U.S. Household Consumption of Fresh Fruits

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This study uses the 1987-88 U.S. Department of Agriculture Nationwide Food Consumption Survey data to analyze the impacts of income, prices, and selected socioeconomic characteristics on household consumption of fresh fruits. Results suggest that fresh fruits are considered economic necessities, with own prices significantly influencing consumption. Cross-price effects are generally weak and insignificant, but the number of adults in the age group 18-64 is an important determinant of household consumption of fresh fruits. While nutrition information and household savings have significant, positive influences on most fresh fruit consumption, the presence of a working wife has a significant and negative influence.

Total consumption of fresh fruits in the United States has increased dramatically in the last 20 years, although the increases may differ for specific fruits. Total fresh fruit consumption increased by 21 percent between 1977 and 1987, with most growth occurring after 1983 (Senauer et al.). The literature on household consumption of specific fresh fruits remains sparse, however, especially at the national level. This dearth of information hinders food industry and government responses to changing consumption patterns.

A variety of factors are responsible for the observed changes in food consumption patterns, including increases in real disposable income and nutrition and health concerns. Senauer et al. suggest that consumers' concerns about health and nutrition may be the most important factor influencing the increased consumption of fresh produce. In addition, changes in the population characteristics also have contributed to shifts in consumption patterns (Putnam). The aging of the population, smaller households, more two-earner and single-person households, and an increasing proportion of ethnic minorities are the most pronounced changes found in the composition of U.S. population. These socio-demographic changes likely augur dietary modifications and consumptive changes in both the levels and the composition of fruits, vegetables, and other foodstuffs which will influence decision making in all segments of the U.S. food industry.

The extant literature on household consumption patterns for fruit is incomplete in several respects. First, in most studies, fruits have been commonly aggregated into either a single group (Buse and Salathe; Salathe) or a few selected groups (George and King; Price and Mittelhammer). Consumption patterns or demand for specific individual items or product forms are generally ignored. Second, research that considers particular fruit items and product forms has been geographically specific, with limited products coverage. These studies typically have employed survey data obtained within the boundary of a particular state, such as Georgia (Raunikar et al.), and Washington (Price et al.). Third, most cross-sectional data contain only household expenditures and socioeconomic information. Citing the examples of West and Price and of Buse and Salathe, Cox et al. note that prices are generally not included in cross-sectional analysis, given the lack of price information.

This study estimates the impacts of income, price, and other household characteristics on the consumption of fresh fruits at the household level using the 1987-88 U.S. Department of Agriculture (USDA) Nationwide Food Consumption Survey (NFCS) data. Specifically, we identify and evaluate the importance of factors that influence the consumption of disaggregated fresh fruits and estimate demand elasticities of income, own prices and cross prices for some specific fresh

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fruits. By pinpointing key socio-demographic determinants, we provide information useful to the fresh produce industry in developing more effective advertising and promotion programs that can target specific market segments.

Model Specification and Estimation Method

Previous research has shown that socioeconomic and demographic variables play a key role in explaining consumption behavior. In his review of the literature on food demand, Tomek cited income, household composition, and household size as the three most important socioeconomic factors that explain food consumption variations among households. He also considered other socioeconomic variables, including a measure of assets, education of household head, occupation, urbanization, region, and race. Price et al. went beyond the traditional bounds to analyze the impact of nontraditional factors, such as liquid assets, household management style, and psychological need levels, on the consumption of fruits and vegetables. Their results showed that nontraditional variables influenced both the type and variety of fruits and vegetables served by Washington households, while the explanatory power of the traditional variables, such as income and occupation, were relatively weak. While prices are generally omitted in cross-sectional demand analysis, Tomek warned that failure to account for the effects of price variation in cross-sectional demand analysis might bias the income coefficient downward and result in misleading demand elasticities. Mincer also suggested that conventional Engel analysis may be inappropriate, if prices are not constant among all cross sections.

