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# New Economic Approaches to Consumer Welfare and Nutrition

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# Measuring the welfare effects

# of nutrition information

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and

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Policy makers are often required to use cost/benefit analysis to justify regulations that alter the amount of health-related information presented to consumers.[1] Currently, the method used to estimate the social benefits of a change in health-related information on a food label is to follow a ‘cost of avoided illness’ approach. The method begins by estimating shifts in demand for a food product due to information provision. These demand shifts are used to estimate changes in nutrient intakes that are then combined with scientists' estimates of risk associated with the nutrient consumption to calculate changes in disease rates. Social benefits (medical cost savings and dollar value of life years gained) are then based on these decreased disease rates.

The assumptions needed to support these calculations are often tenuous and difficult to evaluate. First, the cost of avoided illness approach takes the position that the value of a label change should be judged by the degree to which it provides "nutritionally-correct" behavior. This perspective presumes that the researcher can prejudge the “correct behavior”. Here we take a different perspective and assume, as is common in other economic analyses, that the individual is the best judge of her well being, conditional on the information provided on the food label.

A second limitation with the cost of avoided illness approach is that it assumes that the social benefits associated with the provision of health-related information are adequately represented by changes in illness occurrences. However, providing health information may increase social welfare by allowing individuals the ability to alter their consumption patterns so as to increase their utility without any change in overall health risk. As a result, the cost of avoided illness approach may underestimate the social benefits of providing health information.

Although there have been several studies documenting changes in consumer purchase behavior with exposure to information (e.g., Brown and Schrader; Chang and Kinnucan; Swartz and Strand) only one published paper has attempted to estimate the welfare effects of providing health-related information. Foster and Just (F&J) developed a theoretical framework to estimate the welfare effects associated with different levels of information about a good's quality change. We adapt F&J's approach to measure the effects of providing simplified nutrient information on consumer purchase behavior and welfare.[2] The approach measures changes in food purchase behavior due to a labeling program over time while controlling for other time-varying parameters. In addition, we aim to provide insights into the magnitude and prevalence of distributional effects of information policies with respect to the characteristics of the individual.

## Theory

While it is widely believed that a relationship exists between long-term health and consumption of different types of food, the relationship is never actually observed; no matter what illness an individual suffers from, or ultimately dies from, we never know the contribution that food consumption had to the illness. However, empirical evidence indicates that one of the characteristics important to consumer behavior is the perceived contribution of food to reducing long-term health risks. To the extent that this is true, utility-theoretic models of behavior can take as given the potential for current utility to be a function of current estimates of a food's contribution to long-term health. However, these behavioral models should allow for differences across individuals in terms of their ability to process health-related information and their perceptions and preferences for health-related risks.

If health-related information affects individuals' consumption behavior, then changes in that information must affect welfare. However, conceptualizing the welfare effect of improved information is somewhat perplexing. If one attempts to measure the welfare effect of information change by using changes in the consumer surpluses behind affected demand curves, then a paradox results. Consider a good, Z, whose production is found to decrease health-related quality. Dissemination of information on this link may lead to backward shifts in the demand for Z. The consumer surplus associated with the consumption of Z shrinks and, using this measure, the consumer *appears* to be worse off with the information than he was without it.

F&J addresses this problem; *ceteris paribus*, individuals are viewed as worse off if information exists that would help them make better choices but, because they are ignorant of the information, they cannot optimally adjust their behavior. When comparing utility under two states of information, the choice made with less information can be viewed as restricted against the context of better information. While individuals make optimal decisions conditional on the information set available, utility differences under different information states can be measured as the difference between the optimal and restricted decisions (where the restricted decision is the optimal decision under poorer information).

To provide a modeling framework to measure changes in consumer welfare due to changes in health-related information one needs to know how health-related awareness enters an individual's utility function (here defined in terms of a purchase occasion or decision). The utility evaluation can be represented by the indirect utility function: $V^S = V(\mathbf{A}^S, \mathbf{q}, Y, \mathbf{p})$, where $\mathbf{A}^S$ denotes a vector of health-related assessments for m products given information set S (i.e., $\mathbf{A}^S = [A^S_1, ... A^S_m]$), $\mathbf{q}$ denotes a vector of other quality characteristics (e.g., taste or texture), $\mathbf{p}$ is a corresponding vector of prices and Y denotes income. $V^S$ is increasing in $\mathbf{q}$ and Y, decreasing in $\mathbf{p}$.

The technology that extracts and translates health-related information into an assessment of a product's health-related impact can be viewed as a 'household production' process by which an individual combines her prior health-related knowledge, cognitive abilities, time and the health-related information presented during the purchase decision. Thus, we could model the health assessment process during the purchase decision as: $A^S_j = f(S_j, G, t_j;$ [illegible]$)$, where $A^S_j$ denotes the (subjectively) assessed health-related impact of purchasing good j given information set S, $S_j$ is the health-related information displayed about product j at the point of purchase, G denotes the consumer's prior stock of health-related information which may include information from news accounts, firm-provided advertising and public health education campaigns and $t_j$ denotes the time that the individual devotes to processing $S_j$.

The objective level of the health-related impact represented by the information variable S is denoted by $\theta$. For example, if S represents the product's fat content provided on the label, then $\theta$ denotes the actual fat content of the product. $\theta$ is separate from the assessment function because the individual does not observe it at the time of purchase except through the variable S. Although $\theta$ may be unobservable to the consumer at the time of the purchase decision, we include it within the discussion to distinguish between the factor that affects consumer decisions, S, and the one that ultimately determines consumer health, $\theta$.

Denote $e(\mathbf{A}^0(\bullet), \mathbf{q}, U, \mathbf{p})$ as the expenditure function when the health-related impact of a product is at level 0 and the information about the health-related impact accurately reflects that level. Likewise, $e(\mathbf{A}^1(\bullet), \mathbf{q}, U, \mathbf{p})$ is the expenditure function when the health-related impact of a product is at level 1 and the information about the health-related impact reflects the new level.

