

The Effect of New Food Labeling on Nutrient Intakes: An Endogenous Switching Regression Analysis

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Abstract

This study examines the impact of consumers' use of food labels on nutrient intakes of Americans. Concerns about the effect of diet on health have resulted in the legislation of the NLEA. As a result, most food products now carry a revised label that provides information about saturated fat, cholesterol, and other nutrients in a format designed to help consumers choose a more healthful and nutritious diet.

Besides the use of the 1994-96 CSFII data for the nutrient intakes variable, the 1994-96 Diet and Health Knowledge Survey (DHKS) data also are used in this study. The empirical work uses DHKS respondent files which completed the survey of both day1 and day2 intakes. Due to incomplete data for some of the variables, 5203 observations are used in the analysis.

To assess the effect of consumer label use on diet quality, endogenous switching regression techniques are employed to control for unobservable heterogeneity in the label use decision. It consists of nutrient intake equations for label users and non-label users, and an equation for the label use decision. Independent variables consist of personal or household characteristics, demographic factors, participation in government programs such as the Food Stamp Program, and knowledge about linkage between diet and health problems. The dependent variables include five nutrient intakes such as calories from total fat, calories from saturated fat, cholesterol, fiber and sodium, and binary label use variables.

Sample means of calories from total fat and saturated fat are 36.57 and 12.16, respectively. Sample means of cholesterol, dietary fiber and sodium are 2267.05 milligrams, 15.53 grams and 3233.72 milligrams, respectively. About 75.8% of the sample used nutrition information about total fat, 73.4% used information about saturated fat, 73.3% used information about cholesterol, 70.8% used information about fiber, and 73.6% used information about sodium.

In the first stage probit nutrition information use model, income, education, special diet, diet-health knowledge, exercising, and vegetarian are significantly and positively related to the probability of using nutrition information on the food label. On the other hand, household size, male, ages, food stamp program participation, and smoking are significantly and negatively related to the probability of using nutritional labels.

In the second stage nutrient intakes models, the variables that are statistically significant are different between label user and non-label user. The coefficients of education, exercise, smoker, vegetarian, and household head are statistically significant in the nutrient intake model for label users but not for non-label users. In the nutrient intake model for non-label users, the coefficients for age, race some regions and special diet are statistically significant. Results indicate that use of nutrition information on food labels improves consumers' intakes of the selected nutrients examined in this study. Consumer nutritional label use decreases the average daily calories from total fat by -6.30%, the average daily calories from saturated fat by -2.78%, the average daily cholesterol intake by -111.66 milligrams, and the average daily sodium intake by -36.29 milligrams, respectively. On the other hand, consumer nutritional label use increases average daily fiber intake by 4.25 grams.

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Introduction

Reducing intakes of fat, cholesterol, and sodium, and increasing fiber intake have been reported to help decrease a person's risk of health problems. These concerns about the effect of diet on health have resulted in the legislation of the Nutrition Labeling and Education Act (NLEA) and its implementation in 1994. As a result, most food products now carry a revised label that provides information about saturated fat, cholesterol, and other nutrients in a format designed to help consumers choose a more healthful and nutritious diet. Zarkin et al.(1993) estimated that the potential health benefits from better diet due to these new labels could be as much as 1.2 million life years gained during the next 20 years. USDA(1995) also estimates that improved dietary patterns could save \$43 billion in medical care costs. These estimates, however, are contingent upon the presumption that consumers' diets are improved by their use of food labels. Most previous analyses on the effectiveness of government programs have been focused on the Food Stamp, National School Lunch, and Federal Transfer programs (Akins et al., 1985; Bulter and Raymond, 1996; Devaney and Fraker, 1989; Long, 1991). Little empirical work, however, has been conducted on determining the effectiveness of the NLEA in improving the diet of Americans.

The purpose of this paper is to assess the impact of the NLEA on consumers' intake of selected nutrients. In particular, we attempt to determine the characteristics of consumer who use nutritional labels as well as evaluate the effect of consumer label use on nutrient intakes. Key factors such as diet-health knowledge, dietary practice, other health behavior such as smoking, exercise, and food assistance program also will be

examined in this study in relation to label use and nutrient intakes. This analysis is particularly timely and important because there is considerable debate and ongoing legislation to alter regulation of food labels.

