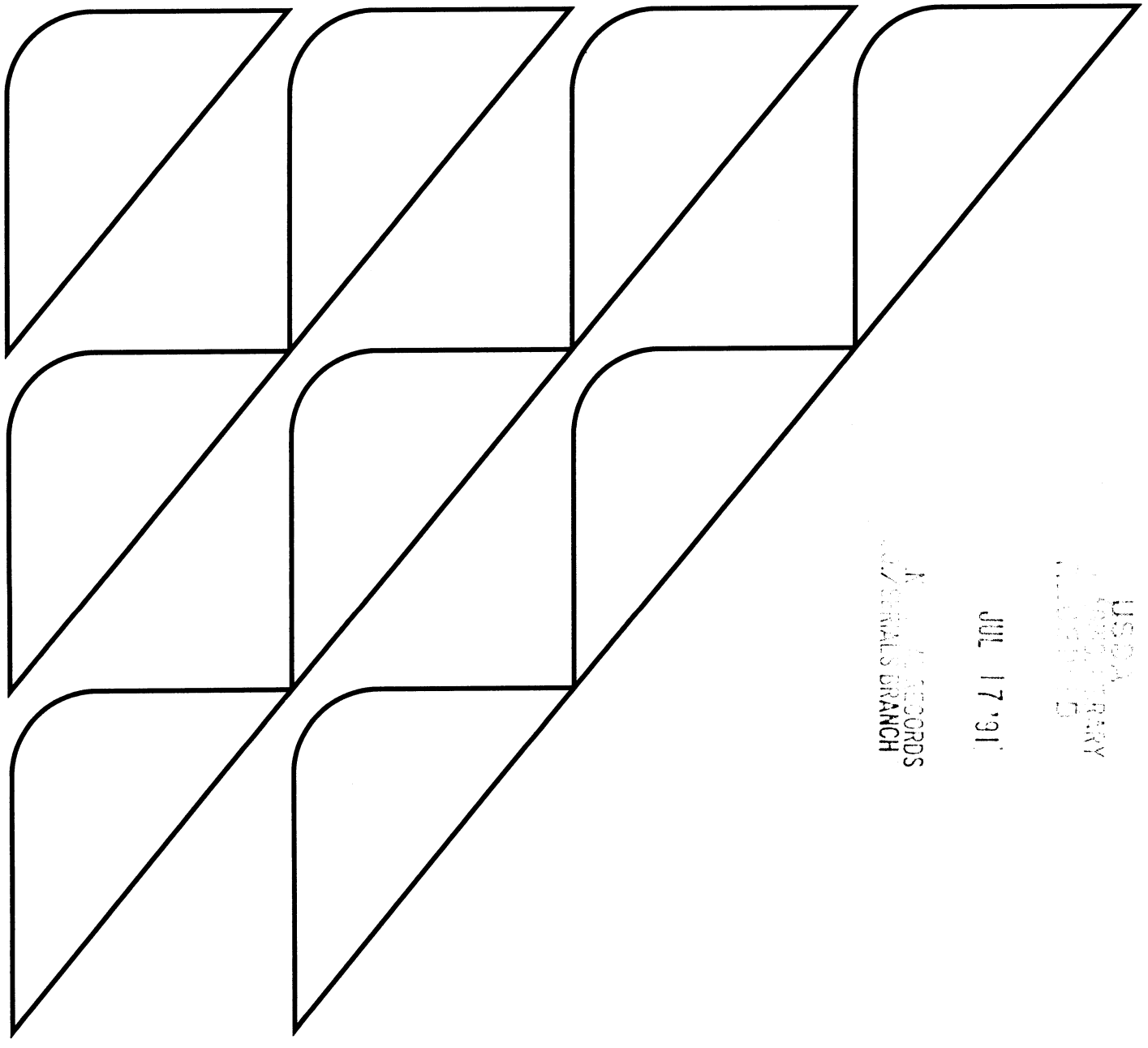
United States
Department of
Agriculture

Economic
Research
Service

Technical
Bulletin
Number 1787

Construction of True Cost of Food Indexes From Estimated Engel Curves

William N. Blisard
James R. Blaylock



It's Easy To Order Another Copy!

Just dial 1-800-999-6779. Toll free (in the United States and Canada). All other areas please dial 301-725-7937.

Ask for *Construction of True Cost of Food Indexes From Estimated Engel Curves (TB-1787).*

The cost is $8.00 per copy. For non-U.S. addresses (including Canada), add 25 percent. Charge your purchase to your VISA or MasterCard, or we can bill you. Or send a check or purchase order (made payable to ERS-NASS) to:

ERS-NASS
P.O. Box 1608
Rockville, MD 20849-1608.

We'll fill your order by first-class mail.

Construction of True Cost of Food Indexes From Estimated Engel Curves. By William N. Blisard and James R. Blaylock. Commodity Economics Division, Economic Research Service, U.S. Department of Agriculture. Technical Bulletin Number 1787.

Abstract

Comparisons of estimated indexes of the true cost of food with the Consumer Price Index (CPI) for households of different size, race, and region show that most of the true food cost indexes were very close to the CPI for total food. The true cost of food indexes indicate that in 1980-85 food costs rose more for higher income households than for their lower income counterparts because the higher income group spent a greater proportion of its total food dollars on food eaten away from home than did the lower income group. The method of estimating the indexes is also described.

Keywords: True cost of living index, true cost of food index, Engel curves, demand.

Acknowledgments

The authors appreciate the valuable comments of Richard Haidacher and Lester Myers. We are grateful to Thomas Cox for his valuable insights and criticisms. Special thanks are extended to Betty Barrett and Kyra Toland, who competently typed this report.

Washington, DC 20005-4788 June 1991

Contents

Summary

Comparisons of estimated indexes of the true cost of food with the Consumer Price Index (CPI) for households of different size, race, and region show that most of the true food cost indexes were very close to the CPI for total food. The true cost of food indexes indicate that over the 1980-85 period food costs rose more for higher income households than for their lower income counterparts because the more affluent group spent a greater proportion of its total food dollars on food eaten away from home than did the lower income group. The report describes the method of estimating the indexes.

Food cost indexes were constructed for eight types of "reference households," defined as households with the minimum total food expenditures in each demographic category. The eight reference household types included white and nonwhite households in the Northeast, the North Central States, the South, and the West. Indexes also were constructed for households having one to five members and those having average and high food expenditures.

Food cost indexes that were constructed were based on the premise that it is possible to capture substitution effects by estimating Engel curves in which the intercepts are allowed to shift from one time period to another. This technique allows the analyst to estimate many individual items that compose a broad category such as food and to capture the substitution effects that occur within that category (for example, consumers substitute one type of food for another as relative food prices change).

Other report highlights follow. Indexes of true food costs indicated that:

- Higher income households, which allocate a greater share of their total food purchases to food eaten away from home (the costliest kind of food purchase) than other groups, experienced faster rising food costs than lower income households.

- Food costs rose more slowly for nonwhite than white households.

- Households in the Northeast had the lowest food cost inflation, while households in the West had the highest.

- Total food costs rose less for larger households than for smaller households.

Construction of True Cost of Food Indexes From Estimated Engel Curves

William N. Blisard
James R. Blaylock*

Introduction

Economists and Government agencies have used various fixed-weight price indexes to find out how changing price levels affect consumers and to adjust the benefit levels of welfare and transfer programs. The premier fixed-weight index in the United States today is the Consumer Price Index (CPI). The CPI was originally constructed to measure the inflation rate in the economy over time. However, when Government agencies or private industry use the CPI to adjust benefits or salaries, they are no longer using it as a measure of inflation but as a measure of the cost of living. Cost of living is not what the CPI was designed to measure.

There is another, specialized index termed the "CPI for total food," which captures the changing price level of food eaten at home and food eaten away from home. A major criticism of the CPI for total food index is that it may be a biased estimate of the cost of food because it does not take into account the substitution of one kind of food for another. Consequently, it is important to determine how much bias may or may not exist in the CPI because the index is the basis on which many Government programs are adjusted annually. Food stamp, social security, and school lunch program benefits, among others, are all adjusted by the CPI. If the CPI overestimates or underestimates the increase in the cost of living, then the Government will overcompensate or undercompensate these program participants.

The CPI compares the cost of a fixed "market basket" of goods and services over time. It uses as weights representative expenditures on goods and services from various types of U.S. households for some base period. These weights are then multiplied by the ratio of the current price of a particular good or service to the price in some base period and summed to form the index. The CPI is a modified Laspeyres index because the weights are expenditures and not base period quantities. The main point is that the CPI compares the cost of this fixed market basket of goods with the cost of the same basket at some other point in time.

Economic theory postulates that consumers will substitute relatively expensive goods with relatively less expensive goods as prices change, holding income constant. Therefore, if economists wish to construct an index that in some way measures the change in the cost of living of consumers, they cannot use a fixed-weight index because it cannot take into account the substitution effects that occur as relative prices change. To construct index numbers that

*William N. Blisard and James R. Blaylock are agricultural economists with the Commdity Economics Division, Economic Research Service, U.S. Department of Agriculture.

are based on economic theory and that incorporate substitution effects (and thereby measure the change in the cost of living), economists have developed "true cost of living indexes" that typically are derived from the estimated parameters of a complete demand system. Demand systems, however, tend to be limited to several broad categories of goods due to estimation problems, and they do not capture the substitution effects that are most likely to occur within the individual categories.

Given these obstacles, attempts have been made to find a true index that does not require estimating a demand system. One kind of index, advanced by Diewert (1976)[1] and Fry and Pashardes (1989) is the Tornqvist price index which, under specific conditions, is a true index. This index is easy to construct because it simply requires a knowledge of budget shares and prices over the relevant time period. However, this index may also fail to capture substitution effects that occur as relative prices change if budget shares tend to be fairly constant over time.

A second major criticism of using the CPI as a measure of the cost of living is that the CPI applies one index to all consumers in society although many economic studies have shown that consumers of different races, in different regions, with different household sizes, and with different expenditure levels consume different bundles of goods. Thus, one would expect, *a priori*, that the rate of change in the cost of living would not be the same for the various demographic groups. The CPI's shortcomings indicate a need to develop true cost indexes that take into account substitution and demographic effects.

The main purpose of the research reported here was to construct, from estimated Engel curves, indexes of the true cost of food (termed "true cost of food indexes") based on 16 food categories for various U.S. demographic groups. In particular, we constructed true cost of food indexes for whites and nonwhites, by household size, in the northeastern, north central, southern, and western regions. To our knowledge, only limited economic analyses have been conducted with index numbers to determine if different demographic groups experience different rates of change in their cost of food. In addition, we wished to determine if the CPI for total food overestimates or underestimates the change in the cost of food for any demographic group relative to its own true cost index.

The index numbers we constructed are based on the premise that it is possible to capture substitution effects by estimating Engel curves in which the intercepts are allowed to shift from one time period to another. This procedure allows the analyst to estimate many individual items that make up a broad category such as food and to capture the substitution effects that occur within that category. The true indexes we constructed are closely related to the Tornqvist index but they used as weights the estimated intercepts from Engel curves.

We constructed food cost indexes for eight "reference households." Reference households were defined as demographic households having the minimum total food expenditures in each demographic category. These included white and

---

[1]References, denoted by last name of author and date of publication, are listed in the References section at the end of this report.

nonwhite households in the Northeast, the North Central States, the South, and the West. In addition, indexes based on our sample data were constructed for households with one to five people having average food expenditures and for households with the highest total food expenditure.

