**Food Cost Indexes for Low-Income Households and the General Population.** By Noel Blisard, David Smallwood, and Steve Lutz. Food and Rural Economics Division, Economic Research Service, U.S. Department of Agriculture. Technical Bulletin Number 1872.

## Abstract

The results of this study indicate that the Consumer Price Index (CPI) has not systematically overestimated or underestimated the food costs incurred by the general population. "True-cost-of-food" indexes calculated for the general population tend to be the same as or slightly lower than the CPI except for 1994 and 1995. The true-cost indexes also indicate that there are economies to household size, that black households incur lower costs than nonblack households, and that households in the West tend to have the highest costs. True-cost indexes for low-income households tend to be about the same as the CPI for one-person households, and lower than the CPI for two- and four-person households in all years. This is a significant finding in that components of the CPI for food at home are indirectly used to adjust benefit levels for food stamp recipients.

**Keywords:** True cost of living index, true cost of food at home, Engel curve, demand.

## Acknowledgments

The authors appreciate the valuable comments of Mike Harris and Craig Gundersen. A special thanks is extended to Sharon Lee for editorial review and Wynnice Pointer-Napper for preparing this report for publication.

Washington, DC 20036-5831 February 1999

# Contents

# Summary

The results of this study indicate that the Consumer Price Index (CPI) has not systematically overestimated or underestimated food costs incurred by the general population. True-cost-of-food indexes calculated for the general population tend to be the same as or slightly lower than the CPI except for 1994 and 1995. The true-cost indexes also indicate that there are economies to household size, that black households incur lower costs than nonblack households, and that households in the West tend to have the highest costs. True-cost indexes for low-income households tend to be about the same as the CPI for one-person households, and lower than the CPI for two- and four-person households in all years. This is a significant finding in that components of the CPI for food at home are indirectly used to adjust benefit levels for food stamp recipients.

Food cost indexes were constructed for eight types of reference households for the total population. These are defined as households with the minimum food-at-home expenditures in each demographic category. The eight reference household types are nonblack and black households in the Northeast, the North Central States, the South, and the West. Indexes were also constructed for households with two and four members. In addition, food cost indexes were constructed for low-income households. These included the same demographic groups and household sizes, except this group could not be broken down into black and nonblack groups due to the small sample size.

The constructed food cost indexes 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, like the cost of food consumed at home, and to capture the substitution effects within that category.

# Food Cost Indexes for Low-Income Households and the General Population

Noel Blisard
David Smallwood
Steve Lutz

## Introduction

Economists and Federal Government agencies have used various fixed-weight price indexes to determine how changing price levels affect consumers and to adjust the benefit levels of welfare and transfer payment programs. The most widely known fixed-weight index in the United States today is the Consumer Price Index (CPI). The total CPI was originally constructed to measure the inflation rate in the economy over time. 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, a function it was not designed to do.

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.

However, economic theory postulates that consumers will substitute relatively expensive goods with relatively less expensive goods as relative 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 should not use a fixed-weight index because it cannot take into account these substitution effects. To construct index numbers based upon economic theory and to 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 most likely within individual categories.

Given these obstacles, attempts have been made to find a true-cost index that does not require estimating a demand system. One kind of index, advanced by Diewert (1976) 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 as relative prices change if budget shares tend to be fairly constant over time, since the budget shares are used as weights to construct the index.

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.

These criticisms of the CPI's shortcomings indicate a need to develop true-cost indexes that take into account substitution and demographic effects. In this way, economists and other interested parties can approximate the extent to which the CPI may be a biased indicator of the real cost of living changes experienced by society as a whole, and by selected demographic groups, especially low-income households.

The main purpose of the research reported here was to construct, from estimated Engel curves, indexes of the true cost of food at home (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 blacks and nonblacks, by household size, in the Northeast, North Central, South, and West. In addition, we compared indexes for the total population to indexes constructed for low-income households (using household income that is no greater than 130 percent of the poverty line, which represents the gross income test for food stamp eligibility). 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 food at home overestimates or underestimates the change in the cost of food for any demographic group relative to its own true-cost index, particularly the low-income households that may be eligible for food stamps.

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 like food and to capture the substitution effects 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 for the total population. Reference households are demographic households having the minimum food-at-home expenditures in each demographic category. In addition, indexes based on our sample data were constructed for households with one, two, and four people having average food expenditures. For the low-income households, we constructed food cost indexes for four reference households. These were the households having the minimum food expenditure. The size of the low-income sample was too small to allow us to analyze the data by race.

# 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, $P$ the component prices in the current period $t$ and the base period $0$, and $Q$ 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 food-at-home component of the CPI represents about 7 percent of the average household's expenditures. Within the food-at-home category are 16 food commodity groups. They consist of cereals, bakery products, dairy products, eggs, 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 make different substitutions.

A true-cost-of-living or food expenditure index, on the other hand, takes into account substitution as relative prices change. It specifically represents the costs or expenditures 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, 1975). 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-cost 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-cost index depends on the estimated parameters of the demand system. For example, true-cost 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-cost index that does not require direct estimation 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:

$$\ln P(p_1, p_0, t) = \Sigma_k\, 0.5\, (w_1 k + w_0 k) \ln (p_1 k / p_0 k), \qquad (2)$$

where $w_1$ and $w_0$ are budget shares in the two time periods, is a true-cost 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 as relative prices change. Later we will demonstrate how the estimated intercepts from Engel curves can be used to capture the substitution effects 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 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 like symmetry and separability may hold, while at the macro level they may not. Therefore, the market demand functions that we estimate 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 prices of different goods 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 in the $h^{th}$ household, 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:

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

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

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

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 $\alpha_{ih}$ and $\beta_i$ of $p$ alone, such that:

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

where $\alpha$ is indexed on $h$ but $\beta$ is not. Note that if either $\alpha$ or $\beta$ were negative, then expenditures would have to be restricted within some range to keep quantities from also being negative. For the aggregate function, we would then have:

$$\overline{q} = \alpha_i (p) = \beta_i (p) \overline{x}, \tag{7}$$

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 (denoted $u_h$), 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:

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

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

Note that the cost function in equation 8 implies quasi-homothetic 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 disagregated 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 budget share for the $i^{th}$ good as:

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

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, nonlinear aggregation requires 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 $\varphi(x,\mathrm{p})$, with corresponding cost function $c(u,p)$ exists, so that for some level of utility $u_0 = \varphi(x_0,p)$, we have:

$$\bar{w}_i = w_i(u_0,p) = \delta\ln c(u_0,p)/\delta\ln p_i \quad (11)$$
$$= \Sigma \left(x_h/\Sigma x_h\right) \delta\ln c_h(u_h,p)/\delta\ln p,$$

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

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

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

$$c(u_0,p) = \theta[u_0, a(p), b(p)], \quad (13)$$

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:

$$\bar{w}_i = (\delta 1\mathrm{n}\ \theta/\delta 1\mathrm{n}\ a)\ (\delta 1\mathrm{n}\ a/\delta 1\mathrm{n}\ p_i) \quad (14)$$
$$+ (\delta 1\mathrm{n}\ \theta/\delta 1\mathrm{n}\ b)\ (\delta 1\mathrm{n}\ b/\delta 1\mathrm{n}\ p_i).$$

Since $\theta$ is homogeneous of degree one, the above equation can be written as:

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

where

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

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. In addition, prices are 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:

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

with a representative cost function of:

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

When $\alpha$ tends to zero, we have the piglog model where:

$$\ln c(u_0,p) = (1 - u_0)\ln a(p) + u_0 \ln (p). \tag{18}$$

The nonlinear Engel curve associated with this cost function is:

$$w_i = \gamma + \eta\ln(x/k), \tag{19}$$

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

In conclusion, by using a demand or Engel curve 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 that are multiplied by the log ratio of prices. We define the Tornqvist index for a household as:

$$I_t = 0.5 \Sigma_i (w_{ih1} + w_{ih0}) \ln (p_{i1}/p_{i0}), \quad (20)$$

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:

$$\ln c(u_h,p) = a(p) + b(p)u_h, \quad (21)$$

where $a(p)$ and $b(p)$ are 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:

