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Effects of income and demographics on expenditures for whole, lowfat, and skim milk in the U.S.

Kevin Dale Lambert Jr.

To the Graduate Council:

I am submitting herewith a thesis written by Kevin Dale Lambert Jr. entitled "Effects of income and demographics on expenditures for whole, lowfat, and skim milk in the U.S.." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.

Kim Jensen, Major Professor

We have read this thesis and recommend its acceptance:

M.S. Younger, Dan McLemore, David Eastwood

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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Effects of Income and Demographics on Expenditures for Whole, Lowfat, and Skim Milk in the U.S.

A Thesis
Presented for the
Master of Science
Degree
The University of Tennessee, Knoxville

Kevin Dale Lambert
May 1994

DEDICATION

This Thesis is dedicated to my parents
Mr. Kenneth Dale Lambert
and
Mrs. Betty Jean Lambert
who have given of their time,
and of their love
Thank You.

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ABSTRACT

This research was conducted in order to better understand and identify the demographic characteristics of markets for whole, lowfat, and skim milk in the United States. The cross sectional data used in this study was gathered by the U. S. Department of Agriculture (USDA) in their 1987-88 National Food Consumption Survey (NFCS). The effects of income and other socioeconomic characteristics on the probability that a household will buy whole, lowfat, and skim milk were measured and compared. The probit model was used to examine these effects statistically.

The results showed that distinct expenditure patterns do exist for the three types of fluid milk. Income before taxes tended to decrease the probability of expenditures for whole milk while having had a positive effect on skim milk. General nutritional information was found significant and tended to increase the probability of lowfat and skim milk expenditures. The level of formal education of the food manager also had a positive effect on the probability of expenditure of lowfat and skim milk. Increasing formal education along with nutritional awareness had negative effects on the probability of whole milk expenditure. These results have important implications for the dairy industry, health professionals, and policy makers. Potential target markets may be identified from these results for whole, lowfat, and skim milk.

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CHAPTER 1

INTRODUCTION AND OBJECTIVES

Introduction

A significant and steady substitution of lowfat milk and skim milk for whole milk occurred in the U.S. between 1968 and 1989 (Figure 1.1). Studies have shown that there are continuing changes in U.S. household food expenditure patterns in general and specifically in the case of fluid milk (Huang and Raunikar; Haidacher, Blaylock, and Myers). While whole milk represented 84 percent of all beverage milk consumption in 1968, U.S.D.A. statistics show that its share dropped to 44 percent in 1989. Lowfat and skim milk's share increased from 16 percent to 56 percent. Although lowfat and skim milk's share has increased, overall fluid milk consumption per capita has been decreasing. In 1968, total per capita consumption of fluid milk (whole, skim, and lowfat) was 254.8 pounds per person. By 1989, that total had dropped to 206.8 pounds (Table 1.1).

The changes in consumption patterns may be the result of several factors. One of these factors is increased public concern about cholesterol and animal fat consumption. Organizations, such as the American Heart Association, have been educating people for the past three decades on the importance of moderation in their diet (Hettinga). Individuals have been urged to cut back on their intake of foods high in fat content. The steady

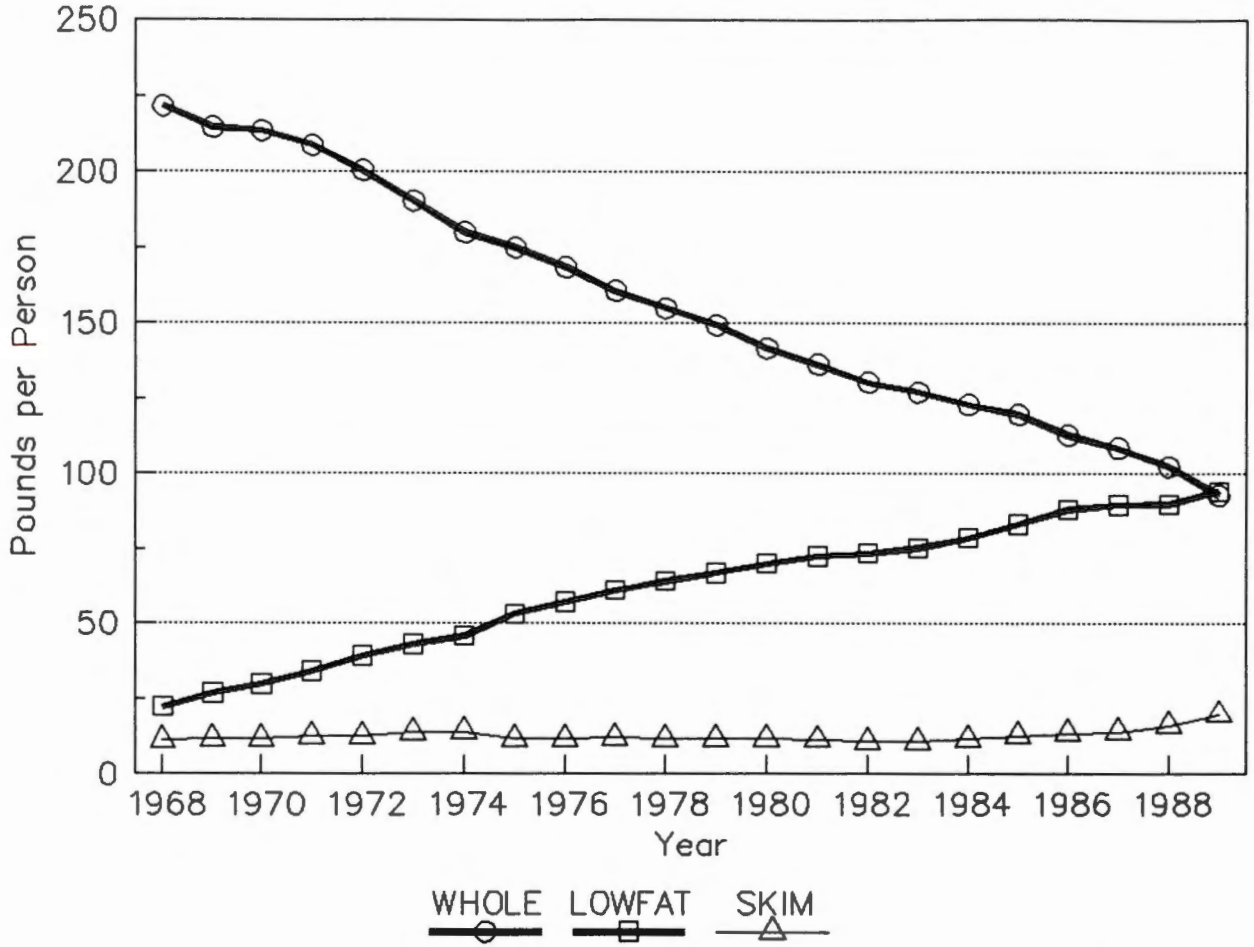

Figure 1.1 U.S. Per Capita Consumption of Fluid Milk

Source:Putnam, J.J. Food Consumption, Prices, Expenditures, 1966-1987. Stat. Bull. No. 773, U.S. Dept. of Agriculture, Econ. Res. Ser. Washington D.C., January 1989.