The true food cost indexes indicate that over the 1980-85 period households that budgeted more for total food experienced the fastest rising food costs, due mainly to a greater percentage of their food budgets being allocated to food consumed away from home. Since a strong relationship is known to exist between income and spending on food eaten away from home, this finding implies that food costs rose more for higher income households than for their lower income counterparts.

We also found that true food cost indexes rose less for larger households than for their smaller counterparts from 1980 to 1985. Whites were found to have more rapidly increasing food costs than nonwhites. Among the regions, the Northeast had lowest food cost inflation rates and the West had the highest, all other things being equal. While most of the indexes for the true cost of food were close to the CPI for total food, there were some differences. True cost of food indexes were lower for certain households with the lowest expenditures: nonwhite households with two or more members in the Northeast and North Central States and nonwhite households with three or more members in the South and West.

Laspeyres and True Cost of Food Indexes

The CPI is a fixed-weight Laspeyres type of index. A Laspeyres index can be formally defined as:

$$I_t = \Sigma P_t Q_0 / \Sigma P_0 Q_0 \qquad (1)$$

with I being the index, with P being the component prices in the current period t and the base period 0, and with Q being the fixed-quantity weights in the base period with summations taken over the components of the index category.

Food is just one component of the total CPI. The other components are housing, apparel, transportation, medical care, entertainment, personal care, and other goods and services. The total food component of the CPI represents about 16 percent of the average household's expenditures. Within the total food category, there are 16 food commodity groups. They include cereals and bakery products, dairy products, eggs, food eaten away from home, fresh fruit, fish, fats and oils, fresh vegetables, nonalcoholic beverages, beef, poultry, pork, other meats, processed fruit, processed vegetables, and sugar and sweeteners. Like the total index, each item is weighted by the average household expenditure in the United States. Thus, as relative food prices change among the various categories, it is assumed that the representative household allocates its food budget in the same proportion as before.

The CPI is an excellent measure of changes in the price of a fixed basket of goods and services. However, it may be a poor indicator of changes in the cost of living or the cost of food because it ignores the fact that consumers substitute among goods and services as relative prices change and that different consumers do so differently.

A true cost of living or food cost index, on the other hand, takes into account substitution that occurs as relative prices change. It specifically represents the costs of obtaining a given level of utility (or indifference curve) under two different price regimes. It is thus a function of the two sets of prices, the preference of an individual or a household and the level of utility chosen for reference (Muellbauer, 1977). If no substitution occurs as relative prices change, then the Laspeyres and true cost indexes will be the same. When substitution does occur, the two indexes generally will be different, although the actual outcome depends on the shape of the consumers' indifference curves and the relative prices of the goods under consideration.

In reality, the closest we are likely to approach the calculation of a true index is through the estimation of a complete demand system. However, there are as many different "true cost indexes" as there are functional forms for demand systems, because each true index depends on the estimated parameters of the demand system. For example, true indexes calculated from an Almost Ideal Demand System and a Linear Expenditure System will be different, because the estimated parameters of each system will be different.

There have been attempts to improve on the Laspeyres index by finding a true index that does not require direct estimating of a complete demand system. Work by Fry and Pashardes (1989) has been useful in this regard. They have shown that the Tornqvist price index defined as:

$$\ln P(p_1, p_0, t) = \Sigma_k \; .5 \; (w_{1k} + w_{0k}) \ln (p_{1k}/p_{0k}), \qquad (2)$$

where w_1 and w_0 are budget shares in the two time periods, is a true index if the logarithm of the cost function underlying the demand system is quadratic in the logarithms of prices and utility. However, if budget shares tend to be rather constant over time, this index will also fail to capture the substitution effects that occur as relative prices change. Later we will demonstrate how the estimated intercepts from Engel curves can be used to capture the substitution effects that occur as relative prices change and how these intercepts can be substituted for the observed budget shares in the Tornqvist index.

The Piglog Model

The cost function underlying both the Engel curves and the Tornqvist type of indexes we constructed are based on the piglog functional form (Deaton and Muellbauer, 1980). The piglog model was developed so that it would be possible to treat aggregate consumer behavior as if it were the outcome of a single maximizing consumer. This problem of how to treat aggregate consumer behavior as if it were the outcome of a single maximizing consumer exists because it is neither necessary nor desirable for a macroeconomic relationship to perfectly mimic its microeconomic foundation. Hence, in demand analysis, theory deals with behavior at the individual level and the "laws of demand" apply to individuals. At the micro level, conditions such as symmetry and separability may hold, while at the macro level they may not. Therefore, the market demand functions that we estimate may or may not have the desirable properties of micro demand functions. This problem is known in economics as the aggregation problem.

We assume that each household's expenditure (x_h) is exogenous and that it varies from household to household. The n different prices are assumed to be

the same for all consumers, and this assumption is crucial to the analysis. Its effect is to ensure that all consumers face the same prices so that only differences in expenditure levels need to be considered. Consequently, the conditions that must exist for aggregation can be determined by establishing what restrictions have to be placed on the Engel curve.

First, consider the individual demand for the i^{th} good and write the demand function as:

$$q_{ih} = g_{ih}(x_h, p). \tag{3}$$

If there are H different households, then average demand would imply that:

$$\bar{q} = f_i(x_1, x_2, \ldots x_h, p) = (\Sigma g_{ih}(x_h, p))/H \tag{4}$$

for some function f_i. Exact linear aggregation is possible if we can write the above equation as:

$$\bar{q} = g(\bar{x}, p). \tag{5}$$

This last term implies that a reallocation of a single unit of currency from any one household to another must leave market demands unchanged. In other words, equation 5 implies that the marginal propensity to spend must be identical for all households. This, in turn, means that the above function must be linear in expenditure (x_h) for some functions α_{ih} and β_i of p alone, such that:

$$q_{ih} = \alpha_{ih}(p) + \beta_i(p)x_h \tag{6}$$

where α is indexed on h but β is not. Note that if either α or β were negative, then expenditure would have to be restricted within some range in order to keep quantities from also being negative. For the aggregate function, we would then have:

$$\bar{q} = \alpha_i(p) + \beta_i(p)\bar{x} \tag{7}$$

where it is assumed that none of the individual x_h's is such to make quantities negative. If, however, we do not want to place any restrictions on the range of expenditures, we must then delete the intercepts from the two preceding equations. This then implies that quantities demanded will be proportional to expenditures, which is a severe restriction.

If we go one step further and assume that our representative consumer maximizes utility, then each household would have the cost function:

$$c_h(u_h, p) = a_h(p) + u_h b(p), \tag{8}$$

where the corresponding average function would be:

$$\bar{x} = c(u, p) = a(\bar{p}) + ub(\bar{p}). \tag{9}$$

Thus, if we assume that individuals maximize utility and preferences are such as to satisfy the aggregation condition, the average demands above will also be consistent with utility maximization. The reason is that Engel curves can be derived from the above cost function in equation 8.

Note that the cost function in equation 8 implies quasihomothetic preferences, or linear Engel curves. This is a very strong restriction as we showed earlier. For broad aggregate data, it is possible that all consumers will have some positive purchases. For desegregated data, however, there very likely would be some zero purchases, which would then require Engel curves without intercepts. As noted above, this then implies that quantities are proportional to expenditures.

Another approach to the problem that leads directly to a piglog model is to require exact nonlinear aggregation. One difference with this approach is that average budget shares are used as the dependent variable. Hence, we define the average aggregate budget share for the i^{th} good as:

$$\bar{w}_i = p_i \Sigma_h q_{ih} / \Sigma_h x_h = \Sigma_h (x_h / \Sigma x_h)\ w_{ih} \tag{10}$$

so that the market demand is a weighted average of individual household demands, the weights being proportional to the expenditure of each household.

If we restrict the average budget share to be a function of prices and average expenditure, we arrive at the same results as before: linear Engel curves. However, what nonlinear aggregation requires is that average budget shares depend on prices and a representative level of expenditure. Hence, the market demand can be thought of as deriving from the behavior of a single representative consumer faced with prices p and expenditure x_0.

A representative consumer exists if some indirect utility function $\Psi(x,p)$ with corresponding cost function $c(u,p)$ exists, so that for some level of utility $u_0 = \Psi(x_0,p)$, and:

$$\begin{aligned} \bar{w}_i &= w_i(u_0,p) = \partial \ln c(u_0,p)/\partial \ln p_i \\ &= \Sigma\ (x_h/\Sigma x_h)\ \partial \ln c_h(u_h,p)/\partial \ln p \end{aligned} \tag{11}$$

where $c_h(u_0,p)$ is the cost function of household h, with $u_h = \Psi(x_h,p)$. The cost function from which the above average budget share equation can be derived must take the form:

$$c_h(u_0,p) = \theta[u_0,a(p),b(p)] + \phi_h(p) \tag{12}$$

where a(p), b(p), and $\phi_h(p)$ are linearly homogeneous functions of prices and θ is linearly homogeneous in a and b. Over all consumers, the $\phi_h(p)$ functions must sum to zero, so that the representative cost function takes the form:

$$c(u_0,p) = \theta[u_0,a(p),b(p)] \tag{13}$$

for the same functions a(p) and b(p). These two functions can be thought of as the "prices" of two intermediate goods that, together with utility, define

the macro cost function. From this cost function, the representative average budget can be derived as:

$$\bar{w}_i = (\partial \ln \theta / \partial \ln a)(\partial \ln a / \partial \ln p_i) + (\partial \ln \theta / \partial \ln b)(\partial \ln b / \partial \ln p_i). \quad (14)$$

Since θ is homogeneous of degree one in a and b, $\partial \ln \theta / \partial \ln a = 1 - \partial \ln \theta / \partial \ln b$. Thus, equation 14 can be written as:

$$\bar{w}_i = (1-\lambda)\partial \ln a / \partial \ln p_i + \lambda \, \partial \ln b / \partial \ln p_i \quad (15)$$

where

$$\lambda = \partial \ln \theta / \partial \ln b = \lambda(x_0, p).$$

Thus, each budget share is a weighted sum of the value shares associated with the two functions a(p) and b(p), with the weights depending on representative utility, u_0, or total expenditure and prices (x_0, p), the same for all consumers. Consequently, at constant prices each budget share is a linear function of all other budget shares. This cost function still places strong restrictions on the Engel curves. For instance, the slopes of the Engel curves representing different households vary linearly with one another as total expenditures change at constant prices. This does not mean that the Engel curves are linear themselves.

The cost function in equation 13 allows for consistent nonlinear aggregation. By definition, representative expenditure x_0 will be some point in the expenditure distribution, the position of which is determined by the degree of nonlinearity of the Engel curves and by the price vector p. When the representative expenditure level is independent of prices and depends only on the distribution of expenditures, we have what is known as price independent generalized linearity (pigl). Its general cost function is given by:

$$c_h(u_h, p) = k_h[a(p)^\alpha(1 - u_h) + b(p)^\alpha u_h]^{1/\alpha} \quad (16)$$

with a representative cost function of:

$$c(u_0, p) = [a(p)^\alpha(1 - u_0) + b(p)^\alpha u_0]^{1/\alpha}. \quad (17)$$

When α tends to zero, we have the piglog model where:

$$\ln c(u_0, p) = (1 - u_0) \ln a(p) + u_0 \ln b(p). \quad (18)$$

The nonlinear Engel curve associated with this cost function is:

$$w_i = \gamma + \eta \ln(x/k) \quad (19)$$

where k can vary over households and is used to capture demographic effects.

