SPECIFICATION OF THE IMPACT OF SOCIOECONOMIC FACTORS ON CONSUMPTION OF THE ANIMAL AND VEGETABLE SOURCES OF PROTEIN*

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Proteins are one of the basic and essential nutrients consumed by man. Both animal and vegetable sources provide proteins in the human diet. Many proteins derived from animal sources are nutritionally adequate because all essential amino acids are present. However, proteins from vegetable sources are often deficient in one or more essential amino acids. Therefore, vegetable protein must generally be supplemented with other proteins in order to provide good nutition. However, vegetable proteins can provide a satisfactory diet if the individual is judicious in selecting foods [4, pp. 41-53].

A study of 1955 data indicated that approximately 55 percent of the protein component of the American diet came from animal sources [6, p. 64]. A recent analysis indicated that red meats contributed approximately 30 percent of the animal source to total protein. Dairy products, poultry, and fish contributed the balance. Similarly, wheat flour provided approximately 15 percent of total vegetable protein intake with other cereals (rice, corn, barley and rye), legume seeds (beans, peas and soybeans), and nuts constituting the balance [5, pp. 3 and 4].

These differences in consumption levels of protein sources are coupled with relatively large differentials in unit prices of alternative protein sources. In 1974, a pound of protein derived from beef, pork, tuna fish, eggs, cheddar cheese and chicken had an annual average wholesale price of approximately $7.50, $6.60, $5.50, $5.00, $4.60, and $4.20, respectively. Similarly, a pound of protein derived from wheat flour, extruded soybean flour and granular soybean concentrate cost $2.00, $.70, and $.65 [5, p. 5]. Thus, units of protein derived from vegetable sources were relatively much cheaper.

Studies analyzing variations in consumption of animal and vegetable protein with respect of socioeconomic factors are few. However, relationships between nutrient consumption and such socioeconomic factors as income, race, age, urbanization and education have been analyzed in several studies of localized areas or particular groups of people [11, 12, 13, 14, 15].

This analysis estimated household demand for animal and vegetable protein with major emphasis on assessing the impact of income on consumption of these two sources. The objective was to contrast animal and vegetable protein income elasticities, while accounting for changes in other socioeconomic characteristics of the household. Such estimates provide insight into future demand trends which directly affect the types of agricultural products produced and marketed in the United States.

DATA AND MODEL

Data from USDA'S 1965-66 nationwide household food consumption survey were utilized to specify the impact of various household socioeconomic factors on consumption of animal and vegetable protein. This survey included approximately 7,500 households located in contiguous

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states of the United States. Usable schedules were tabulated for 6,950 households.[1] These schedules included data from 2,495, 2, 028, 1,503, and 924 households located in the South, North Central, Northeast and West regions, respectively.[2]

Quantities of animal and vegetable protein consumed per household were computed by separating total protein into contributing sources (animal and vegetable foods) and multiplying the quantity of each food consumed times the percent of protein available in each unit of the food. The summation of these products for each protein food source provided an approximation of the quantity of animal and vegetable protein available for weekly household consumption.

Hypothesized socioeconomic characteristics of a household influencing the consumption of animal and vegetable protein were: disposable income, location, degree of urbanization, race, educational attainment of the homemaker, stage in the family life cycle, family size, meals and employment status of the homemaker.

Multiple regression analysis was used to estimate the impact of socioeconomic characteristics on consumption of animal and vegetable protein. The statistical models utilized to estimate these relationships were:

$$Q_{ij} = a + b_1Y + b_2Y^2 + b_3U_1 + b_4U_2 + b_5R_1 + b_6R_2 + b_7E_1 + b_8E_2 + b_9E_3 + b_{10}L_1 + b_{11}L_2 + b_{12}L_3 + b_{13}L_4 + b_{14}L_5 + b_{15}S + b_{16}M + b_{17}F + u.$$

where:

Q_{ij} = grams of animal protein (i=1) and vegetable protein (i=2) consumed per household per week for the United States (j=1) and the South (j=2), North Central (j=3), Northeast (j=4) and West (j=5) regions, respectively.

