc}} = \frac{\phi(\tilde{W}_{gc} + \beta_g)(1 - \tilde{W}_{gc} - \beta_g)}{\tilde{W}_{gc}} \ . \tag{65}$$

The Cournot own-price elasticity measures the percent change in the demand of group *g* when its price changes by 1% while nominal income remains unchanged but real income changes. The group Cournot own-price elasticity for the Florida PI model as

$$C_{PI} = \frac{\phi\Theta_g(1-\Theta_g)}{\tilde{W}_{gc}} - \Theta_g = \frac{\phi(\tilde{W}_{gc}+\beta_g)(1-\tilde{W}_{gc}-\beta_g)}{\tilde{W}_{gc}} - (\tilde{W}_{gc}+\beta_g)\,. \tag{66}$$

Note that the first term of the Cournot own-price elasticity is simply the Slutsky own-price elasticity. As a result, the Cournot own-price elasticity of the Florida PI model is the difference between its Slutsky own-price elasticity and the marginal share of good *i*.

Stage-two Income and Own-Price Elasticities

The Florida Slutsky model written in conditional form is

$$w_{ic}^* = \alpha_i^* + \beta_i^* q_{gc} + (\alpha_i^* + \beta_i^* q_{gc})\left[\log\left(\frac{p_{i\in S_g,c}}{\bar{p}_{i\in S_g}}\right) - \sum_{j\in S_g}(\alpha_j^* + \beta_j^* q_{gc})\log\left(\frac{p_{jc}}{\bar{p}_j}\right)\right]$$
$$+ \sum_{j\in S_g}\pi_{ij}^* \log\left(\frac{p_{jc}}{\bar{p}_j}\right) + \varepsilon_{ic}^*\ , \tag{67}$$

where $w_{ic}^* = w_{ic}/W_{gc}$ is the conditional budget share of good $i \in S_g$, q_{gc} is the log of real expenditure on group S_g, and α_i^*, β_i^*, and π_{ij}^* are conditional parameters to be estimated where π_{ij}^* are conditional Slutsky (compensated) price parameters.

The conditional income elasticity measures the percent change in quantity demand of good $i \in S_g$ when group expenditure changes by 1% while the unconditional one measure the percent the percent change in quantity demand of good i when total expenditure changes by 1%. The conditional income elasticity of the conditional Florida Slutsky model is

$$\eta_{ic}^{C} = \frac{\theta_{ic}^{*}}{\tilde{w}_{ic}^{*}} = 1 + \frac{\beta_{i}^{*}}{\tilde{w}_{ic}^{*}}. \tag{68}$$

while the unconditional income elasticity is

$$\eta_{ic}^{U} = \frac{\theta_{ic}^{*}}{\tilde{w}_{ic}^{*}} \frac{\Theta_{gc}}{\tilde{W}_{gc}}. \tag{69}$$

This is simply the product of the conditional income elasticity ($\theta_{ic}^{*} / \tilde{w}_{ic}^{*}$) and the group income elasticity ($\Theta_{gc} / \tilde{W}_{gc}$).

Own-price elasticities obtained from the Florida Slutsky model are the conditional own-price elasticities, measuring a percentage change in quantity demanded from a one percentage change in its own price given group expenditure. Three types of own-price elasticities of demand are discussed as follows. For simplicity, we ignore the country subscript *c*.

Given food expenditure, the Frisch own-price elasticity is defined as the own-price elasticity when there is an income compensation that keeps the marginal utility of income constant. This is simply the elasticity with respect to the Frisch-deflated price of good *i*. The conditional Frisch own-price elasticity for the Florida Slutsky model can be expressed as

$$F_{Slutsky}^{C} = \frac{\phi_{g} \theta_{ii}^{*}}{w_{i}^{*}}, \tag{70}$$

where ϕ_g is the Frisch group own-price elasticity of group g calculated from the parameters of group g in the first state; $\theta_{ii}^{*} = \theta_{ii} / \Theta_{g}$ (Θ_g is the group marginal share); and $w_{i}^{*} = w_{i} / W_{g}$ is the conditional budget share of good *i* (for $i \in S_g$) given group expenditure. The unconditional Frisch own-price elasticity of the disaggregated good *i* ($i \in S_g$) is

$$F_{Slutsky}^{U} = \phi \frac{\theta_{i}^{*}}{w_{i}^{*}} \frac{\Theta_{g}}{W_{g}} = \phi \eta_{i}^{U}, \tag{71}$$

where ϕ is the income flexibility obtained from the parameter estimation in the first stage, and $\eta_i^U = \theta_i / w_i$ is the unconditional income elasticity of the disaggregated good *i* (for $i \in S_g$).

Given group expenditure, the Slutsky own-price elasticity measures the change in demand of good *i* when its price changes while real group expenditure remains unchanged. The conditional Slutsky own-price elasticity for the Florida Slutsky model is

$$S_{Slutsky}^C = \frac{\pi_{ii}^*}{w_i^*}, \tag{72}$$

where π_{ii}^* is the conditional Slutsky price parameter, and w_i^* is the conditional budget share of good *i* (for $i \in S_g$) given group expenditure. The unconditional Slutsky own-price elasticity of the disaggregated good *i* is

$$S_{Slutsky}^U = \phi \frac{\theta_i^*}{w_i^*} \frac{\Theta_g}{W_g} \frac{\theta_i^*}{\Theta_g} \left(1 - \Theta_g\right) + \frac{\pi_{ii}^*}{w_i^*}. \tag{73}$$

Rearranging the first term of Equation 6.28 gives

$$S_{Slutsky}^U = \phi \frac{\theta_i^*}{w_i^*} \frac{\Theta_g}{W_g} \frac{\theta_i^*}{w_i^*} \frac{w_i^*}{\Theta_g} \left(1 - \Theta_g\right) + \frac{\pi_{ii}^*}{w_i^*}. \tag{74}$$

Using $\eta_i^G = \Theta_g / W_g$ and $\eta_i^C = \theta_i^* / w_i^*$, we can rewrite Equation 6.29 as

$$S_{Slutsky}^U = \phi \eta_i^C \eta_i^C \frac{w_i^*}{W_g} \left(1 - \eta_i^G W_g\right) + \frac{\pi_{ii}^*}{w_i^*}. \tag{75}$$

Given group expenditure, the Cournot own-price elasticity measures the change in demand of good *i* when its price changes while nominal group expenditure remains unchanged. The conditional Cournot own-price elasticity is

$$C_{Slutsky}^C = \frac{\pi_{ii}^*}{w_i^*} - \theta_i^*. \tag{76}$$

Note that the conditional Cournot own-price elasticity of the Florida Slutsky model is simply the difference between its conditional Slutsky own-price elasticity and the conditional marginal share of good *i*.

The unconditional Cournot own-price elasticity of the disaggregated good *i* (for $i \in S_g$) is

$$C^U_{Slutsky} = \phi \frac{\theta^*_i}{w^*_i} \frac{\Theta_g}{W_g} \frac{\theta^*_i}{\Theta_g} \left(1 - \Theta_g\right) + \frac{\pi^*_{ii}}{w^*_i} - \frac{\theta^*_i \Theta_g}{W_g}. \qquad (77)$$

where the sum of the first two terms is the unconditional Slutsky own-price elasticity of disaggregated good *i*. The unconditional Cournot own-price elasticity of disaggregated good *i* (for $i \in S_g$) can be written as

$$C^U_{Slutsky} = S^U_{Slutsky} - \frac{\theta^*_i \Theta_g}{W_g} = S^U_{Slutsky} - \eta^U_i w^*_i, \qquad (78)$$

where $S^U_{Slutsky}$ is the unconditional Slutsky own-price elasticity of the disaggregated good; η^U_i is the unconditional income elasticity of the disaggregated good *i*; and w^*_i is the conditional budget share of good *i* (for $i \in S_g$) given the group expenditure.

Empirical Elasticities of Pooled Data

Unconditional income elasticities

Unconditional income elasticities by country for food, beverages and tobacco and the eight subcategories of food are calculated at the geometric mean prices based on the parameter estimates of the pooled data and are reported in Table 6. Countries are sorted by descending order of percentage shares of their total real income per capita with respect to that of the United States in 1999. There is no presence of inferior goods when the data are pooled. Of the nine broad categories of goods, the food, beverages, and tobacco category is the most income inelastic group with the smallest income elasticities. Income elasticities of the demand for food, beverages, and tobacco vary greatly from 0.40 for Luxembourg in 1999 to 0.73 for Ukraine in 1999. A pattern is noticeable. As real income decreases over the sample of countries, the income elasticity of demand for food, beverages and tobacco increase in size.

For the eight food subcategories, the unconditional income elasticity results show that most of the unconditional income elasticities are less than one indicating that these food subcategories, like the food aggregate category, are necessities (inelastic). The exception is food away from home for some lower income countries. On average, the fats and oil subgroup has the smallest unconditional income elasticities, while food away from home has the largest unconditional income elasticities. Negative unconditional income elasticities of the demand for fats and oil indicate that fats and oil is considered an inferior good for some higher income countries (such as Luxembourg in 1993, 1996, and 1999; the United States in 1996; Switzerland in 1999, and Cyprus in 1999), but it is a necessity for all other countries in the pooled sample. Overall, the unconditional income elasticities of the demand for fats and oil vary from -0.17 for Luxembourg in 1999 to 0.46 for Ukraine in 1999. On the other hand, food away from home becomes a luxury food item as we move from higher income to lower income countries. Unconditional income elasticities of the demand for food away from home are between 0.59 for Luxembourg in 1999 and 4.40 for Ukraine in 1999.