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

where

$$a_i(p_t) = \delta a(p_t)/\delta \ln p_{it},$$
$$b_i(p_t) = \delta b(p_t)/\delta \ln p_{it}.$$

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

$$\ln P(p_1,p_0;u_{hR}) = \ln c(u_{hR},p_1) - 1n\ c(u_{hR},p_0). \quad (23)$$

Fry and Pashardes (1989) showed that when the cost function is piglog, the Tornqvist index is the average of the true-cost indexes in $ln\ c(p_1,p_0,u_{H0})$ 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:

$$a(p) = \alpha_0 + \Sigma\alpha_i \ln p_i + 0.5 \Sigma_i\Sigma_j \lambda_{ij} \ln p_i \ln p_j, \quad (24)$$

and

$$b(p) = \beta_0 + \Sigma_i \beta_i \ln p_i, \quad (25)$$

where $\alpha$ sums to one for all $i$ and the $\lambda$ and $\beta$ sum to zero to satisfy adding up, homogeneity, and symmetry, then we can write the piglog cost function as:

$$\ln c(u_h,p) = g(u_h) + \Sigma_i (\alpha_i + \beta_i u_h + 0.5 \Sigma_j \lambda_{ij} \ln p_j) \ln p_i. \quad (26)$$

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

$$\ln P(p_1,p_0;u_{hR}) \Sigma(\alpha_i + \beta_i u_{hR})(\ln p_{i1} - \ln p_{i0}) \quad (27)$$
$$+ 0.5 \Sigma_i \Sigma_j \lambda_{if} (\ln p_{i1} \ln p_{j1} - \ln p_{i0} \ln p_{j0}).$$

The budget shares at reference utility level R are:

$$w_{ihR} = \alpha_i + \Sigma_j\lambda_{if} \ln p_{jR} + \beta u_{hR}. \quad (28)$$

Thus, the true-cost index can be written:

$$\begin{aligned} \ln P(p_1,p_0;u_{hR}) = & \Sigma_i\, w_{ihR}\,(\ln p_{i1} - \ln p_{i0}) \\ & - \Sigma_i\Sigma_j\, \lambda_{ij} \ln p_{jR}(\ln p_{i1} - \ln p_{i0}) \\ & + 0.5\, \Sigma_i\Sigma_j\lambda_{ij}(\ln p_{j1} \ln p_{i1} - \ln p_{j0} \ln p_{i0}). \end{aligned} \tag{29}$$

If the true-cost 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. Computing the average true-cost index for two periods by alternating the reference utility level between a base period and subsequent time period is, therefore, 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:

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

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 a 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 $u_h = [1\text{n}\ x_h - a(p)]/b(p)$, where $x_h$ is the expenditure of the $h^{th}$ household, the Marshallian budget shares of the piglog model can be derived as:

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

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 limited to 8 to 12 different categories of goods. A high degree of aggregation generally results in little substitution 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:

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

where

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

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 the following equation:

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

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.

# 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 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:

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

where $a(p)$ and $b(p)$ have been defined in equations 24 and 25, and where

$$d(p) = \varepsilon + \Sigma_i \zeta_i \ln p_{it}. \tag{35}$$

The complete demand system can then be written as:

$$w_{iht} = a_i(p_t) + [b_i(p_t)/b(p_t)] [\ln x_{th} - a(p_t) - d(p_t) \ln z_h] + \zeta_i \ln z_h. \tag{36}$$

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

$$w_{iht} = A_{it} + B_{it}(\ln x_{th} - \alpha_0 - \eta \ln z_h) + \zeta_i \ln z_h, \tag{37}$$

where $\eta$ 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 $\eta$ and $\ln z_h$ terms can be absorbed into the definition of the minimum household expenditure, $\alpha$.

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 1. 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 seven members. By doing this, we derived the three indexes noted earlier (fixed weight, substitution, and marginal expenditure indexes) plus three marginal indexes for household size, race, and region.

## 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 (CES) for 1990-95. The CES 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 for revising the CPI's but also for government, business, labor, and university research.

The CES 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 normally difficult to recall, consisting of food and beverages, tobacco, housekeeping supplies and nonprescription drugs, personal care products and services, fuels, and utilities.

We used the 16 food categories from the diary survey: cereals, bakery products, dairy, eggs, fresh fruit, fats and oils, fresh vegetables, nonalcoholic beverages, beef, poultry, pork, other meats and fish, processed fruit, processed vegetables, sugar and sweeteners, and miscellaneous prepared foods. We assumed that these food categories were disaggregated enough to allow us to capture the substitution effects as relative prices changed over the study period. We obtained the CPI subindexes for all 16 categories from the food-at-home index of the CPI.

Before discussing empirical results, we describe prices, budget shares, and expenditures for the 16 food categories in our study as well as some income statistics. Table 1 shows the CPI for the 16

**Table 1—Consumer Price Index (CPI) for food at home, 1991-95**

| Food category | 1991 | 1992 | 1993 | 1994 | 1995 |
|---|---|---|---|---|---|
| | | | *1990 = 100* | | |
| Bakery products | 104.0 | 108.0 | 111.9 | 116.3 | 120.3 |
| Beef | 102.8 | 102.7 | 106.4 | 105.6 | 104.7 |
| Cereals | 104.5 | 108.6 | 111.9 | 116.8 | 118.5 |
| Dairy | 98.9 | 101.6 | 102.3 | 104.1 | 105.0 |
| Eggs | 97.7 | 87.3 | 94.4 | 92.1 | 97.1 |
| Fresh fruit | 113.5 | 107.8 | 110.5 | 117.7 | 128.1 |
| Fats and oils | 104.3 | 102.8 | 102.9 | 105.7 | 108.7 |
| Fresh vegetables | 102.2 | 104.5 | 111.4 | 114.0 | 127.8 |
| Miscellaneous prepared food | 104.5 | 106.8 | 109.5 | 112.3 | 115.1 |
| Nonalcoholic beverages | 100.5 | 100.7 | 101.0 | 108.5 | 116.0 |
| Other meats and fish | 102.2 | 103.6 | 106.1 | 109.7 | 113.1 |
| Pork | 103.3 | 98.5 | 101.5 | 103.2 | 103.9 |
| Processed fruit | 96.3 | 100.6 | 96.6 | 97.2 | 100.2 |
| Poultry | 99.2 | 99.2 | 103.3 | 106.8 | 108.3 |
| Processed vegetables | 100.8 | 101.0 | 102.6 | 107.1 | 108.5 |
| Sugar and sweeteners | 103.7 | 106.7 | 107.0 | 108.4 | 110.3 |
| Food at home | 102.6 | 103.4 | 105.9 | 108.9 | 112.5 |

Source: USDA, ERS.

food categories when 1990 equals 100. Overall, total prices for food at home increased by 12.5 percent over the 6-year period. Individual categories that rose more than this were cereals (up 18.5 percent), bakery (up 20.3 percent), other meats and fish (up 13.1 percent), fresh fruit (up 28.1 percent), fresh vegetables (up 27.8 percent), and nonalcoholic beverages (up 16 percent). The only decline was for eggs, which fell 2.9 percent. Beef was relatively flat, increasing only 4.7 percent over the 6-year period.

Table 2 presents the average budget shares and expenditures for the total population and low-income households from 1990 through 1995. It is somewhat surprising just how close the budget shares of the low-income households are to the budget shares for the total population. The difference between the two never exceeds 0.6 percentage point, except for miscellaneous prepared foods, where the total population's budget exceeded that of the low-income households by 1.2 percentage points. The big difference between the two populations lies in the dollar amounts spent on food at home. The total population averaged $57.53 per week on food at home, while the low-income households spent about $38.87 per week. The greatest budget shares for total and low-income households went for miscellaneous prepared foods (14.1 and 12.8 percent), and the smallest for eggs (1.2 and 1.6 percent). In fact, miscellaneous prepared foods, dairy, and bakery products accounted for approximately one-third of the food-at-home budget for both groups.