Table 1.1 Per Capita Consumption of Fluid Milk in Pounds Per Person

YEAR	WHOLE	LOWFAT	SKIM	TOTAL
1968	221.5	22.2	11.1	254.8
1969	214.6	26.8	11.5	252.9
1970	213.5	29.8	11.6	254.9
1971	208.7	34.0	12.3	255.0
1972	200.4	39.2	12.4	252.0
1973	190.4	43.1	13.8	247.3
1974	180.0	45.8	13.9	239.7
1975	174.9	53.2	11.5	239.6
1976	168.4	57.1	11.6	237.1
1977	160.7	61.1	11.9	233.7
1978	154.9	64.2	11.5	230.6
1979	149.3	67.0	11.6	227.9
1980	141.7	70.1	11.6	223.4
1981	136.3	72.6	11.3	220.2
1982	130.3	73.5	10.6	214.4
1983	127.1	75.4	10.6	213.1
1984	123.0	78.6	11.6	213.2
1985	119.7	83.3	12.6	215.6
1986	112.9	88.1	13.5	214.5
1987	108.5	89.6	14.0	212.1
1988	102.4	89.9	16.1	208.4
1989	92.8	94.2	19.8	206.8

Source:Putnam, J.J. Food Consumption, Prices, Expenditures, 1966-1987. Stat. Bull. No. 773, U.S. Dept. of Agriculture, Econ. Res. Ser. Washington D.C., January 1989.

trend away from consumption of whole milk toward lowfat and skim milk may be directly attributed to increased health concerns on the part of consumers (Haidacher, Blaylock, and Myers; Herrmann, Sterngold, and Warland; Hettinga; Smith, Herrmann, and Warland). While consumers perceive negative health aspects to consuming milk, they also perceive positive aspects. Milk is an excellent source of many nutrients. Calcium, protein, zinc, riboflavin, magnesium, and fortified vitamin D are all present in fluid milk (Hettinga). An aging population has concerns about the intake of calcium and vitamin D. Also, women consumers are particularly concerned about maintaining adequate intake of calcium. These factors may have helped increase consumption of lowfat milk (Haidacher, Blaylock, and Myers; Herrmann, Sterngold, and Warland; Hettinga; Smith, Herrmann, and Warland; Smith and Yonkers; Vassavada and Smith).

Changing age demographics may be contributing to the overall decline in total fluid milk consumption. U.S. Census statistics show that the average age category in the United States is getting higher. In 1960, the total population was approximately 180 million and the median age was 29.4 years. In 1988, total population equalled 246 million, and the median age had grown to 32.3 years. The percent of the population under the age of 5 years was 11.3 in 1960. In 1988, the percent of the population under the age of 5 years dropped to 7.5 percent. Also, the percent of the population 65 years and older increased from 9.2 percent in 1960 to 12.3

percent in 1988 (U.S. Bureau of the Census). Thus, the proportion of the U.S. population made up by children, the group with the greater tendency to consume fluid milk (Gould, Cox, and Perali), is getting smaller. Gould, Cox, and Perali estimate that between the years 1985 and 2010, changes in the age structure are projected to cause an average annual decline in whole milk consumption of 1.66 percent per capita. Yet, a positive per capita average growth rate of 2.63 percent (resulting from the increase in population of "older" Americans) is projected for lowfat milk.

Other demographic factors, such as race composition and education level of the population, may also affect milk consumption trends in the future. Results from several studies have shown that nonwhite households tend to consume lower amounts of fluid milk than white households (Boehm; Haidacher, Blaylock, and Myers; Huang and Raunikar). United States Census Statistics projections are that the white population will grow at a slower rate than the nonwhite population through the year 2010. Results from several studies have indicated that more years of schooling positively influence consumption of lowfat milk and negatively influence consumption of whole milk (Boehm; Gould, Cox, and Perali; Huang and Raunikar). According to US Census Statistics, the median years of schooling of the U.S. population over age 25 has been increasing during the last several decades.

During the 1980's, about 69 percent of fluid milk was consumed at

home, 16 percent was consumed away from home, and 15 percent was used as ingredients (Haidacher, Blaylock, and Myers). Therefore, the at-home market has comprised the majority of fluid milk consumption. The trend toward eating away from home has likely contributed to lower total fluid milk consumption per capita.

Gould, Cox, and Perali stress the importance of understanding the factors that affect the consumption or lack of consumption on fluid milk. They suggest that future research be conducted to analyze the effects of changes in demographic characteristics on the demand for manufactured dairy products. As noted by Heien and Wessells and Haidacher, Blaylock, and Myers, changing economic factors coupled with shifts in demographic distribution and increased awareness of dietary concerns, have likely influenced the changing product mix in the fluid milk consumption patterns.

The changing mix in dairy products consumption from whole to lowfat varieties has serious repercussions in matters of policy both at the farm level and for the manufactured dairy product industry. Gould, Cox, and Perali point out that should the increase in consumption of lowfat and skim milk continue, surpluses in the supply of milk fat for use in government-supported products may increase and could have important ramifications in terms of the level of government subsidy payments required to maintain the price of milk and milk-based products.

This study measures the impacts of income and demographics on the

probability of household at-home expenditures on whole, lowfat and skim milk. The study uses the 1987-88 U.S. Nationwide Food Consumption Survey (NFCS). The previous NFCS was conducted in 1977-78. Studies by Boehm, Haidacher, Blaylock, and Myers, Heien and Wessells, and Huang and Raunikar used household data collected in the 1970's to examine household demand for milk and other dairy products. Comparisons of household fluid milk expenditures and selected socioeconomic characteristics between the 1977-78 and 1987-88 National Food Consumption Surveys are displayed in Table 1.2 The summary statistics shown in Table 1.2 reflect the fact that milk expenditure patterns and demographics have changed markedly since the 1970's when the previous NFCS was conducted. Therefore, updated estimates of the impacts of demographics and income on whole, lowfat, and skim milk expenditures are needed.

Objectives

The objective of this study is to measure the effects of income and other socioeconomic characteristics on the probability of household expenditures for fluid milk in the United States. The effects of income and other socioeconomic characteristics on the probability of household expenditures on whole, low fat, and skim milk are measured and compared. The results from the study may provide insights into demographic characteristics of households which are shifting fluid milk expenditures from whole milk to lower fat milks. The study uses probit models to examine

Table 1.2. Comparisons of Expenditures and Selected Household Characteristics. 1977-78 and 1987-88 National Food Consumption Surveys.[a]

Variable	Households Reporting Whole Milk Expenditures	Households Reporting Lowfat Milk Expenditures
Whole Milk Expenditure ($/week)		
1977-78	2.69	0.48
1987-88		
nominal	2.99	0.23
1977-78 = 100	1.62	0.12
Lowfat Milk Expenditure ($/week)		
1977-78	0.13	2.37
1987-88		
nominal	0.23	2.81
1977-78 = 100	0.12	1.52
Household Income($)		
1977-78	13,477	17,260
1987-88		
nominal	27,235	33,680
1977-78 = 100	14,774	18,270
Household Size (Persons)		
1977-78	3.07	3.04
1987-88	3.01	2.80
Education of Female Head (Years)		
1977-78	10.59	12.20
1987-88	12.03	13.17
White Households (Percent)		
1977-78	81.84	95.19
1987-88	80.60	91.00
Percent Households Consuming Fluid Milk		
1977-78	67.20	29.97
1987-88	43.90	55.36

[a] The 1977-78 statistics are from Huang and Raunikar. Lowfat milk was defined as including skim milk.

these effects. The data used is the 1987-88 U.S. Department of Agriculture (USDA) Nationwide Food Consumption Survey (NFCS).

CHAPTER 2

LITERATURE REVIEW

Several studies have examined the consumption and expenditure patterns on milk and other dairy products in the United States. These studies have included analyses of cross-sectional data (Boehm; Haidacher, Blaylock, and Myers; Heien and Wessells; Hermann, Sterngold, and Warland; Huang and Raunikar) and time-series data (Boehm; Gould, Cox, and Perali; Haidacher, Blaylock, and Myers; Heien and Wessells). Each of these studies included analysis of the effects of demographic and socioeconomic characteristics on fluid milk consumption or expenditures. This chapter summarizes results from several of these studies.

Herrmann, Sterngold, and Warland conducted a 1990 nationwide phone survey regarding changes in consumption of dairy products. The results from their survey showed that almost half of whole milk users had shifted to lower fat milks. Shifts to lower fat milks were more likely among those respondents who expressed strong concerns about intake of cholesterol, fat, or calories than among those who expressed low levels of concern. Respondents who were age 35 and over were more likely to have switched consumption of milk to lowfat or skim milk. Those under age 35 were more likely to have continued consuming whole milk than respondents

in the older age group. White respondents were more likely to have shifted from whole milk consumption to lower fat milk consumption that were nonwhite respondents. Consumption of lowfat versus skim milk was associated with the respondent's level of formal education. Respondents who had completed 16 or more years of education were more likely to have switched to skim milk from lowfat milk than were respondents who had attained lower levels of education.