A common problem associated with the analysis of household survey data is the occurrence of numerous zero-value observations due to non-purchasing or non-consumption. If the observations of the non-purchasing households are discarded, then both the probability of use or non-use and the level of use are determined by the same consuming household characteristics. Traditional regression procedures thus obtain biased estimates of the behavioral relationships. While several procedures can be used to overcome this data problem, we employ Amemiya's maximum likelihood Tobit procedure (Amemiya) to analyze simultaneously the probability of purchase and the level of quantity consumed, using information from both consuming and non-consuming households. From a theoretical perspective, the use of the Tobit model assumes the existence of a threshold, albeit unobservable, for each individual's preference function. This underlying behavioral assumption implies that unless a consumer's preference exceeds a threshold level, the preference would not be expressed in terms of purchase or other measurable behavior.[1]

The Tobit model can be expressed mathematically for a typical consumer unit i, as

$$
\begin{aligned}
q_{ij} &= X_{ij}\beta_j + \mu_{ij}, \text{ if RHS} > 0 \\
&= 0 \text{ otherwise}, \qquad i = 1, 2, \ldots, n.
\end{aligned}
$$

Where n is the number of observations, q_{ij} represent the quantity of the j^{th} commodity consumed by i^{th} household, X_{ij} is a matrix of relevant exogenous variables, β_j is an unknown parameter vector, and μ_{ij} is an independently and normally distributed random disturbance term with mean zero and constant variance σ^2.

As Tobin shows, the expected value of q for all households is

[1]Alternatively, the problem of censoring may be treated as a specification error arising from sample selectivity bias and the structural parameters may be estimated by applying Heckman's two-step procedure. The Heckman procedure may appear to be less restrictive than the Tobit model in the sense that it allows the flexibility such that the probability and level of consumption may be determined by different sets of explanatory variables. However, in practice, the same regressors are usually used in the estimation of both the probability and level of consumption because of the difficulty of specifying, *a priori*, the appropriate sets of explanatory variables for each regression. In addition, some Monte Carlo experiments have shown that the Tobit estimator outperforms the Heckman procedure under the assumption of normality, but they both perform poorly when the errors are Cauchy (Paarsch). Also, Tobit is considered to be a more efficient estimator than the Heckman procedure, especially as degree of censoring increases. In this regard, we considered the Tobit model to be more appropriate, given that the degree of censoring for the individual commodity varies from slightly less than 50 percent for banana to about 80 percent for other citrus.

$$E(q) = X\beta F(z) + \sigma f(z),$$

where $z = X\beta/\sigma$; and $F(z)$ and $f(z)$ are the standard normal distribution and density function, respectively. Amemiya has shown that the expected value for only those purchasing households is simply $X\beta$ plus the expected value of the truncated normal, conditional error term:

$$E(q^*) = E(q \mid q > 0) = E(q \mid \mu > -X\beta) = X\beta + \sigma f(z)/F(z),$$

where q^* represents the level of non-zero consumption. Therefore, the expected value of all observations is directly related to the expected value of purchasing households via $F(z)$, the probability of non-zero consumption, as follows:

$$E(q) = F(z)E(q^*). \quad (1)$$

McDonald and Moffitt have suggested that a useful decomposition of the marginal effects on (1) due to a change in the k^{th} variable of X can be expressed as:

$$\partial E(q)/\partial X_k = F(z)[\partial E(q^*)/\partial X_k] + E(q^*)[\partial F(z)/\partial X_k]. \quad (2)$$

Thus, the total change in q can be disaggregated into two, very intuitive parts: (1) the change in quantity consumed of the purchasing households weighted by the probability of being a purchasing household; and (2) the change in the probability of being a purchasing household weighted by the expected value of consumption for such a household (McDonald and Moffitt).

Data and Variable Definitions

The USDA has conducted surveys of food use within households and by individuals in the U.S. since 1956 to provide the most comprehensive data available for analyzing food consumption behavior and the dietary status of Americans. The most recent national food consumption survey was conducted in 1987-88 and provided data on food consumption and dietary levels of 4,495 households in the 48 conterminous states. Although the response rate for the household component was low, approximately 38 percent (U.S. Department of Agriculture), the surveys provide the major source of available data to study changes in food consumption behavior patterns and to assess the nutritional adequacy of American diets.