Table 3 shows differences in household income and food expenditures. In dollar terms, the lowest income quintile received an average of $6,388 per household in 1990 and $7,508 in 1995, for a gain of about 17.5 percent (a quintile represents 20 percent of the population). However, the highest income quintile received $80,287 and $89,306 for the same 2 years, a gain of about 11 percent. If we deflate incomes by the CPI, we find that in real terms the lowest income quintile remained about constant over the 6-year period, while the highest income quintile was off slightly by about 5 percent.

Over the sample period, the lowest income quintile received 3.68 percent of all income in 1990 and 3.83 percent in 1995. Contrasted to this, the highest income quintile received about 46 percent of all income in 1990 and about 45.5 percent in 1995. All quintiles except the highest saw their relative shares increase slightly in 1990-95. Data other than the CES have shown that the highest quintile gained relative to the lowest. For instance, data from the U.S. Census Bureau indicate that the low-

**Table 2—Average budget shares and expenditures, 1990-95**

| Food category | Total population | | Low-income households | |
|---|---|---|---|---|
| | Budget share | Expenditure | Budget share | Expenditure |
| | *Percent* | *Dollars* | *Percent* | *Dollars* |
| Bakery products | 10.32 | 5.82 | 9.69 | 3.57 |
| Beef | 7.84 | 4.75 | 7.90 | 3.31 |
| Cereals | 5.66 | 3.26 | 6.07 | 2.39 |
| Dairy | 11.54 | 6.24 | 12.05 | 4.41 |
| Eggs | 1.22 | .64 | 1.62 | .60 |
| Fresh fruit | 5.34 | 2.96 | 5.30 | 1.98 |
| Fats and oils | 3.08 | 1.82 | 3.22 | 1.30 |
| Fresh vegetables | 5.20 | 2.92 | 5.17 | 2.00 |
| Miscellaneous prepared food | 14.05 | 8.24 | 12.82 | 5.07 |
| Nonalcoholic beverages | 8.77 | 4.83 | 8.72 | 3.24 |
| Other meats and fish | 6.61 | 4.04 | 6.30 | 2.60 |
| Pork | 5.18 | 3.19 | 5.68 | 2.37 |
| Processed fruit | 3.81 | 2.12 | 3.75 | 1.39 |
| Poultry | 4.69 | 2.78 | 5.02 | 1.97 |
| Processed vegetables | 2.80 | 1.64 | 2.97 | 1.18 |
| Sugar and sweeteners | 3.89 | 2.27 | 3.72 | 1.47 |
| Total | | 57.53 | | 38.87 |

Source: USDA, ERS.

est income quintile declined from 4.6 percent in 1990 to 4.2 percent in 1994 (the last year reported), while the highest income quintile increased from 44.3 to 46.9 percent over the same time period.

Table 3 also shows the share of total national food expenditures for each quintile. The pattern is similar to that for income, with the lowest quintile having the smallest share and the highest quintile having the largest share.

**Table 3—Household food expenditures by income level, 1990-95**

| Item | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 |
|---|---|---|---|---|---|---|
| | | | *Percent* | | | |
| Share of U.S. income by quintile: | | | | | | |
| Q1 | 3.68 | 3.83 | 3.88 | 3.73 | 3.69 | 3.83 |
| Q2 | 9.31 | 9.25 | 9.43 | 9.11 | 9.13 | 9.40 |
| Q3 | 15.90 | 15.81 | 16.03 | 16.39 | 15.67 | 15.99 |
| Q4 | 25.16 | 24.93 | 25.33 | 25.09 | 25.13 | 25.29 |
| Q5 | 45.95 | 46.18 | 45.33 | 45.68 | 46.38 | 45.50 |
| Share of U.S. food spending by quintile: | | | | | | |
| Q1 | 15.65 | 15.01 | 15.51 | 15.27 | 15.89 | 15.16 |
| Q2 | 17.78 | 18.14 | 18.11 | 17.54 | 18.03 | 18.18 |
| Q3 | 20.13 | 19.56 | 19.86 | 20.32 | 19.63 | 20.26 |
| Q4 | 22.57 | 21.94 | 21.76 | 22.26 | 22.22 | 22.71 |
| Q5 | 23.87 | 25.35 | 24.75 | 24.62 | 24.24 | 23.69 |
| | | | *Dollars per household* | | | |
| Average income by quintile: | | | | | | |
| Q1 | 6,388 | 6,656 | 6,887 | 6,908 | 7,946 | 7,508 |
| Q2 | 16,175 | 16,037 | 16,713 | 17,066 | 16,984 | 18,419 |
| Q3 | 27,776 | 27,461 | 28,454 | 29,980 | 29,346 | 31,377 |
| Q4 | 43,135 | 43,494 | 44,581 | 46,481 | 46,991 | 49,563 |
| Q5 | 80,287 | 79,729 | 81,030 | 84,627 | 86,864 | 89,306 |

Source: USDA, ERS.

# Empirical Results

The equation we estimate for each of the 16 food groups based upon theoretical equation 37 is:

$$w_{iht} = A_{it} + A_{inc}D_{nc} + A_{is}D_s + A_{iw}D_w + Z_{iz} \ln Z_h + R_1 D_r + (Y_{it} + Y_{inc}D_{nc} + Y_{is}D_s + Y_{iw}D_w + Y_{ir}D_r)(\ln X_{ht} - \alpha_0), \qquad (38)$$

where $t = 1990...1995$ and the $D$ subscripted variables are dummy variable shifters for both the intercepts $A_{it}$ and $Y_{it}$ for the demographic groups in the North Central States, the South, and the West as well as for race (race is dropped from the low-income equations). 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 seven persons. $X_{ht}$ is household expenditure on food at home. Thus, we have made the assumption that at-home food expenditures are separable from expenditures on all other goods including food away from home. We also made the usual assumptions of intertemporal separability and separability of market goods from leisure and public goods. Finally, $\alpha_0$ is the minimum household expenditure on food at home and is known as the reference household. We used eight demographic reference households for the total population in this study: black and nonblack single-person households in the Northeast, the North Central States, the South, and the West. For the low-income population, we used four demographic reference households: single-person households in the Northeast, the North Central States, the South, and the West.

Tables 4 and 5 present the estimates for the 16 Engel curves for the total population and the food stamp eligible population. For each equation, $A_{90}$ through $A_{95}$ represent the intercept for the Northeast for each year of data (nonblack households for the total population). $A_{nc}$ through $A_w$ represent 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.

Slope expenditure parameters are represented by $Y$ through $Y_w$, where $Y$ represents the estimated expenditure coefficient for nonblacks (both nonblacks and blacks in the eligible for food stamp equations) in the Northeast and $Y_{nc}$, $Y_s$, and $Y_w$ are the estimated dummy slope shifters for nonblacks' expenditures in the North Central States, the South, and the West, respectively. $Y_r$ is the dummy expenditure slope shifter for the black race (only in the total population equations). $R^2$ 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 except for pork in the low-income population. The regional dummy intercepts, which are in effect a test of their significance relative to nonblack households of the Northeast, are mixed. For the total population, many of these dummy shifts are insignificant. All three regional dummy shifters are significant at the 5-percent level or better in the poultry, eggs, processed fruit, and miscellaneous prepared food equations. Two of the three regional dummy shifters are significant at the 5-percent level or better in the bakery products, fresh vegetables, sugar and sweeteners, and nonalcoholic beverages equations. In the remaining equations, at least one regional dummy shifter is significant at the 5-percent level or better except for the cereals and pork equations.

The regional dummy intercept shifters are even less significant in the low-income equations. All three regional shifters are statistically significant at the 5-percent level or better only in the egg equation. Equations in which two of the three dummy shifters are significant at the 5-percent level include bakery products, pork, poultry, dairy, and processed fruit. One regional shifter is significant in the cereals, fresh fruit, processed vegetables, sugar and sweeteners, and the miscellaneous prepared foods equations. Remember, in this population, the regional shifters are strictly tests for a difference between regional expenditures, regardless of race.

All coefficients for the household size variable are significant at the 5-percent level in the total population except those for the equations for bakery products, pork, poultry, and nonalcoholic beverages. For low-income households, the household size variable was significant at the 5-percent level or better except for pork, poultry, and miscellaneous prepared foods.