Own-Price Elasticity of Demand

While Frisch, Slutsky and Cournot own-price elasticities of demand are calculated for each country based on the pooled parameter estimates, only the Frish own-price elasticities are reported. The unconditional Frish own-price elasticites for the broad group food, beverages and tobacco and for the eight food subcategories are reported in Table 7. Countries are sorted by descending order of percentage shares of their real income per capita with respect to that of the

United States in 1999. The most own-price inelastic consumption broad category is food, beverages, and tobacco because of its smallest absolute value of own-price elasticities. The Frisch own-price elasticities of the demand for food, beverages, and tobacco are between -0.32 for Luxembourg in 1999 and -0.57 for Ukraine in 1999. As with the unconditional income elasticities of demand for food, beverages and tobacco, the Frish own-price elasticities increase absolutely when one travels from rich to poorer countries.

Figures 5.2 to 5.4 illustrate comparisons of own-price elasticities of the demand for food, beverages, and tobacco obtained from pooled estimates for each of the years. Overall, comparisons of the own-price elasticities show that the absolute values of the three own-price elasticities of the demand for food, beverages, and tobacco decrease between 1985 and 1996. However, in 1999, the absolute values of the own-price elasticities of the demand for food, beverages, and tobacco increase as compared to those of 1996 for most of the countries with higher real income per capita. In contrast, the absolute values of the own-price elasticities of the demand for food, beverages, and tobacco in 1999 decrease from the 1996 values for some countries with lower levels of real income per capita.

The unconditional Frisch own-price elasticities of the demand for food subgroups for the pooled data are also reported in Table 7. In the analysis of the demand for food subgroups, unconditional price elasticities measure percentage changes in demand for a particular food item for a one percentage change in food price, given total income. Countries were sorted by descending order of percentage shares of their real income per capita with respect to that of the United States in 1999. Unconditional Frisch own-price elasticities are obtained using the unconditional income elasticities of demand for food subgroups obtained from previous section and income flexibility (ϕ) estimated by fitting the Florida PI model to the pooled data in the first stage of the allocation process.

The absolute values of the unconditional Frisch own-price elasticities of the demand for seven food subgroups (cereals and bread, meat and fish, dairy, fats and oil, fruit and vegetables, other foods, and beverages and tobacco) are less than one (own-price inelastic) for all countries in all years. This indicates that a percentage increase on the price of these seven food subgroups will decrease its own demand by less than 1%. In contrast, the demand for food away from home has changed from an own-price inelastic food item to an own-price elastic food item as we move to countries with lower income levels. The unconditional Frisch own-price elasticities of the demand for food away from home are between -0.46 for Luxembourg in 1999 and -3.45 for Ukraine in 1999. On average, consumers are least responsive to price change of the demand for fats and oil, followed by cereals and bread, and fruit and vegetables. On the other hand, consumers are more responsive to price change of the demand for food away from home. It should be pointed out that in a few cases for the richest countries (such as Luxembourg in 1993, 1996, and 1999; the United States in 1996; Switzerland in 1999, and Cyprus in 1999), the unconditional Frisch own-price elasticities are positive for the fats and oil subgroup. This is because, for these rich countries, this category is found to be an inferior good.

Summary and Conclusions

The analysis of the average budget shares indicates that OECD consumers spend most of their total income on the demand for food, beverages, and tobacco, followed by gross rent, fuel, and power, and transport and communications. However, OECD consumers spend the least of their total income on the demand for medical care. By comparing the percentage share over time, the percentage share of food consumption has decreased during 1985-1993, while the percentage share of the demand for gross rent, fuel, and power has increased since 1985. Within the demand for food, beverages, and tobacco, our analysis shows that OECD consumers spend most of their food expenditure on the demand for food away from home. The least allocation of food expenditure is on the demand for fats and oil. Moreover, consumers have decreased their percentage share of food budget on the demand for meat and fish but have increased their percentage share on cereals and bread, beverages and tobacco, and food away from home. The percentage share of the demands for dairy, fruit and vegetables, and other foods have been stable over time. Overall, the results suggest that consumers are now shifting toward the consumption of cereals and bread, beverages and tobacco, and food away from home.

By pooling the cross-country and the time series data, most of the pooled estimates for the allocation of total food expenditure among food subgroups fall within parameter estimates obtained by fitting the Florida Slutsky model to each round of data individually. Estimated conditional income elasticities obtained from the pooled data show that beverages and tobacco and food away from home are conditionally income elastic food items. The rest of the food subgroups are conditionally income inelastic. Fats and oil is the most conditionally income inelastic food item, followed by cereals and bread. Dairy is the least conditionally income inelastic food item. Unconditional income elasticities can be obtained by using parameters estimated from the Florida PI model to convert the conditional income elasticities to their unconditional values. Our results show that, except for food away from home, the unconditional income elasticities of the demand for food subgroups are less than one. Food away from home shifts from being a necessity food item for higher income countries to being a luxury food item for lower income countries. Similarly, unconditional Frisch own-price elasticities suggest that the demand for food away from home becomes own-price elastic as we move from higher income to lower income countries.

Our findings are also comparable to other studies. For instance, Reimer and Hertel (2003) estimated a global demand system by fitting the AIDADS model to the 1996 ICP data. They reported income elasticity of the demand for ten consumption categories (i.e., grains and other crops; meat, dairy, and fish; processed food, beverages, and tobacco; apparel and footwear; rent and house utilities; home furnishings and appliances; medical products and services; transport and communications; recreation and education; and other goods and services). In their study, grains and other crops is comparable to the cereals and bread and the fruits and vegetable subgroups in our study, while processed food is comparable to the fats and oil and the other foods subgroups in our study. In addition, in our study, food includes both food consumed at home and food consumed away from home. Overall, their results showed that income elasticities of food items (such as grains and other crops; meat, dairy, and fish; and processed food, beverages, and tobacco) and apparel and footwear are significantly smaller than one, indicating that they are necessities. Additionally, their results suggested that the rest of the consumption categories, including rent and house utilities and recreation and education, are luxuries. In contrast, our 1996 results, obtained from the Florida PI model, indicate that rent and house utilities have unitary income elasticity and suggest that education is a necessity.

Although the OECD data used in our study are considered to be of high quality, the study is not without some limitations. First, data covered in our study are mainly from the developed parts of the world. With this in mind, although the study has provided evidence on consumption patterns up to the most present time, general conclusions on global food consumption patterns cannot be made. However, the availability of global data with comparable quality level in the future would make it possible for the in-depth analysis for global food consumption pattern over time.

Second, the complexity of the GK approach requires the use of special software to update the data once the outlier is removed. Past studies used the ICP Toolpak developed by the World Bank when working with the ICP data. Due to the absence of software designed specifically for the OECD data, the data updating process was not pursued in our study. Third, it is possible for the predicted budget shares calculated from our models to fall outside the [0,1] range. In addition, there exist some assumption violations through the presence of inferior goods in the first stage of the two-stage budgeting process. These assumption violation problems are resolved when data are pooled.

In conclusion, our analyses provide useful information on demand elasticities of the OECD data for the years 1985, 1990, 1993, 1996, and 1999, respectively. Additional information gained by pooling the data yields better and precise estimates that will best reflect changing consumption patterns. Similar studies with global consumption data will provide a broader spectrum for global consumption patterns. In addition, demand elasticities obtained from our study can be further used in the simulation models to determine policies' impact under different scenarios.

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Table 1. List of participating countries in the 1985, 1990, 1993, 1996, and 1999 rounds of the OECD PPP data

22 countries in 1985			24 countries Non-OECD Countries in 1990 and 1993		
OECD Countries		Non-OECD Countries	OECD Countries		Non-OECD Countries
EU Countries	Non-EU Countries		EU Countries	Non-EU Countries	
Belgium	Australia	—	Belgium	Australia	—
Denmark	Austria		Denmark	Austria	
France	Canada		France	Canada	
Germany	Finland		Germany	Finland	
Greece	Japan		Greece	Iceland	
Ireland	New Zealand		Ireland	Japan	
Italy	Norway		Italy	New Zealand	
Luxembourg	Sweden		Luxembourg	Norway	
Netherlands	Turkey		Netherlands	Sweden	
Portugal	United States		Portugal	Switzerland	
Spain			Spain	Turkey	
United Kingdom			United Kingdom	United States	

32 countries in 1996			43 countries in 1999		
OECD Countries		Non-OECD Countries	OECD Countries		Non-OECD Countries
EU Countries	Non-EU Countries		EU Countries	Non-EU Countries	
Austria	Australia	Israel	Austria	Australia	Bulgaria
Belgium	Canada	Russian Federation	Belgium	Canada	Croatia
Denmark	Czech Republic	Slovak Republic	Denmark	Czech Republic	Cyprus
Finland	Hungary	Slovenia	Finland	Hungary	Estonia
France	Iceland		France	Iceland	Israel
Germany	Japan		Germany	Japan	Latvia
Greece	Mexico		Greece	Korea	Lithuania
Ireland	New Zealand		Ireland	Mexico	Macedonia
Italy	Norway		Italy	New Zealand	Malta
Luxembourg	Poland		Luxembourg	Norway	Romania
Netherlands	Switzerland		Netherlands	Poland	Russian Federation
Portugal	Turkey		Portugal	Slovak Republic	Slovenia
Spain	United States		Spain	Switzerland	Ukraine
Sweden			Sweden	Turkey	
United Kingdom			United Kingdom	United States	

Sources: Ward, 1985; OECD, 1987; OECD, 1993; OECD, 2000; OECD, 2002

Table 2. Average budget shares for broad consumption groups from 1985 to 1999, by country group

Year	Country group	Food, beverages, and tobacco	Clothing and footwear	Gross rent, fuel, and power	House furnishings and operations	Medical care	Transport and communications	Recreation	Education	Other expenditures
1985	Higher income group	26%	7%	19%	7%	6%	14%	7%	9%	7%
	Lower income group	43%	8%	12%	7%	3%	13%	4%	6%	5%
1990	Higher income group	26%	7%	19%	7%	7%	15%	8%	9%	5%
	Lower income group	41%	8%	11%	7%	3%	13%	6%	6%	4%
1993	Higher income group	24%	6%	19%	7%	7%	14%	7%	8%	8%
	Lower income group	37%	7%	12%	7%	4%	13%	6%	6%	7%
1996	Higher income group	23%	6%	19%	7%	7%	14%	8%	9%	8%
	Lower income group	35%	7%	16%	6%	3%	12%	6%	8%	7%
1999	Higher income group	24%	6%	20%	7%	4%	15%	9%	7%	8%
	Lower income group	35%	6%	18%	5%	3%	14%	6%	7%	5%

Note: Percentage shares are rounded to the nearest integer values.