The Econometric Model

In evaluating the effect of label use on nutrient intakes, a model that can be employed is the following:

$$(1) \quad N = X'\beta + \delta I + \varepsilon$$

where N is nutrient intakes, X is a vector of exogenous personal characteristics and I is a dummy variable ($I=1$ if the individual uses nutrition information on the food label when shopping; $I=0$ otherwise). However, this model is very restrictive, because the label use decision may create interaction effects with observed or unobserved personal characteristics (Maddala). If the label use decision is based on individual self-selection, it is likely that label users have systematically different characteristics from non-label users. This sub-sample heterogeneity is econometrically problematic when unobserved characteristics are distributed differently across label users and non-label users. Thus, unobserved variables may influence both label use decision and nutrient intakes, resulting in inconsistent estimates of the effect of label use on nutrient intakes.

A more general model for econometric analysis is the endogenous switching regression model (Lee; 1978; Maddala, 1983; Willis and Rosen, 1979). It consists of nutrient intake equations for label users and non-label users, and an equation for the label use decision. Define N_i as the observed i th nutrient intakes; N_{i1} and N_{i0} as the i th nutrient intakes of label user and non-label user, respectively; I_i^* as a latent variable that determines label use decision; I_i as an indicator variable that equals one if consumer uses

nutritional labels and equals zero otherwise; X as a vector of observed characteristics that affect nutrient intakes and Z as vector characteristics that affect label use. The endogenous switching regression model is written as

$$(2) \quad N_1 = X\beta + \varepsilon$$

$$(3) \quad N_0 = X\beta + \varepsilon$$

$$(4) \quad I^* = Z\gamma + \mu$$

$$(5) \quad I = 1 \text{ if and only if } I^* > 0 \\ = 0 \text{ if and only if } I^* < 0$$

The observed nutrient intakes are defined as

$$N_i = N_{i1} \text{ if and only if } I = 1$$

$$N_i = N_{i0} \text{ if and only if } I = 0$$

The error terms of the above equations, ε_i , ε_o , and μ are assumed to have a trivariate normal distribution, with mean vector zero and covariance matrix

$$\text{cov}(\varepsilon_1, \varepsilon_0, \mu) = \begin{bmatrix} \sigma_{11}^2 & \sigma_{10} & \sigma_{1\mu} \\ \sigma_{10} & \sigma_{00}^2 & \sigma_{0\mu} \\ \sigma_{1\mu} & \sigma_{0\mu} & 1 \end{bmatrix}$$

Since the choice of using labels or not is endogenous, the error terms in equation (6) and (7), conditional on the sample selection criterion, have a nonzero expected value. Thus OLS estimates of β are biased. Sample selection corrected nutrient intake equations are specified following Lee (1976):

$$(6) \quad N_1 = X'\beta_1 + \sigma_{1\mu} \frac{\phi(Z'\gamma)}{\Phi(Z'\gamma)} + \xi_1 \quad \text{if } I = 1$$

$$(7) \quad N_0 = X'\beta_0 + \sigma_{0u} \frac{-\phi(Z'\gamma)}{1-\Phi(Z'\gamma)} + \xi_0 \quad \text{if } I = 0$$

where the new residuals

$$\zeta_1 = \varepsilon_1 + \sigma_{1u}$$

$$\zeta_0 = \varepsilon_0 + \sigma_{0u}$$

are uncorrelated. The two-stage procedure for estimating (6) and (7) involves first calculating the Mill's ratio, $\phi(Z'\gamma)/\Phi(Z'\gamma)$ and $-\phi(Z'\gamma)/1-\Phi(Z'\gamma)$, using probit estimates of (5). The ordinary least squares method is used next to estimate (6) and (7). Since the variables, $\phi(Z'\gamma)/\Phi(Z'\gamma)$ and $-\phi(Z'\gamma)/1-\Phi(Z'\gamma)$ have already been estimated, however, the residuals ζ_1 and ζ_0 in equation (6) and (7) cannot be used to determine the variances of the two-stage estimates. Thus the variance-covariance matrix is adjusted using the procedure described by Maddala.