In conclusion, by using a demand or Engel curve that is derived from a piglog cost function, we are assured that our macro or market functions have the same desirable properties as the micro functions.

The Tornqvist Index as a True Cost Index

The next step is to establish that a Tornqvist index can be interpreted as a true cost index within the framework of Muellbauer's piglog model. First, note that the Tornqvist index is calculated from data about budget shares gathered in two different time periods which are multiplied by the log ratio of prices. We define the Tornqvist index for a household as:

$$I_t = .5 \Sigma_i (w_{ih1} + w_{ih0}) \ln (p_{i1}/p_{i0}), \tag{20}$$

where w_{iht} is the budget share for the i^{th} good of the h^{th} household in period $t = 0,1$.

As noted above, Muellbauer's piglog cost function can be written as:

$$\ln c(u_h,p) = a(p) + b(p)u_h, \tag{21}$$

where $a(p)$ and $b(p)$ are some price functions and u_h is the level of utility of household h. The Hicksian budget shares of the piglog model for the h^{th} household in period t are:

$$w_{iht} = a_i(p_t) + b_i(p_t,u_{th}), \tag{22}$$

where

$$a_i(p_t) = \partial a(p_t)/ \partial \ln p_{it} \text{ and } b_i(p_t) = \partial b(p_t)/ \partial \ln p_{it}.$$

The true cost index in period 1 relative to period 0 and referenced to utility u_{hR} is given by:

$$\ln P(p_1,p_0;u_{hR}) = \ln c(u_{hR},p_1) - \ln c(u_{hR},p_0). \tag{23}$$

Fry and Pashardes (1989) showed that when the cost function is piglog, the Tornqvist index is the average of the true cost indexes $\ln c(p_1,p_0,u_{h0})$ and $\ln c(p_1,p_0,u_{h1})$, if $a(p)$ is quadratic and $b(p)$ is linear in log prices.

If we let:

$$a(p) = \alpha_0 + \Sigma\alpha_i \ln p_i + .5 \Sigma_i\Sigma_j \lambda_{ij} \ln p_i \ln p_j \tag{24}$$

and:

$$b(p) = B_0 + \Sigma_i \beta_i \ln p_i, \tag{25}$$

where $\Sigma_i\alpha_i = 1$, $\Sigma_i\lambda_{ij} = \Sigma_iB_i = 0$ for adding up, $\Sigma_j\lambda_{ij} = 0$ for homogeneity, and $\lambda_{ij} = \lambda_{ji}$ for symmetry, then we can write the piglog cost function as:

$$\ln c(u_h,p) = g(u_h) + \Sigma_i (\alpha_i + B_iu_h + .5 \Sigma_j\lambda_{ij} \ln p_j) \ln p_i. \tag{26}$$

The true cost index in period 1 relative to period 0 would then be:

$$\begin{aligned} \ln P(p_1,p_0;u_{hR}) &= \Sigma_i(\alpha_i + B_iuh_R)(\ln p_{i1} - \ln p_{i0}) \\ &\quad + .5 \Sigma_i\Sigma_j \lambda_{ij} (\ln p_{i1} \ln p_{j1} - \ln p_{i0} \ln p_{j0}). \end{aligned} \tag{27}$$

The budget shares at R are:

$$w_{ihR} = \alpha_i + \Sigma_j \lambda_{ij} \ln p_{jR} + Bu_{hR}. \tag{28}$$

Thus, the true cost index can be written:

$$\begin{aligned} \ln P(p_1,p_0;u_{hR}) &= \Sigma_i w_{ihR}(\ln p_{i1} - \ln p_{i0}) \\ &\quad - \Sigma_i\Sigma_j \lambda_{ij} \ln p_{jR}(\ln p_{i1} - \ln p_{i0}) \\ &\quad + .5 \Sigma_i\Sigma_j\lambda_{ij}(\ln p_{j1} \ln p_{i1} - \ln p_{j0} \ln p_{i0}). \end{aligned} \tag{29}$$

If the true index is calculated by setting R = 1, then setting R = 0, and lastly taking the average, all terms on the right-hand side except the first cancel out due to symmetry. What this means is that computing the average true cost index for two periods by alternating the reference utility level between some base period and a subsequent time period is equivalent to computing the Tornqvist index.

Estimating the True Cost Index of the Piglog Model

The true cost index for any household, within the context of the piglog model, may be written as:

$$\ln P(p_1,p_0;u_{hR}) = [a(p_1)-a(p_0)] + [b(p_1)-b(p_0)]\, u_{hR} \tag{30}$$

for price vectors p_1 and p_0 and for reference utility u_{hR}. Equation 30 can be interpreted as the cost of living at some minimum level of consumer expenditure, say, $\ln S_t = a(p_1)-a(p_0)$, and a marginal expenditure index $\ln M_t = [b(p_1)-b(p_0)]u_{hR}$. Fry and Pashardes (1989) note that this interpretation is useful because changes in $\ln S_t$ over time should incorporate the effects of substitution among goods, while differences in $\ln M_t$ across households should reflect the distributional effects of inflation.

If one uses the associated indirect utility function $u_h = [\ln x_h - a(p)]/b(p)$, where x_h is the expenditure of the h^{th} household, the Marshallian budget shares of the piglog model can be derived as:

$$w_{iht} = a_i(p_t) + [b_i(p_t)/b(p_t)]\ [\ln x_{ht}-a(p_t)]. \tag{31}$$

This complete demand system could be estimated, but one is generally limited in the number of commodities or groups that can be considered because of the effects of multicollinearity. Demand systems are usually, but not always, limited to 8 to 12 different categories of goods. A high degree of aggregation generally results in little substitution occurring between the groups. Rather, most of the substitution occurs within the separate groupings, and these substitution effects are lost in the estimation process. However, Fry and Pashardes (1989) propose a different strategy for dealing with a larger number of commodities. They propose modeling the substitution effects as shifts in the a(p) part of the piglog cost function over time.

Specifically, when the piglog cost function takes the Almost Ideal Demand System form, we can write the Engel curve as:

$$w_{iht} = A_{it} + B_i\ [\ln x_{ht}-a(p_t)], \tag{32}$$

where

$$A_{it} = A_{i0} + \Sigma_j \lambda_{ij} \ln(p_{jt}/p_{j0}).$$

The A_{it} terms reflect the substitution effects imbedded in the time varying intercept as prices change from p_{i0}, and where $a(p_t)$ is equal to the household with the minimum expenditure level.

The results of the estimation of the above Engel curves can be used to construct a base-period referenced true cost index series for any given household h (Fry and Pashardes, 1989) as shown in equation (33):

$$\ln I_{ht} = \Sigma_i A_{i0} \ln(p_{it}/p_{i0}) + \Sigma_i A_{it} \ln(p_{it}/p_{i0}) + [\Pi_i p_{it}^{Bi} - 1]. \quad (33)$$

We see that three indexes can be derived from estimation of the Engel curves. The first is a fixed weight price index. The second is a price index that shows the effects of substitution. The third is a marginal index that shows the effect on the index of different expenditure levels. The average of the first two indexes is the "reference household's" true cost index. It corresponds to the original Tornqvist index except that the A_{it} terms from the estimated Engel curves are used in place of the budget shares. These intercept terms reflect the substitution effects that occur over time as relative prices change. All other indexes are relative to the reference household's index and differ by the effect of their expenditure level.

Note that since $A_{it} = A_{i0} + \Sigma_j \lambda_j \ln(p_{jt}/p_{j0})$, we should be able to solve for the λ_j parameters after estimating the Engel curves, if our data base contains enough observation periods to solve for all the unknown parameters. These would correspond to the estimated price coefficients of the Almost Ideal Demand System. If these were derived, one could calculate the compensated own-price and cross-price elasticities. It would then be fairly easy to check if the concavity condition had been satisfied. Such findings would lend credibility to this technique. In our study, however, we have too many parameters (16) relative to observation periods (6) to estimate the own-price and cross-price elasticities.

Incorporating Demographics into the Model

Household characteristics are important in the way they affect demand patterns and thereby result in different rates of food cost increases for different households. Incorporating a vector of household characteristics in our model means that the Tornqvist indexes can differ across household types, depending on the extent that inflation affects the goods that are purchased. For illustrative purposes, assume that there is only one household characteristic that is a continuous variable. Hence, the cost function may be written as:

$$\ln c(u_h, p, z_h) = a(p) + b(p)u_h + d(p) \ln z_h \quad (34)$$

where $a(p)$ and $b(p)$ have been defined above and $d(p) = \epsilon + \Sigma_i \zeta_i \ln p_{it}$. The complete demand system can then be written as:

$$w_{iht} = a_i(p_t) + [b_i(p_t)/b(p_t)] [\ln x_{th} - a(p_t) - d(p_t) \ln z_h] + \zeta_i \ln z_h. \quad (35)$$

Again, we can let the intercept shift for each time period, thereby capturing the substitution effects, and estimate the Engel curves in this way:

$$w_{iht} = A_{it} + B_{it}(\ln x_{th} - \alpha_t - \eta \ln z_h) + \zeta_i \ln z_h \quad (36)$$

where η is the equivalent income scale (already estimated) at reference period prices. However, following the logic of Fry and Pashardes (1989), our strategy is to cross-tabulate the data by the "z" variables, say by household size, so that the $\eta \ln z_h$ term can be absorbed into the definition of the minimum household expenditure α_t.

Note that with the data tabulated by "z" variables, dummy variables can also be entered in a traditional way to account for various types of noncontinuous demographic effects such as race and region for both the intercept and the slope parameters. The practical implication is that we can have more than one reference household, for instance, grouped by race, age, and/or region.

We cross-tabulated our data by race, region, and household size. For race and region, z_h was a dummy variable equaling zero or one. For household size, we let z_h equal the log of the household equivalent scale implicit in the official poverty lines for households of one to five members. By estimating a version of equation 36, we were able to derive the three indexes noted earlier (fixed weight, substitution, and marginal expenditure indexes) plus the following three marginal indexes for household size, race, and region:

$$\ln z_{ht} = \Sigma_i \zeta_i \ln(p_{it}/p_{i0}) \ln z_h, \quad (37)$$

$$\ln x_{ht} = \Sigma_i \Gamma_i \ln(p_{it}/p_{i0}) D_r, \quad (38)$$

and

$$\ln y_{ht} = \Sigma_i \gamma_i \ln(p_{it}/p_{i0}) D_{rg}. \quad (39)$$

Data Sources and Descriptive Statistics

We constructed true cost of food indexes from Engel curves estimated from data taken from the Continuing Consumer Expenditure Survey (CCES) for 1980 through 1985. The CCES grew out of consumer expenditure surveys of American households that the U.S. Department of Labor's Bureau of Labor Statistics (BLS) had been conducting periodically at about 10-year intervals since 1888.

A major objective of the first surveys was to collect the expenditure information needed to construct CPI's. However, the BLS found that the decennial surveys were inadequate. The bureau initiated a continuing survey of consumer expenditures and expanded the survey objectives in late 1979. The survey was broadened to gather a continuous flow of information on the buying habits of Americans, not only to be used for revising the CPI's but also for government, business, labor, and university research.