Table 3. Average conditional budget shares for food subgroups for higher and lower income countries, 1985-1999

Year	Country group	Cereals and Bread	Meat and Fish	Dairy	Fats and Oil	Fruit and Vegetables	Other Foods	Beverages and Tobacco	Food away from home
1985	Higher income group	8%	19%	8%	3%	10%	9%	19%	23%
	Lower income group	10%	24%	8%	5%	14%	5%	17%	17%
1990	Higher income group	9%	18%	9%	2%	10%	9%	19%	24%
	Lower income group	7%	24%	9%	3%	13%	6%	15%	24%
1993	Higher income group	9%	18%	8%	2%	10%	8%	19%	25%
	Lower income group	6%	19%	10%	3%	13%	7%	19%	25%
1996	Higher income group	9%	16%	8%	2%	10%	8%	20%	26%
	Lower income group	10%	19%	10%	3%	12%	10%	19%	16%
1999	Higher income group	9%	15%	7%	2%	9%	9%	22%	27%
	Lower income group	11%	20%	10%	3%	13%	10%	20%	13%

Note: Percentage shares are rounded to the nearest integer values.

Table 4. Parameter estimates for broad consumption groups, 1985 – 1999 and pooled.

Parameters/Consumption categories	1985		1990		1993		1996		1999		Pooled	
Income flexibility (ϕ)	-0.628	(0.060)	-0.601	(0.069)	-0.506	(0.073)	-0.698	(0.058)	-0.747	(0.036)	-0.783	(0.027)
Beta (β)												
Food, beverages, and tobacco	-0.189	(0.022)	-0.188	(0.025)	-0.180	(0.032)	-0.105	(0.014)	-0.107	(0.012)	-0.115	(0.008)
Clothing and footwear	-0.016	(0.007)	-0.011	(0.009)	-0.007	(0.009)	-0.012	(0.006)	-0.002	(0.004)	-0.003	(0.003)
Gross rent, fuel, and power	0.052	(0.022)	0.047	(0.024)	-0.003	(0.035)	0.001	(0.019)	-0.035	(0.014)	-0.007	(0.009)
House furnishings and operations	-0.004	(0.006)	0.001	(0.010)	0.013	(0.011)	0.015	(0.004)	0.017	(0.003)	0.014	(0.002)
Medical care	0.060	(0.020)	0.087	(0.025)	0.113	(0.028)	0.066	(0.019)	0.019	(0.009)	0.037	(0.007)
Transport and communications	0.019	(0.013)	0.016	(0.016)	0.003	(0.015)	0.023	(0.009)	0.018	(0.007)	0.012	(0.004)
Recreation	0.017	(0.011)	0.010	(0.015)	0.007	(0.014)	0.026	(0.007)	0.029	(0.004)	0.022	(0.003)
Education	0.021	(0.013)	0.012	(0.018)	0.000	(0.024)	-0.033	(0.018)	0.032	(0.010)	0.014	(0.006)
Other expenditures	0.041	(0.011)	0.027	(0.010)	0.055	(0.017)	0.019	(0.007)	0.030	(0.003)	0.026	(0.004)
Alpha (α)												
Food, beverages, and tobacco	0.188	(0.014)	0.201	(0.012)	0.178	(0.017)	0.195	(0.010)	0.203	(0.011)	0.200	(0.006)
Clothing and footwear	0.059	(0.005)	0.064	(0.005)	0.060	(0.005)	0.054	(0.005)	0.059	(0.004)	0.061	(0.002)
Gross rent, fuel, and power	0.201	(0.013)	0.195	(0.011)	0.182	(0.017)	0.186	(0.013)	0.162	(0.012)	0.178	(0.007)
House furnishings and operations	0.069	(0.004)	0.073	(0.005)	0.074	(0.005)	0.073	(0.003)	0.074	(0.004)	0.075	(0.002)
Medical care	0.083	(0.013)	0.095	(0.012)	0.113	(0.013)	0.099	(0.013)	0.054	(0.008)	0.076	(0.006)
Transport and communications	0.150	(0.009)	0.151	(0.008)	0.137	(0.008)	0.150	(0.007)	0.161	(0.007)	0.149	(0.004)
Recreation	0.073	(0.007)	0.078	(0.008)	0.075	(0.007)	0.088	(0.005)	0.101	(0.005)	0.088	(0.003)
Education	0.092	(0.008)	0.088	(0.008)	0.082	(0.010)	0.067	(0.010)	0.094	(0.008)	0.088	(0.004)
Other expenditures	0.086	(0.007)	0.055	(0.005)	0.098	(0.008)	0.088	(0.006)	0.092	(0.004)	0.085	(0.004)
Autoregressive (τ)	n.a.		n.a.		n.a.		n.a.		n.a.		0.396	(0.022)

Note: Asymptotic standard errors of the associated parameters are shown in parentheses.
n.a. represents not applicable.

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Table 5. Parameter estimates for food subgroups, 1985 – 1999 and pooled.

Parameters/food subgroups	1985		1990		1993		1996		1999		Pooled	
Beta (β)												
Cereals and bread	-0.100	(0.017)	-0.039	(0.045)	-0.078	(0.026)	-0.069	(0.015)	-0.045	(0.013)	-0.046	(0.010)
Meat and fish	-0.138	(0.040)	-0.160	(0.040)	0.007	(0.041)	-0.055	(0.017)	-0.061	(0.025)	-0.033	(0.013)
Dairy	0.016	(0.021)	-0.015	(0.035)	-0.002	(0.021)	-0.049	(0.011)	-0.042	(0.011)	-0.008	(0.007)
Fats and oil	-0.051	(0.011)	-0.037	(0.010)	-0.008	(0.006)	-0.013	(0.004)	-0.014	(0.005)	-0.021	(0.004)
Fruit and vegetables	-0.025	(0.020)	0.018	(0.042)	0.036	(0.034)	-0.025	(0.014)	-0.066	(0.011)	-0.022	(0.009)
Other foods	-0.003	(0.027)	0.008	(0.036)	-0.075	(0.030)	-0.045	(0.014)	-0.023	(0.012)	-0.011	(0.008)
Beverages and tobacco	-0.033	(0.061)	-0.095	(0.083)	-0.047	(0.068)	0.020	(0.032)	0.090	(0.022)	0.005	(0.020)
Food away from home	0.333	(0.083)	0.320	(0.094)	0.167	(0.098)	0.235	(0.043)	0.161	(0.035)	0.135	(0.028)
Alpha (α)												
Cereals and bread	0.047	(0.007)	0.074	(0.013)	0.071	(0.007)	0.064	(0.007)	0.081	(0.007)	0.071	(0.006)
Meat and fish	0.149	(0.016)	0.148	(0.012)	0.181	(0.011)	0.148	(0.009)	0.142	(0.016)	0.171	(0.009)
Dairy	0.089	(0.008)	0.084	(0.010)	0.081	(0.005)	0.063	(0.005)	0.063	(0.007)	0.090	(0.005)
Fats and oil	0.011	(0.005)	0.012	(0.003)	0.017	(0.001)	0.016	(0.002)	0.016	(0.004)	0.022	(0.003)
Fruit and vegetables	0.101	(0.008)	0.112	(0.012)	0.114	(0.009)	0.099	(0.007)	0.076	(0.006)	0.101	(0.006)
Other foods	0.085	(0.011)	0.088	(0.010)	0.063	(0.008)	0.068	(0.008)	0.081	(0.008)	0.095	(0.006)
Beverages and tobacco	0.171	(0.026)	0.156	(0.025)	0.181	(0.020)	0.211	(0.017)	0.257	(0.014)	0.196	(0.014)
Food away from home	0.347	(0.034)	0.326	(0.028)	0.292	(0.028)	0.333	(0.022)	0.284	(0.020)	0.253	(0.018)
Diagonal of π_{ij}												
Cereals and bread	-0.009	(0.028)	-0.099	(0.051)	-0.051	(0.028)	-0.024	(0.024)	-0.087	(0.019)	-0.012	(0.008)
Meat and fish	-0.160	(0.061)	-0.083	(0.029)	-0.134	(0.039)	-0.125	(0.026)	-0.122	(0.058)	-0.168	(0.008)
Dairy	-0.091	(0.022)	-0.105	(0.021)	-0.151	(0.021)	-0.081	(0.021)	-0.118	(0.019)	-0.125	(0.009)
Fats and oil	-0.008	(0.013)	-0.009	(0.005)	-0.012	(0.005)	-0.014	(0.005)	-0.005	(0.010)	-0.043	(0.004)
Fruit and vegetables	-0.216	(0.031)	-0.161	(0.039)	-0.125	(0.033)	-0.137	(0.024)	-0.091	(0.024)	-0.104	(0.008)
Other foods	-0.280	(0.036)	-0.127	(0.024)	-0.117	(0.028)	-0.078	(0.026)	-0.083	(0.024)	-0.145	(0.009)
Beverages and tobacco	-0.031	(0.047)	-0.112	(0.054)	-0.080	(0.048)	-0.119	(0.042)	-0.002	(0.039)	-0.061	(0.005)
Food away from home	-0.245	(0.123)	-0.391	(0.088)	-0.341	(0.102)	-0.200	(0.047)	-0.145	(0.055)	-0.174	(0.006)
Autoregressive (τ)	n.a.		n.a.		n.a.		n.a.		n.a.		0.842	(0.013)