Gould, Cox and Perali studied the demand for fluid milk in the United States between 1955 and 1985 and made projections for milk consumption to the year 2010. They disaggregated fluid milk into whole milk and lowfat milk. The results from their study projected an average annual increase in per capita consumption for lowfat milk of 3.556 percent and an average annual decrease in per capita consumption for whole milk of 0.498 percent (between the years 1985-2010) due to changes in demographics of the population. Gould, Cox, and Perali examined the effects of age structure of the population, race composition of the population, and education level of the population.

The proportion of the population under age five had a positive effect on whole milk consumption and a negative effect on lowfat milk consumption. The proportion of the population ages five to 13 years also had a positive effect on whole milk consumption and a negative effect on

lowfat milk consumption. However, the proportion of the population over the age of 65 had a negative effect of whole milk consumption and a positive effect on the lowfat milk consumption. The proportion of the population which is nonwhite had a positive effect on whole milk consumption and a positive but very small effect on lowfat milk consumption. The median years of schooling had an insignificant effect on whole milk consumption and a large positive effect on lowfat milk consumption.

Heien and Wessells used 1977-78 Household Food Consumption Survey data to estimate the structure of U.S. dairy products demand. The demand relations estimated from the cross-section data were then used with time-series data to project trends in dairy products consumption between 1948 and 1984. They classified the factors affecting the decline in consumption into three groups of economic effects and three groups of demographic impacts. The economic impacts were due to own-price changes, cross-price changes, and changes in income. The demographic impacts were due to changes in age-sex categories which comprise the household, proportion of meals at home, and all other demographic variables. The results from their study showed that demographic impacts caused a 1.49 percent annual decline in the per capita demand for milk. Changes in age-sex groupings had a negative effect on milk demand (-0.77

percent per year). Changes in "other" demographic variables had a small but negative effect on milk demand because of offsetting effects of individual demographic variables included in the "other" category. The proportion of the population which is black had a negative effect on milk demand.

Haidacher, Blaylock, and Myers examined the demand for dairy products using time-series analysis and elasticities derived from household expenditure surveys. The effects of socioeconomic and demographic factors on dairy products consumption were estimated using data from the 1977-78 NFCS. The results from their study showed that changes in income had little effect on fluid milk expenditures. Haidacher, Blaylock and Myers found that per capita expenditures on whole milk were the highest in the Northeast and South. Expenditures on other milk (including skim and lowfat milk) were highest in the North Central and West regions. Expenditures on other milk were higher in suburban and nonmetro areas than in metro areas. Per capita expenditures on fluid milk were lower for nonwhites than for whites. Also, per capita dairy expenditures were found to vary across households with members of different ages. Households with children aged 2 and under spent more per person on fluid milk than did households without young children. Households with teenagers spent considerably more per person on fluid milk than did those with infants or children age three through 12. Households composed of elderly persons had the highest per capita

expenditures on skim and lowfat milk.

Boehm studied household demand for dairy products in the Southern Region. A cross-sectional model using household data and a model using time series aggregates were estimated. The cross-sectional model measured the effects of education level of the household head, occupation of the household head, race of the household, employment status of the wife, urbanization, and age/sex composition of the household, and income on household consumption of dairy products. The data for the cross-sectional data were household panel data from the Market Research Corporation of America and were limited to consuming households. Boehm found that household consumption rates for most dairy products in the South tended to be lower than the National average. Reasons for these differences could be attributed in part to the differing demographic characteristics of the Southern population relative to the entire United States. Boehm reported that while total fluid milk consumption was substantially below the national average, the average household consumption rate for regular whole milk in the South was only 12 percent below the national average. The shift to lowfat milk consumption from whole milk consumption appeared to be less dramatic in the South than in the rest of the United States. The presence of young adult and teenage males tended to increase the consumption of fluid milk. However, the presence of young adult and

teenage females tended to decrease the consumption of fluid milk. Presence of children tended to increase the consumption of fluid milk. Having a college education positively influenced lowfat milk consumption and negatively influenced whole milk consumption compared with having a high school education. Boehm found that a household being nonwhite in race had a negative influence on fluid milk consumption.

Huang and Raunikar studied household fluid milk expenditure patterns in the South and the U.S. using the 1977-78 NFCS data. Huang and Raunikar used Tobit regressions to analyze the effects of income, household size, education level of female household head, race of the household, urbanization, and family life cycle category of the household on expenditures on whole milk and on lowfat milk. The results from their study showed that, for the total U.S., as income rose, whole milk expenditures decreased and lowfat milk expenditures increased. Similar results were found for the Southern region, except the effects of income on whole milk expenditures were not significantly different from zero. For both the U.S. and the Southern Region, Huang and Raunikar also found that as the educational level of the female head of household rose, household whole milk expenditure decreased and lowfat milk expenditure increased. Huang and Raunikar postulated that these results could reflect that higher educational levels may lead to more nutritional awareness and diet-conscious behavior.

Huang and Raunikar found that for the Southern region, white households had greater expenditures on both whole and lowfat fluid milk than nonwhite households. For the total U.S. sample, no statistically significant difference in whole milk expenditure was found between white and nonwhite households. Household size increases affected whole milk expenditures at a decreasing rate. No statistically significant relationships existed between the household size variables and lowfat milk expenditure. Because children are likely present in a larger household, these results could reflect higher whole milk expenditure rates by households with children than households without children. The results from their study also showed that, for the United States, household whole milk expenditures were lower in metropolitan areas than in suburban areas and lowfat milk expenditures were higher in metropolitan areas than in suburban areas. In the Southern Region, rural household lowfat milk expenditures were lower than in suburban areas and whole milk expenditures were higher than in suburban areas.

CHAPTER 3

METHODOLOGY

Model Specification

The probability of nonzero household expenditures on whole, lowfat, and skim milk is hypothesized to be influenced by income and socioeconomic characteristics. The models hypothesized to describe the probability of nonzero expenditures on whole, lowfat, and skim milk can be expressed as:

Prob(MLKV = 1) = f(INCBT, INCSQ, REG, URB, AGE*SEX, HHSQ, PREG, NURS, FMRACE, FMAGE, FMED, NIPROF, NIMED, NIPAC),

where:

MLKV = occurrence of household purchase of a given type of fluid milk: Whole, Lowfat, or Skim (1 if had expenditures, 0 if did not),

INCBT = income before taxes,

INCSQ = income before taxes squared,

REG = region in which household is located,

URB = urbanization of location of household,

AGE*SEX = age and sex composition of the household,

HHSQ = household size squared,

PREG = pregnant household members,

NURS = nursing children in household,

FMRACE = race of food manager,

FMAGE = age of food manager,

FMED = education level of food manager,

NIPROF = nutritional information from medical or nutrition professionals,

NIMED = nutritional information from media sources, and

NIPAC = nutritional information from packages or labeling.

A more complete description of the data and variables is provided in Chapter 4.

Household income is hypothesized to have a negative effect on the probability of whole milk expenditures and a positive effect on the probability of lowfat and skim milk expenditures. Results from past studies have shown that as income increases, whole milk expenditures fall and lowfat milk expenditures rise (Blaylock and Smallwood; Huang and Raunikar). The effects of income squared cannot be postulated a priori, but it is included to measure changes in effects of income as income increases or decreases.

A household located in the South or Northeast is hypothesized to increase the probability of expenditures on whole milk and decrease the

probability of expenditures on lowfat and skim milk compared with households not in these regions. A household in the Midwest region is hypothesized to decrease the probability of expenditures on whole milk and increase the probability of expenditures on lowfat and skim milk compared with households not in the Midwest region. This hypothesis is based on findings from several past studies (Blaylock and Smallwood; Haidacher, Blaylock, and Myers; Huang and Raunikar).

The effects of urbanization of the household cannot be hypothesized. Huang and Raunikar and Blaylock and Smallwood found conflicting results for the influence of urbanization on fluid milk expenditures. However, being in a suburban household might increase the probability of expenditures on whole milk compared to not being in a suburban household because of the higher proportion of white households with small children in the suburban areas.