Y = annual household disposable income, $1,000.

$U_0 - U_2$ = degree of urbanization (rural farm, urban and rural nonfarm).

$R_0 - R_2$ = race of household (black, white, other).

$E_0 - E_3$ = level of education attained by the homemaker (high school, grade school, some college and college graduate).

$L_0 - L_5$ = state of the household in the family life cycle (average age of the children ranged from 6 to less than 12 years — stage 3, no children were present and the housewife was 40 years of age or less — state 1, average age of the children was less than 6 years — stage 2, average age of the children ranged from 12 to 17 years — stage 4, average age of the children was over 17 years— stage 5, no children were present and the housewife was over 40 years of age — stage 6. See the Lansing and Kish article for a detailed explanation of this variable.

S = family size, representing the total number of individuals in a household depending on a common pool of income for their livelihood.

M = meal adjustment, representing the influence of home, guest, skipped and away meals.[3] Meal adjustment was computed as the difference between the total number of meals each household reported serving and the number of economic family members multiplied by 21. The 21 represented meal equivalents per week for one household member.

F = employment status of the homemaker (unemployed and employed).[4]

A household's protein consumption is influenced by stomach capacity of its members. Despite level of income, the household must eventually limit consumption. Thus, the ratio of quantities of animal and vegetable protein consumed to disposable income would not be constant at each respective level of income; i.e., a curvilinear rela-

[1]The 550 households were eliminated from the analysis because relevant income, race and other data were missing.

[2]Regions corresponded to Census definitions [11].

[3]Home and guest meals represented the number of meals consumed from the home food supply. Away meals represented the number of meals eaten from other than the home food supply, either purchased or free meals.

[4]Dummy variables (0, 1) were utilized to analyze the impact of urbanization, race, educational attainment, family life cycle and employment status. The initial class in each category, as inciated, was excluded to avoid singularity.

tionship would be expected. Therefore, a quadratic functional form was utilized to estimate the respective nutrient consumption relationships.

RESULTS

Nationally, 67 percent of protein consumed by households was derived from animal sources and 33 percent came from vegetable sources. On a regional basis, households in the North Central, Northeast and West regions derived 69 percent of their protein from animal sources and 31 percent from vegetable sources. A larger portion (36 percent) of the protein consumed by households in the South was derived from vegetable sources.

Differences in socioeconomic variables included in the statistical models explained over 50 percent of the variation in household animal protein consumption and 61 percent of that regarding protein consumption (Tables 1 and 2).

Table 1. ESTIMATES OF UNITED STATES AND REGIONAL CONSUMPTION RELATIONSHIPS FOR ANIMAL PROTIEN IN GRAMS; INCLUDING REGRESSION COEFFICIENTS, STANDARD ERRORS, AND R^2's