Data

Besides the use of the 1994-96 CSFII data for the nutrient intake variables, the 1994-96 Diet and Health Knowledge Survey (DHKS) data also are used in this study. The DHKS includes detailed information about the individual's socioeconomic background and questions on label usage. The empirical work uses DHKS respondent files which completed the survey of both day1 and day2 intakes. Due to incomplete data for some of the variables, 5203 observations are used in the analysis.

The name, definitions, and means for the variables used in the analysis are exhibited in Table 1. The dependent variables include the binary label use variables as well as average daily intakes of calories from total fat, calories from saturated fat,

cholesterol, fiber and sodium. About 75.8% of the sample used nutrition information about total fat, 73.4% used information about saturated fat,

Table1.Definition of Variables

		Description	
Dependent Variables		Binary Nutritional Label use	Nutrient Intakes Means
Calories from total fat (%)		0.7578	36.57
Calories from saturated fat (%)		0.7338	12.16
Cholesterol (milligrams)		0.7328	2267.05
Dietary Fiber(grams)		0.7080	15.53
Sodium(milligrams)		0.7355	3233.72
Explanatory Variables		Means	Std. Dev.
Income	Household income(10,000 dollars)	3.5211	2.6386
Inc ^{m2}	Square of household income	1936.6887	2623.2295
Household size	Number of household member	2.5813	1.4493
Age	Age of respondent (in years)	50.8388	17.1452
Age ²	Square of age of respondent	2879.3387	1805.5917
Male	Respondent is male (1=yes; 0=no)	0.5025	0.5000
Black	Respondent is black (1=yes; 0=no)	0.1125	0.3161
Other races	Respondent is other nonwhite race (1=yes; 0=no)	0.0630	0.2430
Employed	Respondent is employed (1=yes; 0=no)	0.5822	0.4932
City	Respondent resides in the central city (1=yes; 0=no)	0.2941	0.4557
Nonmetro	Respondent resides in the non-metropolitan (1=yes; 0=no)	0.2643	0.4410
Education	Schooling in years	12.6610	3.0824
Northeast	Respondent resides in the Northeast (1=yes; 0=no)	0.1911	0.3932
West	Respondent resides in the West (1=yes; 0=no)	0.3542	0.4783
Midwest	Respondent resides in the Midwest (1=yes; 0=no)	0.2528	0.4347
Food stamps	Participant in the food stamps program(1=yes; 0=no)	0.0761	0.2651
Exercise	Respondent has regular exercise (1=yes; 0=no)	0.6043	0.4890
BMI_SP	Body-mass ratio of respondent	27.9662	11.5336
Smoker	Respondent is smoking (1=yes; 0=no)	0.2564	0.4367
Nutrition	Nutrition is important when buying food (1=yes; 0=no)	0.6949	0.4605
Vegetarian	Respondent is a vegetarian	0.0302	0.1710
Diet-Health Knowledge	Health problems caused by eating too much fat	0.8703	0.3360
	Health problems caused by not eating enough fiber	0.6638	0.4724
	Health problems caused by eating too much sodium	0.8807	0.3242
	Health problems caused by eating too much cholesterol	0.8746	0.3310
Special Diet	Respondent is on a low fat or low cholesterol diet (1=yes; 0=no)	0.0918	0.2888
	Respondent is on a low sodium diet(1=yes; 0=no)	0.0501	0.2182
	Respondent is a high fiber diet(1=yes; 0=no)	0.0150	0.1215

73.3% used information about cholesterol, 70.8% used information about fiber, and 73.6% used information about sodium. Binary variables (1=use; 0=not use) are used to capture the decision to use each type of nutrition information on food labels.

Independent variables consist of personal or household characteristics, demographic factors, participation in government programs such as the Food Stamp Program, and knowledge about linkage between diet and disease. Personal or household characteristics include body mass index, age, gender, education, race, employment status, special diet status, smoking, exercise status, and vegetarian. Other demographic factors include region, urbanization, household size, and income.

The binary variable, Diet-Heath Knowledge is constructed to reflect consumer's awareness about linkage between diet and health problems. Questions in the DHKS used to construct the variable take the general form: "Have you heard about any health problems caused by eating too much fat (eating too much cholesterol, too much sodium, and not eating enough fiber). Each answer of "Yes" is given a value of one while each answer of "No" is given a value of zero.

The binary dummy variable, NUTRITION is added into the probit label use model, following Nayga (1996). The variable NURITION indicates whether the individual consider nutrition as an important factor when buying foods.