Note: Asymptotic standard errors of the associated parameters are shown in parentheses.
n.a. represents not applicable

Table 6. Unconditional income elasticities for food and food subgroups, pooled data

Country	Year	Food, beverages, and tobacco	Cereals and Bread	Meat and Fish	Dairy	Fats and Oil	Fruit and Vegetables	Other Foods	Beverages and Tobacco	Food away from home
Luxembourg	1999	0.40	0.07	0.32	0.37	-0.17	0.31	0.35	0.41	0.59
Luxembourg	1993	0.41	0.12	0.33	0.37	-0.04	0.32	0.36	0.42	0.61
United States	1996	0.41	0.13	0.33	0.37	-0.02	0.32	0.36	0.42	0.61
Luxembourg	1996	0.41	0.11	0.33	0.38	-0.08	0.32	0.36	0.42	0.61
United States	1993	0.42	0.15	0.34	0.38	0.01	0.33	0.37	0.43	0.64
United States	1999	0.43	0.15	0.34	0.39	0.02	0.33	0.37	0.44	0.65
Switzerland	1993	0.48	0.18	0.39	0.44	0.04	0.38	0.42	0.49	0.74
United States	1990	0.48	0.18	0.39	0.44	0.04	0.38	0.42	0.49	0.74
Switzerland	1996	0.49	0.17	0.39	0.44	0.01	0.38	0.43	0.50	0.74
United States	1985	0.49	0.18	0.40	0.45	0.04	0.39	0.43	0.50	0.76
Japan	1996	0.50	0.23	0.41	0.46	0.13	0.40	0.44	0.51	0.81
Switzerland	1999	0.50	0.17	0.40	0.46	-0.01	0.39	0.44	0.51	0.75
Belgium	1996	0.50	0.20	0.41	0.46	0.06	0.40	0.44	0.52	0.78
Belgium	1993	0.50	0.19	0.41	0.46	0.04	0.40	0.44	0.52	0.78
Japan	1993	0.51	0.22	0.41	0.46	0.11	0.40	0.45	0.52	0.81
Cyprus	1999	0.51	0.15	0.41	0.46	-0.07	0.39	0.44	0.52	0.76
Luxembourg	1990	0.51	0.21	0.41	0.46	0.09	0.40	0.45	0.52	0.80
Germany	1996	0.51	0.23	0.42	0.47	0.12	0.40	0.45	0.52	0.82
Canada	1996	0.51	0.21	0.42	0.47	0.08	0.41	0.45	0.53	0.81
Germany	1993	0.51	0.24	0.42	0.47	0.14	0.41	0.45	0.53	0.84
Canada	1993	0.51	0.23	0.42	0.47	0.11	0.41	0.45	0.53	0.83
Australia	1996	0.51	0.21	0.42	0.47	0.07	0.41	0.45	0.53	0.81
France	1993	0.51	0.22	0.42	0.47	0.10	0.41	0.45	0.53	0.82
Iceland	1996	0.52	0.22	0.42	0.47	0.09	0.41	0.46	0.53	0.82
Switzerland	1990	0.52	0.20	0.42	0.48	0.05	0.41	0.46	0.53	0.80

Note: Countries were sorted by real income per capita.

Table 6. Continued

Country	Year	Food, beverages, and tobacco	Cereals and Bread	Meat and Fish	Dairy	Fats and Oil	Fruit and Vegetables	Other Foods	Beverages and Tobacco	Food away from home
Austria	1999	0.52	0.21	0.42	0.48	0.07	0.41	0.46	0.53	0.81
Netherlands	1996	0.52	0.25	0.43	0.48	0.14	0.42	0.46	0.53	0.86
Italy	1993	0.52	0.21	0.42	0.48	0.08	0.41	0.46	0.54	0.82
Netherlands	1993	0.52	0.26	0.43	0.48	0.17	0.42	0.46	0.54	0.89
Austria	1993	0.52	0.21	0.43	0.48	0.08	0.41	0.46	0.54	0.82
Iceland	1999	0.52	0.21	0.43	0.48	0.08	0.41	0.46	0.54	0.82
Austria	1996	0.52	0.21	0.43	0.48	0.07	0.41	0.46	0.54	0.82
Italy	1999	0.52	0.22	0.43	0.48	0.09	0.42	0.46	0.54	0.83
Italy	1996	0.52	0.23	0.43	0.48	0.10	0.42	0.46	0.54	0.84
Denmark	1996	0.52	0.24	0.43	0.48	0.13	0.42	0.46	0.54	0.86
France	1996	0.53	0.22	0.43	0.48	0.09	0.42	0.47	0.54	0.84
Australia	1993	0.53	0.22	0.43	0.48	0.08	0.42	0.47	0.54	0.84
Italy	1990	0.54	0.21	0.44	0.49	0.06	0.42	0.47	0.55	0.84
Iceland	1993	0.54	0.24	0.44	0.49	0.13	0.43	0.47	0.55	0.87
Germany	1990	0.54	0.25	0.44	0.49	0.14	0.43	0.48	0.55	0.88
France	1990	0.54	0.24	0.44	0.49	0.12	0.43	0.48	0.55	0.87
Canada	1999	0.54	0.26	0.44	0.49	0.15	0.43	0.48	0.55	0.89
Canada	1985	0.54	0.26	0.44	0.50	0.15	0.43	0.48	0.56	0.89
United Kingdom	1996	0.54	0.24	0.44	0.50	0.12	0.43	0.48	0.56	0.87
Denmark	1999	0.54	0.24	0.44	0.50	0.11	0.43	0.48	0.56	0.87
United Kingdom	1993	0.54	0.23	0.44	0.50	0.10	0.43	0.48	0.56	0.86
Denmark	1993	0.54	0.25	0.44	0.50	0.14	0.43	0.48	0.56	0.89
Germany	1999	0.54	0.24	0.44	0.50	0.11	0.43	0.48	0.56	0.87
Australia	1999	0.55	0.24	0.44	0.50	0.11	0.43	0.48	0.56	0.87
Norway	1996	0.55	0.27	0.45	0.50	0.17	0.44	0.48	0.56	0.92

Note: Countries were sorted by real income per capita.

Table 6. Continued

Country	Year	Food, beverages, and tobacco	Cereals and Bread	Meat and Fish	Dairy	Fats and Oil	Fruit and Vegetables	Other Foods	Beverages and Tobacco	Food away from home
United Kingdom	1999	0.55	0.23	0.44	0.50	0.09	0.43	0.48	0.56	0.86
Norway	1999	0.55	0.26	0.45	0.50	0.16	0.44	0.48	0.56	0.91
Canada	1990	0.55	0.26	0.45	0.50	0.15	0.44	0.48	0.56	0.91
New Zealand	1996	0.55	0.23	0.45	0.50	0.09	0.43	0.48	0.56	0.87
Belgium	1990	0.55	0.24	0.45	0.50	0.12	0.44	0.49	0.57	0.89
Norway	1993	0.55	0.27	0.45	0.51	0.16	0.44	0.49	0.57	0.92
France	1999	0.55	0.24	0.45	0.51	0.12	0.44	0.49	0.57	0.89
Belgium	1999	0.55	0.26	0.45	0.51	0.14	0.44	0.49	0.57	0.90
Japan	1990	0.55	0.26	0.45	0.51	0.14	0.44	0.49	0.57	0.90
Netherlands	1999	0.56	0.26	0.46	0.51	0.15	0.44	0.49	0.57	0.91
Austria	1990	0.56	0.24	0.46	0.51	0.11	0.44	0.49	0.57	0.89
New Zealand	1993	0.56	0.26	0.46	0.51	0.15	0.45	0.49	0.57	0.92
Iceland	1990	0.56	0.27	0.46	0.51	0.16	0.45	0.49	0.57	0.93
United Kingdom	1990	0.56	0.23	0.46	0.51	0.09	0.44	0.49	0.58	0.89
Denmark	1990	0.56	0.28	0.46	0.52	0.18	0.45	0.50	0.58	0.95
Netherlands	1990	0.56	0.28	0.46	0.52	0.18	0.45	0.50	0.58	0.96
Luxembourg	1985	0.57	0.25	0.46	0.52	0.12	0.45	0.50	0.58	0.91
Spain	1996	0.57	0.20	0.46	0.52	0.01	0.44	0.50	0.58	0.86
Japan	1999	0.57	0.28	0.47	0.52	0.18	0.46	0.50	0.58	0.96
Israel	1996	0.57	0.29	0.47	0.52	0.19	0.46	0.50	0.58	0.97
Australia	1990	0.57	0.26	0.46	0.52	0.13	0.45	0.50	0.58	0.92
Sweden	1996	0.57	0.30	0.47	0.52	0.21	0.46	0.50	0.58	0.99
Sweden	1993	0.57	0.30	0.47	0.52	0.21	0.46	0.51	0.59	1.00
Spain	1999	0.57	0.20	0.46	0.52	0.00	0.45	0.50	0.59	0.87
Ireland	1999	0.57	0.23	0.46	0.52	0.08	0.45	0.50	0.59	0.90

Note: Countries were sorted by real income per capita.