Finally, the intercept shifter for black households in the total population is statistically significant at the 5-percent level for all equations except for cereals (significant at the 6-percent level), bakery products, other meats and fish (significant at the 8-percent level), fresh vegetables, processed vegetables, sugar and sweeteners (significant at the 6-percent level), and fats and oils.

Turning to the slope estimates for the expenditure variables of the total population, all estimates for nonblack households in the Northeast are statistically significant at the 5-percent level except for poultry and fresh vegetables. The remaining dummy variables for the slope coefficients, which, like the intercept shifters, are a test for significant difference between nonblack households in the Northeast and the relevant region, offer very mixed results. For the North Central States, three slope shifters were statistically significant at the 5-percent level: other meats and fish, eggs, and nonalcoholic beverages. In addition, both the fresh fruit and fresh vegetable shifters were significant at the 10-percent level. For the South, four slope shifters were statistically significant at the 5-percent level: other meats and fish, poultry, eggs, and nonalcoholic beverages. In addition, pork was significant at the 6-percent level, and fresh vegetables was significant at the 9-percent level. Three slope shifters were significant at the 5-percent level or better for the West: eggs, processed fruit, and fats and oils. Furthermore, the slope shifter for cereals was significant at the 7-percent level, and the shifter for miscellaneous prepared food was significant at the 10-percent level.

For low-income households in the Northeast, the slope expenditure coefficients were significant at the 5-percent level except those for cereals, poultry, fresh fruit, and fresh vegetables. In addition, the slope expenditure coefficient for miscellaneous prepared food was significant at the 7-percent level, and the estimate for sugar and sweeteners was significant at the 10-percent level. Evidently, these households tend to concentrate their marginal food dollars on the remaining 10 food categories: bakery products, beef, pork, other meats and fish, eggs, dairy, processed fruit, processed vegetables, fats and oils, nonalcoholic beverages, and perhaps sugar and sweeteners, as well as miscellaneous prepared foods.

Among the regional slope shifters for the low-income households, bakery products and eggs were statistically significant at the 5-percent level for the North Central States and the South. For the West, eggs, dairy, and fresh fruit were statistically significant at the 5-percent level, while cereals and pork were significant at the 7-percent level, and processed fruit was significant at the 8-percent level.

The last variable of the model for the total population is an estimate for a significant difference between black and nonblack households on marginal expenditures for the 16 food categories. Eight categories were found to be statistically insignificant: cereals, beef, dairy, fresh vegetables, processed fruit, processed vegetables, sugar and sweeteners, and miscellaneous prepared food. Other meats and fish and poultry were significant at the 6-percent level, and fats and oils were significant at the 9-percent level. Note that these are for differences in marginal expenditures above that of the appropriate reference household. Hence, for an item like dairy, blacks have a substantially lower budget share and a statistically significant negative dummy intercept shifter, relative to nonblacks, even though marginal expenditure levels may not be different.

F-tests indicate that most equations for the total population are better represented by letting the intercept shift from one time period to another rather than using a single estimated parameter,

**Table 4—Parameter estimates of Engel curves, total population**

| Food category | $A_{90}$ | $A_{91}$ | $A_{92}$ | $A_{93}$ | $A_{94}$ | $A_{95}$ | $A_{nc}$ | $A_s$ | $A_w$ |
|---|---|---|---|---|---|---|---|---|---|
| Bakery products | 0.1226 | 0.1236 | 0.1263 | 0.1256 | 0.1271 | 0.1260 | -0.0036 | -0.0121 | -0.0152 |
| | (.003) | (.003) | (.003) | (.003) | (.003) | (.003) | (.004) | (.004) | (.004) |
| Beef | .0585 | .0574 | .0543 | .0558 | .0537 | .0527 | -.0046 | -.0008 | -.0040 |
| | (.004) | (.004) | (.004) | (.004) | (.004) | (.004) | (.005) | (.005) | (.005) |
| Cereals | .0491 | .0533 | .0520 | .0582 | .0589 | .0598 | .0000 | .0028 | -.0053 |
| | (.003) | (.003) | (.003) | (.003) | (.003) | (.003) | (.003) | (.003) | (.003) |
| Dairy | .1609 | .1560 | .1583 | .1528 | .1516 | .1506 | .0084 | .0045 | -.0060 |
| | (.003) | (.003) | (.003) | (.003) | (.004) | (.004) | (.005) | (.005) | (.004) |
| Eggs | .0203 | .0205 | .0195 | .0204 | .0198 | .0200 | -.0060 | -.0045 | -.0025 |
| | (.0009) | (.0009) | (.0009) | (.0009) | (.0009) | (.0009) | (.001) | (.001) | (.001) |
| Fresh fruit | .0650 | .0630 | .0639 | .0651 | .0656 | .0678 | .0049 | -.0058 | .0101 |
| | (.003) | (.003) | (.003) | (.003) | (.003) | (.003) | (.004) | (.004) | (.004) |
| Fats and oils | .0233 | .0238 | .0233 | .0241 | .0235 | .0242 | -.0029 | .0023 | .0047 |
| | (.002) | (.002) | (.002) | (.002) | (.002) | (.002) | (.002) | (.002) | (.002) |
| Fresh vegetables | .0606 | .0614 | .0611 | .0620 | .0642 | .0642 | -.0152 | -.0086 | .0013 |
| | (.002) | (.002) | (.002) | (.002) | (.002) | (.002) | (.003) | (.003) | (.003) |
| Miscellaneous prepared food | .0992 | .1070 | .1093 | .1030 | .1032 | .1012 | .0223 | .0251 | .0497 |
| | (.005) | (.005) | (.005) | (.005) | (.005) | (.005) | (.007) | (.007) | (.007) |
| Nonalcoholic beverages | .0975 | .0949 | .0891 | .0936 | .0958 | .0977 | .0276 | .0292 | .0052 |
| | (.004) | (.004) | (.004) | (.004) | (.004) | (.004) | (.005) | (.005) | (.005) |
| Other meats and fish | .0599 | .0555 | .0513 | .0512 | .0513 | .0534 | -.0067 | -.0035 | -.0111 |
| | (.003) | (.003) | (.003) | (.003) | (.003) | (.003) | (.004) | (.004) | (.004) |
| Pork | .0262 | .0273 | .0306 | .0276 | .0289 | .0263 | -.0008 | -.0025 | -.0051 |
| | (.003) | (.003) | (.003) | (.003) | (.003) | (.003) | (.004) | (.004) | (.004) |
| Processed fruit | .0533 | .0508 | .0540 | .0524 | .0495 | .0491 | -.0074 | -.0111 | -.0113 |
| | (.002) | (.002) | (.002) | (.002) | (.002) | (.002) | (.003) | (.003) | (.003) |
| Poultry | .0511 | .0538 | .0539 | .0544 | .0546 | .0535 | -.0243 | -.0223 | -.0204 |
| | (.003) | (.003) | (.003) | (.003) | (.003) | (.003) | (.004) | (.004) | (.004) |
| Processed vegetables | .0205 | .0197 | .0200 | .0205 | .0208 | .0191 | .0011 | .0053 | .0008 |
| | (.002) | (.002) | (.002) | (.002) | (.002) | (.002) | (.002) | (.002) | (.002) |
| Sugar and sweeteners | .0318 | .0320 | .0332 | .0334 | .0316 | .0346 | .0071 | .0021 | .0091 |
| | (.002) | (.002) | (.002) | (.003) | (.003) | (.003) | (.003) | (.003) | (.003) |