Although not commonly framed as such, compensating variation (CV) measures the change in individual welfare when the qualities of a good changes (denoted as a move from $\theta = \theta^0$ to $\theta = \theta^1$) along with a corresponding change in information about the quality change (S=0 to S=1). That is, $CV = e(\mathbf{A}^1(\bullet), U^0, \mathbf{p^0}) - e(\mathbf{A}^0(\bullet), U^0, \mathbf{p^0})$, where $U^0$ denotes the initial utility level (q is dropped for simplicity).

CV is an appropriate welfare measure when a good's attribute changes and the individual is provided with information reflecting the change. However, CV is not appropriate when a good's attribute does not change but the individual is provided with new information so that she adjusts consumption to avoid possible welfare losses (due to a decrease in assessed quality) or obtain possible welfare gains (due to an increase in assessed quality).

F&J provides a useful welfare measure in this case; the cost of ignorance (COI) measures the change in individual welfare when the quality of a good does not change but there is a change in information about the good's quality. Following F&J, the consumer's choice without new information can be viewed as being restricted in terms of the allowed choice of **x** (the elements of **x** measure the quantities purchased of different products). F&J note that COI can be defined as the difference between a restricted and an unrestricted expenditure function

(1) $$COI = \varepsilon\,(\mathbf{p^0}, U^0, \mathbf{A}^1(\bullet)|\,\mathbf{x}^0)) - e(\mathbf{p^0}, U^0, \mathbf{A}^1(\bullet))$$

where $\varepsilon(\bullet)$ is a restricted expenditure function because the individual's consumption is restricted to the original bundle, $\mathbf{x}^0$ (that is the quantities of goods chosen under the old information set). Note that the COI measure assumes that the individual eventually obtains better information. That is, the restricted expenditure function reflects the situation where the individual has obtained the better information but that the individual's choice is restricted to what it was when the consumer was ignorant.

COI can be measured by finding a price vector, $\mathbf{p^1}$, such that the point represented by the restricted choice (given $\mathbf{p^0}$) is represented by an unrestricted choice (given $\mathbf{p^1}$). Using this approach COI can be redefined as:

$$(2) \qquad COI = e(\mathbf{p^0}, U^0, \mathbf{A}^1(\bullet)) - e(\mathbf{p^1}, U^0, \mathbf{A}^1(\bullet)) + (\mathbf{p^1} - \mathbf{p^0})\, \mathbf{x^0},$$

where $\mathbf{p^1}$ is the price vector such that the original consumption bundle, $\mathbf{x}^0$, would be freely chosen. Note that COI (for a normal good) is always greater than or equal to zero; COI denotes the amount of money an individual is willing to give up to gain better information about $\theta$ so that she is free to alter consumption.

The model used here is based on Deaton and Muelbauer's (D&M) Almost Ideal Demand System (AIDS) expanded to include information effects (Piggott et al.) and demographic characteristics (Muelbauer and Pashards). The expanded AIDS model begins with the household's expenditure function (e)

$$(3) \qquad \log e\,(P, U, a(S; \chi), W; \varphi)/k_h = \Phi(p, a(S; \chi), W; \varphi) + \beta_0 \, \Pi \, P_{jt}^{\beta_j} \; U$$

where P denotes prices; U denotes utility; a($\bullet$) denotes an awareness function which is influenced by information, S, and $\chi$, a vector of individual characteristics that may affect information access costs; W denotes other product-specific demand influences (such as taste or seasonality); $\varphi$ denotes a vector of household demographic characteristics that may affect the relative weights given to health assessments versus other quality attributes; and $k_h$ is a general measure of household size to deflate the budget of the household to a 'needs-corrected' per capita basis (Deaton and Muelbauer). During time t, $\Phi(P, a(S;\chi), W;\varphi) = \alpha_0 + \Sigma\alpha_i \log P_{it} + (1/2)\Sigma\Sigma\gamma_{ij}\log P_{it}\log P_{jt}$, and $\alpha_i = f\{a(S;\chi), W;\varphi\} = g\{S, W;\chi,\varphi\}$, where the subscripts i and j denote goods, t denotes time, and h denotes household.

Following D&M, the AIDS model provides estimate-able share equations for the $i^{th}$ good during time t at the household level,

(4) $W_{iht} = \alpha_i + \Sigma_j \gamma_{ij}\log P_{jt} + \beta_i \log(Y_{ht}/ k_h P^*_t)$

where $W_{iht} = \{(P_{it} X_{iht})/ Y_{ht}\}$ is the share of household income spent on good 'i' ($X_{iht}$ denotes the quantity of good i chosen by household h during time t), and $\log P^* = \Phi(P, a(S;\chi), W;\varphi)$.[3]

A limitation often encountered by researchers is that data on market purchases are often aggregated at some level. A benefit of the AIDS framework is that it fulfill the conditions required for exact non-linear aggregation. The individual household share equations can be aggregated across households by multiplying $W_{iht}$ by individual household income, summing over all households, and dividing by the aggregate income:

(5) $W_{it} = \Sigma_h\{Y_{ht}\,\alpha_i /\Sigma_h Y_{ht}\} + \Sigma_j \gamma_{ij}\log P_{jt} + \beta_i \log(Y_t/P^*_t)$

where $W_{it}$ is the share of aggregate income spent on good i in the aggregate income of all households and $\log Y_t = \Sigma_h\{Y_{ht} \log (Y_{ht}/k_h)/\Sigma_h Y_{ht}\}$.

D&M note that one can find an aggregate index, K, such that

$\log(Y/K) \equiv \Sigma_h\{Y_{ht} \log(Y_{ht}/k_h)/\Sigma_h Y_{ht}\}$ where Y is average household income and Y/K is the representative budget level. If cross-sectional data on $Y_{ht}$ and $k_h$ is available then one could calculate a value for K. Economists have typically not used this approach rather they have followed one of two practices: Y/K is either replaced by per capita income (i.e., income/population) or by per capita 'conditional' expenditures (i.e., total expenditures on the goods within the system/population).