First Stage Probit Nutrition Information Use Model

Estimates of the first stage probit model for each of the five types of nutrition information on labels are presented in Table 2. The estimation results are generally consistent across the equations. The probability of using nutrition information on the label use increases with income, while the probability of label use decreases with age.

Table 2. Parameter Estimates of Probit Nutritional Information Label Use Equations

	Total Fat	Saturated fat	Cholesterol	Dietary Fiber	Sodium
Constant	-0.0482*** (-3.726)	-0.9070*** (-4.299)	-0.8813*** (-4.186)	-1.0327*** (-5.051)	-0.8994*** (-4.305)
Income	0.0031*** (2.988)	0.0023** (2.324)	0.0018* (1.827)	0.0007 (0.727)	0.0016* (1.672)
Household Size	-0.0743*** (-4.601)	-0.0735*** (-4.695)	-0.0607*** (-3.864)	-0.0463*** (-3.009)	-0.0478*** (-3.059)
Age	-0.0063*** (-3.937)	-0.0046*** (-2.928)	-0.0040** (-2.547)	-0.0022 (-1.458)	-0.0032** (-2.113)
Male	-0.5761*** (-13.087)	-0.4828*** (-11.449)	-0.4682*** (-11.148)	-0.4066*** (-9.936)	-0.4834*** (-11.544)
Black	0.0187 (0.268)	0.0125 (0.185)	0.1006 (1.464)	0.0658 (0.981)	0.0584 (0.846)
Other races	-0.0218 (-0.220)	-0.0256 (-0.269)	0.0270 (0.283)	-0.0262 (-0.284)	-0.0713 (-0.759)
Employed	-0.0361 (-0.679)	-0.0322 (-0.628)	-0.0733 (-1.425)	-0.0036 (-0.072)	-0.0374 (-0.732)
City	-0.0289 (-0.544)	-0.0480 (-0.946)	-0.1046** (-2.059)	-0.0865* (-1.752)	-0.0594 (-1.173)
Nonmetro	-0.2097*** (-4.043)	-0.1821*** (-3.617)	-0.2416*** (-4.807)	-0.2085*** (-4.239)	-0.2661*** (-5.332)
Education	0.0623*** (7.828)	0.0569*** (7.363)	0.0457*** (5.875)	0.0562*** (7.294)	0.0577*** (7.475)
Northeast	0.0265 (0.381)	0.0330 (0.494)	0.0449 (0.671)	0.1225* (1.874)	0.0953 (1.430)
West	-0.0551 (-0.900)	-0.0284 (-0.482)	-0.0346 (-0.589)	-0.0113 (-0.198)	0.0031 (0.054)
Midwest	0.0748 (1.136)	0.0541 (0.855)	0.0239 (0.380)	0.0501 (0.818)	0.0866 (1.381)
Food Stamp	-0.1524* (-1.869)	-0.2043*** (-2.548)	-0.2217*** (-2.777)	-0.1329* (-1.680)	-0.1790** (-2.258)
Diet-Health Knowledge	0.5602*** (9.797)	0.5090*** (9.019)	0.5784*** (9.893)	0.4165*** (9.928)	0.4714*** (8.090)
Special Diet	0.3530*** (4.179)	0.3451*** (4.309)	0.3824*** (4.720)	0.4317** (2.105)	0.5017*** (4.617)
Smoker	-0.2851*** (-6.065)	-0.2442*** (-5.333)	-0.2886*** (-6.320)	-0.2179*** (-4.860)	-0.2642*** (-5.794)
Exercise	0.2817*** (6.349)	0.2850*** (6.645)	0.2693*** (6.282)	0.2499*** (5.965)	0.2509*** (5.870)
Vegetarian	0.0251 (0.191)	0.0491 (0.388)	0.0230 (0.853)	-0.0507 (-0.426)	0.0372 (0.296)
Nutrition	0.9779*** (12.613)	0.9756*** (12.557)	0.9803*** (12.618)	1.007*** (12.699)	0.9552*** (12.391)
R ²	0.466	0.454	0.453	0.450	0.447

*** significance at 1 % level; ** significance at 5% level; * significance at 10% level

Consistent with Nayga (1996)'s finding, males are less likely to use label than females.