Following the suggestion of USDA Human Nutrition Information Service (HNIS), only housekeeping households (4,273 of 4,495 households in the data set) are used for this study. The housekeeping household is defined as a household with at least one person having 10 or more adjusted meals (of 21-meals-at-home-equivalent) from the household food supply during the 7 days before the interview. Households with missing or incomplete information were deleted from the sample. We also excluded from the empirical analysis those households with weekly incomes that deviated from the mean value by more than five standard deviations and those with weekly incomes less than reported weekly total food expenditure. The final sample size used for this study contains 4,133 households.

Five fresh fruit groups were selected for empirical analysis: oranges, other citrus fruits, apples, bananas, and other non-citrus fruits. The dependent variables are quantities of fresh fruits (pounds) consumed by the household during a 7-day period. Included in the explanatory variables is a set of imputed prices for individual fruit products and other major food products. As noted previously, the NFCS data do not contain price information. Thus, prices are obtained by dividing quantity of food used (pounds) into the money value of food (dollars). For non-purchasing households, the missing prices are estimated as the average prices for households from the same geographic division (New England, Middle Atlantic, East North Central, West North Central, South Atlantic, East South Central, West South Central, Mountain, Pacific) and for the same season (Spring, Summer, Fall, Winter). This practice is very similar to the mean price "grid" procedure used by Cox et al. in their cross-sectional analysis of household demand for fresh potatoes. The assignment of divisional and quarterly average prices for the missing information is appropriate if the cross-sectional price differences reflect primarily spatial variation caused by supply conditions (Cox and Wohlgenant).[2]

In addition to the prices of individual fresh fruits, prices for some aggregate food groups are also calculated. These groups are dairy products, grain products, meats, fresh vegetables, processed vegetables, processed fruits, and all other foods. The own price and aggregated group prices are included in each regression.

Savings have been included infrequently in empirical analyses of food consumption, although a number of studies indicate that they should be recognized (Ferber). Savings include household members' savings and cash assets. If household members have more than $5,000 dollars in savings and cash assets, the dummy variable for household savings is set to one, and zero otherwise.

We divide the sources used by consumers to obtain information on the nutrition, health, and safety of foods into four groups: (1) nutritional profession and government, which includes doctors, nurses or other health professionals, nutritionists, dietitians, home economists or extension agents, and government or health organization publications; (2) relatives or friends; (3) media, which includes radio, television, newspapers, magazines or books; and (4) food industry, which includes food company publications, food packages or labels. If the household obtained information from one of the sources above during the past year, then the value of the variable for that source of information on nutrition is assigned the value one, and zero otherwise.

The increasing participation of women in the labor force is one of the major social and economic trends of the last quarter century (Senauer et al.). Participation in the labor market by the female head means there is a relative scarcity of time in the household because of the wife's time spent outside the home. Therefore, working wife households tend to purchase more convenience foods than households in which the female head of household is a full-time homemaker (Tucci). For a household with both a male head and a female head, if both of them are employed, the value of the variable for time pressure will be assigned the value one, and zero otherwise. For a single-headed household, however, if the household head is employed, then the household is assigned the value of a time-pressured household.

Other independent variables include education, household composition, occupation, seasonality, region, urbanization, and race. Except for education and household composition, all these variables are coded as binary variables. The variable of education is measured by years of schooling completed. For double-headed households, years of education for the male or female head with the greater number of years represents household education level. To capture the effect of variations in household size, the composition of household is specified into six categories by age and gender.

We distinguish the occupational groups by four categories: white collar, blue collar, farmer, and other occupation. Persons employed as professional/technical, manager/officer/ proprietor, or clerical/sales workers are considered white collar. Craftsmen/foremen, operatives, and service workers are considered blue collar. The category "other occupations" excludes those identified above. For households with both male and female heads, if at least one of them belongs to the white collar, then the occupation for the household head is set to be white collar; otherwise, if at least one of them belongs to the blue collar grouping, then the occupation for the household head is set to be blue collar. The same hierarchy procedure is used to determine the occupation of household head as farmer or other oc-