Given the above, the AIDS model provides a method of determining the 'representative household's' COI from aggregate data. First use (5) to estimate income share of product 'i' when nutrition information is and is not present. Denote the share expression for i with nutrition information present as $W_i^1 = w(a^1(\bullet; \chi), p^0, P^0, Y, W; \varphi)$ and without nutrition information present as $W_i^0 = w(a^0(\bullet; \chi), p^0, P^0, Y, W; \varphi)$. Next calculate a virtual price, $p^1$, such that $w(a^1(\bullet; \chi), p^1, P^0, Y, W; \varphi) = w(a^0(\bullet; \chi), p^0, P^0, Y, W; \varphi)$. The virtual price, along with the parameters of the demand system can be substituted into (2) to obtain estimates of the welfare effects of the label information.[4]

## Data

The data are from a cooperative effort between industry (Stop & Shop Supermarkets) and the U.S. Food and Drug Administration to test the efficacy of nutrition shelf labeling (brand specific nutrition information provided on the shelf in conjunction with the products' unit and item price information). The nutrition information carried on the shelf label consisted of a simple message highlighting whether the food product was low or reduced in fat, cholesterol, sodium or calories.

A total of 25 Stop & Shop Supermarket stores in Connecticut, Rhode Island, New Hampshire and Massachusetts were included within the experiment. Thirteen stores were designated as the treatment group, with the remaining 12 stores designated as the control group. During 1985, both the treatment and control stores began using shelf tags to provide products' unit and item price information to consumers. From 1986 to 1989, the 13 stores in the treatment group implemented a nutrition education program. During the first year of the program (1986), treatment stores exhibited shelf tags augmented with nutrition information, distributed information booklets and displayed posters that provided nutrition information and an explanation of the shelf labeling program. In the second and third years of the program (1987-88) the treatment stores only maintained the nutritional shelf labeling. During the entire period, the 12 control stores provided shelf labels displaying only unit and item price information and did not provide any additional nutrition information.

Monthly scanner-obtained sales, price and promotional data were collected at the product level (approximately 11,600 products from over 100 food categories) for all participating stores during the entire time frame of the experiment. Relevant data were collected for all products marketed during the time frame of the experiment, including products introduced during the time frame of the experiment. This is important because the marketing and development of ‘healthy’ products gained impetus during the late 80’s (Freidman).

Measuring the behavioral effects of a labeling policy change is problematic because it may take months or years before some consumers notice or incorporate the new information in their consumption decisions (see: Levy and Stokes). During the relevant time period there may be changes in other exogenous variables which can confound the measurement of demand effects due to a particular labeling policy. Given the Stop & Shop data are from a controlled ‘experiment’, comparing demand shifts across treatment and control markets controls for non-label-related changes in demand. As a result, changes in market behavior due to the particular labeling policy can be directly measured between stores having the policy and those not having the policy.

## Empirical Model

Although the data here are complete with respect to food expenditures they do not include market-related information on all other goods. There are two common approaches to demand estimation under this lack of information. The most frequently used approach is to assume a weakly separable utility function and estimate a set of conditional demand functions which are a function of the prices of the goods of interest and of expenditures on the subset of goods. There are two problems with conditional demand functions. One problem is that the expenditure term used in the demand system is assumed weakly exogenous which is inappropriate when there are income or substitution effects between the goods of interest and other goods; expenditure will be correlated with the conditional error leading to the presence of simultaneous equation bias. One can solve the simultaneity problem (LaFrance 1989), however, another problem with conditional demand systems is that they can produce welfare measures that are biased, and this bias can be quite large, up to 40 percent (LaFrance 1993). An alternative (used here) is to specify an incomplete system of demand equations that are functions of: the prices of the goods of interest, the prices of related goods, and total income. When the demand system is integrable then this approach can be used to calculate exact welfare measures from the parameters of the incomplete demand system (LaFrance and Hanemann).

To allow use of the Stop & Shop data, we begin by defining

$\Phi(P, a(S;\chi), W; \varphi) = \alpha_0 + \Sigma\alpha_{ihmt} \log P_{imt} + (1/2)\, \Sigma\Sigma\gamma_{ij} \log P_{imt} \log P_{jmt}$,

$\alpha_{ihmt} = \xi_i + \tau_i T_t + \phi_{1i} L_{mt} + \phi_{2i}(L_{mt} T_t) + \eta_{1i} E_h + \eta_{2i} (L_{mt} E_h) + \omega_{1i} A_h + \omega_{2i} (L_{mt} A_h) + \theta_{1i} S_t + \theta_{2i} W_t$,

where subscripts i and j denote goods, t denotes time, m denotes store and h denotes household; $T_t$ is a time trend, $L_{mt}$, used as an intercept shifter, is equal to one in treatment stores after the labeling program is implemented, zero otherwise; $(L_{mt} T_t)$, is included to measure time dependent label effects[5]; $E_h$ denotes the average number of years of education for the adult shopper in the household[6]; $(L_{mt} E_h)$, a label-education interaction term, is included to measure any differential effect of the label across households with different levels of education; $A_h$ denotes the average age of the adult shopper in the household; $(L_{mt} A_h)$, a label-age interaction term, is included to measure any differential effect of the label across age. $S_t$ and $W_t$ represent seasonal indicator variables, $S_t$ is equal to one in the summer months (June July and August), zero otherwise; and $W_t$ is equal to one during the winter months (December, January and February), zero otherwise; $P_{jmt}$ is the price of good j sold in store m at time t.

The above specification provides store-level share equations

$$(6) \quad W_{imt} = \xi_i + \tau_i T_t + \phi_{1i} L_{mt} + \phi_{2i}(L_{mt} T_t) + \eta_{1i} E_m + \eta_{2i} (L_{mt} E_m)$$
$$+ \omega_{1i} A_m + \omega_{2i} (L_{mt} A_m) + \theta_{1i} S_t + \theta_{2i} W_t + \Sigma_j \gamma_{ij} \log P_{jmt} + \beta_i \log(Y_{mt}/P^*_t)$$

where $W_{imt}$ is the share of aggregate expenditure on good i in the aggregate budget of all households frequenting store m, $E_m = \Sigma_h\{Y_{ht} E_h/\Sigma_h Y_{ht}\}$, $A_m = \Sigma_h\{Y_{ht} A_h/\Sigma_h Y_{ht}\}$, and $\log Y_m = \Sigma_h\{Y_{ht} \log (Y_{ht}/k_h)/\Sigma_h Y_{ht}\}$. The estimated average household size, $K_m$, included in the Stop & Shop data, is used to deflate income.