The CCES is composed of two components, each with its own questionnaire and sample. The first is an interview panel survey in which each of approximately 5,000 households is surveyed every 3 months over a 1-year period. The second is a diary survey of approximately the same sample size in which households keep an expenditure diary for two consecutive 1-week periods. The diary survey obtains data on small, frequently purchased items that are normally difficult to recall, including food and beverages, tobacco, housekeeping

supplies, nonprescription drugs, personal care products and services, fuels, and utilities.

By using the diary survey, we were able to look at 16 food categories that included cereal and bakery products, dairy products, eggs, food eaten away from home, fresh fruit, fish, fats and oils, fresh vegetables, nonalcoholic beverages, beef, poultry, pork, other meats, processed fruit, processed vegetables, and sugar and sweeteners. We assumed that these 16 food categories were disaggregated enough to allow us to capture the substitution effects that occurred as relative prices changed over the study period. We were also able to easily obtain the CPI subindexes for all 16 categories that make up the total food index portion of the CPI.

Before discussing empirical results, we will look at prices, budget shares, and selected expenditures for the 16 food categories in our study as well as some income statistics. Table 1 shows the CPI for all 16 food categories when 1980 equals 100. Categories having the largest price increases in the period 1980 though 1985 included cereal and bakery products (up 28.6 percent), food eaten away from home (up 29.9 percent), fresh fruit (up 37.1 percent), fish (up 22.9 percent), fresh vegetables (up 31 percent), processed fruit (up 33.4 percent), and processed vegetables (up 25.6 percent). Beef was flat over the entire 6-year period and finished 1985 slightly lower than it began in 1980.

Table 2 presents average budget shares by region and year. It is notable that food eaten away from home, cereal and bakery products, dairy, beef, and nonalcoholic beverages accounted for approximately two-thirds or 66 percent of the household food budget over this time period. Of these, food eaten away

Table 1--Consumer Price Index (CPI) for 16 food categories

Food category	1981	1982	1983	1984	1985
			1980 = 100		
Beef	100.8	102.2	100.7	101.9	99.8
Cereals and bakery	110.0	115.0	118.7	123.8	128.6
Dairy	107.2	108.7	110.0	111.4	113.5
Eggs	108.2	105.3	110.3	123.1	102.7
Food eaten away from home	109.0	114.9	119.9	124.9	129.9
Fresh fruit	105.4	117.7	112.1	124.5	137.1
Fish	108.3	112.2	113.5	117.1	122.9
Fats and oils	110.6	107.6	109.1	119.4	121.9
Fresh vegetables	118.6	119.2	123.5	137.0	131.0
Nonalcoholic beverages	104.3	107.1	109.2	111.9	114.1
Other meats	104.3	107.4	107.0	107.4	108.2
Pork	109.3	123.3	122.2	120.6	121.0
Prepared fruit	111.7	117.8	119.5	128.1	133.4
Poultry	104.1	102.2	103.5	114.5	113.3
Prepared vegetables	112.2	118.2	118.7	124.3	125.6
Sugar and sweeteners	108.0	107.7	109.7	114.0	116.9

Table 2--Budget shares by region and year

Food category	1980				1981				1982			
	Northeast	North Central	South	West	Northeast	North Central	South	West	Northeast	North Central	South	West
	Percent											
Beef	8.70	8.60	8.30	7.60	8.40	7.90	8.00	7.60	8.00	7.10	8.00	6.50
Cereals and bakery	10.60	1.20	9.10	9.10	10.80	10.80	9.60	9.20	1.10	10.60	10.00	9.30
Dairy	1.00	10.50	9.10	10.20	10.60	11.10	9.70	9.70	10.40	10.40	1.00	10.20
Eggs	1.60	1.50	1.70	1.50	1.60	1.70	1.60	1.60	1.60	1.50	2.00	1.60
Food eaten away from home	30.00	33.60	34.50	35.20	30.10	31.60	3.30	36.80	30.30	33.40	3.50	37.30
Fresh fruit	3.60	3.20	3.10	4.10	3.70	3.40	3.30	3.90	3.70	3.80	4.00	4.30
Fish	2.50	1.50	2.20	2.30	2.50	1.50	2.20	1.90	2.30	1.70	2.00	2.20
Fats and oils	2.80	2.50	2.50	2.80	2.60	3.00	2.50	2.50	2.70	2.50	2.40	2.40
Fresh vegetables	3.20	2.80	3.40	3.40	3.50	3.40	3.50	3.90	3.50	3.40	3.50	4.00
Nonalcoholic beverages	7.10	6.90	7.20	6.90	6.70	6.40	6.80	6.20	7.20	7.00	6.30	5.80
Other meats	3.80	3.20	2.70	2.40	3.80	3.70	2.80	2.40	3.80	3.50	2.80	2.50
Pork	4.40	5.20	4.90	3.80	4.30	5.10	5.30	4.30	4.10	4.50	5.00	3.80
Prepared fruit	3.10	2.60	2.40	2.90	3.00	2.70	2.70	2.90	3.10	2.80	2.80	2.90
Poultry	3.40	3.00	3.70	3.00	3.60	2.70	3.60	2.90	3.60	2.80	3.60	2.70
Prepared vegetables	2.10	1.70	2.20	1.80	1.80	2.10	2.30	1.80	2.10	2.00	2.10	1.90
Sugar and sweeteners	3.10	3.00	3.00	2.90	2.90	29.00	3.00	2.40	2.70	2.80	2.60	2.70

	1983				1984				1985			
	Northeast	North Central	South	West	Northeast	North Central	South	West	Northeast	North Central	South	West
	Percent											
Beef	7.70	7.00	7.00	6.80	7.30	7.00	7.00	6.00	6.50	6.10	6.30	6.00
Cereals and bakery	11.10	10.40	10.00	9.10	11.30	10.30	10.00	9.30	10.80	10.70	10.10	9.90
Dairy	10.50	10.50	9.00	10.20	10.10	9.40	9.30	9.80	10.10	9.70	9.30	9.70
Eggs	1.50	1.40	2.00	1.50	1.50	1.30	1.70	1.40	1.20	1.10	1.30	1.20
Food eaten away from home	30.40	34.20	3.60	37.20	32.50	35.10	36.80	37.60	33.10	35.90	26.90	38.70
Fresh fruit	3.60	3.80	8.00	3.90	3.80	3.30	3.30	4.30	3.80	3.50	3.40	3.70
Fish	2.30	1.60	2.10	2.20	2.30	1.60	1.90	2.20	2.50	1.70	2.40	2.10
Fats and oils	2.50	2.30	2.30	2.30	2.40	2.60	2.20	2.50	2.50	2.60	2.40	2.50
Fresh vegetables	3.70	3.10	3.60	4.30	3.90	3.30	3.30	4.10	3.60	3.20	3.60	3.90
Nonalcoholic beverages	6.90	7.20	6.80	6.50	6.30	7.50	7.00	6.80	6.80	7.00	7.00	6.60
Other meats	3.70	3.40	2.70	2.40	3.40	3.20	2.50	2.20	3.20	3.40	2.80	2.30
Pork	4.40	4.60	4.60	3.40	4.00	4.50	4.10	3.60	4.00	4.70	4.10	3.60
Prepared fruit	3.40	3.80	2.90	2.70	3.40	2.70	2.60	2.90	3.30	2.90	3.00	2.80
Poultry	3.50	2.60	3.30	2.70	3.50	2.90	3.50	3.00	3.80	2.70	3.00	2.60
Prepared vegetables	2.10	2.10	2.10	2.00	2.10	2.10	2.20	1.90	2.00	2.10	2.10	1.70
Sugar and sweeteners	2.50	3.10	2.60	29.00	2.50	3.10	2.60	2.60	2.70	3.00	2.60	2.80

from home had the largest budget share, ranging from 30 percent in the Northeast to 35 percent in the West in 1980, and from 33 percent in the Northeast to 39 percent in the West in 1985. As income has risen, consumers have allocated more of their food expenditures to this category, even as the cost of doing so has risen. Thus, it would appear that households with greater budget shares of food eaten away from home should have a higher cost of food index.

Table 3--Average budget shares for food by race and year

Food category	Average budget shares of nonwhites						Average budget shares of whites					
	1980	1981	1982	1983	1984	1985	1980	1981	1982	1983	1984	1985
	Percent											
Beef	9	8	8	8	8	7	8	8	7	7	7	6
Cereals and bakery	10	11	11	11	11	10	10	10	10	10	10	10
Dairy	8	8	9	8	8	8	10	11	10	10	10	10
Eggs	2	2	2	2	2	2	2	2	1	1	1	1
Food eaten away from home	28	28	28	30	30	32	33	34	35	36	36	37
Fresh fruit	4	4	4	4	4	4	3	4	4	4	4	4
Fish	3	3	3	3	3	3	2	2	2	2	2	2
Fats and oils	3	2	2	2	2	3	3	3	3	2	2	2
Fresh vegetables	3	4	4	5	4	5	3	4	4	3	4	3
Nonalcoholic beverages	6	6	6	7	7	6	7	7	7	7	7	7
Other meat	3	3	4	3	3	3	3	3	3	3	3	3
Pork	6	7	7	5	5	6	4	4	4	4	4	4
Prepared fruits	3	3	3	3	3	4	3	3	3	3	3	3
Poultry	5	5	5	5	5	5	3	3	3	3	3	3
Prepared vegetables	2	2	2	2	2	2	2	2	2	2	2	2
Sugar and sweeteners	3	2	3	3	2	3	3	3	3	3	3	3
	Average food expenditures by nonwhites						Average food expenditures by whites					
	1980	1981	1982	1983	1984	1985	1980	1981	1982	1983	1984	1985
	Dollars per capita per week											
Food eaten at home	9.90	10.33	10.45	10.68	10.95	11.86	13.31	14.01	14.38	14.52	15.11	15.38
Food eaten away from home	3.59	3.86	4.15	4.21	4.25	4.84	6.51	6.92	7.96	8.64	8.64	9.54

Table 3 shows budget shares and expenditures on food eaten at home and food eaten away from home by race and year. As before, beef, cereal and bakery products, dairy, food eaten away from home, and nonalcoholic beverages accounted for almost two-thirds of the consumer's food budget. What is notable are the differences between white and nonwhite households in budget shares for food eaten away from home. White households allocated approximately 5 percentage points more of their budgets for expenditures on food eaten away from home than did nonwhite households over the sample period. In dollar terms, whites spent about $3.61 weekly per capita more than nonwhites on food eaten at home in 1981 ($13.31 versus $9.70) and about $2.92 weekly per capita more on food eaten away from home ($6.51 versus $3.59). In 1985, whites spent about $15.88 weekly per capita on food eaten at home, while nonwhites spent $11.86 weekly per capita. For food eaten away from home in 1985, the figures were $9.54 weekly per capita for whites and $4.84 weekly per capita for nonwhites. Some of the disparity is due to differences in household income between the two demographic groups.