The age/sex composition of the household is expected to influence the probability of fluid milk expenditures primarily through the presence of children and older adults in the household. Results from past studies have shown that the presence of children, teenagers in particular, has a strong positive effect on whole milk expenditures (Blaylock and Smallwood; Boehm; Gould, Cox, and Perali). Findings from past studies have also shown that the presence of older adults has a negative influence on whole milk

expenditures and a positive influence on lowfat milk expenditures (Blaylock and Smallwood; Gould, Cox, and Perali).

Household size squared is included to measure any nonlinearities of the effects of household size on probability of milk expenditures. No direction of influence on the probability of milk expenditures is hypothesized a priori.

The presence of pregnant members in the household is expected to increase the probability of fluid milk expenditures because of the importance of calcium intake. The presence of nursing children in the household is also expected to have a positive influence on the probability of fluid milk expenditures because nursing mothers are encouraged to maintain adequate nutrient intake.

Characteristics of the food manager are included in the model because the food manager is the individual who makes the majority of decisions about food purchases and preparation. Therefore, the food manager is likely to have a strong influence on the type of fluid milk expenditures for the household. Households with nonwhite food managers are postulated to have a higher probability of whole milk expenditures than households with white food managers. Results from several studies have shown a negative relationship between a household being nonwhite and fluid milk consumption (Blaylock and Smallwood; Huang and Raunikar). Increased age of food

managers is hypothesized to lower the probability of expenditures on whole milk and increase the probability of expenditures on lowfat and skim milk. Older food managers are more likely to be concerned about intake of fat and cholesterol. Increased education levels of the food manager are hypothesized to have a positive influence on the probability of lowfat and skim milk expenditures and a negative influence on the probability of whole milk expenditures. Several studies have shown a positive influence of education level on consumption of lower fat milk and a negative influence on consumption of whole milk (Boehm; Gould, Cox, and Perali; Hermann, Sterngold, and Warland). It is postulated that consumers with higher education levels would be more aware of and able to interpret nutritional information.

Having obtained nutritional information from medical or nutritional professionals, media sources, or labels is hypothesized to have a positive influence on the probability of lowfat and skim milk expenditures and a negative influence on the probability of whole milk expenditures. Three separate variables are used to measure whether the effects of nutrition information differ by the type of information source. Consumers who are more aware of nutritional information are postulated to be more health conscious. Results from the study by Hermann, Sterngold, and Warland showed a link between health consciousness of consumers and their

switching from whole milk to lower fat milk consumption. Consumers who indicated that they devoted a lot of attention to cholesterol, fat, or calories in selecting foods, were more likely to have shifted consumption to lowfat or skim milk from whole milk than those who expressed less concern about intake of cholesterol, fat, or calories.

The Probit Method

This study measures the effects of socioeconomic and demographic factors on the purchase of a given type of milk. The variables which are modeled, purchase of whole, lowfat, or skim milk, are binary choice variables (1 if had expenditures, 0 otherwise). The Probit method enables estimation of a model to explain the binary choices (Greene).

Suppose there is an unobservable random index for consumers that represents their propensity to purchase. This index can be expressed as:

(1) $$I = x'\beta + \epsilon ,$$

where x is a matrix of socioeconomic and demographic characteristics, β is a vector of parameters, and ϵ is a normally distributed error term. While the index cannot be observed, occurrence of purchase can be observed, hence if MLKV = 1, then $I > 0$ and if MLKV = 0 then $I \leq 0$. The values of I have a range from positive infinity to negative infinity. The normal cumulative

distribution function is used to transform the data such that predictions will lie in the (0,1) interval for all X. The probit model assumes that I is a normally distributed variable. Therefore, the probability that I is greater than or less than (or equal to) some critical value can be computed from the cumulative normal distribution function. The probability of I>0 and expenditure occurring given $I_i = x_i'\beta$ (where i=1 to N) is:

(2)
$$PROB(MLK=1) = \int_{-\infty}^{x_i'\beta} \frac{1}{\sqrt{2\pi}} e^{-t^2/2} dt$$

$$= \int_{-\infty}^{x_i'\beta} \phi(t)dt$$

$$= \Phi(\beta' x) ,$$

where ϕ is the normal density function, Φ is the normal cumulative distribution function, t is normally distributed with mean zero and variance of one. To obtain an estimate of I, the inverse of the cumulative normal distribution is applied, so

(3)
$$I_i = \Phi^{-1} = x_i'\beta .$$

Estimates of the parameters of the model $I_i = \mathbf{x}'_i \boldsymbol{\beta}$ can be obtained through maximum likelihood. The likelihood function is the probability of obtaining the observed data from a particular vector of $\boldsymbol{\beta}$. The probability of purchase

$\Phi(\beta'x)$ and independent observations (Y_1 ,...,Y_N) give the joint probability or likelihood function:

$$\text{PROB}(Y_1 = y_1, Y_2 = y_2, \ldots, Y_N = y_N) = \Pi_{yi=0} [1-\Phi(\beta' x_i\ 0)]\ \Pi_{yi=1}\ \Phi(\beta' x_i)$$

This can be expressed as:

$$L = \Pi^i [\Phi(\beta' x_i)]^{yi} [1-\Phi(\beta' x_i)]^{1-yi} .$$

Where Π denotes the product of N factors.

We wish to maximize the likelihood function with respect to our parameters (β's). To find the maximum it is necessary to differentiate the likelihood function with respect to each of the known parameters, equate the derivatives to zero, and solve. It is easier to work with the (natural) logarithm of L rather than L itself, the log-likelihood function is given by:

$$\ln L = \Sigma_i [y_i \ln\Phi(\beta' x_i) + (1-y_i) \ln(1-\Phi(\beta' x_i))]$$

The marginal effects of changes in the explanatory variables on the probability of expenditure are

(4) $$\delta = \frac{\partial\Phi(x_i'\beta)}{\partial x_i} = \frac{d\Phi}{dI} * \frac{dI}{dx_i} = \phi\beta .$$

The goodness of fit of the model may be evaluated by several methods. A likelihood ratio test compares the log of the likelihood function of the model (lnL) with the log of the likelihood function of a model containing only an intercept (lnL_0). The statistic is

$$LR = -2\,(\ln L_0 - \ln L)$$

where $LR \sim \chi^2(k)$ and k is the number of restrictions. The goodness of fit may also be evaluated by examining the frequency of correct predictions of purchase. If the predicted probability of purchase is greater than 50 percent, the predicted value for the binary choice variable is assumed to be one. If the predicted probability of purchase is less than 50 percent, the predicted value for the binary choice variable is assumed to be zero. The occurrence of actual zeros and ones can then be compared with the occurrence of the predicted.

CHAPTER 4

DATA

National Food Consumption Survey

The data are from the 1987-88 household component of the Nationwide Food Consumption Survey conducted by the Human Nutrition Information Service, United States Department of Agriculture. Total responding households were 4,495. This comprised a 38 percent response rate to the survey. The data set contains data on food consumption and dietary levels of households in the United States. The data were collected starting in April 1987 and ending in August 1988. Household data were collected by trained interviewers through personal interviews with the person identified as primarily responsible for food planning and preparation. Recall of the kind, quantity, and cost (if purchased) of food and beverage used in the household during the seven days prior to the interview were recorded. Households were contacted at least seven days prior to the interview and asked to keep informal notes to assist them in recalling the food used during the seven day period.

Households which did not meet housekeeping status were deleted from the sample. Housekeeping status was defined as households in which

at least one member had at least ten adjusted meals during the survey week.[a] Of the 4,495 households with completed questionnaires, 4273 were considered to have housekeeping status.

Description of Variables

A listing of the variables used in the model is presented in Table 4.1. The variable definitions are also shown in Table 4.1.

Milk expenditure variables included fresh fluid milk, but excluded buttermilk, flavored milks, and imitation milks. If the household had fluid milk expenditures during the survey time period (seven days), the dependent variable was given a value of 1, if not, it was assigned a value of zero. Dependent variables for the three models were the occurrence of expenditure on whole milk, lowfat milk, and skim milk. Lowfat milk is defined as milk containing 1 to 2 percent milk fat. Skim milk is defined as containing 0.5 percent or less milk fat.