Equation (6), with some simplifying assumptions, allows us to use the Stop & Shop data for the estimation. The Stop & Shop data includes mean values for education and age. However, the expressions for $E_m$ and $A_m$ are not mean values unless one assumes that either: 1) the probability of a shopper's education or age is equal to $Y_{ht} /\Sigma_h Y_{ht}$ for all h, or 2) the value of education or age is the same value for every household in market m. Neither of these assumptions is entirely satisfactory. However, these are the only measures of education and age available in the data.

The general expression for each equation in the demand system is as in (6) except that the prices for the goods of interest are share-weighted prices, $E_m$ and $A_m$ are represented by their respective means, log $Y_m$ is approximated by log $Y_m/K_m$, and the dependent variable for the equation representing all other goods is $\{\Upsilon_{\mathbf{mt}} - \Sigma_j(P_{jmt} * X_{jmt})\}/\Upsilon_{\mathbf{mt}}$, where $\Upsilon_{\mathbf{mt}}$ is equal to the calculated aggregate income for each store/time period.

The non-linear system of equations is estimated by using iterative seemingly unrelated regression. During estimation, the adding-up ($\Sigma_j \xi_j = 1$; $\Sigma_j \phi_{1j} = 0$; $\Sigma_j \phi_{2j} = 0$; $\Sigma_j \eta_{1j} = 0$; $\Sigma_j \eta_{2j} = 0$; $\Sigma_j \omega_{1j} = 0$; $\Sigma_j \omega_{2j} = 0$; $\Sigma_j \theta_{1i} = 0$; $\Sigma_j \theta_{2i} = 0$; $\Sigma_j \gamma_{ij} = 0$; $\Sigma_j \beta_j = 0$), homogeneity ($\Sigma_i \gamma_{ij} = 0$) and symmetry ($\gamma_{ij} = \gamma_{ji}$) conditions are imposed on the system.[7] Given the data are time-series, potential autocorrelation is corrected by following the procedures outlined by Berndt and Savin and Piggott et al..

The analysis of the impact of the nutrition labeling program focuses on several categories of products that vary in terms of the size/composition of the choice set, and in terms of the nutrition information being provided. Separate demand systems are estimated for six different food categories (milk, cream cheese, refried beans, peanut butter, mayonnaise and salad dressing). Each demand system is composed of three equations, one equation for the 'healthy' goods in the food category, one for the 'unhealthy' goods in the category and one equation for spending on all other goods. For the analysis, 'healthy' products are those that qualify for one of the nutrition shelf labels (e.g., ‘healthy’ refried beans are those that qualify for a low-fat label); ‘unhealthy’ products are those that do not qualify for one of the shelf labels.

Except for salad dressing (where multiple flavors of salad dressing are represented in each equation), the products represented by the ‘healthy’ and unhealthy’ demand equations are relatively homogeneous across products within a category. Note that before implementation of the labeling program both ‘healthy’ and ‘unhealthy’ goods are unlabeled. ‘Healthy’ goods are labeled (unlabeled) in treatment (control) stores after implementation of the labeling program; ‘unhealthy’ goods are not labeled in either the treatment or control stores.

## Results

This section begins with a brief presentation of the non-label parameters followed by a discussion of the label-related parameters. Interpretation of the label coefficients is complicated by the presence of the interaction terms. To derive the net impact of the labeling program on market behavior, both the signs and the magnitudes of the main-effect coefficients (label dummy) and the label interaction coefficients (label-trend, label-education and label-age) must be taken into account. The section ends with the COI estimates.

### *Parameter Estimates*

Except for the ‘unhealthy’ cream cheese equation, all the significant income coefficients suggest that the share of income devoted to purchases of these food categories decreases with increases in income, i.e., that these food items are not luxury goods (Table 1). The coefficients on the seasonal variables indicate that milk share decreases (increases) during the summer (winter). Conversely, mayonnaise and salad dressing shares increase during the summer months. All the own-price coefficients indicate that an increase in own-price leads to a decrease in share; all the cross-price coefficients indicate ‘healthy’ and ‘unhealthy’ products are substitute goods.

The time trend coefficients in the milk equations indicate that consumers were shifting their purchases from ‘unhealthy’ milk to ‘healthy’ milk even without the labeling program in place. The time trend coefficients in both the cream cheese and refried bean equations indicate overall growth in both markets, although sales of ‘unhealthy’ refried beans were increasing relatively more than sales of ‘healthy’ refried beans. The time trend coefficients in both the peanut butter and mayonnaise equations indicate that sales of these products were decreasing during the time period. Without the labeling program in place, shares of ‘healthy’ peanut butter and ‘healthy’ mayonnaise were decreasing relatively more rapidly than their corresponding ‘unhealthy’ shares. The time trend coefficients in the salad dressing equations indicate decreased (increased) expenditures on (un)healthy salad dressings. Presumably, these shifts in consumption are due to changes in consumers’ health preferences (i.e., consumers’ value for health changed) or consumers’ became more aware of diet-disease issues. Ippolito and Mathios indicate that consumers in the United States became more aware of diet-disease links during the mid to late 80’s.

As indicated by the education coefficients, shares of ‘healthy’ milk, peanut butter and mayonnaise were greater among more educated households whereas shares of ‘unhealthy’ cream cheese, refried beans and salad dressing were greater among these households. Except for salad dressing, the age coefficients indicate that shares of ‘healthy’ products were lower among older households; there was no differential effect of age on the shares of ‘healthy’ and ‘unhealthy’ salad dressing.

In the milk equation the net effect of the label-related coefficients indicate that the labeling program initially increased the ‘healthy’ share among all consumers and that these increases continued to increase with time. The time-dependent increases in ‘healthy’ share were occurring while the labeling program was much reduced in scope. In the cream cheese equations the net effect of the label-related coefficients is that the labeling program increased the share of ‘healthy’ cream cheese and that these increases remained stable with time. For refried beans, the net effect is that the presence of the labeling program increased ‘healthy’ share and that initial increases in the ‘healthy’ refried bean share continued to increase with time.