Results also indicate that education is significantly and positively related to the probability of label use. This finding is consistent with those of Guthrie et al.

Urbanization differences also are evident in using nutritional labels. Specifically, individuals who reside in nonmetro areas are less likely to use labels than those who reside in suburban areas.

Individuals who are on a special diet are more likely to use labels than individuals who are not on a special diet. Individuals who are more informed about the linkage between diet and health problems also are more likely to use nutritional labels. This result is consistent with the argument that poorly informed consumers tend to underestimate the marginal benefit of label use. Health behaviors such as non-smoking and exercising are significantly and positively related to the probability of using labels. Non-smokers or individuals who regularly exercise are more likely to use labels than others. In addition, individuals who consider nutrition as an important factor when buying foods are more likely to use nutritional labels than others.

Second Stage Nutrient Intakes Equation Models

The second-stage estimates of the endogenous switching-regression model for the different types of nutritional information on labels are exhibited in Table 3 (the estimation results of saturated fat and sodium are omitted due to space limitations). The parameter estimates for education, special diet, smoking, exercising, vegetarian, household head, and gender are statistically significant and have the expected signs in the model for label users. In the model for non label-users, these coefficients are either insignificant or have opposite signs.

Income is not significant in all of the nutrient intake equations for both users and non-users. Age is positively related to calories from total fat for label users. Also, there exists a nonlinear relationship between age and calories from total fat. Black label users have more calories from total fat and more cholesterol intakes than white label users. Label users of other races, however, have less calories from total fat and cholesterol intakes than white label users.

Non-label users from central cities have more calories from fats than non-label users from suburban areas. On the other hand, label users from nonmetro areas have more calories from fat and cholesterol intakes than label users from suburban areas. Regionally, label users from the south have more fiber intakes than those from other regions. More importantly, food stamp participants who are label users have more calories from saturated fat and cholesterol than non-food stamp participants who are label users. This finding is consistent with that of Butler and Raymond (1996). They observed that, controlling for participation in the food stamp program, nutrition intake is negatively affected by food stamp income for a sample of elderly people.

Body mass index is negatively related to fiber intakes for label users. As expected, those who are on special diet have less (more) calories from fat, cholesterol and Sodium (fiber) than those who are not on a special diet. Vegetarian label user have less (more) calories from fat, cholesterol, sodium (fiber) intakes than non-vegetarians. Label users who regularly exercise have more calories from fat, and cholesterol intakes than label users who do not exercise. Label users who are more informed about the linkage between diet and health problems have more fiber intakes than others.