The variables representing income were income before taxes for the previous year and income before taxes squared. Income was the main meal-planner/preparer's estimate of the total money income from all sources, before taxes, of all household members 15 years and over for the calendar year prior to the interview. An attempt was made to eliminate as many

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[a] Adjusted meals are the number of meals and meal equivalents. Food eaten away from home, skipped meals, and snacks which might substitute for meals are adjusted to meal equivalents on a 21 meals per week basis.

Table 4.1. Variable Names and Definitions

Variable Name	Definition
Occurrence of Milk Expenditures	
WMLK	1 if had expenditures on whole milk, 0 otherwise
LMLK	1 if had expenditures on lowfat milk, 0 otherwise
SMLK	1 if had expenditures on skim milk, 0 otherwise
Income	
INCBT	income before taxes, previous year, dollars
INCSQ	INCBT squared
Pregnancy or Lactation	
PREG	1 if pregnant member present in household , 0 otherwise
NURS	1 if nursing child in household, 0 otherwise
Geographic Region	
REG1	1 if household in Northeast Region, 0 otherwise
REG2	1 if household in Midwest Region, 0 otherwise
REG3	1 if household in Southern Region, 0 otherwise
REG4	Western Region, Base Variable
Urbanization	
URB1	1 if household in central city, 0 otherwise
URB2	1 if household in suburbs, 0 otherwise
URB3	nonmetro area, Base Variable
Age/Sex Composition	
SUM1	number of children age 0-2 years
SUM2	number of children age 3-6 years
SUM3	number of children age 7-14 years
SUM4	number of males age 15-20
SUM5	number of males age 21-40

Variable Name	Definition
SUM6	number of males over age 40
SUM7	number of females age 15-20
SUM8	number of females age 21-40
SUM9	number of females over age 40
HHSQ	household size squared
Food Manager Characteristics	
FMRACE	1 if food manager is nonwhite, 0 otherwise
FMAGE	age of food manager, years
FMED	education of food manager, years
Use of Nutritional Information	
NIPROF	1 if obtained nutritional information from a doctor, nurse, dietician, home economist, or extension agent, 0 otherwise
NIMED	1 if obtained nutritional information from radio, television, newspapers, magazines, or books, 0 otherwise
NIPAC	1 if obtained nutritional information from packages or labeling, 0 otherwise

households receiving outside income assistance as possible. Households which had received food stamps in the last 12 months or were currently receiving food stamps, did not respond to the question, or did not know were deleted from the sample (410 households). Those households which had some member currently receiving other public assistance, observations with no response, or where the respondent did not know were deleted from the sample. Other public assistance included general public or private assistance (167 observations), aid to families with dependent children (AFDC) (154 observations), or women with infants and children (WIC) benefits (253 observations). The households receiving outside assistance were omitted due to the difficulty in calculating an accurate measure of their income which would reflect the levels of the assistance.

Dummy variables were used to measure the impacts of pregnant women or nursing children in the household. If a pregnant woman or a nursing child was currently present in the household, the dummies were assigned a value of one, otherwise they were assigned a value of zero. Two observations where there was no response to the question regarding pregnant members in the household were eliminated. The effects of geographic region were measured with dummy variables for three regions: Northeast, Midwest, and South. The Northeast Region included Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New

York, Pennsylvania, Rhode Island, and Vermont. The Midwest Region included Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin. The Southern Region included Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia. The Western Region (the base variable) included Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

Measures of urbanization indicated whether the household was located in the central city, a suburban area, or a nonmetro area. A central city area was defined as a city which has a population of 50,000 or more and is the main city within a standard metropolitan statistical area (SMSA). A suburban area was an area generally within the boundaries of an SMSA but not within the legal limits of the central city. A nonmetropolitan area (the base variable) is any area not within an SMSA.

The age/sex composition of the household was measured by groupings of age categories, with sex categories distinguished beyond age 14, for household members. Household size squared was included to measure any nonlinearities of effects of household size on probability of expenditure. The household size was limited to persons actually living in the household excluding roomers, boarders, and employees.

The food manager characteristics included race and age of the food manager and education level attained by the food manager. If the household was headed by a female or co-headed by a male and female and the usual meal planner was the female head or the female head and someone else, then the food manager was assumed to be the female head. If the household was headed by a male and the usual meal planner was the male head or the male head and someone else, then the food manager was assumed to be the male head. Observations where there was no response or the respondent did not know the answer were eliminated from the sample. Thirty-five of the observations for education of the female head and 16 of the observations for education of the male head were eliminated for these reasons. One observation for race of female head was eliminated because there was no response.

Measures of use of nutritional information included whether the respondent had obtained nutritional information from nutrition or medical professionals, from media sources, or from packaging or labeling during the last year. Nutrition or medical professionals included doctors, nurses, dieticians, home economists, or extension agents. Media sources included radio, television, newspapers, magazines, or books. Observations where there was no response or the respondent did not know the answer were eliminated from the sample.

After all nonusable responses were deleted, the number of usable observations in the sample was 3723. A summary of the means and standard deviations for continuous variables and frequencies for discrete variables is shown in Tables 4.2 through 4.4.

Slightly less than 44 percent of the households had expenditures on whole milk, 37.7 percent had expenditures on lowfat milk, and 19.2 percent had expenditures on skim milk (Table 4.2). Mean expenditure per week for all households on whole milk was $1.27, on lowfat milk was $1.06, and skim milk was $0.44. Mean expenditures for households with greater than zero expenditures on whole milk was $2.90, on lowfat milk was $2.80, and on skim milk was $2.28 per week.

Mean income for the sample was $29,402 (Table 4.3). Mean household size was 2.7 persons. The largest age/sex groupings were females and males over age 40, followed by females and males age 21-40. The mean age of the food manager was 47.86 years and the mean education level of the food manager was 12.64 years.

Less than 2 percent of the households had a member that was pregnant or was a nursing child (Table 4.4). The largest proportion of the households were from the Southern Region (34.0 percent). The largest proportion of the households were located in suburban areas (49.5 percent). About 12 percent of the food managers were nonwhite. During the previous

Table 4.2. Descriptive Statistics for Milk Expenditures Per Week

Milk Expenditures	Total Sample			Greater than Zero Expenditures			Percent of House-holds with Expend-itures
	Mean ($)	Std.Dev. ($)	N	Mean ($)	Std.Dev. ($)	N	
Whole	1.27	2.38	3723	2.90	2.87	1632	43.83
Lowfat	1.06	2.10	3723	2.80	2.60	1403	37.68
Skim	0.44	1.30	3723	2.28	2.15	714	19.18

Table 4.3. Descriptive Statistics for Continuous Explanatory Variables (Total Sample).

Variable Name	Mean	Std. Dev.
Income		
INCBT($)	29,402.56	23,884.35
INCSQ($)	1,434,819,501	3,973,241,440
Age/Sex Composition		
SUM1	0.11	0.34
SUM2	0.17	0.44
SUM3	0.33	0.69
SUM4	0.11	0.37
SUM5	0.40	0.53
SUM6	0.48	0.51
SUM7	0.11	0.35
SUM8	0.43	0.53
SUM9	0.57	0.55
HHSQ	9.21	9.67
Food Manager Characteristics		
FMAGE(YRS)	47.86	17.15
FMED(YRS)	12.64	2.84

Table 4.4. Descriptive Statistics for Binary Explanatory Variables (Total Sample).

Variable Name	Percent
Pregnancy or Lactation	
PREG	1.90
NURS	1.40
Geographic Region	
REG1	20.70
REG2	26.00
REG3	34.00
REG4	19.30
Urbanization	
URB1	21.90
URB2	49.50
URB3	28.60
Food Manager Characteristics	
FMRACE	12.20
Use of Nutritional Information	
NIPROF	40.50
NIMED	54.30
NIPAC	53.50

year 40.5 percent of the households had obtained nutritional information from medical or other nutrition professionals, 54.3 percent had obtained nutritional information from media sources, and 53.5 percent had obtained nutritional information from packages or labeling.