In the peanut butter equations the results indicate that the labeling program increased the ‘healthy’ share and that initial gains made in the ‘healthy’ share eroded with time. Although the share of ‘healthy’ peanut butter is declining through time, the labeling program countered this decrease so that by the end of 1988 ‘healthy’ peanut butter’s share with the labeling program was roughly equivalent to what it was at the beginning of 1985 (a three percent decline). In contrast, without the labeling program the estimated ‘healthy’ share would have decreased by approximately 17.6 percent during the same time period. In the mayonnaise and salad dressing equations the net effect is that the labeling program *decreased* ‘healthy’ share and that these initial decreases in ‘healthy’ share became smaller with time.

*Cost of ignorance estimates*

For a 33-year-old individual with a high school education (the mean values for age and education), the monthly household COI associated with low fat labeling of milk is initially $0.430 (Figure 1). This initial COI continues to increase so that by the end of 1988 the COI associated with low fat labeling of milk is $0.548. The relatively high COI result is partially due to milk making up a relatively large proportion of food expenditures. Consistent with the share effects, the COI is largest among individuals with less education (i.e., the value of the labeling program is greater for less educated individuals); COI for individuals with 10 years of education is initially $0.572, increasing to $0.803 and for individuals with 14 years of education is $0.111 and $0.138, respectively.

That COI for more educated individuals is relatively small may be due to the fact that fluid milk is already labeled by fat content (e.g. whole, two percent and skim); using shelf labels to indicate low fat milk products seems to have a relatively low value (provides less information) to more educated individuals. Given that most of the information value occurs initially, much of the COI may be due to the ancillary activities of the labeling program (educational brochures and posters) and not due to the labeling of milk *per se*.

The monthly household COI associated with low sodium labeling of cream cheese is initially $0.028, declining by the end of 1988 to $0.022 (Figure 2). Fluctuations in COI are due to seasonal fluctuations in cream cheese demand; all things equal, COI will be greater when consumption is greater. Again, the COI is largest among individuals with less education, although the difference between more and less educated individuals is rather small; COI for individuals with 10 years of education is initially $0.032, declining to $0.025, and for individuals with 14 years of education is $0.026, declining to $0.020. Apparently individuals from all education levels were similar in ignorance regarding the sodium content of cream cheese.

The monthly household COI associated with low fat labeling of refried beans is initially $0.002, increasing to $0.003 by the end of 1988 (Figure 3). Here, there is no difference in COI across individuals with different levels of education.

The monthly household COI associated with low sodium labeling of peanut butter is initially $0.336, decreasing to $0.285 by the end of 1988 (Figure 4). The COI is larger among individuals with less education. COI for individuals with 10 years of education is initially $0.568, declining to $0.422, and for individuals with 14 years of education is $0.018, declining to $0.013. COI for more educated individuals may be relatively small because these individuals may have determined the salt content of peanut butters independently of the shelf label; the presence of salt is easily determined from the product’s ingredient list and awareness of the link between sodium consumption and hypertension is particularly high among more educated individuals. Even without the labeling program low sodium peanut butter consumption is high among more educated individuals. Alternatively, the education variable may be partially denoting a ‘race effect’. Sodium is a major factor contributing to high blood pressure among individuals sensitive to salt, salt sensitivity is particularly high among African-Americans.

The monthly household COI associated with low cholesterol labeling of mayonnaise is relatively constant at $0.096, increasing to $0.103 by the end of 1988 (Figure 5). Although this COI represents a decrease in ‘healthy’ share, the COI again is largest among individuals with less education; COI for individuals with 10 years of education ranges from $0.103 to $0.112 and for individuals with 14 years of education from $0.083 to $0.088. Again, the difference in COI is small across education levels; apparently individuals from all education levels were similarly ignorant regarding the cholesterol content of mayonnaise.

The monthly household COI associated with low fat, cholesterol and calorie labeling of salad dressing is initially $0.157, increasing to $0.161 by the end of 1988 (Figure 6). The COI is largest among individuals with less education; COI for individuals with 10 years of education ranges from $0.234 to $0.239 and for individuals with 14 years of education from $0.071 to $0.075.

To allow comparison, we apply the same discounting assumptions (20 year time frame and a five percent interest rate) to the COI estimates as used by the Food and Drug Administration (FDA) when they estimated the costs and benefits associated with labeling changes promulgated under the Nutrition Labeling and Education Act of 1990 (NLEA). FDA's estimate of the cost of NLEA labeling requirements ranged from $1.4 to $2.3 billion whereas the benefits of NLEA were estimated to be approximately $4.5 billion (Frazao). Using the cost of ignorance approach, the social benefit of nutrition shelf labeling for the six product categories studied here is approximately $14.4 billion, over three times larger than FDA's benefit estimate for NLEA.

## Conclusions

The results confirm that the labeling of food products with respect to their nutritional characteristics along with an information campaign to educate consumers can significantly affect consumer behavior and welfare. The results also provide some evidence that consumers act as if they have nutrient or health risk budgets (e.g., a fat budgetary constraint). It is not simply the case that providing health-related information leads to increased consumption of 'healthy' foods across all food categories. In fact, providing nutrient information on food products may cause two effects: 1) consumers may reduce their net intake of 'unhealthy' nutrients by increasing their purchases of 'healthy' products (i.e., analogous to an 'income effect') and/or 2) consumers may switch consumption away from 'unhealthy' products in those food categories where differences in other quality characteristics (e.g., taste) are relatively small between the more and less ‘healthy’ products, and switch consumption toward ‘unhealthy’ products in food categories where differences in other quality characteristics may be relatively large between the more and less ‘healthy’ products (i.e., a ‘substitution effect’).

If this substitution effect is large then overall consumption of ‘healthy’ products (and the resulting health risk) may be unchanged or relatively small. In this case, providing nutrition information may increase social welfare without any significant change in health risk. Thus, if individuals maintain nutrient (or health risk) budgets then the current method of valuing the social benefits of providing health-related information (the cost of avoided illness approach) may underestimate the social benefits of providing this information.