[2] As discussed by Cox and Wohlgenant, the calculated price may reflect consumer choice of quality as well as changes in supply conditions. Thus, they suggested that the imputed price should be adjusted for quality variations before it is used for estimating demand functions from cross-sectional data. However, their study of quality effects in cross-sectional prices for three broad aggregates of vegetable products concludes that quality correction did not have much impact on the price variables, and it is unlikely that using unadjusted prices will cause much parameter bias (p. 914). Given that the bias resulting from failure to adjust for quality variations increases with the degree of heterogeneity and commodity aggregation, the potential distortion from using unadjusted prices is considered to be inconsequential as this study is based on disaggregated and fairly homogeneous individual commodities.

cupations. For the single-headed household, the occupation of the household head is determined by the male head or female head accordingly.

Table 1. Sample Means and Standard Deviations, 1987-88 USDA NFCS

Variable	Mean	Standard Deviation
Household before-tax income ($/wk.)	523.65	383.46
Education of household head (yr.)	12.92	3.09
Household age-sex composition (persons):		
Child ≤ 5 years	0.27	0.61
Child 6-17 years	0.55	0.94
Adult male 18-64 years	0.76	0.64
Adult female 18-64 years	0.86	0.59
Adult male ≥ 65 years	0.14	0.35
Adult female ≥ 65 years	0.20	0.41
Nutrition information sources:		
Professional & government	0.46	0.50
Friends & relatives	0.24	0.43
Media	0.53	0.50
Food industry	0.46	0.50
Black household	0.11	0.32
Time pressure	0.46	0.50
Saving	0.38	0.49
Occupation:		
White collar	0.54	0.50
Blue collar	0.30	0.46
Urbanization:		
Central city	0.23	0.42
Suburban	0.48	0.50
Nonmetro	0.29	0.46
Region:		
Northeast	0.21	0.40
North Central	0.26	0.44
South	0.34	0.47
West	0.19	0.39
Season:		
Spring	0.29	0.46
Summer	0.40	0.49
Fall	0.15	0.36
Winter	0.16	0.37

Seasonality is measured as Spring, Summer, Fall, or Winter. The four primary census regions of the U. S. (Northeast, North Central, South, and West) represent regions of residence. Urbanization of residence is measured as central cities, suburban areas and non-metro areas. The distinction as white, black, and other race serves to measure racial category. Table 1 presents descriptive statistics for the included variables of interest in this paper.

Results and Discussion

Factors Influencing Fresh Fruit Consumption

The results of the Tobit analysis for individual fresh fruits are presented in Table 2. All income coefficients, except for banana, are positive and statistically significantly different from zero at the 0.01 significance level. As expected, the effect of own prices on fresh fruit consumption is negative and significant. However, cross-price effects are generally weak and insignificant among individual fruits. Consumption of fresh fruits is positively and generally significantly related to numbers of household members in each of the age/gender groups, excepting children under age five with regard to oranges and other citrus. Estimated coefficients for consumption by females over 64, however, were generally more than double those for the younger age groups of females and considerably higher than for males in either age group. Raunikar et al. showed that the number of adults in a household did not have a significant effect upon the level of banana quantities purchased, which is inconsistent with the results of this study. All the age/gender groups demonstrate positive and significant relationships with banana consumption.

An unexpected finding is that households with time pressure, such as working wife households, consume significantly less fresh bananas. Bananas are used in salads and cooking, besides snacks. This may mean the less time-pressured households have the greater opportunity to obtain and prepare bananas in home consumption. Other citrus fruits also carry a negative value for time pressure, while the signs for the variables education and savings were both positive for this group.

Households with savings of more than 5,000 dollars consume significantly more apples, bananas, other citrus, and other non-citrus fresh fruits than households with lower reported savings. The effects of education on fresh fruit consumption are positive and generally significant. These results are consistent with the findings of Price et al., which showed that higher educated households tended to consume more nutritious fresh items.