Table 3. Parameter Estimates of the Nutrient Intakes Equations

	Calories from total fat		Cholesterol		Dietary Fiber	
	User	Non-user	User	Non-user	User	Non-user
Constant	32.626*** (13.270)	35.372*** (10.081)	226.74*** (4.427)	247.07*** (3.166)	12.639*** (5.825)	17.591*** (5.840)
Income	0.0234 (0.9041)	0.0397 (0.863)	-0.0454 (-0.085)	0.5192 (0.510)	0.0201 (0.895)	-0.0059 (-0.149)
Inc ^{m2}	-0.0003 (-1.116)	-0.0004 (-0.865)	-0.0019 (-0.384)	-0.0066 (-0.673)	0.045×10 ⁻⁴ (0.217)	0.0003 (0.877)
Household Size	-0.0257 (-0.174)	-0.2910 (-1.323)	0.5265 (0.176)	-4.3418 (-0.871)	-0.1291 (-1.037)	-0.2132 (-1.112)
Age	0.1066** (1.596)	0.2189** (2.246)	0.9615 (0.704)	0.0036 (0.002)	-0.0029 (-0.049)	-0.1273 (-1.485)
Age ²	-0.0013*** (-2.023)	-0.0022** (-2.355)	-0.0188 (-1.396)	-0.0059 (-0.281)	0.0002 (0.294)	0.0011 (1.404)
Male	1.0367** (2.030)	-1.0421 (-1.185)	106.28*** (10.543)	95.135 (5.178)	4.8392*** (11.871)	4.9408*** (7.273)
Black	1.1109* (1.874)	0.5930 (0.602)	42.373*** (3.481)	25.038 (1.098)	-1.1234** (-2.198)	-1.1011 (-1.263)
Other races	-3.1082*** (-3.894)	-4.7063*** (-3.220)	21.433 (1.300)	-41.296 (-1.293)	0.6781 (0.963)	-0.3408 (-0.283)
Employed	0.6508 (1.484)	1.4752* (1.925)	11.937 (1.326)	21.856 (1.243)	-0.4159 (-1.100)	0.0878 (0.131)
City	-0.1518 (-0.367)	-1.5329** (-1.975)	-6.1317 (-0.712)	2.6777 (0.153)	0.2214 (0.611)	0.7507 (1.131)
Nonmetro	1.5547*** (3.395)	-0.1754 (-0.241)	18.478* (1.908)	-1.4944 (-0.089)	0.2751 (0.684)	1.3111** (2.035)
Education	-0.1216 (-1.476)	0.0219 (0.183)	-4.0420** (-2.509)	1.4439 (0.549)	0.1743** (2.415)	-0.1820* (-1.737)
Northeast	-0.2725 (-0.500)	-0.4867 (-0.480)	1.4558 (0.130)	-7.5233 (-0.329)	-1.7985*** (-3.769)	-1.4236 (-1.603)
West	0.2566 (0.522)	2.0022** (2.304)	-2.5886 (-0.257)	-15.071 (-0.772)	-2.1013*** (-4.937)	-1.9927*** (-2.660)
Midwest	0.9208* (1.772)	1.3387 (1.410)	12.931 (1.214)	9.4281 (0.446)	-1.3104*** (-2.904)	-0.0959 (-0.118)
Food stamps	1.2060 (1.545)	-0.2232 (-0.204)	30.893* (1.889)	27.569 (1.105)	-0.0135 (-0.020)	-0.8092 (-0.837)
Diet-Health knowledge	-0.3639 (-0.481)	0.4404 (0.522)	-7.1631 (-0.429)	5.3154 (0.267)	1.4201*** (3.110)	1.1142* (1.672)
Special diet	-4.6803*** (-7.946)	-2.4861* (-1.690)	-53.311*** (-4.332)	-94.600** (-2.796)	3.7127*** (3.396)	-5.4272 (-1.544)
Smoker	1.3223*** (2.851)	0.4128 (0.593)	18.029* (1.845)	14.688 (0.927)	-2.1391*** (-5.403)	-1.8373*** (-3.068)
Exercise	-1.2858*** (-3.104)	1.7715** (2.574)	-20.950** (-2.424)	34.418** (2.275)	0.3654 (1.007)	0.8327 (1.431)
BMI_SP	0.0048 (0.318)	0.0081 (0.319)	0.0378 (0.121)	0.6381 (1.161)	-0.0253* (-1.902)	0.0303 (1.448)
Vegetarian	-2.8738*** (-3.008)	-3.1370 (-1.582)	-81.225*** (-4.146)	-49.658 (-1.127)	1.8778** (2.260)	3.5368** (2.159)
Lambda	0.8517 (0.528)	2.5229** (1.987)	-20.386 (-0.596)	54.093* (1.811)	-1.1849 (-0.826)	-2.0227* (-1.699)
N	3944	1259	3814	1389	3685	1518
R ²	0.053	0.051	0.076	0.071	0.118	0.079

*** significance at 1 % level; ** significance at 5% level; * significance at 10% level

Self-selection occurs in non-label user equations because the Mill's ratios are not (variable lambda) statistically significant except in the sodium intake equation. These estimates imply that self-selection bias could have occurred if the endogenous switching model was not employed in the estimation of the equations.

Nutritional Label Use and Changes in Nutrient Intakes

To evaluate the benefit of label use, we need to consider the total gross benefit for label users. For each label user with characteristics X and Z , we can compare the nutrient intakes when using the label $[E(N_1 | I=1)]$ and the expected potential nutrient intakes when not using the label $[E(N_0 | I=1)]$. Thus, their current decisions are compared to what they would have been if they had not used the labels. The expected gross benefit in terms of nutrient intakes due to label use is

$$(8) \quad E(N_1 | I = 1) - E(N_0 | I = 1) = X'(\beta_1 - \beta_0) + (\sigma_{1u} - \sigma_{0u}) \frac{\phi(Z'\gamma)}{\Phi(Z'\gamma)}$$

The differences in the expected nutrient intakes are calculated for all label users. The sample means of differences are reported in Table 4. The observed effects of label use are decomposed into a structural effect (the first term in the above equation) and an effect through the unobservable (the second term). Consumer nutritional label use decreases the average calories from total fat by -6.30 , the average calories from saturated fat by -2.78 , the average cholesterol intakes by -111.66 and the average sodium intakes by -36.29 , respectively. On the other hand, consumer nutritional label use increase the average fiber intakes by 4.25 .