**Table 1. Parameter results.**

| | Milk[A] | | Cream Cheese[B] | | Refried Beans[C] | |
|---|---|---|---|---|---|---|
| | 'Healthy' | 'Unhealthy' | 'Healthy' | 'Unhealthy' | 'Healthy' | 'Unhealthy' |
| Intercept | 1.50E-03*** | 4.3E-3*** | -1.6E-04 | -1.0E-03*** | 3.9E-05*** | 9.6E-05*** |
| | (4.3E-04) | (6.3E-04) | (1.3E-04) | (1.4E-04) | (8.1E-06) | (1.3E-05) |
| $\log(\Psi_{mt}/P^*_t)$ | -5.1E-04 | -3.1E-04*** | -2.8E-05** | 5.0E-05*** | -4.5E-06*** | -1.6E-05*** |
| | (3.6E-05) | (6.2E-05) | -1.4E-05 | (1.5E-05) | (1.1E-06) | (2.1E-06) |
| Time | 3.5E-06*** | -1.8E-06** | 2.1E-06*** | 2.4E-06*** | 4.4E-08*** | 1.1E-07*** |
| | (4.6E-07) | (7.5E-07) | (3.2E-07) | (2.7E-07) | (1.2E-08) | (2.7E-08) |
| Label | 9.8E-04*** | 1.9E-04 | 2.1E-04* | 6.5E-04*** | 3.8E-05*** | 1.2E-04*** |
| | (2.0E-04) | (3.8E-04) | (1.1E-04) | (8.0E-05) | (5.8E-06) | (1.1E-05) |
| Label * Time | 8.1E-06*** | 3.1E-06* | -1.4E-06*** | -8.4E-07** | 5.7E-08** | 5.1E-08 |
| | (9.9E-07) | (1.8E-06) | (4.8E-07) | (4.1E-07) | (2.7E-08) | (6.0E-08) |
| Education | 2.2E-04*** | 2.6E-05 | 2.3E-06 | 2.3E-05*** | 1.9E-06*** | 4.3E-06*** |
| | (1.1E-05) | (2.1E-05) | (4.8E-06) | (3.9E-06) | (2.8E-07) | (5.7E-07) |
| Label * Educ | -8.8E-05*** | -4.8E-06 | -2.5E-06 | -2.6E-05*** | -5.0E-08 | 2.8E-07 |
| | (1.1E-05) | (2.1E-05) | (6.2E-06) | (4.4E-06) | (3.2E-07) | (6.2E-07) |
| Age | -3.1E-05*** | 1.6E-05*** | -1.0E-06 | 2.2E-06** | -5.2E-07*** | -1.8E-07 |
| | (2.5E-06) | (4.6E-06) | (1.4E-06) | (9.3E-07) | (7.1E-08) | (1.3E-07) |
| Label * Age | 1.3E-06 | -1.0E-05 | -4.9E-06* | -1.1E-05*** | -1.1E-06*** | -3.8E-06*** |
| | (4.5E-06) | (8.5E-06) | (2.5E-06) | (1.8E-06) | (1.4E-07) | (2.7E-07) |
| Summer | -1.8E-05* | -3.9E-05** | -7.5E-06* | 6.8E-06* | 1.3E-07 | 1.2E-06* |
| | (1.0E-05) | (1.8E-05) | (4.4E-06) | (4.1E-06) | (2.7E-07) | (6.3E-07) |
| Winter | 2.8E-05*** | 5.8E-05*** | 9.2E-07 | -6.2E-06 | 3.3E-07 | 2.6E-06*** |
| | (9.7E-06) | (1.7E-05) | (4.1E-06) | (3.8E-06) | (2.7E-07) | (6.5E-07) |
| Own Price | -6.7E-04*** | -1.4E-03*** | -3.0E-04*** | -2.2E-04*** | -1.3E-06 | 8.1E-07 |
| | -1.1E-04 | (1.4E-04) | (3.5E-05) | (2.4E-05) | (1.8E-06) | (1.8E-06) |
| Cross Price | 1.0E-03*** | 1.0E-03*** | 3.3E-05 | 3.3E-05 | 2.41E-06*** | 2.4E-06*** |
| | (1.1E-04) | (1.1E-04) | (2.3E-05) | (2.3E-05) | (9.0E-07) | (9.0E-07) |

NOTES: Standard errors in parentheses. An * denotes significance at the 10 percent level, ** denotes significance at the five percent level and *** denotes significance at the one percent level.

A ‘healthy’ milk is labeled as having low or reduced fat

B ‘healthy’ cream cheese is labeled as having low or reduced sodium

C ‘healthy’ refried beans are labeled as having low or reduced fat

D ‘healthy’ peanut butter is labeled as having low or reduced sodium

E ‘healthy’ mayonnaise is labeled as having low or reduced cholesterol

F ‘healthy’ salad dressing is labeled as having low or reduced fat, cholesterol or calories