Table 2. Tobit Regression Results on Household Consumption of Fresh Fruits

Variable	Orange	Other Citrus	Apple	Banana	Other Non-citrus
Constant	-0.68	-2.67***	-0.89*	-0.44	-10.62***
	(-1.06)	(-3.20)	(-1.57)	(-0.90)	(-5.25)
Income	0.6E-2***	0.001***	0.5E-2**	0.2E-2	0.004***
	(2.77)	(5.73)	(2.74)	(1.14)	(5.63)
Price:					
Orange	-0.98***	-0.67**	0.48**	0.17	-0.36
	(-4.21)	(-1.89)	(1.98)	(0.81)	(-0.41)
Other Citrus	-0.21***	-0.61***	-0.02	-0.08	0.50**
	(-2.37)	(-7.16)	(-0.24)	(-1.27)	(1.90)
Apple	-0.28	-0.20	-1.91***	-0.09	0.90
	(-0.79)	(-0.44)	(-6.61)	(-0.34)	(0.81)
Banana	-0.44	-1.32**	0.22	-1.27***	0.66
	(-0.78)	(-1.85)	(0.45)	(-3.25)	(0.38)
Other Non-citrus	0.07	-0.31*	-0.17	-0.21**	-4.95***
	(0.41)	(-1.42)	(-1.16)	(-1.69)	(-10.97)
Vegetables	0.08	0.88***	-0.11	0.30*	1.57**
	(0.31)	(2.78)	(-0.47)	(1.56)	(1.92)
Dairy Products	0.15	0.28	-0.03	-0.31**	0.69
	(0.69)	(1.09)	(-0.15)	(-1.71)	(1.08)
Grain Products	-0.12*	-0.11	-0.10*	-0.05	-0.39**
	(-1.64)	(-1.27)	(-1.64)	(-0.93)	(-1.79)
Meat Products	-0.08	-0.05	-0.16**	-0.04	0.41*
	(-0.76)	(-0.39)	(-1.76)	(-0.49)	(1.32)
Processed Vegetables	-0.08	0.11	0.10	0.08	0.36
	(-0.80)	(0.86)	(1.10)	(1.01)	(1.17)
Processed Fruits	-0.04	0.54***	-0.27*	-0.35***	-0.55
	(-0.22)	(2.42)	(-1.62)	(-2.37)	(-0.93)
All Other Food Products	-0.14**	-0.09	-0.12***	-0.04	-0.37**
	(-2.32)	(-1.21)	(-2.60)	(-1.07)	(-1.99)
Household Composition:					
Child ≤ 5 yr.	-0.06	-0.22*	0.24***	0.18**	1.03***
	(-0.56)	(-1.59)	(2.69)	(2.30)	(3.26)
Child 6-17 yr.	0.37***	0.26***	0.41***	0.30***	0.25
	(5.66)	(3.00)	(6.89)	(5.82)	(1.17)
Male 18-64 yr.	0.40***	0.08	0.23***	0.42***	0.94***
	(3.38)	(0.50)	(2.19)	(4.74)	(2.51)
Female 18-64 yr.	0.27***	0.47***	0.37***	0.45***	1.82***
	(2.15)	(2.84)	(3.22)	(4.65)	(4.49)
Male ≥ 65 yr.	0.16	0.48**	0.21	0.70***	1.75***
	(0.78)	(1.95)	(1.16)	(4.74)	(2.82)
Female ≥ 65 yr.	0.68***	1.01***	0.92***	0.97***	3.26***
	(3.35)	(4.03)	(5.23)	(6.53)	(5.18)
Education	0.04*	0.05**	0.06***	0.03*	0.03
	(1.48)	(1.72)	(2.62)	(1.43)	(0.39)
Time Pressure	-0.20*	-0.86***	-0.06	-0.41***	-1.32***
	(-1.44)	(-4.73)	(-0.45)	(-3.93)	(-3.03)
Saving	-0.03	0.63***	0.51***	0.32***	1.40***
	(-0.23)	(3.51)	(4.11)	(3.05)	(3.21)

Table 2. (continued)