Table 4. The effect of consumer label use on the diet quality

Types of nutrition information on the label	Calories from total fat	Calories From saturated fat	Cholesterol	Dietary Fiber	Sodium
$E[N_1 I=1]$	36.05	11.85	253.63	15.77	3176.17
$E[N_0 I=1]$	42.35	14.63	365.29	11.52	3212.46
Differences in Expected Nutrient Intakes					
Sample means	-6.30	-2.78	-111.66	4.25	-36.29
Standard Deviation	2.38	1.12	38.02	2.04	271.26
Minimum	-13.75	-7.42	-236.27	-5.76	-1045.68
Maximum	2.15	2.14	58.53	16.90	793.69

Conclusions and Implications

Concerns about the effect of diet on health have resulted in the legislation of the NLEA. To assess the effect of consumer label use on diet quality, endogenous switching regression techniques are employed to control for unobservable heterogeneity in the label use decision. The results show that nutritional label use, indeed, improves the intakes by consumers of the selected nutrients examined in this study. Calories from total fat and saturated fat, cholesterol, and sodium intakes are reduced with the use of each nutritional information on the labels, while fiber intakes increased with the use of the label.

The variables that are statistically significant in the nutrient intake equations are different between label user and non-label user. The coefficients of education, exercise, smoker, vegetarian, and household head are statistically significant in the nutrient intake model for label users but not for non-label users. In the nutrient intake model for non-label users, the coefficients for age, race, some regions, and special diet are statistically significant. Of interest in the results as well is the negative relationship between calories from saturated fat and cholesterol intakes and food stamp participation because it raises questions about the role of the Food Stamps Program in improving the diets of participants.

References

- Akin, J.S., D.K. Guilkey, B.M. Popkin, and K.M. Smith. "The Impact of Federal Transfer Program on the Nutrient Intake of Elderly Individuals." *The Journal of Human Resource* 20 (Summer 1985): 385-404.
- Bulter, J.S. and J.E. Raymond. "The Effect of the Food Stamp Program on Nutrient Intakes." *Economic Inquiry* 34(October 1996): 781-98.
- Devaney, B. and T. Fraker. "The Dietary Impact of the School Breakfast Program." *American Journal of Agricultural Economics* 71(1989):932-48.
- Frazao, E. *The American Diet: Health and Economic Consequences*, U.S. Dept. of Agr., Econ. Res. Serv., AIB-711, 1995.
- Guthrie, J., J. Fox, L. Cleveland, and S. Welsh. "Who Uses Nutrition Labeling and What Effects Does Label Use Have on Diet Quality?" *Journal of Nutrition Education* 27(1995): 153-72.
- Lee, L. "Unionism and Wage Rates: A Simultaneous Equation Model with Qualitative and Limited Dependent Variables." *International Economic Review* 19(June 1978): 415-433.
- Maddala, G.S. *Limited Dependent and Qualitative Variables in Econometrics*, New York: Cambridge University Press, 1983.
- McNutt, K. "3.6 to \$21 Billion Benefit from New Labeling Regulations." *Nutrition Today* 27 (March/April 1992): 39-43.
- Nayga Jr., R.M., "Determinants of Consumers' Use of Nutritional Information on Food Packages", *Journal of Agricultural and Applied Economics*, 28,2(1996):303-312.
- Willis, R.J. and S. Rosen. "Education and Self-Selection." *Journal of Political Economy* 87(1979): s7-s36.
- Variyam, J.N., J. Blaylock, and D. Smallwood. "A Probit Latent Variable Model of Nutrient Information and Dietary Fiber Intake." *American Journal of Agricultural Economics* 78(August 1996): 629-39.
- Zarkin, G.A., N. Dean, J.A. Mauskopf, and R. Williams, "Potential Health Benefits of Nutrition Label Changes." *American Journal of Public Health* 83(May 1993): 717-724.