**Table 1. (continued).**

| | Peanut Butter[D] | | Mayonnaise[E] | | Salad Dressing[E] | |
|---|---|---|---|---|---|---|
| | 'Healthy' | 'Unhealthy' | 'Healthy' | 'Unhealthy' | 'Healthy' | 'Unhealthy' |
| Intercept | 5.1E-04*** | 6.4E-04*** | 4.2E-04*** | 4.7E-04** | 1.9E-04*** | -2.6E-04** |
| | (8.0E-05) | (1.1E-04) | (1.4E-04) | (2.2E-04) | (7.0E-05) | (1.4E-04) |
| $\log(\Psi_{mt}/P^{*}_{t})$ | -1.9E-04*** | 2.5E-06 | -2.9E-05 | -4.0E-05 | 9.0E-06 | -5.6E-05*** |
| | (9.9E-06) | (1.6E-05) | (1.7E-05) | (3.0E-05) | (2.0E-05) | (1.7E-04) |
| Time | -1.2E-06*** | -7.9E-07*** | -3.1E-06*** | -8.2E-07*** | -7.0E-07*** | 3.1E-06*** |
| | (1.2E-07) | (1.7E-07) | (3.5E-07) | (4.8E-07) | (2.6E-07) | (3.1E-07) |
| Label | 7.2E-04*** | -5.9E-05 | -2.0E-04* | 2.8E-06** | -4.5E-04*** | 6.5E-04*** |
| | (5.3E-05) | (8.6E-05) | (1.2E-04) | (1.4E-04) | (1.0E-04) | (1.0E-04) |
| Label * Time | -1.0E-07 | 1.6E-06*** | 2.8E-06*** | 5.6E-07*** | 9.2E-07* | -2.4E-06*** |
| | (2.9E-07) | (4.3E-07) | (5.4E-07) | (7.2E-07) | (5.3E-07) | (6.3E-07) |
| Education | 7.8E-05*** | -8.8E-06* | 8.9E-06* | -3.1E-06 | -1.4E-05*** | 4.5E-05*** |
| | (3.0E-06) | (5.2E-06) | (5.4E-06) | (7.1E-06) | (5.3E-06) | (5.4E-06) |
| Label * Educ | -3.6E-05*** | 2.1E-05*** | 4.5E-06 | 3.3E-05*** | 1.4E-05*** | -1.7E-05*** |
| | (3.0E-06) | (5.0E-06) | (6.7E-06) | (8.3E-06) | (5.9E-06) | (5.9E-06) |
| Age | 3.7E-06*** | 6.4E-06*** | -2.9E-06** | 5.1E-06** | 6.0E-06*** | 6.0E-06*** |
| | (6.3E-07) | (1.1E-06) | (1.5E-06) | -1.8E-06 | (1.3E-07) | (1.3E-06) |
| Label * Age | -9.2E-06*** | -6.0E-06*** | 2.8E-06 | -1.4E-06*** | 7.0E-06*** | -1.3E-05*** |
| | (1.1E-06) | (1.9E-06) | (2.7E-06) | (3.4E-06) | (2.2E-06) | (2.3E-06) |
| Summer | -1.4E-05*** | 6.0E-07 | 3.0E-05*** | 2.6E-06*** | 1.7E-05*** | 4.16E-05*** |
| | (2.6E-06) | (3.8E-06) | (5.8E-06) | (8.0E-06) | (4.6E-06) | (5.6E-06) |
| Winter | 8.7E-07 | 4.9E-06 | -9.0E-06** | -2.1E-06 | -3.0E-06 | 8.73E-06* |
| | (2.5E-06) | (3.6E-06) | (4.6E-06) | (6.4E-06) | (3.9E-06) | (4.7E-06) |
| Own Price | -1.1E-04*** | -2.4E-07 | -2.E-04*** | -7.0E-05 | -1.5E-04* | -1.1E-05 |
| | (2.5E-05) | (3.2E-05) | (3.0E-05) | (4.0E-05) | (3.0E-05) | (3.0E-05) |
| Cross Price | 4.9E-05** | 4.9E-05** | 1.5E-04*** | 1.5E-04*** | 3.0E-05 | 3.0E-05 |
| | (2.5E-05) | (2.5E-05) | (3.0E-05) | (3.0E-05) | (2.0E-05) | (2.0E-05) |

Figure 1: Estimated monthly household cost of ignorance if low fat labeling of milk was not implemented, by education

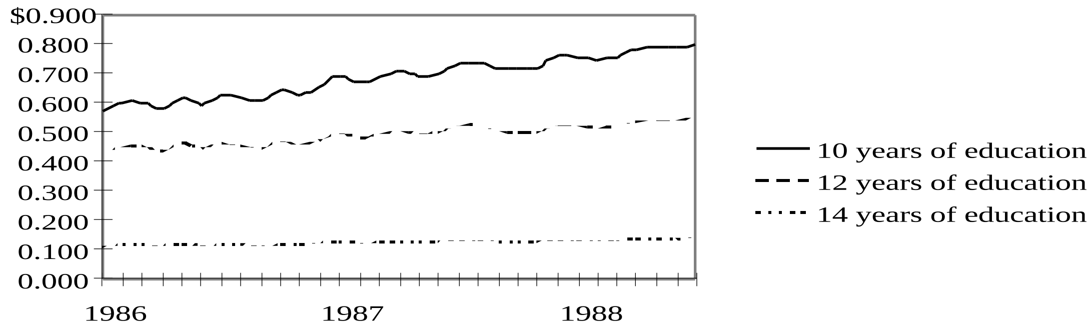



Figure 2: Estimated monthly household cost of ignorance if low sodium labeling of cream cheese was not implemented, by education

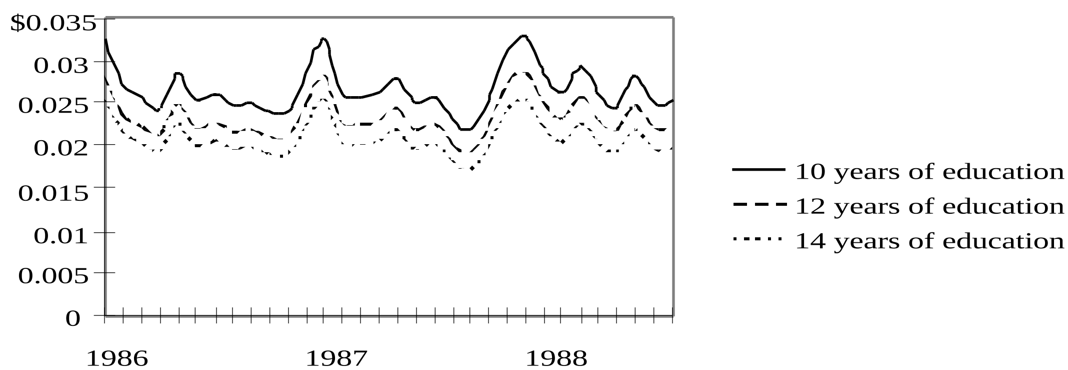



Figure 3: Estimated monthly household cost of ignorance if low fat labeling of refried beans was not implemented, by education