*See notes at the end of the table.* *--Continued*

**Table 4—Parameter estimates of Engel curves, total population--Continued**

| Food category | Z | $R_1$ | Y | $Y_{nc}$ | $Y_s$ | $Y_w$ | $Y_r$ | $R^2$ | F |
|---|---|---|---|---|---|---|---|---|---|
| Bakery products | -0.0017 | -0.0055 | -0.0069 | 0.0006 | 0.0003 | 0.0013 | -0.0065 | 0.68 | 10.87 *** |
| | (.002) | (.005) | (.002) | (.002) | (.002) | (.002) | (.003) | | |
| Beef | .0083 | .0152 | .0108 | -.0006 | .0032 | -.0012 | -.0003 | .45 | 2.52 ** |
| | (-.002) | (.006) | (-.002) | (.003) | (.003) | (.003) | (.003) | | |
| Cereals | .0168 | .0072 | -.0029 | .0009 | -.0014 | .0034 | -.0200 | .52 | 23.27 *** |
| | (.001) | (.004) | (.001) | (.002) | (.002) | (.002) | (.002) | | |
| Dairy | .0454 | -.0392 | -.0307 | -.0006 | -.0016 | .0040 | .0042 | .71 | 10.69 *** |
| | (.002) | (.005) | (.002) | (.003) | (.003) | (.003) | (.003) | | |
| Eggs | .0052 | .0095 | -.0058 | .0026 | .0027 | .0021 | -.0027 | .31 | 1.92 * |
| | (.001) | (.001) | (.000) | (.001) | (.001) | (.001) | (.001) | | |
| Fresh fruit | -.0138 | -.0127 | -.0032 | -.0034 | .0012 | -.0034 | .0047 | .45 | 2.58 ** |
| | (.002) | (.004) | (.002) | (.002) | (.002) | (.002) | (.002) | | |
| Fats and oils | -.0061 | -.0032 | .0053 | .0010 | -.0013 | -.0025 | .0021 | .47 | .52 |
| | (.001) | (.002) | (.001) | (.001) | (.001) | (.001) | (.001) | | |
| Fresh vegetables | -.0150 | -.0015 | -.0003 | .0028 | .0029 | .0002 | -.0010 | .51 | 3.24 *** |
| | (.001) | (.004) | (.001) | (.002) | (.002) | (.002) | (.002) | | |
| Miscellaneous prepared food | -.0133 | -.0325 | .0122 | .0036 | -.0020 | -.0067 | -.0010 | .62 | 4.46 *** |
| | (.003) | (.008) | (.003) | (.004) | (.004) | (.004) | (.004) | | |
| Nonalcoholic beverages | .0033 | -.0275 | -.0084 | -.0068 | -.0100 | .0003 | .0081 | .54 | 5.82 *** |
| | (.002) | (.006) | (.002) | (.003) | (.003) | (.003) | (.003) | | |
| Other meats and fish | -.0094 | .0089 | .0133 | -.0052 | -.0048 | -.0008 | .0052 | .46 | 9.10 *** |
| | (.002) | (.005) | (.002) | (.002) | (.002) | (.002) | (.003) | | |
| Pork | -.0009 | .0450 | .0111 | .0002 | .0041 | -.0003 | -.0064 | .38 | 2.51 ** |
| | (.002) | (.005) | (.002) | (.002) | (.002) | (.002) | (.003) | | |
| Processed fruit | -.0084 | .0080 | -.0041 | .0019 | .0031 | .0044 | -.0026 | .43 | 7.55 *** |
| | (.001) | (.003) | (.001) | (.002) | (.001) | (.002) | (.002) | | |
| Poultry | -.0009 | .0337 | .0020 | .0027 | .0047 | .0025 | -.0044 | .38 | 1.66 |
| | (.002) | (-.004) | (.002) | (.002) | (.002) | (.002) | (.002) | | |
| Processed vegetables | -.0055 | .0017 | .0050 | -.0007 | -.0013 | -.0007 | .0002 | .42 | 1.14 |
| | (.001) | (.002) | (.001) | (.001) | (.001) | (.001) | (.001) | | |
| Sugar and sweeteners | -.0035 | -.0071 | .0027 | -.0008 | .0000 | -.0025 | .0023 | .34 | 1.60 |
| | (.001) | (.004) | (.001) | (.002) | (.002) | (.002) | (.002) | | |

*, **, *** = Significant at the 10-, 5-, and 1-percent levels. Numbers in parentheses are standard errors.

Source: USDA, ERS.

**Table 5—Parameter estimates of Engel curves, low-income households**

| Food category | $A_{90}$ | $A_{91}$ | $A_{92}$ | $A_{93}$ | $A_{94}$ | $A_{95}$ | $A_{nc}$ | $A_s$ | $A_w$ |
|---|---|---|---|---|---|---|---|---|---|
| Bakery products | 0.1514 | 0.1564 | 0.1581 | 0.1563 | 0.1588 | 0.1533 | -0.0241 | -0.0490 | -0.0452 |
| | (.010) | (.010) | (.010) | (.010) | (.010) | (.010) | (-.014) | (.011) | (.011) |
| Beef | .0364 | .0346 | .0331 | .0336 | .0343 | .0388 | -.0178 | .0148 | .0206 |
| | (.013) | (.013) | (.013) | (.013) | (.013) | (.013) | (.018) | (.015) | (-.014) |
| Cereals | .0625 | .0593 | .0614 | .0662 | .0643 | .0672 | .0038 | .0000 | -.0203 |
| | (.009) | (.009) | (.009) | (.009) | (.009) | (.009) | (.012) | (.010) | (.010) |
| Dairy | .2060 | .1974 | .1947 | .1937 | .1889 | .1902 | -.0043 | -.0310 | -.0627 |
| | (.013) | (.012) | (.012) | (.013) | (.013) | (.013) | (.018) | (.015) | (.014) |
| Eggs | .0317 | .0324 | .0316 | .0327 | .0326 | .0341 | -.0123 | -.0116 | -.0108 |
| | (.003) | (.003) | (.003) | (.003) | (.003) | (.003) | (.004) | (.004) | (.004) |
| Fresh fruit | .0518 | .0498 | .0530 | .0518 | .0532 | .0568 | .0120 | .0025 | .0342 |
| | (.009) | (.009) | (.009) | (.009) | (.009) | (.009) | (.013) | (.010) | (.010) |
| Fats and | .0162 | .0190 | .0174 | .0213 | .0160 | .0193 | .0009 | .0008 | .0099 |
| oils | (.005) | (.005) | (.005) | (.005) | (.005) | (.005) | (.007) | (.006) | (.006) |
| Fresh | .0445 | .0487 | .0523 | .0497 | .0489 | .0490 | -.0035 | .0049 | .0114 |
| vegetables | (.008) | (.008) | (.008) | (.008) | (.008) | (.008) | (.011) | (.009) | (.009) |
| Miscellaneous | .0797 | .0810 | .0752 | .0783 | .0730 | .0767 | .0350 | .0321 | .0719 |
| prepared food | (.016) | (.016) | (.016) | (.016) | (.017) | (.017) | (.023) | (.019) | (.019) |
| Nonalcoholic | .1065 | .1048 | .0974 | .1064 | .1077 | .1031 | .0302 | .0008 | -.0027 |
| beverages | (.012) | (.012) | (.012) | (.012) | (.013) | (.013) | (.017) | (.014) | (.014) |
| Other meats | .0449 | .0426 | .0358 | .0314 | .0331 | .0401 | .0006 | .0040 | .0025 |
| and fish | (.010) | (.010) | (.010) | (.010) | (.010) | (.010) | (.014) | (.012) | (.012) |
| Pork | .0006 | .0065 | .0161 | .0071 | .0155 | .0086 | .0182 | .0318 | .0281 |
| | (.011) | (.011) | (.011) | (.011) | (.011) | (.011) | (.015) | (.012) | (.012) |
| Processed | .0625 | .0555 | .0608 | .0590 | .0587 | .0597 | -.0138 | -.0134 | -.0194 |
| fruit | (.007) | (.007) | (.007) | (.007) | (.007) | (.007) | (.009) | (.008) | (.008) |
| Poultry | .0626 | .0661 | .0689 | .0695 | .0698 | .0638 | -.0300 | -.0117 | -.0318 |
| | (.010) | (.010) | (.010) | (.010) | (.010) | (.010) | (.014) | (.012) | (.011) |
| Processed | .0218 | .0207 | .0222 | .0202 | .0226 | .0186 | -.0028 | .0123 | .0007 |
| vegetables | (.006) | (.005) | (.006) | (.006) | (.006) | (.006) | (.008) | (.006) | (.006) |
| Sugar and | .0221 | .0252 | .0219 | .0225 | .0225 | .0207 | .0080 | .0058 | .0136 |
| sweeteners | (.007) | (.007) | (.007) | (.007) | (.007) | (.007) | (.010) | (.008) | (.008) |