Variable	Orange	Other Citrus	Apple	Banana	Other Non-citrus
Nutrition Information Sources:					
Professional	0.30***	0.19	0.32***	0.25***	0.71**
	(2.41)	(1.18)	(2.88)	(2.70)	(1.83)
Friends & Relatives	0.04	-0.06	-0.03	-0.12	0.24
	(0.26)	(-0.31)	(-0.25)	(-1.04)	(0.52)
Media	0.31**	0.23	0.14	0.20**	0.65*
	(2.19)	(1.24)	(1.13)	(1.87)	(1.48)
Industry	-0.01	0.51***	0.31***	0.23**	2.17***
	(-0.09)	(2.87)	(2.50)	(2.16)	(4.99)
Season:					
Summer	-0.89***	-1.07***	-0.56***	0.09	3.71***
	(-6.25)	(-5.81)	(-4.23)	(0.76)	(7.67)
Fall	-2.87***	-1.94***	-0.88***	-0.09	8.15***
	(-10.27)	(-6.77)	(-4.29)	(-0.52)	(11.78)
Winter	-1.53***	-1.14***	0.48***	-0.18	0.08
	(-7.92)	(-4.76)	(2.93)	(-1.27)	(0.12)
Region:					
North Central	-0.38**	-0.28	0.24*	-0.13	0.27
	(-2.05)	(-1.17)	(1.48)	(-0.92)	(0.47)
South	-0.69***	-0.25	-0.21*	-0.07	-0.85*
	(-3.84)	(-1.12)	(-1.30)	(-0.51)	(-1.50)
West	-0.07	0.34*	0.17	0.35**	0.82*
	(-0.37)	(1.35)	(0.98)	(2.32)	(1.33)
Urbanization:					
Suburban	0.01	0.11	0.44***	-0.0007	0.49
	(0.59)	(0.53)	(9.68)	(-0.006)	(0.98)
Nonmetro	0.05	-0.27	0.005	-0.10	-0.54
	(0.31)	(-1.17)	(0.03)	(-0.77)	(-0.97)
Occupation:					
Blue Collar	-0.12	-0.29*	-0.11	-0.24**	-1.13**
	(-0.74)	(-1.39)	(-0.82)	(-1.98)	(-2.27)
Farmer	0.38	-0.05	0.93**	-0.16	0.85
	(0.72)	(-0.07)	(6.89)	(-0.40)	(0.51)
Others	-0.30*	-0.21	-0.32**	-0.23*	-1.02*
	(-1.41)	(-0.80)	(-1.74)	(-1.50)	(-1.56)
Race:					
Black	0.27	0.03	-0.28*	-0.47***	-0.61
	(1.23)	(0.12)	(-1.44)	(-2.85)	(-0.88)
Others	0.94***	0.81**	0.85***	-0.003	-0.45
	(2.88)	(1.91)	(2.83)	(-0.01)	(-0.40)
R^2 of model[a]	0.09	0.11	0.08	0.13	0.20
% Consuming Household	24.44	20.42	50.25	51.34	43.50

Note: Number in the parenthesis is t-value. *, **, and *** denote significant at 10%, 5%, and 1% levels, respectively.
[a]The R^2 measure used here is the squared correlation between the observed and expected values of each equation.

The estimated parameters are positive and significant on nutrition information from government and health agents (except for other citrus) and the food industry (except for oranges). These results confirm the value of those sources to decisions on the consumption of fresh fruits. Nutritional information obtained through the media has positive and significant effects on consumption of all selected fruits except for apples and other citrus. On the other hand, information from friends and relatives has a somewhat mixed and insignificant influence on the consumption of the different groups of fresh fruits.

Seasonal differences are significant for all fruits except bananas, where there was very little variation by time of year. Households consume more oranges in Spring than in other seasons. This may be due to two of the most important oranges - Navel and Valencia - beginning their market seasons in November and March, respectively. Consumption of apples in Winter is higher than in Spring, and consumption in Fall and Summer is lower than in Spring. Apples are a cool season crop, harvested in late Fall, so their consumption may suggest accordingly higher preferences for fresh apples in Winter. Also, many warm-season fruits are out-of-season in the Winter, which may also contribute to the higher apple consumption in Winter. Although technological advances - such as cold storage and controlled atmosphere storage - make high quality apples available the year around, the additional cost and some loss of quality incurred when using these technologies may put downside pressure on apple consumption in Summer and Fall.