Table 6. Continued

Country	Year	Food, beverages, and tobacco	Cereals and Bread	Meat and Fish	Dairy	Fats and Oil	Fruit and Vegetables	Other Foods	Beverages and Tobacco	Food away from home
New Zealand	1999	0.57	0.27	0.47	0.53	0.15	0.46	0.51	0.59	0.94
Sweden	1990	0.57	0.31	0.48	0.53	0.23	0.47	0.51	0.59	1.04
France	1985	0.58	0.25	0.47	0.53	0.12	0.46	0.51	0.59	0.92
Ireland	1996	0.58	0.27	0.47	0.53	0.14	0.46	0.51	0.59	0.94
Germany	1985	0.58	0.29	0.47	0.53	0.18	0.46	0.51	0.59	0.97
Sweden	1999	0.58	0.30	0.48	0.53	0.21	0.47	0.51	0.59	1.01
Finland	1996	0.58	0.30	0.48	0.53	0.20	0.47	0.51	0.59	0.99
Portugal	1996	0.58	0.23	0.47	0.53	0.06	0.46	0.51	0.59	0.90
Spain	1993	0.58	0.20	0.47	0.53	0.01	0.45	0.51	0.60	0.89
Greece	1999	0.58	0.24	0.47	0.53	0.09	0.46	0.51	0.60	0.91
Portugal	1999	0.58	0.27	0.48	0.53	0.14	0.46	0.51	0.60	0.95
Portugal	1993	0.58	0.22	0.47	0.53	0.05	0.46	0.51	0.60	0.90
Greece	1996	0.58	0.24	0.47	0.53	0.09	0.46	0.51	0.60	0.92
Finland	1993	0.58	0.30	0.48	0.53	0.21	0.47	0.52	0.60	1.01
Italy	1985	0.58	0.25	0.48	0.53	0.12	0.46	0.51	0.60	0.93
Australia	1985	0.58	0.26	0.48	0.53	0.14	0.46	0.51	0.60	0.95
Japan	1985	0.58	0.31	0.48	0.54	0.22	0.47	0.52	0.60	1.03
Belgium	1985	0.58	0.27	0.48	0.54	0.16	0.47	0.52	0.60	0.96
New Zealand	1990	0.59	0.30	0.48	0.54	0.20	0.47	0.52	0.60	1.00
Greece	1993	0.59	0.20	0.47	0.54	0.00	0.46	0.52	0.60	0.89
Netherlands	1985	0.59	0.30	0.49	0.54	0.20	0.47	0.52	0.61	1.01
Finland	1990	0.59	0.30	0.49	0.54	0.20	0.48	0.52	0.61	1.02
Finland	1999	0.59	0.28	0.48	0.54	0.17	0.47	0.52	0.61	0.98
Ireland	1993	0.59	0.28	0.48	0.54	0.16	0.47	0.52	0.61	0.97
Denmark	1985	0.59	0.30	0.49	0.55	0.20	0.48	0.53	0.61	1.01

Note: Countries were sorted by real income per capita.

Table 6. Continued

Country	Year	Food, beverages, and tobacco	Cereals and Bread	Meat and Fish	Dairy	Fats and Oil	Fruit and Vegetables	Other Foods	Beverages and Tobacco	Food away from home
Norway	1990	0.60	0.32	0.49	0.55	0.22	0.48	0.53	0.61	1.05
United Kingdom	1985	0.60	0.28	0.49	0.55	0.17	0.48	0.53	0.62	0.99
Israel	1999	0.60	0.31	0.50	0.55	0.22	0.48	0.53	0.62	1.04
New Zealand	1985	0.60	0.31	0.50	0.55	0.20	0.49	0.54	0.62	1.03
Sweden	1985	0.60	0.34	0.50	0.56	0.26	0.49	0.54	0.62	1.12
Spain	1990	0.61	0.26	0.49	0.55	0.11	0.48	0.53	0.62	0.96
Norway	1985	0.61	0.33	0.50	0.56	0.24	0.49	0.54	0.62	1.09
Austria	1985	0.61	0.29	0.50	0.56	0.17	0.48	0.54	0.62	1.00
Slovenia	1996	0.61	0.31	0.50	0.56	0.21	0.49	0.54	0.62	1.05
Slovenia	1999	0.62	0.32	0.51	0.57	0.23	0.50	0.55	0.63	1.08
Czech Republic	1996	0.62	0.33	0.51	0.57	0.23	0.50	0.55	0.64	1.09
Finland	1985	0.62	0.32	0.51	0.57	0.22	0.50	0.55	0.64	1.08
Spain	1985	0.62	0.29	0.51	0.57	0.15	0.50	0.55	0.64	1.02
Korea	1999	0.63	0.37	0.52	0.58	0.29	0.51	0.56	0.64	1.23
Czech Republic	1999	0.63	0.32	0.52	0.58	0.21	0.51	0.56	0.65	1.07
Portugal	1990	0.63	0.31	0.52	0.58	0.18	0.51	0.56	0.65	1.05
Ireland	1990	0.64	0.31	0.53	0.59	0.19	0.51	0.57	0.66	1.07
Greece	1990	0.64	0.31	0.53	0.59	0.20	0.52	0.57	0.66	1.08
Hungary	1996	0.65	0.38	0.54	0.60	0.31	0.53	0.58	0.67	1.29
Mexico	1996	0.66	0.37	0.55	0.60	0.29	0.53	0.58	0.67	1.23
Estonia	1999	0.66	0.38	0.55	0.60	0.30	0.54	0.58	0.67	1.28
Hungary	1999	0.66	0.38	0.55	0.60	0.30	0.54	0.58	0.68	1.27
Greece	1985	0.66	0.33	0.54	0.60	0.21	0.53	0.58	0.68	1.11
Slovak Republic	1999	0.66	0.36	0.55	0.60	0.27	0.53	0.58	0.68	1.19
Slovak Republic	1996	0.67	0.39	0.56	0.61	0.31	0.54	0.59	0.68	1.31

Note: Countries were sorted by real income per capita.

Table 6. Continued

Country	Year	Food, beverages, and tobacco	Cereals and Bread	Meat and Fish	Dairy	Fats and Oil	Fruit and Vegetables	Other Foods	Beverages and Tobacco	Food away from home
Lithuania	1999	0.67	0.39	0.56	0.61	0.32	0.55	0.59	0.69	1.35
Mexico	1999	0.67	0.39	0.56	0.61	0.31	0.55	0.59	0.69	1.29
Poland	1999	0.67	0.39	0.56	0.62	0.32	0.55	0.60	0.69	1.33
Poland	1996	0.67	0.41	0.56	0.62	0.34	0.55	0.60	0.69	1.42
Ireland	1985	0.67	0.36	0.56	0.62	0.26	0.54	0.60	0.69	1.20
Bulgaria	1999	0.67	0.45	0.57	0.62	0.41	0.56	0.60	0.69	2.43
Russian Federation	1996	0.68	0.44	0.57	0.62	0.38	0.56	0.61	0.70	1.79
Croatia	1999	0.68	0.40	0.57	0.63	0.33	0.56	0.61	0.70	1.38
Portugal	1985	0.68	0.40	0.57	0.63	0.32	0.56	0.61	0.70	1.36
Latvia	1999	0.69	0.43	0.58	0.63	0.37	0.57	0.61	0.70	1.63
Turkey	1999	0.69	0.42	0.58	0.64	0.35	0.57	0.62	0.71	1.46
Macedonia	1999	0.69	0.41	0.58	0.64	0.34	0.57	0.62	0.71	1.41
Russian Federation	1999	0.71	0.47	0.61	0.66	0.42	0.60	0.64	0.73	2.18
Romania	1999	0.71	0.46	0.60	0.66	0.40	0.59	0.64	0.73	1.87
Ukraine	1999	0.73	0.50	0.62	0.68	0.46	0.61	0.66	0.75	4.40
Average		0.57	0.27	0.47	0.52	0.16	0.46	0.50	0.59	1.01

Note: Countries were sorted by real income per capita.

Table 7. Unconditional Frisch own-price elasticities for food subgroups, pooled data