Variable	United States	South	North Central	Northeast	West
a	527.19* (55.40)[a]	497.08* (84.51)	641.52* (111.54)	684.30* (130.34)	1,006.36* (177.43)
Y	90.88* (6.00)	103.02* (9.83)	72.16* (11.19)	73.94* (13.26)	41.89* (16.75)
Y^2	-2.57* (0.27)	-2.68* (0.45)	-2.19* (0.52)	-2.31* (0.60)	-0.39 (0.73)
U_1	-166.57* (21.08)	-80.16* (32.49)	-288.73* (36.70)	-197.71* (67.08)	-389.80* (68.81)
U_2	-179.24* (25.16)	-95.79* (36.47)	-218.94* (44.63)	-231.32* (72.60)	-342.48* (98.17)
R_1	116.27* (27.59)	131.40* (37.82)	-24.74 (68.22)	-84.86 (60.42)	-118.12 (94.45)
R_2	63.84 (62.31)	131.50 (122.15)	-131.11 (152.23)	-55.10 (112.42)	-275.14* (140.67)
E_1	-86.11* (20.67)	-100.39* (33.00)	-7.96 (37.32)	-17.31 (43.81)	-134.73* (68.68)
E_2	16.40 (28.13)	-15.90 (50.36)	85.70 (52.26)	-63.05 (59.62)	66.45 (64.85)
E_3	-69.98 (34.64)	-141.80* (58.53)	-8.41 (64.12)	64.80 (79.58)	-65.88 (81.50)
L_1	-276.60* (49.25)	-279.95* (83.00)	-98.32 (92.29)	-247.58* (99.65)	-336.76* (134.12)
L_2	-136.34* (27.44)	-138.38* (44.79)	-173.29* (49.05)	-4.95 (58.03)	-187.75* (79.21)
L_3	143.24* (30.68)	63.02 (48.38)	209.55* (55.99)	280.41* (65.97)	178.03* (90.28)
L_4	38.84 (50.13)	29.74 (79.94)	79.83 (90.06)	167.81 (108.73)	-48.76 (146.04)
L_5	-224.50* (34.38)	-240.42* (54.74)	-184.24* (62.87)	-146.79* (73.57)	-218.22* (102.07)
S	283.89* (6.31)	241.42* (9.56)	341.18* (11.98)	295.73* (13.95)	334.07* (19.64)
M	21.36* (0.57)	20.53* (0.88)	21.92* (1.06)	18.60* (1.30)	25.11* (1.68)
F	1.60 (18.86)	15.56 (30.45)	21.66 (35.10)	29.67 (38.69)	-6.82 (53.97)
R^2	.53	.50	.58	.53	.59

[a]Figures in parentheses are standard errors.

*Indicates that the coefficient is significant at the 5 percent level.

Table 2. ESTIMATES OF UNITED STATES AND REGIONAL CONSUMPTION RELATIONSHIPS FOR VEGETABLE PROTEIN IN GRAMS; INCLUDING REGRESSION COEFFICIENTS, STANDARD AND ERRORS, AND R^2's

Variable	United States	South	North Central	Northeast	West
a	162.22* (30.07)[a]	150.52* (51.21)	115.30 (60.47)	152.92* (66.69)	52.02 (84.84)
Y	-10.43* (3.26)	-7.33 (5.95)	-15.59* (6.07)	0.21 (6.78)	-0.55 (8.01)
Y^2	0.25 (1.71)	0.19 (0.27)	0.48 (0.28)	-0.15 (0.30)	-0.22 (0.35)
U_1	-159.79* (11.44)	-160.54* (19.69)	-162.66* (19.90)	-133.72* (34.32)	-89.47* (32.90)
U_2	-82.80* (13.66)	-76.36* (22.10)	-69.45* (24.19)	-96.70* (37.15)	-56.85 (46.94)
R_1	37.62* (14.98)	91.35* (22.91)	62.10 (36.98)	-37.39 (30.91)	18.54 (45.17)
R_2	113.69* (33.83)	184.04* (74.02)	95.89 (82.53)	81.92 (57.52)	69.15 (67.27)
E_1	47.51* (11.22)	56.14* (19.99)	27.15 (20.23)	46.13* (22.42)	33.26 (32.84)
E_2	-5.36 (15.27)	-6.38 (30.52)	39.04 (28.34)	-50.84 (30.50)	-34.66 (31.01)
E_3	-12.65 (18.80)	-81.81* (35.47)	5.21 (34.76)	21.35 (40.72)	9.09 (38.97)
L_1	21.52 (26.73)	12.44 (50.29)	47.76 (50.04)	39.91 (50.99)	-9.09 (64.13)
L_2	-103.62* (14.90)	-113.70* (27.14)	-80.78* (26.59)	-81.73* (29.69)	-141.66 (37.88)
L_3	64.48* (16.65)	27.18 (29.32)	113.33* (30.35)	85.64* (33.76)	37.84 (43.17)
L_4	19.34 (27.21)	-7.10 (48.44)	53.77 (48.83)	35.06 (55.63)	-13.01 (69.83)
L_5	-48.71* (18.66)	-61.57 (33.17)	-26.84 (34.09)	-33.88 (37.64)	-45.13 (48.81)
S	236.41* (3.43)	238.17* (5.79)	233.36* (6.49)	230.85* (7.14)	254.94* (9.39)
M	10.36* (0.31)	10.51* (0.54)	10.54* (0.57)	9.96* (0.67)	10.54* (0.80)
F	23.41* (10.24)	18.06 (18.45)	40.75* (19.03)	11.79 (19.80)	2.54 (25.81)
R^2	.63	.62	.61	.64	.67