*See notes at the end of the table.* *--Continued*

**Table 5—Parameter estimates of Engel curves, low-income households--Continued**

| Food category | Z | Y | $Y_{nc}$ | $Y_s$ | $Y_w$ | $R^2$ | F |
|---|---|---|---|---|---|---|---|
| Bakery products | -0.0116 | -0.0208 | 0.0113 | 0.0130 | 0.0086 | 0.66 | 1.02 |
| | (.004) | (.004) | (.006) | (.006) | (.006) | | |
| Beef | .0105 | .0169 | .0033 | .0048 | -.0052 | .45 | .32 |
| | (.005) | (.006) | (.008) | (.007) | (.007) | | |
| Cereals | .0138 | -.0017 | -.0027 | -.0028 | .0093 | .49 | 1.48 |
| | (.003) | (.004) | (.005) | (.005) | (.005) | | |
| Dairy | .0403 | -.0373 | .0052 | .0000 | .0172 | .66 | 2.94 ** |
| | (.005) | (.006) | (.007) | (.007) | (.007) | | |
| Eggs | .0088 | -.0088 | .0052 | .0046 | .0039 | .37 | .94 |
| | (.001) | (.001) | (.002) | (.002) | (.002) | | |
| Fresh fruit | -.0170 | .0036 | -.0069 | -.0047 | -.0176 | .42 | .77 |
| | (.003) | (.004) | (.005) | (.005) | (.005) | | |
| Fats and | -.0056 | .0067 | -.0010 | -.0013 | -.0019 | .43 | 1.98 * |
| oils | (.002) | (.002) | (.003) | (.003) | (.003) | | |
| Fresh | -.0169 | .0032 | -.0009 | -.0007 | -.0006 | .48 | 1.34 |
| vegetables | (.003) | (.003) | (.005) | (.004) | (.005) | | |
| Miscellaneous | -.0065 | .0133 | -.0041 | -.0034 | -.0125 | .56 | .42 |
| prepared food | (.006) | (.007) | (.010) | (.009) | (.010) | | |
| Nonalcoholic | .0091 | -.0116 | -.0061 | -.0004 | -.0039 | .50 | 1.14 |
| beverages | (.005) | (.006) | (.007) | (.007) | (.007) | | |
| Other meats | -.0078 | .0144 | -.0051 | .0003 | .0035 | .44 | 3.69 *** |
| and fish | (.004) | (.005) | (.006) | (.006) | (.006) | | |
| Pork | -.0001 | .0200 | -.0061 | -.0007 | -.0115 | .37 | 4.27 *** |
| | (.004) | (.005) | (.006) | (.006) | (.006) | | |
| Processed | -.0103 | -.0062 | .0047 | .0013 | .0067 | .40 | 1.65 |
| fruit | (.002) | (.003) | (.004) | (.004) | (.004) | | |
| Poultry | .0047 | -.0022 | .0050 | -.0002 | .0051 | .34 | 1.18 |
| | (.004) | (.005) | (.006) | (.006) | (.006) | | |
| Processed | -.0055 | .0053 | -.0010 | -.0046 | .0005 | .37 | .82 |
| vegetables | (.002) | (.002) | (.003) | (.003) | (.003) | | |
| Sugar and | -.0059 | .0052 | -.0009 | .0012 | -.0017 | .36 | .58 |
| sweeteners | (.003) | (.003) | (.004) | (.004) | (.004) | | |

*, **, *** = Significant at the 10-, 5-, and 1-percent levels. Numbers in parentheses are standard errors.

Source: USDA, ERS.

except for poultry, processed vegetables, sugar and sweeteners, and fats and oils. We hypothesize that very little substitution occurs between these four categories and the other food categories. Just the opposite happens with the low-income population. In this group, just four equations are better represented by letting the intercept shift from one time period to another. They are pork, other meats and fish, dairy, and fats and oils.

There may be a very good reason why the low-income population has rather fixed budget shares. About 70 percent of this group receive food stamps, and they have the lowest food expenditures of the total population. This group is likely to consume the least costly foods, and have less possibility for substitution when relative prices change. Given this, we could calculate the Tornqvist index for the population eligible for food stamps. However, we choose to calculate the true-cost index developed by Fry and Pashardes that is based on the estimated Engel curves, since we gain both the demographic and the marginal expenditure differences. Hence, while substitution effects are quite muted for this group, some substitution does take place.

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 (just region for the population eligible for food stamps).

Tables 6 and 7 show the demographic marginal indexes for race, region, and household size for the total population and low-income households. All values are shown in logs so that the antilog converts the value into a standard index in which 1990 = 100. The reference index for the Northeast is shown in column one. This index is for the nonblack household with the least expenditures in 1990. In log terms, food costs rose by 0.1212 over the 6-year period. The race variable is for black reference households, because the dummy variable for nonblack households was eliminated from the model to avoid perfect multicollinearity. For the study period, food-at-home costs of black households increased less than those of nonblack households. These values ranged from -0.002 in 1991 to -0.009 in 1995. The three regional dummy variables are all positive, indicating that the reference household in the

**Table 6—Demographic marginal indexes and marginal expenditure indexes, total population, 1991-95**

| | Demographic marginal indexes | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Region | | | Household size | | | |
| Year | Northeast reference | Black household | North Central | South | West | 2 | 3 | 4 | 5 |
| 1991 | 0.0229 | -0.0017 | 0.0016 | 0.0007 | 0.0034 | -0.0019 | -0.0030 | -0.0038 | -0.0044 |
| 1992 | .0345 | -.0058 | .0022 | .0013 | .0032 | -.0013 | -.0021 | -.0026 | -.0030 |
| 1993 | .0561 | -.0035 | .0005 | .0001 | .0029 | -.0015 | -.0023 | -.0030 | -.0034 |
| 1994 | .0869 | -.0060 | .0022 | .0015 | .0035 | -.0021 | -.0034 | -.0043 | -.0049 |
| 1995 | .1212 | -.0088 | .0022 | .0014 | .0046 | -.0043 | -.0068 | -.0086 | -.0099 |
| | Marginal expenditure indexes | | | | | | | | |
| | | | Region | | | | | | |
| | Northeast reference | Black household | North Central | South | West | | | | |
| 1991 | 0.0016 | 0.0005 | -0.0004 | -0.0001 | -0.0011 | | | | |
| 1992 | .0009 | .0006 | -.0005 | -.0007 | -.0008 | | | | |
| 1993 | .0015 | .0000 | -.0001 | -.0002 | -.0009 | | | | |
| 1994 | .0012 | .0007 | -.0007 | -.0010 | -.0011 | | | | |
| 1995 | .0003 | .0012 | -.0009 | -.0012 | -.0012 | | | | |

Source: USDA, ERS.

Northeast experienced the lowest rate of food-at-home price increases. In general, and relative to the Northeast, the South appears to have had the smallest increases and the West the largest.

Table 6 also includes the demographic marginal indexes for household size. Each value for household size 2 through 5 is negative, and increases in size as household size increases. In addition, the value for any household size tends to be larger in the later years, especially 1994-95. This pattern indicates that, relative to a single-member household, the true cost of food at home rises proportionally less as household size increases. This may seem contradictory, but one needs to remember that costs can increase at a decreasing rate as household size increases.

Table 6 also shows the 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 food-at-home expenditures. The race variable for black households is positive, although very small, indicating that the true-cost-of-food index increases as expenditures surpass the expenditure of the reference household relative to nonblacks. Note, this does not mean that the indexes for blacks will be higher than the indexes for nonblacks. Simply, that black households have a higher marginal propensity to consume food at home than nonblacks. Contrasted to this, 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. The marginal indexes for the regions are all very small.