A closer look at the means of the continuous explanatory variables () reveals that the mean income of whole milk consumers ($26,584) is less than that of lowfat and skim milk ($32,086-$36,716) consumers. The percentages for the binary explanatory variables (Table 4.6) show that consuming households in the South had much greater expenditures for whole milk (44.67%) compared to expenditures on lowfat (22.17%) and skim (24.65%) milk. The Midwest region had a higher percentage of consumer expenditures on lowfat (33.71%) and skim (35.01%) with a small percentage on whole (16.97%) milk. Suburban households had greater percentages of expenditures for lowfat (54.31%) and skim (51.68%) milk. Also, a higher percentage of nonwhite food managers consumed whole (18.57%) milk as opposed to lowfat (4.85%) and skim (6.58%) milk.

Table 4.5. Means of Continuous Explanatory Variables: Expending versus Nonexpending Households.

Variable Name	Means					
	Whole		Lowfat		Skim	
	Users	Nonusers	Users	Nonusers	Users	Nonusers
Income						
INCBT	26,584.00	31,602.00	32,086.00	27,780.00	36,716.00	27,667.00
INCSQ	1.21 e+09	1.61 e+09	1.61 e+09	1.33 e+09	2.14 e+09	1.27 e+09
Age/Sex Composition						
SUM1	0.13	0.09	0.11	0.10	0.09	0.11
SUM2	0.19	0.15	0.19	0.15	0.14	0.17
SUM3	0.36	0.30	0.37	0.30	0.26	0.34
SUM4	0.14	0.10	0.11	0.11	0.10	0.12
SUM5	0.45	0.36	0.39	0.40	0.35	0.41
SUM6	0.46	0.49	0.49	0.47	0.53	0.46
SUM7	0.12	0.10	0.11	0.10	0.09	0.11
SUM8	0.47	0.40	0.45	0.42	0.41	0.44
SUM9	0.55	0.58	0.56	0.58	0.63	0.56
HHSQ	10.31	8.36	9.63	8.96	8.37	9.41
Food Manager Characteristics						
FMAGE	46.98	48.55	46.99	48.39	49.00	47.59
FMED	12.04	13.11	13.10	12.36	13.41	12.46

Table 4.6 Percents for Binary Explanatory Variables: Expending versus Nonexpending Households.

Variable Name	Percent					
	Whole		Lowfat		Skim	
	Users	Nonusers	Users	Nonusers	Users	Nonusers
Pregnancy or Lactation						
PREG	2.39	1.53	1.64	2.07	1.68	1.96
NURS	1.23	1.48	1.64	1.21	1.40	1.36
Geographic Region						
REG1	22.55	19.27	20.67	20.73	20.73	20.71
REG2	16.97	33.00	33.71	21.29	35.01	23.83
REG3	44.67	25.63	22.17	41.12	24.65	36.19
REG4	15.81	22.09	23.45	16.85	19.61	19.28
Urbanization						
URB1	21.14	22.53	21.60	22.11	23.53	21.54
URB2	46.08	52.22	54.31	46.64	51.68	49.02
URB3	32.78	25.25	24.09	31.25	24.79	29.45
Food Manager Characteristics						
FMRACE	18.57	7.27	4.85	16.68	6.58	13.56
Use of Nutritional Information						
NIPROF	34.93	44.91	44.19	38.32	49.72	38.35
NIPAC	38.85	52.56	53.31	42.46	55.32	44.47
NIMED	47.73	59.40	60.23	50.69	60.92	52.71

CHAPTER 5

RESULTS FROM THE PROBIT MODELS

Whole Milk

The estimated probit model for whole milk is presented in Table 5.1. All of the coefficients on the explanatory variables were statistically different from zero at the .05 probability level except for PREG, NURS, SUM2, SUM9, FMAGE, NIMED, and HHSQ. The calculated value for the log likelihood ratio test was 557.97 which exceeds the Chi-square critical value (14.6114, with 25 degrees of freedom, $\alpha = .05$). Therefore, the null hypothesis that all slope parameters are zero was rejected, and at least one of the variables in the model was of value in explaining the probability of expenditure on whole milk. The results of an in-sample evaluation of the predictive power of the model are presented in Table 5.2. The probit model correctly classified 67.7 percent of the individual responses.

The estimated marginal effects of each of the variables which had a significant effect on the probability of expenditure on whole milk are presented in Table 5.3. Income before taxes had a negative marginal effect on the probability of expenditures when calculated at the sample mean.[b] The marginal effects would be negative up to a household income of

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[b] Marginal effects of variables for which squared terms were also included (income and household size) are calculated as:

$$\delta_x + 2*\delta_{x^2}*(\text{mean of X})$$

Table 5.1. Probit Estimates for Household Expenditure on Whole Milk.

Variable	Coefficient	Standard Error	t-ratio	Significance Level
Constant	0.51224	0.20660	2.480	0.01314
INCBT	-8.8e-06	0.000002	-4.503	0.00001
INCSQ	3.25e-11	1.02e-11	3.187	0.00144
PREG	0.30783	0.16350	1.883	0.05972
NURS	-0.26072	0.20400	-1.278	0.20120
URB1	-0.13738	0.06365	-2.158	0.03090
URB2	-0.24056	0.05372	-4.478	0.00001
REG1	0.27372	0.06965	3.930	0.00008
REG2	-0.29832	0.06762	-4.412	0.00001
REG3	0.38160	0.06336	6.023	0.00001
SUM1	0.30544	0.09436	3.237	0.00121
SUM2	0.13568	0.08284	1.638	0.10144
SUM3	0.15299	0.07417	2.063	0.03914
SUM4	0.27293	0.08548	3.193	0.00141
SUM5	0.39129	0.07265	5.386	0.00001
SUM6	0.25861	0.07066	3.660	0.00025
SUM7	0.22469	0.08844	2.540	0.01107
SUM8	0.21627	0.07822	2.765	0.00569
SUM9	0.13962	0.07820	1.786	0.07418
FMRACE	0.36775	0.07137	5.153	0.00001
FMAGE	-0.00122	0.00218	-0.559	0.57626
FMED	-0.05776	0.00907	-6.369	0.00001
NIPROF	-0.19198	0.04556	-4.214	0.00003
NIPAC	-0.16247	0.04969	-3.270	0.00108
NIMED	-0.06899	0.04948	-1.394	0.16327
HHSQ	-0.01197	0.00843	-1.420	0.15567
Log Likelihood		-2273.23		
Log Likelihood-Intercept Only		-2552.22		
Chi-Square (25)		557.9747		

Table 5.2. Frequencies of Actual and Predicted Outcomes, Whole Milk.

	Predicted		
	0	1	
Actual			
0	1644	447	2091
1	755	877	1632
	2399	1324	TOTAL = 3723

Table 5.3. Estimated Marginal Effects for Whole Milk.

Variable	Marginal Effect
INCBT	-0.102908
PREG	0.12104
URB1	-0.05402
URB2	-0.09459
REG1	0.10762
REG2	-0.11730
REG3	0.15004
SUM1	0.12010
SUM3	0.06016
SUM4	0.10731
SUM5	0.15385
SUM6	0.10168
SUM7	0.08835
SUM8	0.08504
SUM9	0.05490
FMRACE	0.14460
FMED	-0.02271
NIPROF	-0.07549
NIPAC	-0.06388

$136,718. A household being in the Northeast or Southern region had positive marginal effects relative to the western region, while a household being located in the Midwest had negative marginal effects relative to households located in the West. The marginal effects of URB1 (central city) and URB2 (suburban) were negative relative to nonmetro areas. Therefore, households located in these urbanized areas were less likely to have whole milk expenditures than were households in nonmetro areas. The marginal effects for each significant age*sex category were positive. Large positive marginal effects were found for children age 0-2 years, males age 15-20, males age 21-40 and males over age 40. Smaller positive marginal effects were found for children age 7-14 years, females age 15-20, females age 21-40 and females over age of 40. The marginal effects for male members were larger than for female members in each age grouping. The marginal effect for education of the household food manager was negative indicating that as the food manager's education increased, the probability of whole milk expenditure decreased. The probability of expenditure on whole milk was higher for households in which the food manager was nonwhite than for households with white food managers. If nutritional information from a medical or nutrition professional had been used during the last year, this had a negative effect on the probability of expenditure on whole milk. If nutritional information from a package or label had been used during the last

year, this also had a negative effect on the probability of expenditure on whole milk.