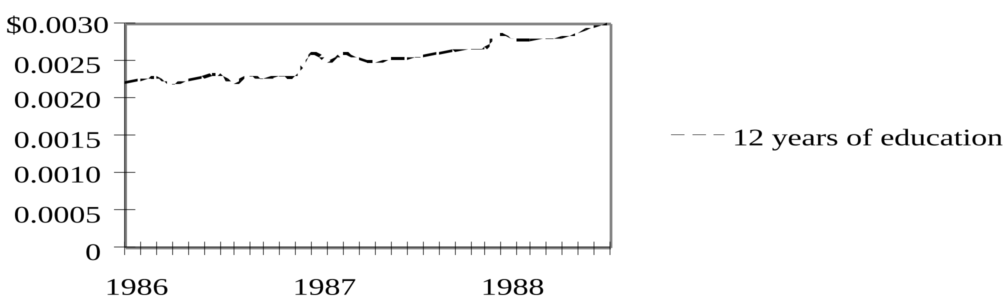



Figure 4: Estimated monthly household cost of ignorance if low sodium labeling of

peanut butter was not implemented, by education

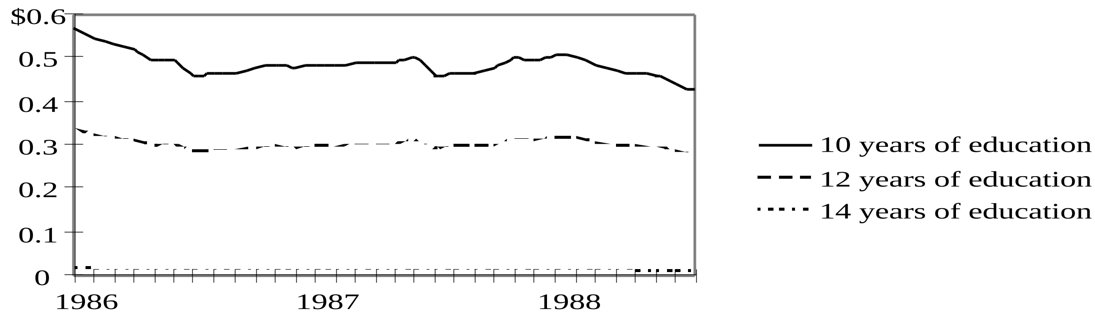



Figure 5: Estimated monthly household cost of ignorance if low cholesterol labeling of mayonnaise was not implemented, by education

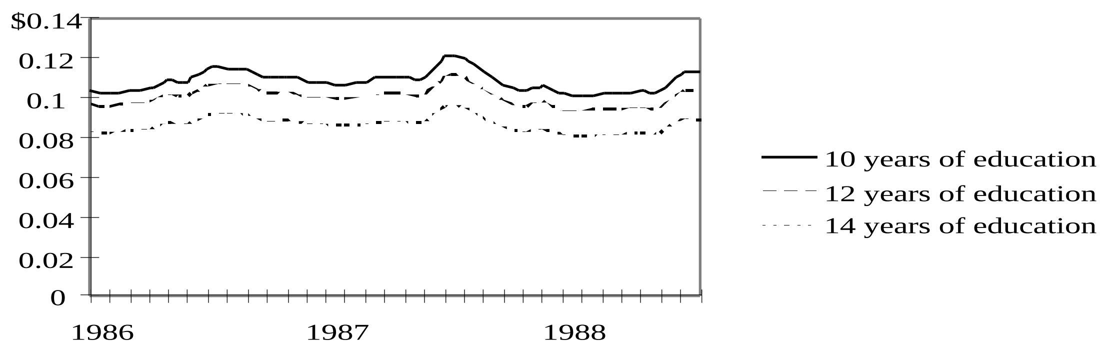
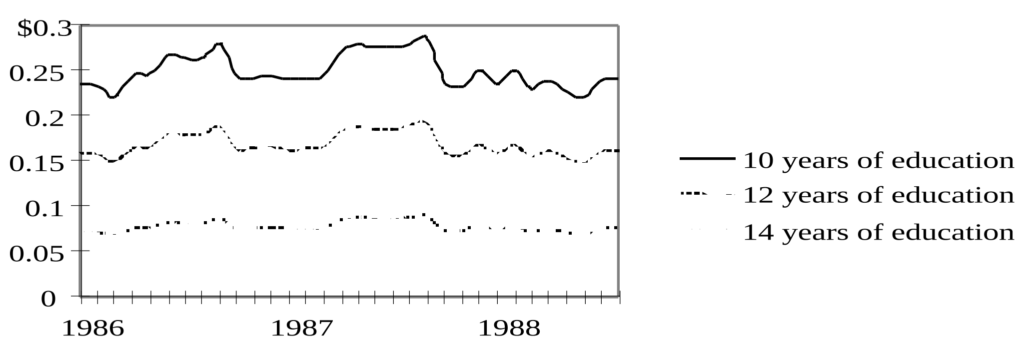



Figure 6: Estimated monthly household cost of ignorance if low cholesterol, fat and calorie labeling of salad dressing was not implemented, by education



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## Footnotes

[1] Labels that provide information about the product's environmental characteristics have also become increasingly important (e.g., Teisl, Roe and Hicks, under review).

[2] Although welfare analysis using individual level data is well researched, data based on market behavior are often available at some aggregate level rather than at the individual level. One of the challenges here is to use aggregate market data for welfare estimation.

[3] Most AIDS studies have substituted $P^*$ with Stone's price index. Although simpler to estimate, this Linearized model provides inconsistent parameter estimates (Buse).

[4] LaFrance and Hanemann show that estimation of the welfare effects due to a change in a non-price parameter is only valid if one assumes that the constant of integration is not affected by changes in the non-price parameter. Fortunately, this assumption seems reasonable here; changes in the level of health-related information about a good does not affect welfare if the good is not normally consumed. Unfortunately, this assumption has no behavioral consequences and is thus untestable.

[5] Other functional forms were considered, however, this specification provided the best fit.

[6] Socio-demographic data for individuals who shopped at the stores were provided by Stop & Shop (the provided data were aggregated at the store level).

[7] All the models were estimated both with and without the restrictions imposed. Using the joint test procedure of Gallant no significant differences between the restricted and unrestricted models were found.