Country	Year	Food, beverages, and tobacco	Cereals and Bread	Meat and Fish	Dairy	Fats and Oil	Fruit and Vegetables	Other Foods	Beverages and Tobacco	Food away from home
Luxembourg	1999	-0.32	-0.06	-0.25	-0.29	0.13	-0.24	-0.28	-0.32	-0.46
Luxembourg	1993	-0.32	-0.10	-0.26	-0.29	0.03	-0.25	-0.28	-0.33	-0.48
United States	1996	-0.32	-0.10	-0.26	-0.29	0.02	-0.25	-0.28	-0.33	-0.48
Luxembourg	1996	-0.32	-0.08	-0.26	-0.29	0.06	-0.25	-0.28	-0.33	-0.48
United States	1993	-0.33	-0.12	-0.27	-0.30	-0.01	-0.26	-0.29	-0.34	-0.50
United States	1999	-0.33	-0.12	-0.27	-0.30	-0.01	-0.26	-0.29	-0.34	-0.51
Switzerland	1993	-0.37	-0.14	-0.30	-0.34	-0.03	-0.29	-0.33	-0.38	-0.58
United States	1990	-0.38	-0.14	-0.31	-0.34	-0.03	-0.30	-0.33	-0.39	-0.58
Switzerland	1996	-0.38	-0.13	-0.31	-0.35	0.00	-0.30	-0.33	-0.39	-0.58
United States	1985	-0.38	-0.14	-0.31	-0.35	-0.03	-0.30	-0.34	-0.39	-0.59
Japan	1996	-0.39	-0.18	-0.32	-0.36	-0.10	-0.31	-0.34	-0.40	-0.64
Switzerland	1999	-0.39	-0.13	-0.31	-0.36	0.01	-0.31	-0.34	-0.40	-0.59
Belgium	1996	-0.39	-0.16	-0.32	-0.36	-0.05	-0.31	-0.35	-0.40	-0.61
Belgium	1993	-0.40	-0.15	-0.32	-0.36	-0.03	-0.31	-0.35	-0.41	-0.61
Japan	1993	-0.40	-0.18	-0.32	-0.36	-0.09	-0.32	-0.35	-0.41	-0.64
Cyprus	1999	-0.40	-0.11	-0.32	-0.36	0.05	-0.31	-0.35	-0.41	-0.59
Luxembourg	1990	-0.40	-0.17	-0.32	-0.36	-0.07	-0.31	-0.35	-0.41	-0.63
Germany	1996	-0.40	-0.18	-0.33	-0.36	-0.09	-0.32	-0.35	-0.41	-0.65
Canada	1996	-0.40	-0.17	-0.33	-0.37	-0.06	-0.32	-0.35	-0.41	-0.63
Germany	1993	-0.40	-0.19	-0.33	-0.37	-0.11	-0.32	-0.36	-0.41	-0.66
Canada	1993	-0.40	-0.18	-0.33	-0.37	-0.09	-0.32	-0.35	-0.41	-0.65
Australia	1996	-0.40	-0.16	-0.33	-0.37	-0.05	-0.32	-0.36	-0.41	-0.63
France	1993	-0.40	-0.18	-0.33	-0.37	-0.08	-0.32	-0.36	-0.41	-0.65
Iceland	1996	-0.41	-0.17	-0.33	-0.37	-0.07	-0.32	-0.36	-0.42	-0.64
Switzerland	1990	-0.41	-0.16	-0.33	-0.37	-0.04	-0.32	-0.36	-0.42	-0.63

Note: Countries were sorted by real income per capita.

Table 7. Continued

Country	Year	Food, beverages, and tobacco	Cereals and Bread	Meat and Fish	Dairy	Fats and Oil	Fruit and Vegetables	Other Foods	Beverages and Tobacco	Food away from home
Austria	1999	-0.41	-0.16	-0.33	-0.37	-0.05	-0.32	-0.36	-0.42	-0.64
Netherlands	1996	-0.41	-0.19	-0.33	-0.37	-0.11	-0.33	-0.36	-0.42	-0.67
Italy	1993	-0.41	-0.17	-0.33	-0.37	-0.06	-0.32	-0.36	-0.42	-0.64
Netherlands	1993	-0.41	-0.21	-0.34	-0.38	-0.14	-0.33	-0.36	-0.42	-0.70
Austria	1993	-0.41	-0.17	-0.33	-0.38	-0.06	-0.32	-0.36	-0.42	-0.65
Iceland	1999	-0.41	-0.17	-0.33	-0.38	-0.06	-0.32	-0.36	-0.42	-0.65
Austria	1996	-0.41	-0.17	-0.33	-0.38	-0.06	-0.32	-0.36	-0.42	-0.64
Italy	1999	-0.41	-0.17	-0.33	-0.38	-0.07	-0.33	-0.36	-0.42	-0.65
Italy	1996	-0.41	-0.18	-0.33	-0.38	-0.08	-0.33	-0.36	-0.42	-0.66
Denmark	1996	-0.41	-0.19	-0.34	-0.38	-0.10	-0.33	-0.36	-0.42	-0.67
France	1996	-0.41	-0.17	-0.34	-0.38	-0.07	-0.33	-0.36	-0.42	-0.66
Australia	1993	-0.41	-0.17	-0.34	-0.38	-0.07	-0.33	-0.37	-0.43	-0.65
Italy	1990	-0.42	-0.17	-0.34	-0.38	-0.05	-0.33	-0.37	-0.43	-0.66
Iceland	1993	-0.42	-0.19	-0.34	-0.39	-0.10	-0.34	-0.37	-0.43	-0.68
Germany	1990	-0.42	-0.20	-0.35	-0.39	-0.11	-0.34	-0.37	-0.43	-0.69
France	1990	-0.42	-0.19	-0.34	-0.39	-0.09	-0.34	-0.37	-0.43	-0.68
Canada	1999	-0.42	-0.20	-0.35	-0.39	-0.12	-0.34	-0.37	-0.43	-0.70
Canada	1985	-0.42	-0.20	-0.35	-0.39	-0.12	-0.34	-0.37	-0.44	-0.70
United Kingdom	1996	-0.42	-0.19	-0.35	-0.39	-0.10	-0.34	-0.37	-0.44	-0.69
Denmark	1999	-0.42	-0.19	-0.35	-0.39	-0.09	-0.34	-0.37	-0.44	-0.68
United Kingdom	1993	-0.43	-0.18	-0.35	-0.39	-0.08	-0.34	-0.37	-0.44	-0.68
Denmark	1993	-0.43	-0.20	-0.35	-0.39	-0.11	-0.34	-0.38	-0.44	-0.70
Germany	1999	-0.43	-0.19	-0.35	-0.39	-0.09	-0.34	-0.38	-0.44	-0.68
Australia	1999	-0.43	-0.19	-0.35	-0.39	-0.08	-0.34	-0.38	-0.44	-0.68
Norway	1996	-0.43	-0.21	-0.35	-0.39	-0.13	-0.34	-0.38	-0.44	-0.72

Note: Countries were sorted by real income per capita.

Table 7. Continued

Country	Year	Food, beverages, and tobacco	Cereals and Bread	Meat and Fish	Dairy	Fats and Oil	Fruit and Vegetables	Other Foods	Beverages and Tobacco	Food away from home
United Kingdom	1999	-0.43	-0.18	-0.35	-0.39	-0.07	-0.34	-0.38	-0.44	-0.68
Norway	1999	-0.43	-0.21	-0.35	-0.39	-0.13	-0.34	-0.38	-0.44	-0.71
Canada	1990	-0.43	-0.20	-0.35	-0.39	-0.12	-0.34	-0.38	-0.44	-0.71
New Zealand	1996	-0.43	-0.18	-0.35	-0.39	-0.07	-0.34	-0.38	-0.44	-0.68
Belgium	1990	-0.43	-0.19	-0.35	-0.39	-0.09	-0.34	-0.38	-0.44	-0.69
Norway	1993	-0.43	-0.21	-0.35	-0.40	-0.12	-0.35	-0.38	-0.44	-0.72
France	1999	-0.43	-0.19	-0.35	-0.40	-0.09	-0.34	-0.38	-0.44	-0.70
Belgium	1999	-0.43	-0.20	-0.35	-0.40	-0.11	-0.35	-0.38	-0.44	-0.71
Japan	1990	-0.43	-0.20	-0.36	-0.40	-0.11	-0.35	-0.38	-0.45	-0.71
Netherlands	1999	-0.44	-0.20	-0.36	-0.40	-0.11	-0.35	-0.38	-0.45	-0.72
Austria	1990	-0.44	-0.19	-0.36	-0.40	-0.09	-0.35	-0.39	-0.45	-0.70
New Zealand	1993	-0.44	-0.20	-0.36	-0.40	-0.12	-0.35	-0.39	-0.45	-0.72
Iceland	1990	-0.44	-0.21	-0.36	-0.40	-0.13	-0.35	-0.39	-0.45	-0.73
United Kingdom	1990	-0.44	-0.18	-0.36	-0.40	-0.07	-0.35	-0.39	-0.45	-0.69
Denmark	1990	-0.44	-0.22	-0.36	-0.40	-0.14	-0.35	-0.39	-0.45	-0.74
Netherlands	1990	-0.44	-0.22	-0.36	-0.41	-0.14	-0.36	-0.39	-0.45	-0.75
Luxembourg	1985	-0.44	-0.19	-0.36	-0.41	-0.09	-0.35	-0.39	-0.46	-0.71
Spain	1996	-0.44	-0.16	-0.36	-0.41	-0.01	-0.35	-0.39	-0.46	-0.68
Japan	1999	-0.44	-0.22	-0.37	-0.41	-0.14	-0.36	-0.39	-0.46	-0.75
Israel	1996	-0.44	-0.23	-0.37	-0.41	-0.15	-0.36	-0.39	-0.46	-0.76
Australia	1990	-0.45	-0.20	-0.36	-0.41	-0.11	-0.35	-0.39	-0.46	-0.72
Sweden	1996	-0.45	-0.23	-0.37	-0.41	-0.16	-0.36	-0.39	-0.46	-0.78
Sweden	1993	-0.45	-0.24	-0.37	-0.41	-0.17	-0.36	-0.40	-0.46	-0.78
Spain	1999	-0.45	-0.15	-0.36	-0.41	0.00	-0.35	-0.39	-0.46	-0.68
Ireland	1999	-0.45	-0.18	-0.36	-0.41	-0.07	-0.35	-0.39	-0.46	-0.70

Note: Countries were sorted by real income per capita.