Lowfat Milk

The estimated probit model for lowfat milk is presented in Table 5.4. A number of the coefficients on the explanatory variables were not statistically different from zero at the .05 probability. These included INCBT, INCSQ, PREG, NURS, REG2, SUM4, SUM5, SUM8, FMAGE, and NIMED. The calculated value for the log likelihood ratio test was 357.26 which exceeds the Chi-square critical value (14.6114, with 25 degrees of freedom, $\alpha = .05$). Therefore, the null hypothesis that all slope parameters are zero was rejected, and at least one of the variables in the model was of value in explaining the probability of expenditure on lowfat milk. The results from the in-sample evaluation of the predictive power of the probit model for lowfat milk are shown in Table 5.5. The model correctly classified 64.8 percent of the responses.

The estimated marginal effects of each of the variables which had a significant effect on the probability of expenditure on lowfat milk are presented in Table 5.6. Marginal effects for a household being located in the central city or a suburban area were both positive relative to nonmetro. Therefore, the probability of expenditures by households in more urbanized

Table 5.4. Probit Estimates for Household Expenditure on Lowfat Milk.

Variable	Coefficient	Standard Error	t-ratio	Significance Level
Constant	-0.98898	0.20890	-4.734	0.00001
INCBT	0.000002	0.000002	1.090	0.27586
INCSQ	-1.3e-11	1.07e-11	-1.195	0.23225
PREG	-0.27048	0.16610	-1.628	0.10353
NURS	-0.04454	0.19720	-0.226	0.82133
URB1	0.16886	0.06425	2.628	0.00859
URB2	0.23117	0.05423	4.263	0.00002
REG1	-0.20019	0.06859	-2.919	0.00351
REG2	0.093063	0.06417	1.450	0.14700
REG3	-0.45449	0.06329	-7.181	0.00001
SUM1	0.21058	0.0935	2.252	0.02431
SUM2	0.26568	0.08225	3.230	0.00124
SUM3	0.24818	0.07328	3.387	0.00071
SUM4	0.14622	0.08558	1.709	0.08752
SUM5	0.03062	0.07265	0.422	0.67339
SUM6	0.16756	0.07069	2.370	0.01778
SUM7	0.18282	0.08745	2.090	0.03658
SUM8	0.14091	0.07790	1.809	0.07048
SUM9	0.20941	0.07895	2.652	0.00799
FMRACE	-0.62565	0.08103	-7.721	0.00001
FMAGE	-0.00158	0.00221	-0.713	0.47566
FMED	0.03025	0.00925	3.272	0.00107
NIPROF	0.11561	0.04522	2.556	0.01057
NIPAC	0.12567	0.04925	2.552	0.01072
NIMED	0.07051	0.04930	1.430	0.15266
HHSQ	-0.02273	0.00829	-2.742	0.00610
Log Likelihood		-2287.86		
Log Likelihood-Intercept Only		-2466.49		
Chi-Square (25)		357.258		

Table 5.5. Frequencies of Actual and Predicted Outcomes, Lowfat Milk

	Predicted		
	0	1	
Actual			
0	1971	349	2320
1	960	443	1403
	2931	792	TOTAL = 3723

Table 5.6. Estimated Marginal Effects for Lowfat Milk

Variable	Marginal Effect
URB1	0.06338
URB2	0.08676
REG1	-0.07514
REG3	-0.17058
SUM1	0.07903
SUM2	0.09971
SUM3	0.09315
SUM4	0.05488
SUM6	0.06289
SUM7	0.06861
SUM8	0.05288
SUM9	0.07859
FMRACE	-0.23482
FMED	0.01135
NIPROF	0.04339
NIPAC	0.04717
HHS	0.543678

areas was higher than for rural areas. A household being located in the Northeast region had negative marginal effects on the probability of lowfat milk expenditures relative to the Western region. A household being located in the Southern region also decreased the probability of lowfat milk expenditure compared to those households in the Western region. The age*sex categories, 0-2 years, 3-6 years, 7-14 years, males age 15-20, males over age 40, females age 15-20, females age 21-40 and females over age 40 had significant positive marginal effects on the probability of lowfat milk expenditure. The marginal effects for total household size were positive when calculated at the sample mean. The marginal effects would be positive up to a household size of 34.6. Households with nonwhite food managers had negative marginal effects compared with households with white food managers. Increasing educational level of the food manager had a positive effect on the probability of expenditure. Having obtained nutritional information from a professional or from packaging also had positive marginal effects.

Skim Milk

The estimated probit model for skim milk is presented in Table 5.7. The calculated value for the log likelihood ratio test was 250.50 which exceeds the Chi-square critical value (14.6114, with 25 degrees of freedom, $\alpha = .05$). Therefore, the null hypothesis that all slope parameters are zero

Table 5.7. Probit Estimates for Household Expenditure on Skim Milk.

Variable	Coefficient	Standard Error	t-ratio	Significance Level
Constant	-1.9453	0.23940	-8.127	0.00001
INCBT	0.000014	0.000002	6.274	0.00001
INCSQ	-4.2e-11	1.11e-11	-3.778	0.00016
PREG	-0.11917	0.19280	-0.618	0.53650
NURS	0.04177	0.23100	0.181	0.85648
URB1	0.07231	0.07240	0.999	0.31790
URB2	0.03409	0.06213	0.549	0.58326
REG1	0.00329	0.07903	0.042	0.96682
REG2	0.26638	0.07266	3.666	0.00025
REG3	-0.10958	0.07318	-1.497	0.13429
SUM1	-0.13699	0.11190	-1.224	0.22079
SUM2	-0.10999	0.09675	-1.137	0.25560
SUM3	-0.15298	0.08728	-1.753	0.07966
SUM4	-0.16134	0.10110	-1.595	0.11067
SUM5	-0.21500	0.08525	-2.522	0.01167
SUM6	-0.11191	0.08206	-1.364	0.17266
SUM7	-0.14730	0.10310	-1.429	0.15300
SUM8	-0.00060	0.09078	-0.007	0.99475
SUM9	0.05778	0.09137	0.632	0.52715
FMRACE	-0.21085	0.09067	-2.325	0.02005
FMAGE	0.00173	0.00251	0.689	0.49110
FMED	0.04469	0.01043	4.284	0.00002
NIPROF	0.21291	0.05076	4.195	0.00003
NIPAC	0.09724	0.05583	1.742	0.08154
NIMED	0.02049	0.05609	0.365	0.71486
HHSQ	0.00727	0.01010	0.720	0.47148
Log Likelihood		-1694.53		
Log Likelihood-Intercept Only		-1819.78		
Chi-Square (25)		250.5014		

was rejected, and at least one of the variables in the model was of value in explaining the probability of expenditure on skim milk. The results from the in-sample evaluation of the predictive power of the probit model for skim milk are presented in Table 5.8. The model correctly classified 80.8 percent of the responses. However, the greatest proportion of correctly predicted responses for nonpurchasers. Hence, the model did a good job of predicting nonpurchases, but a poor job of predicting purchases.

The estimated marginal effects of each of the variables which had a significant effect on the probability of expenditure on skim milk are presented in Table 5.9. Income before taxes had a positive marginal effect on the probability of skim milk expenditures when calculated at the mean. The marginal effects would be positive up to a household income of $136,363. Location of households in the Midwest region had positive marginal effects on the probability of expenditures on skim milk relative to the West. The age*sex categories that had significant negative marginal effects for skim milk were children age 7-14 years and males age 21-40. A household having a nonwhite food manager had a negative marginal effect compared with the household having a white food manager. Increasing educational level of the food manager had a positive effect on the probability of expenditure. Having obtained nutritional information from a professional or packaging had positive marginal effects on the probability of expenditure.