Table 4 shows differences in household income. In dollar terms, the lowest income quintile received an average of $3,583 per household in 1980 and $4,669

Table 4--How differences in income affect household food expenditures

Item	1980	1981	1982	1983	1984	1985
			Percentage per household			
Share of U.S. income by quintile*						
Q1 1/	4.78	4.60	4.46	4.33	4.36	4.27
Q2	10.97	10.80	10.17	9.62	10.00	9.64
Q3	17.14	17.10	16.37	15.79	16.21	16.09
Q4	24.96	25.14	24.99	24.35	24.45	24.43
Q5 2/	42.20	42.36	44.01	45.91	44.97	45.59
Share of total U.S. food spending by quintile:						
Q1 1/	13.76	13.20	13.75	12.77	12.80	13.33
Q2	16.94	16.49	16.50	16.22	16.48	15.87
Q3	20.33	19.84	19.03	18.81	19.84	19.40
Q4	22.70	22.85	22.53	22.28	22.41	22.59
Q5 2/	26.28	27.62	28.19	29.91	28.48	28.81
Average propensity to spend on food from income:						
Q1 1/	22.00	22.00	24.00	22.00	21.00	23.00
Q2	12.00	12.00	12.00	13.00	12.00	12.00
Q3	9.00	9.00	9.00	9.00	9.00	9.00
Q4	7.00	7.00	7.00	7.00	7.00	7.00
Q5 2/	5.00	5.00	5.00	5.00	5.00	5.00
			Dollars per household			
Average amount of U.S. income by quintile:						
Q1 1/	3,583	3,891	3,989	3,859	4,362	4,669
Q2	9,068	9,934	10,246	9,993	11,050	11,359
Q3	15,682	16,803	17,606	17,520	18,908	20,128
Q4	22,146	25,410	26,889	29,998	30,022	31,361
Q5 2/	38,383	41,692	46,897	51,853	53,696	58,306

*A quintile is 20 percent of the population.
1/ Q1 is the lowest quintile.
2/ Q5 is the highest quintile.

in 1985. (A quintile represents 20 percent of the population.) However, the highest income quintile received $38,383 and $58,306 for the same 2 years. If we deflate these incomes by the CPI, we find that in real terms the lowest income quintile gained about $300 over the 6-year period, while the highest income quintile gained approximately $10,000.

Over the sample period, the lowest income quintile received 4.78 percent of all income in 1980 but only 4.27 percent in 1985. However, the highest income quintile received 42.20 percent of all U.S. income in 1980 but increased their share to 45.59 percent in 1985. All quintiles except the highest saw their relative shares of income decline in 1980-85.

Table 4 also shows the share of total national food expenditures each quintile made. The pattern is exactly the same as that for income. Hence, all quintiles but the highest experienced a decline in the share of expenditures devoted to all purchased food. The average propensity to spend on food from income is also shown in table 4. The lowest quintile spent 22 percent of income on food in 1980. It spent 23 percent of income on food in 1985 after reaching a high of 24 percent in 1982. Contrasted with this, the highest income quintile spent only 5 percent of income on food over the 6-year period. In fact, the average propensity to spend on food has been constant for quintiles 2 through 5 except for the second quintile in 1983.

The lowest income group in the United States has seen its relative welfare deteriorate from 1980 through 1986, both in terms of gross income and the amount of income spent on food. With a declining real share of income, we would expect households in the bottom quintile to concentrate purchases on rather inelastic "necessary" goods and to make fewer outlays for those food categories that are highly income elastic.

Empirical Results

The equation we estimate for each of the 16 food groups is:

$$W_{iht} = A_{it} + A_{inc}D_{nc} + A_{is}D_s + A_{iw}D_w + Z_{iz} \ln Z_h + R_1D_r$$

$$+ (Y_{it} + Y_{inc}D_{nc} + Y_{is}D_s + Y_{iw}D_w + Y_{ir}D_r)\ (\ln X_{ht} - \alpha_t), \qquad (40)$$

where t = 1980...1985 and the D subscripted variables are dummy variable shifters for both the intercepts A_{it} and the slopes Y_{it} for the demographic groups in the North Central States, the South, and the West as well as for race. In addition, we have the intercept shift variable for household size, Z_{iz}. For the variable Z_h, we used the log of the family size equivalence scales implicit in the official poverty thresholds published by the Bureau of the Census, U.S. Department of Commerce, for households of one to five persons. X_{ht} is household expenditure on total food: thus, we have made the assumption that food expenditures are separable from expenditures on other goods. We also made the usual assumptions of intertemporal separability and separability of market goods from leisure and public goods. Finally, α_t is the minimum household expenditure on total food and is known as the reference household. We used eight demographic reference households in this study: white and nonwhite single households in the Northeast, the North Central States, the South, and the West.

Table 5 presents estimates for the 16 Engel curves. For each equation, A_{80} through A_{85} represents the intercept for the Northeast for each year of data. A_{nc} through A_w represents regional demographic dummy variables for the North Central States, the South, and the West. The variable Z represents the estimated coefficient for household size, while R_1 is the demographic dummy variable for race.

Table 5--Parameter estimates of Engel curves

Food category	A80	A81	A82	A83	A84	A85	A_{nc}	A_s	A_w
Beef	0.0748	0.0722	0.0657	0.0645	0.0610	0.0541	-0.0084	-0.0053	-0.0076
	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)	(.002)	(.002)	(.002)
Cereals and bakery	.1199	.1225	.1224	.1217	.1233	.1272	-.0021	-.0129	-.0201
	(.002)	(.003)	(.003)	(.003)	(.003)	(.003)	(.002)	(.002)	(.002)
Dairy	.0888	.0905	.0882	.0889	.0839	.0869	.0023	-.0089	-.0046
	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)	(.002)	(.002)	(.002)
Eggs	.0228	.0230	.0221	.0216	.0214	.0191	-.0004	-.0009	.0007
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
Food eaten away from home	.2524	.2495	.2622	.2667	.2757	.2763	.0353	.0563	.0637
	(.009)	(.009)	(.009)	(.008)	(.008)	(.008)	(.007)	(.007)	(.008)
Fresh fruit	.0414	.0422	.0447	.0428	.0429	.0422	-.0029	-.0024	.0072
	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)	(.001)	(.001)	(.001)
Fish	.0330	.0326	.0327	.0326	.0323	.0338	-.0073	-.0049	-.0042
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
Fats and oils	.0237	.2336	.0221	.0206	.0217	.0225	.0007	-.0008	.0022
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.009)	(.001)	(.001)
Fresh vegetables	.0392	.0430	.0435	.0438	.0437	.0427	-.0027	-.0013	.0082
	(.002)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
Nonalcoholic beverage	.0732	.0679	.0678	.0709	.0714	.0721	-.0054	-.0056	-.0091
	(.003)	(.003)	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)
Other meats	.0345	.0364	.0360	.0351	.0332	.0341	-.0032	-.0094	-.0134
	(.002)	(.002)	(.002)	(.001)	(.001)	(.002)	(.001)	(.001)	(.001)
Pork	.0498	.0518	.0478	.0464	.0447	.0450	.0058	.0064	-.0035
	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)
Processed fruit	.0405	.0414	.0419	.0424	.0413	.0433	-.0061	-.0075	-.0058
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
Poultry	.0558	.0551	.0051	.0530	.0553	.0530	-.0092	-.0040	-.0102
	(.002)	(.002)	(.002)	(.001)	(.002)	(.002)	(.001)	(.001)	(.001)
Processed vegetables	.0218	.0222	.0222	.0226	.0228	.0216	-.0016	-.0003	-.0027
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
Sugar and sweeteners	.0284	.0264	.0254	.0263	.0253	.0262	.0041	.0015	-.0008
	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)	(.001)	(.001)	(.001)

See footnotes at end of table.

Continued---

Table 5--Parameter estimates of Engel curves--Continued

Food category	Z	R_1	Y	Y_{nc}	Y_s	Y_w	Y_r	R^2	F
Beef	0.0472	-0.0080	0.0119	0.0052	0.0035	-0.0031	-0.0054	0.44	26.23***
	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)	(.001)		
Cereals and bakery	.0184	-.0018	-.0315	-.0074	-.0020	.0069	.0085	.66	17.60***
	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)	(.001)		
Dairy	.0188	.0401	-.0263	-.0076	.0025	.0064	-.0107	.63	2.87**
	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)		
Eggs	.0004	-.0025	-.0047	-.0020	.0009	-.0015	-.0010	.30	11.25***
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)		
Food eaten away from home	-.1140	.0226	.0608	.0085	-.0060	-.0062	.0227	.66	6.62***
	(.006)	(.006)	(.007)	(.007)	(.007)	(.007)	(.006)		
Fresh fruit	-.0111	-.0011	-.0014	-.0005	-.0022	-.0059	-.0025	.36	1.71
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)		
Fish	.0017	-.0135	.0064	-.0014	.0008	.0005	-.0024	.21	.54
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)		
Fats and oils	.0040	.0037	.0010	-.0010	-.0011	-.0033	-.0027	.38	4.34***
	(.008)	(.008)	(.001)	(.001)	(.001)	(.001)	(.001)		
Fresh vegetables	-.0047	-.0066	.0010	-.0015	-.0013	-.0064	-.0001	.43	5.00***
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)		
Nonalcoholic beverage	.0018	.0145	-.0183	.0080	.0081	.0081	-.0026	.48	3.16***
	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)	(.001)		
Other meats	.0124	-.0015	.0006	.0009	.0002	.0013	-.0027	.33	2.79**
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)		
Pork	.0207	-.0174	.0109	-.0015	-.0054	-.0028	-.0065	.35	6.95***
	(.002)	(.001)	(.002)	(.002)	(.002)	(.002)	(.001)		
Processed fruit	-.0055	-.0048	-.0049	.0012	.0027	.0023	.0003	.34	1.88*
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)		
Poultry	.0063	-.0215	-.0019	-.0003	-.0005	.0012	.0008	.31	2.19*
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)		
Processed vegetables	.0045	-.0029	-.0033	.0020	.0021	.0012	.0022	.32	.85
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)		
Sugar and sweeteners	.0038	.0006	-.0033	-.0025	-.0022	.0012	.004	.28	1.70
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)		

* = Significant at the 10-percent level. ** = Significant at the 5-percent level. *** = Significant at the 1-percent level. Standard errors are in parentheses.

Slope expenditure parameters are represented by Y through Y_w, where Y represents the estimated expenditure coefficient for nonwhites in the Northeast and Y_{nc}, Y_s, and Y_w are the estimated dummy slope shifters for nonwhites' expenditures in the North Central States, the South, and the West, respectively. Y_r is the dummy expenditure slope shifter for the white race. R^2 is a statistic for the goodness of fit of each equation. "F" is a significance test of estimating an intercept for each year compared with estimating one common intercept for all years.

Many of the estimated coefficients are highly significant. All of the estimated intercepts for the Northeast are significant at the 5-percent level or greater. The majority of the regional dummy intercepts, which are in effect a test of their significance relative to the Northeast, are also significant at the 5-percent level. Notable exceptions include the North Central States for dairy; the North Central States, the South, and the West for eggs; the North Central States and the South for fats and oils; the South for fresh vegetables; the West for pork; the North Central States and the South for processed vegetables; and the South and the West for sugar and sweeteners.

All coefficients for the household size variable are significant at the 5-percent level except those for the equations for eggs, fish, fats and oils, and nonalcoholic beverages. For the race variable, all estimates show that white and nonwhite households have significantly different consumption patterns at the 5-percent level except for cereals and bakery goods, fresh fruit, fats and oils, other meats, and sugar and sweeteners.