Table 7 contains the marginal indexes for the low-income population. Table 7 is identical to table 6, except there is no race index. Column one again contains the reference index for the Northeast. Over the 6-year period, costs rose in log terms by 0.1168. This is less than the amount for the total population, and indicates that the reference household contained costs by substitution, relative to the total population. Like the total population, the marginal indexes for regions are positive and larger than those of the total population.

The marginal indexes for household size are also negative, but bigger than those of the total population. This is not too surprising. It is logical that poor households will try to conserve expenditures relative to households that are better off. Finally, the marginal expenditure indexes are shown in table 7. Again the first column indicates the marginal expenditure index for the reference household

**Table 7—Demographic marginal indexes and marginal expenditure indexes, low-income households, 1991-95**

| Year | Demographic marginal indexes | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Region | | | Household size | | | |
| | Northeast reference | North Central | South | West | 2 | 3 | 4 | 5 |
| 1991 | 0.0183 | 0.0039 | 0.0033 | 0.0094 | -0.0023 | -0.0036 | -0.0046 | -0.0053 |
| 1992 | .0320 | .0033 | .0006 | .0046 | -.0024 | -.0037 | -.0047 | -.0055 |
| 1993 | .0528 | .0018 | .0008 | .0057 | -.0023 | -.0037 | -.0047 | -.0054 |
| 1994 | .0836 | .0044 | .0007 | .0060 | -.0031 | -.0049 | -.0061 | -.0071 |
| 1995 | .1168 | .0060 | -.0001 | .0084 | -.0053 | -.0084 | -.0106 | -.0123 |

| Year | Marginal expenditure indexes | | | |
|---|---|---|---|---|
| | | Region | | |
| | Northeast reference | North Central | South | West |
| 1991 | 0.0030 | -0.0015 | -0.0007 | 0.0032 |
| 1992 | .0013 | -.0010 | -.0002 | .0010 |
| 1993 | .0020 | -.0007 | -.0001 | .0013 |
| 1994 | .0015 | -.0016 | -.0004 | .0020 |
| 1995 | .0008 | -.0022 | -.0005 | .0031 |

Source: USDA, ERS.

in the Northeast. This is larger than the marginal expenditure index for the total population, indicating that costs rise faster on the margin for these households than for the reference household of the total populations (that is, the marginal propensity to consume food at home is higher). It does not say that costs will be higher for the low-income population than for the total population. Rather, as we showed in the descriptive statistics, these households are starting at a lower base of food spending, and their costs rise faster as more marginal dollars become available for food-at-home spending. Like the total population, 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. Once again these marginal regional indexes are all small.

With this background, we can now look at various cost-of-food-at-home indexes constructed from the estimated Engel curves. In table 8, we constructed indexes for the reference household for each race (black and nonblack) and all four regions. We have included the CPI for food at home to compare with our estimated indexes.

In looking at the constructed indexes, two trends become apparent. First, the indexes for nonblacks tend to be close to the CPI, at least for 1990-93, and just slightly above the CPI for 1994-95. And second, the true indexes for blacks tend to lie below the CPI for all years. Reasons for this may be cultural in the sense that blacks may consume a diet markedly different from that consumed by the majority of the population (the backbone of the CPI), or it could be that black households face higher relative prices than other households. Overall, the CPI for food at home increased by a modest 12.5 percent over the time in question. However, nonblack households in the West saw their food-at-home costs increase by 13.4 percent. This was followed by nonblack reference households in the Northeast at 12.9 percent, the North Central States at 13.1 percent, and the South at 13.0 percent. Contrasted with this, black reference household of the Northeast saw their food-at-home costs increase by 11.9 percent over the 6-year period. Blacks in both the North Central States and the South saw their costs rise by 12.1 percent, and those in the West by 12.4 percent. This is a modest underperformance relative to the CPI, but still indicates that the food price inflation of the early to mid-1990's did not adversely affect these reference households.

Given the low level of inflation over the past few years, it is not surprising that the true-cost indexes are just below or only slightly above the CPI. Given substitution away from more expensive goods as relative prices increase, we would expect the true-cost index to be below the fixed-weight CPI. However, it is possible that nonblack households had a larger budget share of miscellaneous prepared foods in 1994-95 so that their indexes were above the CPI. Over the past 20 years, consumers have increased their budget shares of prepared foods and food away from home.

Table 9 contains the same reference households, except the nonblack and black indexes have been aggregated together. This facilitates comparisons with the indexes constructed for the low-income households. Since nonblack households make up the majority of the population, these indexes are the same as or fairly close to the nonblack indexes of the total population. Briefly, the reference

**Table 8—Single-person reference households from the total population, 1991-95**

| Year | CPI | Northeast nonblack | Northeast black | North Central nonblack | North Central black | South nonblack | South black | West nonblack | West black |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | *1990 = 100* | | | | |
| 1991 | 102.6 | 102.3 | 102.1 | 102.5 | 102.3 | 102.4 | 102.2 | 102.7 | 102.4 |
| 1992 | 103.4 | 103.5 | 102.9 | 103.7 | 103.1 | 103.6 | 103.0 | 103.8 | 103.2 |
| 1993 | 105.9 | 105.8 | 105.4 | 105.8 | 105.5 | 105.8 | 105.4 | 106.1 | 105.7 |
| 1994 | 108.9 | 109.1 | 108.4 | 109.3 | 108.7 | 109.2 | 108.6 | 109.5 | 108.8 |
| 1995 | 112.5 | 112.9 | 111.9 | 113.1 | 112.1 | 113.0 | 112.1 | 113.4 | 112.4 |

Source: USDA, ERS.

**Table 9—Single-person reference households, total population, 1991-95**

| Year | CPI | Northeast | North Central | South | West | National |
|---|---|---|---|---|---|---|
| | | | *1990 = 100* | | | |
| 1991 | 102.6 | 102.3 | 102.5 | 102.4 | 102.7 | 102.5 |
| 1992 | 103.4 | 103.5 | 103.6 | 103.5 | 103.8 | 103.6 |
| 1993 | 105.9 | 105.8 | 105.8 | 105.7 | 106.1 | 105.9 |
| 1994 | 108.9 | 109.0 | 109.2 | 109.1 | 109.5 | 109.2 |
| 1995 | 112.5 | 112.8 | 113.0 | 112.9 | 113.4 | 113.0 |

Source: USDA, ERS.

**Table 10—Single-person reference households, low-income households, 1991-95**

| Year | CPI | Northeast | North Central | South | West | National |
|---|---|---|---|---|---|---|
| | | | *1990 = 100* | | | |
| 1991 | 102.6 | 101.9 | 102.2 | 102.2 | 102.8 | 102.3 |
| 1992 | 103.4 | 103.2 | 103.6 | 103.3 | 103.7 | 103.4 |
| 1993 | 105.9 | 105.4 | 105.6 | 105.5 | 106.0 | 105.6 |
| 1994 | 108.9 | 108.7 | 109.2 | 108.8 | 109.4 | 109.0 |
| 1995 | 112.5 | 112.4 | 113.1 | 112.4 | 113.3 | 112.8 |

Source: USDA, ERS.

household of the West had the largest increase in food cost at 13.4-percent, while the reference household of the Northeast had the smallest at 12.8. Overall, the true food-at-home cost for the Nation increased by 13 percent over the 6-year period, compared with 12.5 percent for the CPI.

Table 10 contains the constructed true-cost indexes for the reference single-person, low-income households. The constructed true-cost indexes tend to lie below or to be the same as the true-cost indexes of the total population, with the exception of the North Central States. Comparisons with the CPI, however, are more mixed. The true indexes for both the Northeast and the South lie below the CPI, whereas the true indexes for the West and the North Central States tend to lie above the CPI. Overall, food-at-home costs rose most in the North Central States and the West, 13.1 and 13.3 percent, and least in the Northeast and South at 12.4 percent. When aggregated together to form a national true-cost-of-food-at-home index, the individual years tend to lie at or below the CPI for 1991-93, and above in 1994-95. This pattern is similar to table 9 for the total population, although the indexes for the low-income population are all below those of the total population except for the North Central States in 1995.

We now turn to taking into account households that spend more on food at home than the reference household. To do this, we decided to construct indexes for two- and four-person households with average expenditures for their group. That is, for the total population (and later the low-income population), we took the expenditure means for two- and four-person households, and then constructed the true-cost-of-food-at-home index for that group.