Table 7. Continued

Country	Year	Food, beverages, and tobacco	Cereals and Bread	Meat and Fish	Dairy	Fats and Oil	Fruit and Vegetables	Other Foods	Beverages and Tobacco	Food away from home
New Zealand	1999	-0.45	-0.21	-0.37	-0.41	-0.12	-0.36	-0.40	-0.46	-0.74
Sweden	1990	-0.45	-0.24	-0.37	-0.41	-0.18	-0.37	-0.40	-0.46	-0.81
France	1985	-0.45	-0.20	-0.37	-0.41	-0.09	-0.36	-0.40	-0.46	-0.72
Ireland	1996	-0.45	-0.21	-0.37	-0.41	-0.11	-0.36	-0.40	-0.46	-0.74
Germany	1985	-0.45	-0.22	-0.37	-0.41	-0.14	-0.36	-0.40	-0.46	-0.76
Sweden	1999	-0.45	-0.24	-0.37	-0.42	-0.16	-0.37	-0.40	-0.47	-0.79
Finland	1996	-0.45	-0.23	-0.37	-0.42	-0.16	-0.36	-0.40	-0.47	-0.78
Portugal	1996	-0.45	-0.18	-0.37	-0.42	-0.05	-0.36	-0.40	-0.47	-0.71
Spain	1993	-0.45	-0.16	-0.37	-0.42	-0.01	-0.36	-0.40	-0.47	-0.69
Greece	1999	-0.45	-0.19	-0.37	-0.42	-0.07	-0.36	-0.40	-0.47	-0.72
Portugal	1999	-0.46	-0.21	-0.37	-0.42	-0.11	-0.36	-0.40	-0.47	-0.74
Portugal	1993	-0.46	-0.17	-0.37	-0.42	-0.04	-0.36	-0.40	-0.47	-0.71
Greece	1996	-0.46	-0.19	-0.37	-0.42	-0.07	-0.36	-0.40	-0.47	-0.72
Finland	1993	-0.46	-0.24	-0.38	-0.42	-0.16	-0.37	-0.40	-0.47	-0.79
Italy	1985	-0.46	-0.20	-0.37	-0.42	-0.09	-0.36	-0.40	-0.47	-0.73
Australia	1985	-0.46	-0.21	-0.37	-0.42	-0.11	-0.36	-0.40	-0.47	-0.74
Japan	1985	-0.46	-0.24	-0.38	-0.42	-0.17	-0.37	-0.41	-0.47	-0.80
Belgium	1985	-0.46	-0.22	-0.38	-0.42	-0.12	-0.37	-0.40	-0.47	-0.75
New Zealand	1990	-0.46	-0.23	-0.38	-0.42	-0.15	-0.37	-0.41	-0.47	-0.78
Greece	1993	-0.46	-0.16	-0.37	-0.42	0.00	-0.36	-0.40	-0.47	-0.70
Netherlands	1985	-0.46	-0.23	-0.38	-0.42	-0.15	-0.37	-0.41	-0.47	-0.79
Finland	1990	-0.46	-0.24	-0.38	-0.42	-0.16	-0.37	-0.41	-0.48	-0.80
Finland	1999	-0.46	-0.22	-0.38	-0.42	-0.13	-0.37	-0.41	-0.48	-0.77
Ireland	1993	-0.46	-0.22	-0.38	-0.42	-0.12	-0.37	-0.41	-0.48	-0.76
Denmark	1985	-0.47	-0.24	-0.38	-0.43	-0.16	-0.37	-0.41	-0.48	-0.79

Note: Countries were sorted by real income per capita.

Table 7. Continued

Country	Year	Food, beverages, and tobacco	Cereals and Bread	Meat and Fish	Dairy	Fats and Oil	Fruit and Vegetables	Other Foods	Beverages and Tobacco	Food away from home
Norway	1990	-0.47	-0.25	-0.39	-0.43	-0.18	-0.38	-0.41	-0.48	-0.82
United Kingdom	1985	-0.47	-0.22	-0.38	-0.43	-0.13	-0.38	-0.41	-0.48	-0.77
Israel	1999	-0.47	-0.24	-0.39	-0.43	-0.17	-0.38	-0.42	-0.48	-0.82
New Zealand	1985	-0.47	-0.24	-0.39	-0.43	-0.16	-0.38	-0.42	-0.49	-0.81
Sweden	1985	-0.47	-0.26	-0.39	-0.44	-0.20	-0.39	-0.42	-0.49	-0.88
Spain	1990	-0.47	-0.20	-0.39	-0.43	-0.09	-0.38	-0.42	-0.49	-0.76
Norway	1985	-0.47	-0.26	-0.39	-0.44	-0.19	-0.38	-0.42	-0.49	-0.85
Austria	1985	-0.47	-0.23	-0.39	-0.44	-0.13	-0.38	-0.42	-0.49	-0.79
Slovenia	1996	-0.48	-0.24	-0.39	-0.44	-0.16	-0.38	-0.42	-0.49	-0.82
Slovenia	1999	-0.48	-0.25	-0.40	-0.44	-0.18	-0.39	-0.43	-0.50	-0.85
Czech Republic	1996	-0.49	-0.26	-0.40	-0.45	-0.18	-0.39	-0.43	-0.50	-0.85
Finland	1985	-0.49	-0.25	-0.40	-0.45	-0.17	-0.39	-0.43	-0.50	-0.84
Spain	1985	-0.49	-0.22	-0.40	-0.45	-0.12	-0.39	-0.43	-0.50	-0.80
Korea	1999	-0.49	-0.29	-0.41	-0.45	-0.23	-0.40	-0.44	-0.50	-0.97
Czech Republic	1999	-0.49	-0.25	-0.40	-0.45	-0.16	-0.40	-0.44	-0.51	-0.84
Portugal	1990	-0.50	-0.24	-0.41	-0.45	-0.14	-0.40	-0.44	-0.51	-0.83
Ireland	1990	-0.50	-0.24	-0.41	-0.46	-0.15	-0.40	-0.44	-0.52	-0.84
Greece	1990	-0.50	-0.25	-0.41	-0.46	-0.15	-0.40	-0.45	-0.52	-0.85
Hungary	1996	-0.51	-0.30	-0.43	-0.47	-0.24	-0.42	-0.46	-0.53	-1.01
Mexico	1996	-0.51	-0.29	-0.43	-0.47	-0.22	-0.42	-0.46	-0.53	-0.96
Estonia	1999	-0.51	-0.30	-0.43	-0.47	-0.24	-0.42	-0.46	-0.53	-1.00
Hungary	1999	-0.51	-0.30	-0.43	-0.47	-0.23	-0.42	-0.46	-0.53	-0.99
Greece	1985	-0.52	-0.26	-0.42	-0.47	-0.16	-0.41	-0.46	-0.53	-0.87
Slovak Republic	1999	-0.52	-0.28	-0.43	-0.47	-0.21	-0.42	-0.46	-0.53	-0.93
Slovak Republic	1996	-0.52	-0.30	-0.43	-0.48	-0.24	-0.43	-0.46	-0.54	-1.03

Note: Countries were sorted by real income per capita.

Table 7. Continued

Country	Year	Food, beverages, and tobacco	Cereals and Bread	Meat and Fish	Dairy	Fats and Oil	Fruit and Vegetables	Other Foods	Beverages and Tobacco	Food away from home
Lithuania	1999	-0.52	-0.31	-0.44	-0.48	-0.25	-0.43	-0.47	-0.54	-1.05
Mexico	1999	-0.52	-0.30	-0.44	-0.48	-0.24	-0.43	-0.47	-0.54	-1.01
Poland	1999	-0.52	-0.31	-0.44	-0.48	-0.25	-0.43	-0.47	-0.54	-1.04
Poland	1996	-0.52	-0.32	-0.44	-0.48	-0.27	-0.43	-0.47	-0.54	-1.12
Ireland	1985	-0.53	-0.28	-0.44	-0.48	-0.21	-0.43	-0.47	-0.54	-0.94
Bulgaria	1999	-0.53	-0.35	-0.45	-0.49	-0.32	-0.44	-0.47	-0.54	-1.91
Russian Federation	1996	-0.53	-0.34	-0.45	-0.49	-0.30	-0.44	-0.47	-0.54	-1.40
Croatia	1999	-0.53	-0.32	-0.45	-0.49	-0.26	-0.44	-0.47	-0.55	-1.08
Portugal	1985	-0.53	-0.31	-0.45	-0.49	-0.25	-0.44	-0.47	-0.55	-1.06
Latvia	1999	-0.54	-0.34	-0.45	-0.50	-0.29	-0.44	-0.48	-0.55	-1.28
Turkey	1999	-0.54	-0.33	-0.45	-0.50	-0.27	-0.44	-0.48	-0.56	-1.14
Macedonia	1999	-0.54	-0.32	-0.45	-0.50	-0.26	-0.44	-0.48	-0.56	-1.10
Russian Federation	1999	-0.56	-0.37	-0.47	-0.52	-0.33	-0.47	-0.50	-0.58	-1.71
Romania	1999	-0.56	-0.36	-0.47	-0.52	-0.32	-0.46	-0.50	-0.58	-1.46
Ukraine	1999	-0.57	-0.40	-0.49	-0.53	-0.36	-0.48	-0.51	-0.59	-3.45
Average		-0.45	-0.21	-0.37	-0.41	-0.12	-0.36	-0.40	-0.46	-0.79

Note: Countries were sorted by real income per capita.