The expenditure coefficient for the Northeast is significant at the 5-percent level except for fresh fruit, fats and oils, fresh vegetables, and other meats. The remaining dummy variables for the slope coefficients, which like the intercept shifters are a test for a significant difference between the Northeast and the relevant region, offer very mixed results. For each remaining region, only seven equations were found to have significantly different slopes from that of the Northeast except for the South, which had six. For the North Central States, the seven equations with slopes significantly different from the Northeast at the 5-percent level or greater were beef, cereal and bakery products, dairy, eggs, nonalcoholic beverages, processed vegetables, and sugar and sweeteners. For the South, the six slope estimates that were significantly different were those for fresh fruit, nonalcoholic beverages, pork, processed fruit, processed vegetables, and sugar and sweeteners. Finally, for the West, slope estimates for cereals and bakery products, dairy, fresh fruit, fats and oils, fresh vegetables, nonalcoholic beverages, and processed fruit were significantly different from those of the Northeast.

The last variable of the model is an estimate for a significant difference between white and nonwhite households on marginal expenditures for the 16 food categories. All categories were found to be significantly different at the 5-percent level or greater except for eggs, fresh vegetables, processed fruit, and poultry.

F-tests indicate that most equations are better represented by letting the intercept shift from one time period to another rather than using a single estimated parameter. Exceptions include fish, fresh fruit, processed vegetables, and sugar and sweeteners. We hypothesize that very little substitution occurs between these four categories and the other food categories. For example, health concerns may have motivated consumers to increase the amount of fish in their diet despite a steady increase in its price over the 1980-85 period. The other three commodity groups may represent categories for which little or no substitution will occur. For instance, households may substitute one kind of fresh fruit for another, but will not substitute fresh vegetables for fresh fruit.

A true cost index for a reference household, as noted above, can be calculated from the estimated intercepts of the Engel curves. In turn, marginal indexes can be used with the reference household index to construct indexes that take into account the effects of race, region, and household size. Marginal expenditure indexes for households with budgets above the reference household can also be constructed, again taking into account race and region.

Table 6 shows demographic marginal indexes for race, region, and household size. All values are shown in logs so that the antilog converts the value into a standard index where 1980 = 100. The race variable is for white reference households, because the dummy variable for nonwhite households was eliminated from the model to avoid perfect multicollinearity. For the study period, food costs of white households increased more than those of nonwhite households. These values ranged from a low of 0.02 percent in 1985 to a high of 0.7 percent in 1983. Likewise, the three regional dummy variables are all positive, indicating that households in the Northeast experienced the lowest rate of food price increases. Although both the North Central States and the South had similar rates of price increases, the West experienced the highest rates of increase (ranging from a low of 0.22 percent in 1981 to a high of 0.85 percent in 1985).

Table 6--Demographic marginal indexes and marginal expenditure indexes

Year	Demographic marginal indexes							
		Region			Household size			
	White households	North Central	South	West	2	3	4	5
				1980 = 0				
1981	0.0019	0.0011	0.0009	0.0022	-0.0011	-0.0020	-0.0029	-0.0038
1982	.0046	.0030	.0029	.0038	-.0018	-.0032	-.0052	-.0063
1983	.0070	.0037	.0046	.0056	-.0030	-.0053	-.0087	-.0106
1984	.0053	.0045	.0043	.0071	-.0032	-.0070	-.0102	-.0135
1985	.0002	.0038	.0068	.0085	-.0051	-.0092	-.0144	-.0179

Year	Marginal expenditure indexes			
		Region		
	White households	North Central	South	West
		1980 = 0		
1981	0.0001	-0.0007	-0.0008	-0.0006
1982	.0013	-.0004	-.0016	-.0010
1983	.0025	-.0005	-.0016	-.0007
1984	.0032	-.0008	-.0019	-.0018
1985	.0041	-.0005	-.0024	-.0013

Table 6 includes the demographic marginal indexes for household size. Each value for household size 2 through 5 is negative and increases in magnitude over the 6 study period years. This pattern indicates that, relative to a single-member household, the true cost of food falls as household size increases. Intuitively, this may seem contradictory. However, the apparent contradiction is dispelled when one considers how food eaten away from home figures into overall food purchases. Our 16 food categories, for example, include food eaten away from home, which experienced one of the largest price increases of all food categories. Our data indicate that per capita spending for food eaten away from home declines as household size increases. A two-member household in 1981 experienced an increase in food cost that was 0.11 percent lower than a single-member household, while a five-member household experienced a rate that was 0.38 percent lower than a single-member household. The rates experienced by a two-member and a five-member household in 1985 were 0.51 and 1.79 percent lower, respectively, than a single-member household.

Table 6 also shows marginal expenditure indexes. These marginal indexes are used to construct true cost of food indexes for households having higher expenditures than the reference household. They indicate how much the reference index changes for every 1-percent increase in total food expenditure. The race variable for white households is again positive, indicating that the true cost of food index increases as expenditures surpass the expenditure of the reference household relative to nonwhites. However, the three regional dummy slope shifters are all negative, indicating that consumers in the Northeast have a larger marginal propensity to consume than consumers in the other three regions. Of the three regions, the North Central States had the smallest negative coefficients, indicating that marginal expenditures there were closest to the Northeast. The largest difference was between the South and the West. Thus, while the Northeast should have the lowest value index for the reference household, households whose expenditures were higher than that of the reference household may have higher true indexes than those of the North Central States, the South, and the West.

To put the marginal expenditure indexes in perspective, we also calculated the marginal expenditure indexes (table 7) for eight possible reference households from the estimated Engel curves. The reference households are white and nonwhite households in the Northeast, the North Central States, the South, and the West. These combine the effects of race and region. All the marginal expenditure indexes are positive except those for nonwhite households in 1981. White households in the Northeast generally experienced the highest rate of increase. Among nonwhite households, the highest rate of increase was also in

Table 7--Combined marginal expenditure indexes for eight possible reference households

Year	Household category							
	Nonwhite Northeast	White Northeast	Nonwhite North Central	White North Central	Nonwhite South	White South	Nonwhite West	White West
	Index							
1981	-0.00001	0.00096	-0.00067	0.00029	-0.00063	0.00014	-0.0006	0.00036
1982	.00251	.00377	.00225	.00334	.00121	.00218	.0015	.00278
1983	.00285	.00538	.00249	.00491	.00150	.00374	.0021	.00464
1984	.00244	.00566	.00189	.00489	.00090	.00375	.0006	.00390
1985	.00354	.00763	.00334	.00713	.00157	.00528	.0022	.00630

the Northeast from 1981 though 1985. For white households in the Northeast, the marginal expenditure index implies that for each 1-percent increase in food expenditures above the reference household, the true food cost index increased from 0.10 percent in 1981 to 0.76 percent in 1985.

With this background, we can now look at various cost of food indexes constructed from the estimated Engel curves. In table 8, we constructed indexes for three kinds of households: a reference (least-expenditure) single-member household, single-member average-expenditure household, and single-member high-expenditure households. Indexes were constructed for the total sample (one person), nonwhites and whites, and by region. Average expenditure refers to the average weekly household expenditure in the sample, which was approximately $62.75. The high-expenditure level was one standard deviation above this figure and was approximately $103.79.

Looking at table 8 and the least-expenditure indexes, we see that each index exceeds the CPI index. This pattern also holds true for households with expenditures above the reference household. Other things being equal, we intuitively would expect the true index to lie below the CPI because the true index allows substitution to occur among the 16 food categories. However, we note that over the 1980-85 period households increased their budget share of food eaten away from home (a food category that has had a large price increase). Because the CPI is a fixed-weight index and because the weight in the CPI was based on expenditures in 1972, the CPI underestimates the increase in total food prices. Note also that our indexes in table 8 are for single households, which our data indicate allocate a larger budget share to food eaten away from home than do larger households.

Focusing on the individual categories, we see that whites have a higher index than nonwhites. The Northeast has the lowest index and the West has the highest index of the four regions. This finding was expected from our discussion of the demographic marginal indexes. Note also that among reference households the differences in the indexes for the races is slight, amounting to 0.1 of an index point in 1981 and 0.2 of an index point in 1985. Differences among the regions similarly are quite small, ranging from 0.2 of an index point difference between the Northeast and the West in 1981 to 1.4 index points between the same two regions in 1985.

When we take into account expenditures exceeding that of the reference household and look at the average-expenditure indexes of table 8, we again see that whites have a higher index than nonwhites. But now the South has the lowest index, while the West again has the highest index. The likely reason is that, of the four regions, the South has the lowest marginal propensity to consume.

It appears that the difference in indexes between the races generally is greater than between the regions. Hence, even given the same dollar amount of food expenditures, the buying patterns of the races differ as shown by the race variable in the estimated Engel curves.

When we examine the high-expenditure level in table 8, the same pattern as the average-expenditure category emerges. Whites have a true cost of food index which is 0.4 of an index point higher than nonwhites in 1981 and 1.3 index points higher than nonwhites in 1985.

Table 8--Indexes of single-member households

Household type and year	CPI*	All	Nonwhite	White	North-east	North Central	South	West
				1980 = 100				
Single-member (least-expenditure) reference household:								
1981	107.8	108.2	108.1	108.2	108.1	108.2	108.2	108.3
1982	112.2	112.8	112.3	112.8	112.5	112.8	112.8	112.9
1983	114.5	115.3	114.9	115.4	114.9	115.3	115.4	115.5
1984	118.9	120.0	119.5	120.1	119.6	130.1	120.0	120.4
1985	121.7	122.5	122.3	122.5	121.8	122.2	122.6	123.2
Single-member average-expenditure household:								
1981	107.8	108.3	108.0	108.4	108.3	108.3	108.2	108.4
1982	112.2	113.4	112.7	113.5	113.3	113.5	113.2	113.5
1983	114.5	116.3	115.1	116.4	116.1	116.4	116.1	116.5
1984	118.9	121.0	119.8	121.2	120.9	121.2	120.8	121.2
1985	121.7	124.0	123.0	124.1	123.6	123.4	123.7	124.6
Single-member high-expenditure household:								
1981	107.8	108.3	108.0	108.4	108.4	108.3	108.2	108.4
1982	112.2	113.6	112.8	113.6	113.5	113.7	113.3	113.6
1983	114.5	116.5	115.3	116.7	116.4	116.6	116.3	116.7
1984	118.9	121.3	119.9	121.4	121.2	121.4	121.0	121.4
1985	121.7	124.4	123.2	124.5	124.0	124.3	124.0	125.0

*CPI = Consumer Price Index.

Table 9 shows the true cost of food index calculated for the average-sized family with average food expenditures from the sample using the same demographic categories as table 8. In addition, we calculated indexes for a family of four using the same categories. Average family size for the study period was 2.5 people and the average weekly household food expenditure ranged from $56.87 in 1980 to $67.60 in 1985. The true cost of food index for the total sample is still greater than the CPI, but it is closer to the value of the CPI due to the negative effect of household size. Hence, the true cost index is 0.3 of an index point higher than the CPI in 1981 and 1.4 index points higher in 1985. When we look at the index from the point of view of race, however, we see that the index for nonwhites is much closer to the CPI. In fact, both indexes are the same in 1981 and differ by just 0.5 of an index point in 1985. All the true indexes exceed the CPI across regions. The biggest differences are between the South and the West.