Table 11 contains the true indexes for two- and four-person households, with average expenditures. Some interesting patterns emerge. For the two-person households, the indexes are the same as or slightly above the reference household index, except for 1995, when they are below. The same holds true for the four-person household, except in the West, where both black and nonblack households have indexes equal to or below the reference household. For nonblack households, the calculated true-cost indexes are the same as or slightly above the CPI. In no instance is the true index ever more than 0.2 percentage point from the CPI. For black households, all the calculated indexes are below those of the CPI. Note that in 1995, the indexes for two-person nonblack households are equal to the CPI, except in the South, which is just below it. For two-person, nonblack households, food costs

**Table 11—Indexes for two- and four-person households from the total population, 1991-95**

| Year | CPI | Northeast nonblack | Northeast black | North Central nonblack | North Central black | South nonblack | South black | West nonblack | West black |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | *1990 = 100* | | | | |
| Two-person household: | | | | | | | | | |
| 1991 | 102.6 | 102.4 | 102.3 | 102.5 | 102.4 | 102.5 | 102.4 | 102.6 | 102.4 |
| 1992 | 103.4 | 103.6 | 103.1 | 103.7 | 103.2 | 103.6 | 103.1 | 103.7 | 103.2 |
| 1993 | 105.9 | 105.9 | 105.5 | 106.0 | 105.6 | 105.9 | 105.5 | 105.7 | 105.6 |
| 1994 | 108.9 | 109.1 | 108.5 | 109.2 | 108.7 | 109.0 | 108.5 | 109.3 | 108.7 |
| 1995 | 112.5 | 112.5 | 111.7 | 112.5 | 111.8 | 112.4 | 111.6 | 112.7 | 112.0 |
| Four-person household: | | | | | | | | | |
| 1991 | 102.6 | 102.3 | 102.2 | 102.4 | 102.3 | 102.3 | 102.2 | 102.4 | 102.3 |
| 1992 | 103.4 | 103.4 | 103.0 | 103.6 | 103.1 | 103.4 | 102.9 | 103.6 | 103.1 |
| 1993 | 105.9 | 105.8 | 105.4 | 105.8 | 105.5 | 105.8 | 105.4 | 105.9 | 105.5 |
| 1994 | 108.9 | 108.9 | 108.4 | 109.0 | 108.5 | 108.8 | 108.3 | 109.0 | 108.5 |
| 1995 | 112.5 | 112.0 | 111.3 | 112.0 | 111.3 | 111.9 | 111.2 | 112.2 | 111.5 |

Source: USDA, ERS.

**Table 12—Aggregated indexes for two- and four-person households, total population, 1991-95**

| Year | CPI | Northeast | North Central | South | West | National |
|---|---|---|---|---|---|---|
| | | | *1990 = 100* | | | |
| Two-person households: | | | | | | |
| 1991 | 102.6 | 102.4 | 102.5 | 102.5 | 102.6 | 102.5 |
| 1992 | 103.4 | 103.6 | 103.7 | 103.5 | 103.7 | 103.6 |
| 1993 | 105.9 | 105.9 | 106.0 | 105.8 | 105.7 | 105.9 |
| 1994 | 108.9 | 109.1 | 109.2 | 108.9 | 109.3 | 109.1 |
| 1995 | 112.5 | 112.4 | 112.4 | 112.3 | 112.7 | 112.5 |
| Four-person households: | | | | | | |
| 1991 | 102.6 | 102.3 | 102.4 | 102.3 | 102.4 | 102.4 |
| 1992 | 103.4 | 103.4 | 103.6 | 103.3 | 103.6 | 103.5 |
| 1993 | 105.9 | 105.8 | 105.8 | 105.7 | 105.9 | 105.8 |
| 1994 | 108.9 | 108.9 | 109.0 | 108.7 | 109.0 | 108.9 |
| 1995 | 112.5 | 111.9 | 111.9 | 111.8 | 112.2 | 112.0 |

Source: USDA, ERS.

rose 12.4 percent in the South, 12.5 percent in the Northeast and North Central States, and 12.7 percent in the West. Among black households, those in the West had the largest increase at 12.0 percent, while those in the South had the smallest at 11.6 percent.

The indexes of the four-person households are all less than those of the two-person households. In this case, the negative effect from the increase in household size has offset the positive effect of an increase in average food expenditures. Finally, note again that all calculated indexes for 1995 lie well below the CPI, and are considerably less than the corresponding numbers for two-person households. Hence, among nonblack households, the West had the largest increase at 12.2 percent, and the South the lowest at 11.9 percent.

In table 12, the indexes for black and nonblack households have been aggregated together to facilitate comparison with the indexes for the low-income households. Once again, these aggregated indexes are equal to or close to the indexes for nonblack households in table 11. In turn, the regional indexes have been aggregated into a national index. The patterns noted above emerge, in that the true indexes are at or below the CPI, with the indexes for four-person households below those for two-person households. Hence, over the 6-year study period, food-at-home costs rose 12.5 percent for a two-person household with average food expenditures, and 12.0 percent for a four-person household.

Finally, table 13 contains the calculated indexes for two- and four-person low-income households. In general, the Northeast and South have lower indexes than the North Central States and the West, with the West having the highest indexes. The calculated indexes tend to lie below the CPI and the true-cost indexes for the total population. For two-person households, food costs rose most in the West, 12.3 percent, and least in the South, 11.8 percent, over the 6-year period; they rose by 12.0 percent in both the Northeast and the North Central States. For four-person households, costs rose 11.7 percent in the West, and 11.3 percent in the South, with the Northeast and the North Central States experiencing a cost increase of 11.4 percent.

In general, the results of this study indicate that the CPI for food at home has been a fairly good indicator of the costs incurred by American households over the study period. True-cost indexes calculated for the general population tend to be the same as or lower than the CPI except for 1994 and 1995. The true-cost indexes also indicate that there are economies to household size, and that black households incur lower costs than nonblack households. Also, households in the West tend to have the highest costs, while those in the Northeast tend to have the lowest. In addition, the true-cost indexes for low-income households tend to be about the same as the CPI for one-person households, and lower than the CPI for two- and four-person households. This is a significant finding in that components of the CPI for food at home are indirectly used to adjust benefit levels for food stamp recipients. The results of this study indicate that the CPI has not systematically overestimated or underestimated the food costs incurred by one-person households or, for that matter, the food costs of the general population.

**Table 13—Aggregated indexes for two- and four-person, low-income households, 1991-95**

| Year | CPI | Northeast | North Central | South | West | National |
|---|---|---|---|---|---|---|
| | | | *1990 = 100* | | | |
| Two-person households: | | | | | | |
| 1991 | 102.6 | 102.3 | 102.4 | 102.4 | 102.6 | 102.4 |
| 1992 | 103.4 | 103.3 | 103.4 | 103.3 | 103.5 | 103.4 |
| 1993 | 105.9 | 105.6 | 105.7 | 105.6 | 105.9 | 105.7 |
| 1994 | 108.9 | 108.6 | 108.8 | 108.7 | 108.9 | 108.8 |
| 1995 | 112.5 | 112.0 | 112.0 | 111.8 | 112.3 | 112.0 |
| Four-person households: | | | | | | |
| 1991 | 102.6 | 102.1 | 102.2 | 102.2 | 102.3 | 102.2 |
| 1992 | 103.4 | 103.1 | 103.2 | 103.1 | 103.3 | 103.2 |
| 1993 | 105.9 | 105.5 | 105.5 | 105.4 | 105.7 | 105.5 |
| 1994 | 108.9 | 108.5 | 108.5 | 108.4 | 108.6 | 108.5 |
| 1995 | 112.5 | 111.4 | 111.4 | 111.3 | 111.7 | 111.5 |

Source: USDA, ERS.

# References


Blisard, W.N., and J. Blaylock (1991). "Construction of True Cost of Living Indexes from Estimated Engel Curves," *American Journal of Agricultural Economics*. Vol. 73, pp. 775-783.

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.

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

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.