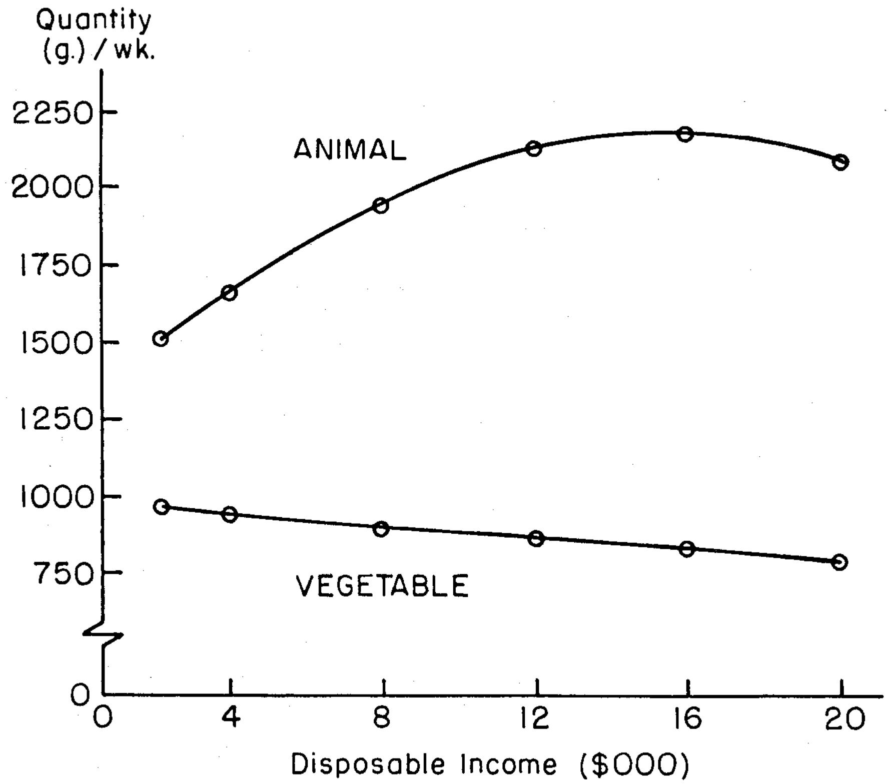
[a]Figures in parentheses are standard errors.

*Indicates that the coefficient is significant at the 5 percent level.

Income

Annual household disposable income had a significant impact on animal protein consumption in all models and on vegetable protein consumption in the United States and North Central models (Tables 1 and 2).[5] Household consumption of animal protein in all regions except the West increased initially, peaked and declined with successive positive increments of income, as indicated by significant positive and negative signs of the respective income coefficients (Y and Y^2). In the West, the same relationship was noted except the income-squared coefficient (Y^2) had a relatively large standard error. Thus, a significant turning point was not ascertained and the relationship was more linear than those noted for other models. In the North Central and national models for vegetable protein, income coefficients (Y) were significant and negative. Income-squared (Y^2) coefficients were not significant. Therefore, vegetable protein consumption declined with additional increments of income and was approximately linear (Figure 1).[6]