Table 5.8. Frequencies of Actual and Predicted Outcomes, Skim Milk

	Predicted		
Actual	0	1	
0	2993	16	3009
1	698	16	714
	3691	32	TOTAL = 3723

Table 5.9. Estimated Marginal Effects for Skim Milk

Variable	Marginal Effect
INCBT	0.088207
REG2	0.06855
SUM3	-0.03937
SUM5	-0.05533
FMRACE	-0.05426
FMED	0.01150
NIPROF	0.05479
NIPAC	0.02502

CHAPTER 6

CONCLUSIONS AND IMPLICATIONS

Conclusions

The results from this study show that income before taxes had a negative effect on the probability of expenditures for whole milk and a positive effect on probability of expenditures for skim milk. Yet, income did not have a significant effect on the probability of expenditures on lowfat milk. Huang and Raunikar found similar results. Their results showed as income rose, whole milk expenditures decreased and lowfat milk (low and skim) expenditures increased.

The results indicated regional differences in the probability of expenditure patterns. Households in the Northeast or Southern regions were more likely to have whole milk expenditures than Western regions. Households being located in the Northeast or Southern regions had negative marginal effects on probability of expenditure on lowfat milk. Households in the Midwestern region had a higher probability of lowfat milk expenditure and a lower probability of whole milk expenditure than the Western region. These results are similar to those from past studies. Boehm found that Southern households had lower expenditures for lowfat milk than

households not in the Southern region. These results also correspond to a study by Haidacher, Blaylock and Myers which found that the Northeast and Southern geographic regions had greater expenditures for whole milk while expenditures for lowfat and skim milk were higher in the North Central and Western regions.

Expenditure patterns also appeared to depend on urbanization of the area in which the household was located. Households in the central city and suburban areas had lower probabilities of expenditures on whole milk than did households in nonmetro areas. Central city and suburban area households had higher probabilities of expenditure on lowfat milk than households in nonmetro areas. Similarly, Haidacher, Blaylock and Myers' results showed expenditures on lowfat milk were higher in suburban and nonmetro areas than in metro areas. Huang and Raunikar found that for the Southern region, rural households had lower lowfat milk expenditures and higher whole milk expenditures compared to households in the suburban areas.

The effects of the age*sex composition of the household were different for the various types of milk. All marginal effects for each of the age*sex categories were positive for whole milk, indicating that as household members were added, the probability of expenditure would increase. Additional children age 0-2 years and adult males age 21-40 years

had the greatest positive impacts on the probability of whole milk expenditures. The marginal effects for male members were larger than for female members in each age grouping. Older children (3-6 years and 7-14 years) had the largest positive marginal effects on the probability of lowfat milk expenditure. Males age 21-40 had insignificant marginal effects. Only males age 21-40 had significantly negative marginal effects on the probability of skim milk expenditure. Huang and Raunikar state that children are likely to be present in a larger household, which is reflected in higher whole milk expenditure rates. The increasing age of household members has been shown to negatively effect expenditures for whole milk while having a positive effect on lowfat milk or skim milk (Herrmann, Sterngold and Warland; Gould, Cox and Perali; Haidacher, Blaylock and Myers).

The results from this study show the probability of expenditure on whole milk was higher for households in which the food manager was nonwhite than for households with white food managers. Gould, Cox and Perali found similar results and also found a small positive effect on lowfat milk demand from nonwhite households. Haidacher, Blaylock and Myers; Boehm; Heien and Wessells report that the proportion of the population which is nonwhite had a negative effect on overall milk demand. Huang and Raunikar found no statistically significant difference in whole milk expenditure between white and nonwhite households. Herrmann, Sterngold

and Warland found that white respondents were more likely than nonwhite respondents to have shifted consumption to lowfat milk. The results of the estimated probit model for this study show that households with nonwhite food managers had negative effects on the probability of expenditures for lowfat and skim milk.

The estimated probit models for this study showed that when general nutritional information was used (medical or nutritional professional or product packaging) consumers were more likely to have expenditures on lowfat and skim milk. These results correspond with the findings of Herrmann, Sterngold and Warland. They found that respondents who expressed concerns about the intake of cholesterol, fat, or calories changed consumption to lower fat milks. The effects of nutritional information differed depending on the source of the information. Nutritional information from health professionals appeared to have the largest negative impact on probability of whole milk expenditure compared to packaging or media sources. The effects of nutritional information from packaging were slightly larger than from health professionals for skim and lowfat milk. For each type of milk, the effects of nutritional information obtained from media sources had the smallest effect.

Huang and Raunikar; Boehm; Gould, Cox and Perali; Herrmann, Sterngold, and Warland, discovered that as the level of formal education

increased the probability of expenditure for lowfat milk increased. These past studies postulated that this could reflect that higher educational levels may lead to more nutritional awareness and diet-conscious behavior. These results are reflected in this study, as the increasing educational level of the food manager had a positive effect on the probability of expenditure of lowfat and skim milk. Increasing education coupled with nutritional awareness has negative effects on the probability of whole milk expenditure.

Implications

The existence of distinct expenditure patterns for whole, lowfat, and skim milk has important implications for the dairy industry, health professionals, and policy makers. The results from this study can be used in identifying potential target markets for milk advertising and nutritional information programs.

The strong market for whole milk may be composed of households with the following socioeconomic characteristics: low in income, located in the Northeast and Southern geographic regions of the United States, with household members age 0-2 years and males age 21-40, a large household size, and households with non-white food managers. The weak market for whole milk may be composed of households which are: located in the

central city and suburban areas, located in the Midwestern and Western geographic regions, have older children (3-6 years and 7-14 years) and females over 40, have highly educated food managers who use nutritional information from health professionals and labeling.

Households residing in the central city or suburban area constitute strong markets for lowfat milk. Households with members age 0-14 years and females over 40 are important markets for lowfat milk. Households with higher education levels of the food manager and those that receive nutritional information from professionals and product packaging also form a strong market for lowfat milk. The weak market for lowfat milk would include the Northeastern and Southern geographic regions, households with males age 21-40, with nonwhite food managers.

Strong markets for skim milk would include households with high incomes. Midwestern and Western households and those households with well-educated and nutritionally conscious food managers also help comprise strong markets for skim milk. Weak markets for skim milk may include males age 21-40 and those with nonwhite food managers.

Identifying these markets is particularly important for the industry given changing demographic patterns over time. An aging of the population will likely continue to cause a decline in whole milk purchases. The U. S. Bureau of the Census projections for the last years of this century and into

the twenty-first century (1990-2010), present the dairy industry with some definite directions toward marketing policy. Census figures show that a younger to middle age population group (0-44 years) will grow at a negative to a very small positive percentage rate. While an older population group (45 and over) will grow at a high positive percentage rate. This disproportionate growth in population can be seen as good news for the probability of lowfat and skim milk expenditures, while having a negative impact on the probability of whole milk expenditures. Yet, in stark contrast, the percentage of nonwhite households will grow at a higher rate (10-30 percent) while white households will grow at a smaller rate (6 percent). This may be seen as causing an increase in the probability of expenditures for whole milk because it has been shown that households with nonwhite food managers have a higher probability of expenditure for whole milk as opposed to households with white food managers. Shifts of the population from rural to suburban and metro areas may also contribute to a decline in whole milk purchases and increases in purchases of lower fat milks. As the population becomes more educated and increasingly conscious of health and nutrition, further shifts toward purchases of lower fat milks may occur. However, it is important to note that these shifts may not be uniform. Households headed by nonwhite food managers still are more likely to purchase whole milk. Young males in the household also still have a large positive effect on whole

milk purchases and negative effects on skim milk purchases.

Nutritional information from health professionals had the largest positive effect on skim milk and negative effect on whole milk of any of the sources of information. However, labeling had the largest marginal effect on lowfat milk of any of the sources. A possible implication of these results is that nutritional information from health professionals may contain the most emphasis on fat and cholesterol intake or that those seeking advise from these professionals are most concerned about fat and cholesterol intake.

This study has examined factors influencing the probability of expenditure. Further research should examine the effects of these socioeconomic and demographic factors on levels of expenditures. This study also only examined patterns for at-home expenditures. An increasing proportion of food expenditures are on meals away-from-home, hence the effects of socioeconomic and demographic factors in this market should also be considered.

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