Table 9--Comparison of the Consumer Price Index (CPI) and the true cost of food index for various sized households

Year	Average weekly household expenditure	CPI
	Dollars	Percent
1980	56.87	100.0
1981	59.48	107.8
1982	62.91	112.2
1983	63.53	114.5
1984	66.13	118.9
1985	67.60	121.7

Household size and year	All	Nonwhite	White	North-east	North Central	South	West
				1980 = 100			
Household size of 2.5 people:							
1981	108.1	107.8	108.2	108.1	108.1	108.0	108.2
1982	113.1	112.4	113.2	113.0	113.2	112.9	113.2
1983	115.8	114.6	116.0	115.6	115.9	115.6	116.0
1984	120.4	119.2	120.6	120.2	120.6	120.2	120.5
1985	123.1	122.2	123.2	122.7	123.0	122.9	123.7
Household size of 4 people:							
1981	108.0	107.7	108.1	108.0	108.0	107.9	108.1
1982	112.8	112.1	112.9	112.7	112.9	112.6	112.9
1983	115.3	114.1	115.5	115.1	115.4	115.1	115.5
1984	119.8	118.6	120.0	119.8	120.0	119.8	119.9
1985	122.2	121.3	122.3	121.8	122.1	122.0	122.8

When household size is increased to four, the calculated index for nonwhites falls below that of the CPI. However, the index for the total sample is very close to the CPI, being 0.2 of an index point higher in 1981 and 0.5 of an index point higher in 1985. The largest difference resulted in 1984 when the true index was 0.9 of an index point higher than the CPI. The regional patterns are the same as for the average family size category.

Tables 10, 11, 12, and 13 look at the true cost of food indexes by region, race, expenditure levels, and household size. Expenditures are defined as before. The reference household is nonwhites in the Northeast. The indexes are directly comparable across region, race, household size, and expenditure level.

Each table presents one region. Table 10 shows true cost of food indexes for nonwhites and whites by household size for the Northeast. Examining the nonwhite category, we see that the true cost of food index falls below the CPI when household size is greater than or equal to two people for the least-expenditure level, when household size is greater than or equal to three people in the average-expenditure category, and when household size is greater than or equal to four people in the high-expenditure category. For whites, the least-expenditure category is below the CPI when household size is greater than or equal to three people. All of the indexes associated with average- and high-expenditure levels exceed the CPI, although some nearly match it.

For the North Central region, the true cost of food index for nonwhites in the least-expenditure category falls below the CPI when household size is greater than or equal to three people (table 11). In addition, the true cost of food index lies below the CPI when household size is greater than or equal to four people for the average-expenditure category and greater than or equal to five people for the high-expenditure category. For whites, the calculated indexes for the least-expenditure category lie below the CPI when household size is greater than or equal to five. The true index exceeds the CPI for all other households.

The South has the same pattern except that the true cost of food index for nonwhites lies below the CPI for both the least- and average-expenditure levels for households of three or more people (table 12). For whites, the true index drops below the CPI for the least-expenditure category when household size is five or more people. All other households exceed the CPI, although the indexes are close.

In the West, the calculated true cost of food index for nonwhites is below the CPI for households with three or more people in the least-expenditure category, households with four or more people in the average-expenditure category, and households with five or more people in the high-expenditure category (table 13). For whites, the true index lies below the CPI for households of five or more people in the least-expenditure category. All other indexes lie above the CPI.

We have seen that the CPI generally underestimated the cost of food over the 1980-85 period. It appears that the CPI more accurately reflects the cost of food for nonwhite households with low food expenditures and with three or more household members. Conversely, the CPI seems to be most biased against white, single-member households with average or above-average food expenditures. It should be noted that most of the true food cost indexes we calculated were fairly close to the CPI for total food. Thus, it appears that overall, for

the period 1980 through 1985, the CPI was a fairly good indicator of food cost for the population as a whole.

Table 10--True cost of food indexes for the Northeast

Household size and year	CPI*	Nonwhite households			White households		
		Least expenditure	Average expenditure	High expenditure	Least expenditure	Average expenditure	High expenditure
		1980 = 100					
One-member household:							
1981	107.8	107.9	107.9	107.9	108.1	108.3	108.4
1982	112.2	112.0	112.5	112.7	112.5	113.4	113.6
1983	114.5	114.2	114.8	115.6	115.0	116.2	116.5
1984	118.7	119.0	119.6	119.7	119.6	121.0	121.3
1985	121.7	121.8	122.6	122.8	121.8	123.7	124.1
Two-member household:							
1980	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1981	107.8	107.8	107.8	107.8	108.0	108.2	108.3
1982	112.2	111.8	112.3	112.5	112.3	113.2	113.4
1983	114.5	113.8	114.5	115.3	114.6	115.8	116.1
1984	118.9	118.6	119.2	119.3	119.2	120.6	120.9
1985	121.7	121.1	122.0	122.2	121.2	123.0	123.5
Three-member household:							
1981	107.8	107.7	107.7	107.7	107.9	108.1	108.2
1982	112.2	111.7	112.3	112.3	112.2	113.0	113.2
1983	114.5	113.6	114.2	115.0	114.4	115.6	115.9
1984	118.9	118.1	118.7	118.9	118.8	120.1	120.4
1985	121.7	120.6	121.5	121.7	120.7	122.5	123.0
Four-member household:							
1981	107.8	107.6	107.6	107.6	107.8	108.0	108.1
1982	112.2	111.4	112.0	112.1	112.0	112.8	113.0
1983	114.5	113.2	113.8	114.6	114.0	115.2	115.5
1984	118.9	117.8	118.3	118.5	118.4	119.7	120.0
1985	121.7	120.0	120.9	121.1	120.0	121.9	122.3
Five-member household:							
1981	107.8	107.5	107.5	107.5	107.7	107.9	108.0
1982	112.2	111.3	111.8	112.0	111.8	112.6	112.9
1983	114.5	113.0	113.6	114.4	113.8	115.0	115.3
1984	118.9	117.4	118.0	118.1	118.0	119.3	119.6
1985	121.2	119.6	120.4	120.6	119.6	121.5	121.9

*CPI = Consumer Price Index.

Table 11--True cost of food indexes for the North Central States

Household size and year	CPI*	Nonwhite households			White households		
		Least expenditure	Average expenditure	High expenditure	Least expenditure	Average expenditure	High expenditure
		1980 = 100					
One-member household:							
1981	107.8	108.0	107.9	107.9	108.3	108.3	108.3
1982	112.2	112.4	112.9	113.0	112.9	113.6	113.8
1983	114.5	114.6	115.2	115.3	115.4	116.5	116.8
1984	118.9	119.5	120.0	120.1	120.1	121.3	121.6
1985	121.7	122.2	123.0	123.2	122.2	124.0	124.4
Two-member household:							
1981	107.8	107.9	107.8	107.8	108.1	108.2	108.2
1982	112.2	112.2	112.6	112.8	112.7	113.4	113.6
1983	114.5	114.3	114.8	115.0	115.1	116.2	116.5
1984	118.9	119.1	119.6	119.7	119.8	120.9	121.2
1985	121.7	121.6	122.4	122.6	121.6	123.4	123.8
Three-member household:							
1981	107.8	107.8	107.7	107.7	108.0	108.1	108.1
1982	112.2	112.0	112.5	112.6	112.5	113.2	113.4
1983	114.5	114.0	114.6	114.7	114.8	115.9	116.2
1984	118.9	118.7	119.1	119.2	119.7	120.5	120.7
1985	121.7	121.1	121.9	122.1	121.1	122.9	123.8
Four-member household:							
1981	107.8	107.7	107.6	107.6	107.9	108.0	108.0
1982	112.2	111.8	112.3	112.4	112.3	113.0	113.2
1983	114.5	113.6	114.2	114.3	114.4	115.5	115.8
1984	118.9	118.3	118.7	118.8	118.9	120.1	120.4
1985	121.7	120.5	121.3	121.5	120.5	122.2	122.6
Five-member household:							
1981	107.8	107.6	107.5	107.5	107.8	107.9	107.9
1982	112.2	111.7	112.1	112.3	112.2	112.9	113.1
1983	114.5	113.4	114.0	114.1	114.2	115.3	115.6
1984	118.9	117.9	118.4	118.4	118.5	119.7	120.0
1985	121.7	120.0	120.9	121.0	120.1	121.8	122.2

*CPI = Consumer Price Index.

Table 12--True cost of food indexes for the South

Household size and year	CPI*	Nonwhite households			White households		
		Least expen-diture	Average expen-diture	High expen-diture	Least expen-diture	Average expen-diture	High expen-diture
				1980 = 100			
One-member household:							
1981	107.8	108.0	107.9	108.0	108.2	108.3	108.3
1982	112.2	112.3	112.6	112.7	112.9	113.3	113.5
1983	114.5	114.7	115.0	115.1	115.5	116.4	116.6
1984	118.9	119.5	119.7	119.7	120.1	121.0	121.2
1985	121.7	122.6	123.0	123.1	122.6	123.9	124.2
Two-member household:							
1981	107.8	107.9	107.8	107.9	108.1	108.1	108.1
1982	112.2	112.1	112.4	112.5	112.7	113.1	113.3
1983	114.5	114.4	114.7	114.8	115.2	116.0	116.2
1984	118.9	119.1	119.3	119.4	119.7	120.6	120.8
1985	121.7	122.0	122.3	122.4	122.0	123.3	123.6
Three-member household:							
1981	107.8	107.8	107.7	107.7	108.0	108.0	108.0
1982	112.2	112.0	112.2	112.3	112.5	113.0	113.1
1983	114.5	114.1	114.4	114.5	114.9	115.7	116.0
1984	118.9	118.5	118.8	118.9	119.3	120.2	120.4
1985	121.7	121.5	121.8	121.9	121.5	122.8	123.1
Four-member household:							
1981	107.8	107.7	107.6	107.7	107.9	108.0	108.0
1982	112.2	111.8	112.0	112.1	112.3	112.7	112.9
1983	114.5	113.7	114.0	114.1	114.5	115.3	115.6
1984	118.9	118.3	118.5	118.5	118.9	119.8	120.0
1985	121.7	120.8	121.2	121.3	120.9	122.1	122.4
Five-member household:							
1981	107.8	107.6	107.5	107.6	107.8	107.9	107.9
1982	112.2	111.6	111.9	112.0	112.2	112.6	112.7
1983	114.5	113.5	113.8	113.9	114.3	115.1	115.3
1984	118.9	117.9	118.1	118.2	118.5	119.4	119.6
1985	121.7	120.4	120.8	120.9	120.4	121.7	122.0

*CPI = Consumer Price Index.