Figure 1. ANIMAL AND VEGETABLE PROTEIN INCOME-CONSUMPTION RELATION SHIPS, UNITED STATES



A more detailed analysis of the magnitude and direction of income influence on animal and vegetable protein consumption was obtained by computing income elasticities at selected levels (Table 3).[7] Animal protein consumption was positively responsive to incremental income increases up to the $16,000 income level. It was negatively responsive at the $20,000 level for all models except the West. In these cases, animal protein consumption was most positively responsive at the $8,000 income level and was most negatively responsive at the $20,000 level. In the West, consumption was positively responsive at all income levels up to $20,000 and was most responsive at the $20,000 level.

[5]Significance was tested at the 95 percent level.

[6]Vertical summation of the quantities of animal and vegetable protein at the respective income levels gives a total protein income-consumption relationship.

[7]Inherent in the analysis of income elasticities for cross-section data is the assumption that a household at one income level will consume as much of a certain nutrient as does a household at a different income level if its income is increased to the new level.

Table 3. **INCOME ELASTICITIES FOR ANIMAL AND VEGETABLE PROTEIN CONSUMPTION AT SELECTED INCOME LEVELS AND LOCATIONS[a]**

Food Nutrient and Location	Selected Income Levels $2,000	$4,000	$8,000	$12,000	$16,000	$20,000
Animal Protein						
United States[b]	.106	.168	.208	.169	.065	-.112
South[b]	.130	.205	.256	.234	.126	-.038
North Central[b]	.074	.120	.148	.111	.015	-.141
Northeast[b]	.084	.134	.160	.114	.000	-.189
West[b]	.051	.093	.157	.199	.226	.240
Vegetable Protein						
United States[b]	-.021	-.039	-.061	-.065	-.048	-.011
South	-.014	-.025	-.038	-.037	-.022	.006
North Central[b]	-.031	-.054	-.076	-.061	-.005	.090
Northeast	-.001	-.005	-.022	-.053	-.097	-.158
West	-.004	-.012	-.041	-.091	-.164	-.265

[a]Elasticities are affected by the functional form selected to derive estimators of the coefficients. These elasticities were computed from a quadratic function with all factors except income held at mean values and the quantity of the respective nutrients consumed allowed to vary only in response to changes indisposable income.

[b]Income elasticities were computed from income coefficients significant at the .05 level.

Income elasticities for the two vegetable protein models with significant income coefficients, United States and North Central, were negative at all selected income levels in the former case and negative at all income levels except the $20,000 level for the latter case (Table 3). Vegetable protein consumption was most negatively responsive at the $12,000 income level for the United States model and the $8,000 level for the North Central model.

Other Variables

Degree of urbanization as reflected by rural farm (U_0), urban (U_1) and rural nonfarm (U_2) categories had a significant influence on household consumption of animal and vegetable protein (Tables 1 and 2). Urban and rural nonfarm households consumed significantly less animal and vegetable protein than did farm households in the United States models. Regional models were similar to national models except for the West, where rural nonfarm household consumption of vegetable protein was not significantly different from that of farms.

Race of the household [black (R_0), white (R_1) and other (R_2)] had a significant impact on consumption of both sources of protein in the aggregate models (Tables 1 and 2). Black households consumed significantly less animal protein than did white households. Furthermore, they consumed significantly less vegetable protein than did either white or other-race households.

In the regional models, significant differences were noted for race only in the Southern and Western models (Tables 1 and 2). In the South, blacks consumed less animal protein than did whites and less vegetable protein than did white or other races. In the West, other-race households consumed significantly less animal protein than did black households.