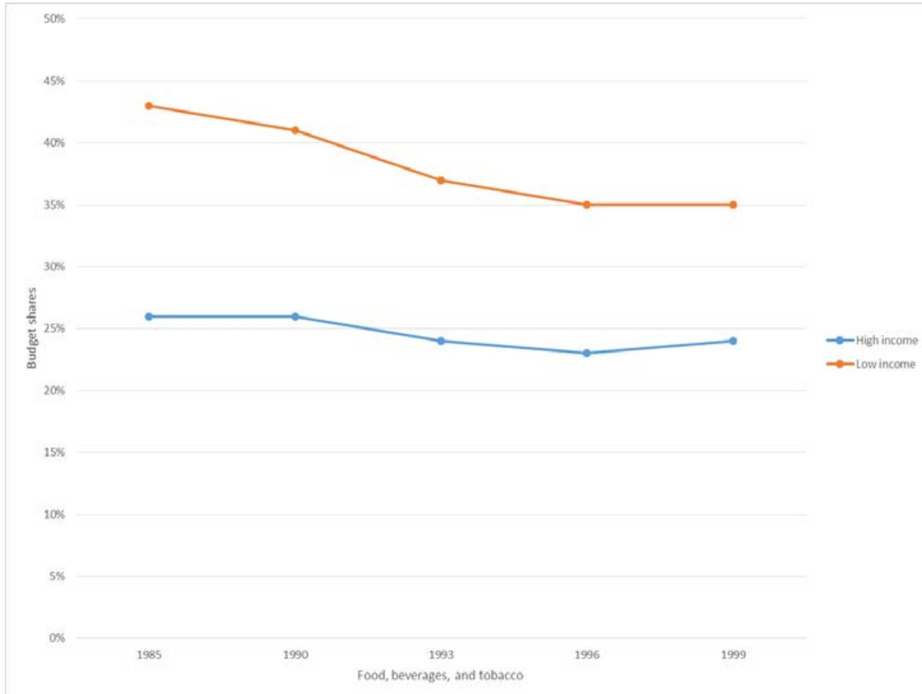

Figure 1. Average Food budget shares in higher and lower income countries, 1985-1999

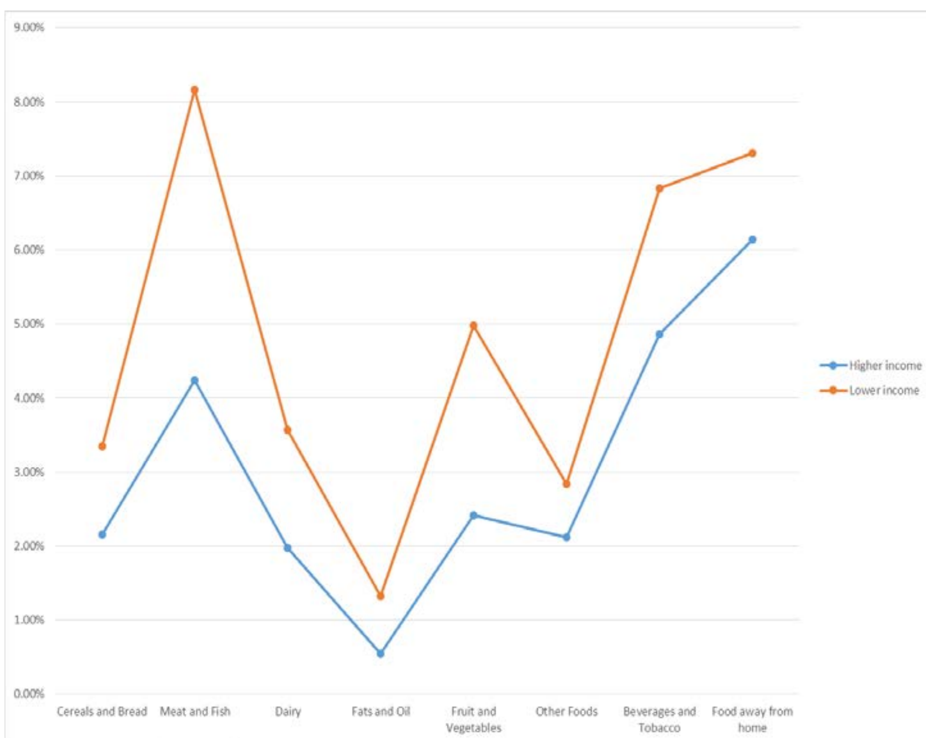

Figure 2. Average unconditional food subgroup budget share, 1985-1999

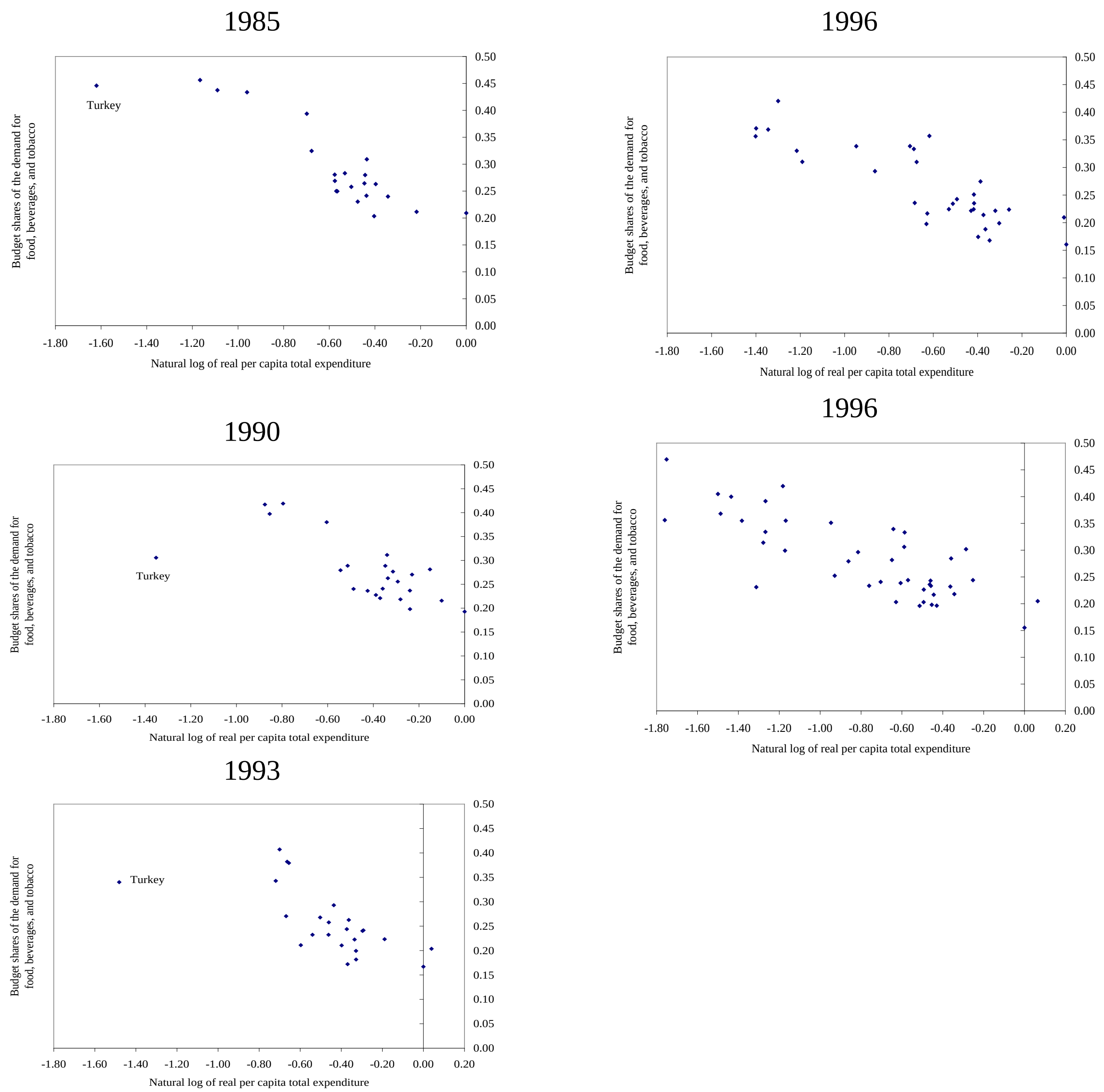

Figure 3. Workings (1943) model for food, 1985, 1990, 1993, 1996, 1999

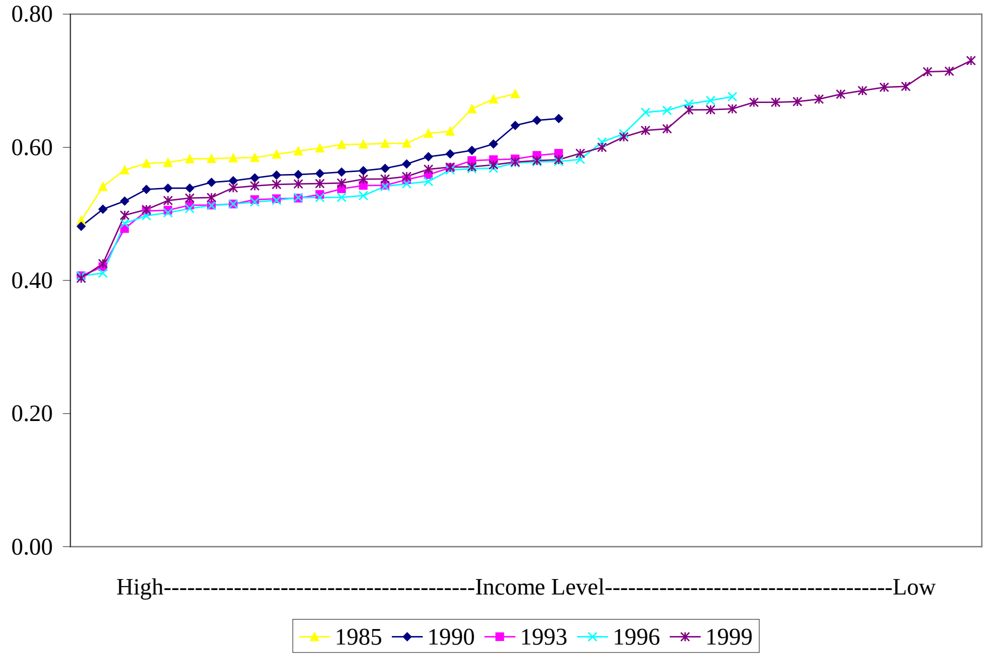

Figure 4. Income elasticities of the demand for food, beverages, and tobacco when data are pooled

Figure 5. Frisch own-price elasticities of the demand for food, beverages, and tobacco when data are pooled