Table 13--True cost of food indexes for the West

Household size and year	CPI*	Nonwhite households			White households		
		Least expen-diture	Average expen-diture	High expen-diture	Least expen-diture	Average expen-diture	High expen-diture
				1980 = 100			
One-member household:							
1981	107.8	108.2	108.0	108.0	108.4	108.4	108.5
1982	112.2	112.4	112.8	112.9	113.0	113.6	113.7
1983	114.5	114.8	115.3	115.4	115.6	116.7	116.9
1984	118.9	119.8	119.9	120.0	120.5	121.4	121.6
1985	121.7	122.8	123.3	123.5	123.3	124.8	125.2
Two-member household:							
1981	107.8	108.0	107.9	107.9	108.3	108.3	108.4
1982	112.2	112.2	112.5	112.7	112.8	113.4	113.5
1983	114.5	114.5	114.9	115.1	115.3	116.3	116.6
1984	118.9	119.4	119.6	119.6	120.1	121.0	121.2
1985	121.7	122.2	122.7	122.8	122.6	124.2	124.6
Three-member household:							
1981	107.8	108.0	107.8	107.8	108.2	108.2	108.3
1982	112.2	112.1	112.4	112.5	112.6	113.2	113.4
1983	114.5	114.2	114.7	114.8	115.0	116.1	116.3
1984	118.9	119.0	119.1	119.2	119.6	120.6	120.7
1985	121.7	121.7	122.2	122.3	122.1	123.7	124.1
Four-member household:							
1981	107.8	107.9	107.7	107.7	108.1	108.1	108.2
1982	112.2	111.9	112.2	112.3	112.4	113.0	113.1
1983	114.5	113.8	114.3	114.4	114.6	115.7	115.9
1984	118.9	118.6	118.8	118.9	119.2	120.2	120.4
1985	121.7	121.0	121.6	121.7	121.5	123.1	123.4
Five-member household:							
1981	107.8	107.8	107.5	107.6	108.0	108.0	108.1
1982	112.2	111.7	112.1	112.2	112.3	112.9	113.0
1983	114.5	113.6	114.1	114.2	114.4	115.4	115.7
1984	118.9	118.2	118.4	118.4	118.8	119.8	120.0
1985	121.7	120.6	121.1	121.3	121.1	122.6	123.0

*CPI = Consumer Price Index.

References

Braithwait, Steven D. (1980), "The Substitution Bias of the Laspeyres Index: An Analysis Using Estimated Cost of Living Indexes," The American Economic Review, Vol. 70, pp. 64-77.

Deaton, A.S., and J. Muellbauer (1980), Economics and Consumer Behavior. Cambridge: Cambridge University Press.

Diewert, W.E. (1976), "Exact and Superlative Index Numbers," Journal of Econometrics, Vol. 4, pp. 115-145.

Fry, V.C., and P. Pashardes (1989), "Constructing the True Cost of Living Index from the Engel Curves of the Piglog Model," Journal of Applied Econometrics, Vol. 4, pp. 41-56.

Kokoski, Mary F. (1987), Consumer Price Indices by Demographic Group, Working Paper 167. U.S. Department of Labor, Bureau of Labor Statistics.

Konus, A.A. (1958), "Consumer Price Indexes and Demand Functions," Review of the International Statistical Institute, Vol. 26, pp. 29-36.

Lau, Lawrence J. (1979), "On Exact Index Numbers," Review of Economics and Statistics, Vol. 61, pp. 73-82.

Muellbauer, J. (1975), "Aggregation, Income Distribution and Consumer Demand," Review of Economic Studies, Vol. 62, pp. 525-543.

_____ (1976), "Community Preferences and the Representative Consumer," Econometrica, Vol. 44, pp. 979-999.

_____ (1977), "The Cost of Living," in Social Security Research, London: Her Majesty's Statistical Office.

Pollak, Robert A. (1975), "Subindexes of the Cost of Living Index," International Economic Review, Vol. 16, pp. 135-150.

Tornqvist, L. (1936), "The Bank of Finland's Consumption Price Index," Bank of Finland Monthly Bulletin, Vol. 10, pp. 1-8.

U.S. Department of Labor, Bureau of Labor Statistics (1978), The Consumer Price Index: Concepts and Content Over the Years, No. 517.

Get these timely reports from USDA's Economic Research Service

These periodicals bring you the latest information on food, the farm, and rural America to help you keep your expertise up-to-date. Get the latest facts, figures, trends, and issues from ERS. To subscribe to these periodicals, call our order desk toll free, 1-800-999-6779 (in the United States and Canada), or use the order form on the next page.

Agricultural Outlook. Presents USDA's farm income and food price forecasts. Emphasizes the short-term outlook, but also presents long-term analysis of issues ranging from international trade to U.S. land use and availability. Packed with more than 50 pages of charts, tables, and text that provide timely and useful information. 11 issues annually.

Economic Indicators of the Farm Sector. Updates economic trends in U.S. agriculture. Each issue explores a different aspect of income and expenses: national and State financial summaries, production and efficiency statistics, and costs of production for livestock and dairy and for major field crops. 5 issues annually.

Farmline. Concise, fact-filled articles focus on economic conditions facing farmers, how the agricultural environment is changing, and the causes and consequences of those changes for farm and rural people. Synthesizes farm economic information with charts and statistics. 11 issues annually.

Food Review. Offers the latest developments in food prices, product safety, nutrition programs, consumption patterns, and marketing. 4 issues annually.

Foreign Agricultural Trade of the United States. Every 2 months brings you quantity and value of U.S. farm exports and imports plus price trends. Subscription also includes two big 300-page supplements containing data for the previous fiscal or calendar year. A must for traders.

Journal of Agricultural Economics Research. Technical research in agricultural economics, including econometric models and statistics on methods employed and results of USDA economic research. 4 issues annually.

Rural Conditions and Trends. Tracks rural events: macroeconomic conditions, employment and underemployment, industrial structure, earnings and income, poverty and population. 4 issues annually.

Rural Development Perspectives. Crisp, nontechnical articles on the results of the most recent and the most relevant research on rural areas and small towns and what those results mean. 3 issues annually.

World Agriculture. Worldwide developments in agricultural markets and trade with an emphasis on implications for global and U.S. agricultural trade. 4 issues annually.

Situation and Outlook Reports. These reports provide timely analyses and forecasts of all major agricultural commodities and related topics such as finance, farm inputs, and land values. Specific titles are listed on the order form on the next page.

Reports. This *free* catalog describes the latest in ERS research reports. It's designed to help you keep up-to-date in all areas related to food, the farm, the rural economy, foreign trade, and the environment. 4 issues annually.

Save by subscribing for up to 3 years!	**1 year**	**2 years**	**3 years**
Agricultural Outlook	____ $26	____ $51	____ $75
Farmline	____ $12	____ $23	____ $33
Economic Indicators of the Farm Sector	____ $14	____ $27	____ $39
Food Review	____ $11	____ $21	____ $30
Journal of Agricultural Economics Research	____ $8	____ $15	____ $21
Foreign Agricultural Trade of the United States	____ $25	____ $49	____ $72
Rural Conditions and Trends	____ $14	____ $27	____ $39
Rural Development Perspectives	____ $9	____ $17	____ $24
World Agriculture (4 per year)	____ $21	____ $41	____ $60
Reports catalog	____ *FREE*		
Situation and Outlook Reports:			
Agricultural Income and Finance (4 per year)	____ $12	____ $23	____ $33
Agricultural Resources (5 per year, each devoted to one topic, including inputs, agricultural land values and markets, and cropland, water, and conservation)	____ $12	____ $23	____ $33
Aquaculture (2 per year)	____ $12	____ $23	____ $33
Cotton and Wool (4 per year)	____ $12	____ $23	____ $33
Dairy (5 per year)	____ $12	____ $23	____ $33
Feed (4 per year)	____ $12	____ $23	____ $33
Fruit and Tree Nuts (4 per year)	____ $12	____ $23	____ $33
Livestock and Poultry (6 per year plus 2 supplements)	____ $17	____ $33	____ $48
Livestock and Poultry Update (monthly)	____ $15	____ $29	____ $42
Oil Crops (4 per year)	____ $12	____ $23	____ $33
Outlook for U.S. Agricultural Exports (4 per year)	____ $12	____ $23	____ $33
Rice (3 per year)	____ $12	____ $23	____ $33
Sugar and Sweetener (4 per year)	____ $12	____ $23	____ $33
Tobacco (4 per year)	____ $12	____ $23	____ $33
U.S. Agricultural Trade Update (monthly)	____ $15	____ $29	____ $42
Vegetables and Specialties (3 per year)	____ $12	____ $23	____ $33
Wheat (4 per year)	____ $12	____ $23	____ $33
Agriculture and Trade Reports (5 per year) Includes *Western Europe, Pacific Rim, China, Developing Economies,* and *USSR.*	____ $12	____ $23	____ $33

For *fastest* service, call toll free, 1-800-999-6779
(8:30-5:00 E.T. in the U.S. and Canada; other areas please call 301-725-7937)

- Use purchase orders, checks drawn on U.S. banks, cashier's checks, or international money orders.
- ***Make payable to ERS-NASS.***
- Add 25 percent extra for shipments to foreign addresses (including Canada).

Mail to: ERS-NASS
P.O. Box 1608
Rockville, MD 20849-1608

Name_____

Organization_____

Address_____

City, State, Zip_____

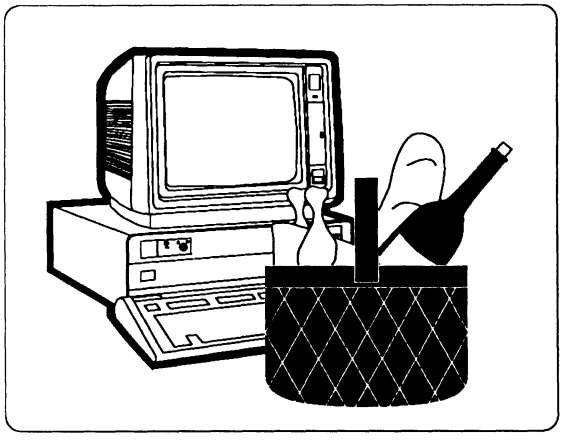
Daytime phone_____

☐ Bill me. Enclosed is $_____. ☐ MasterCard ☐ VISA Total charges $_____.

Credit card number: | | | | | | | | | | | | | | | | |

Expiration date: Month/Year | | |

☆ U.S. Government Printing Office : 1991 - 282-958/40326



Test your knowledge of . . .

Americans and Food

Do you know America's #1 food import or how many new food and grocery products were introduced in 1989? What food showed the largest percentage gain in consumption over the past 20 years? These are just a few of the challenging questions you will find in a new computer quiz developed by USDA's Economic Research Service.

The quiz is available on a 5.25-inch disk and requires MS/PC-DOS Version 3.2 or 3.3 and 640 KB of memory. The program contains 54 questions and answers with important details on a wide variety of topics, ranging from fish consumption and trade to the fast food market. The easy-to-understand questions and answers make the quiz an excellent teaching tool and presentation aid. *Single copies are $25 (Order #91002A), but bulk orders to one address allow a quantity discount: 10 copies for $40 (order #91002B) or 50 copies for $75 (order #91002C)!*

Call **1-800-999-6779** (in the U.S. and Canada; other areas call 301-725-7937) to order your copy today.

Now, here's your chance to test your knowledge of "Americans and Food" with a sample of questions from the quiz. The answers are below.

1. How many new food and grocery products were introduced in 1989?

   (a) 989
   (b) 3,787
   (c) 8,971
   (d) 12,055

2. Which group dines out most often?

   (a) 14-24 year olds
   (b) 25-44 year olds
   (c) 45-64 year olds
   (d) 65 years old and older

3. Do you know the largest market for U.S. exports of processed food?

   (a) Canada
   (b) Japan
   (c) The Netherlands
   (d) Mexico

4. Let's check your knowledge of the many "new" foods available these days. Do you know what *surimi* is?

   (a) A type of cabbage
   (b) A fish product
   (c) A fat substitute
   (d) An artificial sweetener

Ready to tally your score?

1. The correct answer is (d) *12,055*, but an estimated 90 to 99 percent of new food products fail.
2. The correct answer is (b) *25-44 year olds*.
3. Exports of processed food to (b) *Japan* totaled $5.4 billion in 1989, followed by $1.5 billion to Canada.
4. Surimi is a minced (b) *fish product* used in products that simulate crab, shrimp, and other popular seafoods.