Significant differences in animal or vegetable protein consumption were noted among households in which the homemaker had a high school education (L_0) and households whose homemaker had only a grade school (L_1), some college (L_2) or college education (L_3) (Tables 1 and 2). In the United States models, households whose homemaker had a high school education consumed significantly more animal less vegetable protein than did households in which the homemaker had a grade school education. In the South, a similar relationship held at the lower education level, but the more educated consumed significantly less of both protein sources than the base group. In the Northeast, households with less educated housewives consumed significantly more vegetable protein than did the high school educated group. In the West, the less educated consumed significantly less animal protein than households in the base group.

The family life cycle variable was created to reflect the impact of a household's stage of developmemt on food nutrient consumption. In the United States model, households with no children (L_1 and L_5) or children under 6 years of age (L_2) consumed significantly less animal protein than households with children aged from 6 to 12 years (L_0). Households with children between the ages of 12 and 17 (L_3) consumed the most animal protein. Similarly, households with children between the ages of 6 and 12 consumed significantly more vegetable protein than households with younger children, and significantly less than did households with older children. These relationships generally held for the regional models. That is, households with no children or small children consumed the smallest quantities of both animal and vegetable protein, and those with teenaged children consumed the most.

Family size (S) had a significant positive impact on consumption of animal and vegetable protein (Tables 1 and 2). Family size had the largest relative impact on vegetable protein consumption in the West region and on animal protein consumption in the North Central region.

Meal adjustment (M) had a significant positive impact on consumption of both animal and vegetable protein in all models (Tables 1 and 2). Therefore, as expected, an increase in either home or guest meals increased household consumption of animal and vegetable protein. An increase in either skipped or away from home meals had the opposite effect.

The female head of household (F) being employed outside the home had a significant positive impact on the consumption of vegetable protein in the United States and North Central models. However, it was not a significant factor influencing animal protein consumption.

SUMMARY AND CONCLUSIONS

Protein from animal sources contributed approximately 69 percent of the total protein consumed by households in the North Central, Northeast and West regions. Diets of Southern households were composed of a smaller relative portion of protein derived from animal sources, 64 percent. Nationally, 67 percent of the protein consumed by households was derived from animal sources.

Several characteristics of a household and its constituents were found to influence animal and vegetable protein consumption. Consumption of animal protein increased initially, peaked and declined with incremental increases in income in all regions except the West. In these cases, consumption was most responsive to income changes at the $8,000 income level. Income elasticities became negatively responsive at the $20,000 level. A similar relationship was noted in the West, except total consumption was still increasing at the $20,000 income level. Vegetable protein consumption declined with increases in disposable income in an approximately linear fashion in the North Central and United States models. However, vegetable protein consumption was not greatly influenced by changes in income, as indicated by the magnitude of the elasticities.

Farm households consumed more of both protein sources than did nonfarm households. Black households generally consumed less animal and vegetable protein than white households. Vegetable protein consumption was greater for households whose housewives had low educational attainment, while animal protein consumption was greater for households whose homemaker was more educated. Households with no children or small children consumed the smallest quantities of both animal and vegetable protein, while those with teenaged children consumed the most. Employment of the housewife outside the home was not a significant factor influencing animal or vegetable protein consumption, excepting a significant positive impact on vegetable protein consumption in the North Central region.

As average income of households continues to increase, increased demand for animal protein and decreased demand for vegetable protein can be expected. However, this projected trend toward increased consumption of animal protein will be offset to some degree by continued urbanization, decreases in numbers of younger children in households, and increased employment of housewives outside the home.

However, these changes should be considered cautiously. Technological developments in the food processing industry could alter them by making vegetable protein more appealing. Many amino acids present in animal protein and absent in vegetable protein have been synthesized. Also, some problems associated with differences in physical characteristics of animal and plant protein products such as appearance, aroma, and texture have been solved. Thus, large price differentials between units of animal and vegetable protein could accentuate further developments and increase consumption of vegetable protein. Processed vegetable protein is already being used as a meat extender in the school lunch program and for several ground meat products at retail.

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