Regional variations and the effect of urbanization on fresh fruit consumption appear to be minimal. Results show that households in the Northeastern region generally consume significantly more fresh fruits than their counterparts, while households resided in the South had the lowest level of fruit consumption. However, households in the North Central region are found to consume significantly more apples than those resided in the Northeast, and households in the Western region consume significantly more bananas, other citrus, and other non-citrus. Furthermore, suburban residents also have significantly higher apples consumption than do their central cities counterparts.

Occupational effects on fresh fruit consumption are generally weak. Blue-collar-headed households have a significantly lower consumption level of other citrus, bananas, and other non-citrus fruits than their white-collar counterparts. Farmer-headed households tend to consume significantly more fresh apples than white-collar-headed households, while the opposite is true for other-occupation-headed households. Consistent with Smallwood and Blaylock and Raunikar et al., this study finds that both Blacks and other race households have higher orange consumption than their white counterparts. Blacks consume less apples than Whites, while other race households have significantly higher levels of apple consumption than their white counterparts. Black households also consume significantly less bananas than their white counterparts.

Price and Income Elasticities

Estimated price and income elasticities of included fresh fruit groups are presented in Table 3. The estimated income and own-price elasticities for orange consumption are 0.187 and -0.567, respectively. Both of these results are somewhat smaller than those from previous studies. George and King obtained an income elasticity of 0.227 for oranges. Studies of Raunikar et al. and Huang had even higher income elasticities, 0.40 and 0.487, respectively. The previous studies also had higher own-price elasticities in terms of absolute value. George and King, and Huang found own-price elasticities of -0.663 and -0.9996, respectively. Using a 1962 survey, Chapman estimated a much higher price elasticity for Valencia oranges, ranging from -2.30 to -3.42. Overall, it appears that the consumption of oranges has become less responsive to income and price changes in recent years. Alternatively, the non-purchaser effects were greater than previously anticipated.

Income and own-price are important determinants of apple consumption. There is a significant and positive relation between income and apple consumption, with an income elasticity of 0.114, which implies that apples are normal goods. This supports the results of George and

Table 3. Estimated Elasticities for Selected Fresh Fruits

Variable	Orange	OtherCitrus	Apple	Banana	Other Non-citrus
Price:					
Orange	**-0.567**	-0.342	0.192	0.076	-0.048
Other Citrus	-0.196	**-0.511**	-0.012	-0.061	0.112
Apple	-0.105	-0.064	**-0.488**	-0.025	0.079
Banana	-0.110	-0.291	0.038	**-0.243**	0.039
Other Non-citrus	0.037	-0.150	-0.062	-0.088	**-0.663**
Decomposition of Price Elasticities:					
Market Participation	-0.437	-0.404	-0.312	-0.151	-0.471
Conditional Consumption	-0.130	-0.107	-0.176	-0.092	-0.192
Income	**0.187**	**0.416**	**0.114**	**0.045**	**0.278**
Decomposition of Income Elasticities:					
Market Participation	0.144	0.329	0.073	0.028	0.197
Conditional Consumption	0.043	0.087	0.041	0.017	0.081

King (0.142) and Raunikar et al. (0.27), but Huang's study found that apples were economic inferior goods. Our estimated price elasticity of apple consumption is -0.488, smaller than the results of George and King (-0.72), and Price and Mittelhammer (-0.596). Based on the cross-price elasticity, oranges are substitutes for apples.

An interesting finding of banana consumption is that income has no significant effect. Our estimated income elasticity of banana consumption is 0.045, much smaller than previous results, such as 0.135 and 0.15 reported by George and King and Raunikar et al., respectively. The own-price effect is significant and negative, with an estimated elasticity of -0.243. This is also smaller (in terms of absolute value) than Huang's estimate of -0.40 or the -0.615 obtained by George and King. Overall, the comparison of income and price elasticities suggests that banana consumption is less responsive to price and income changes than those reported previously.

For the group of other citrus fruits, which includes grapefruit, lemons, limes, etc., the estimated income elasticity is 0.416, more than twice the income elasticity of orange consumption (0.187). The estimated own-price elasticity is -0.511, which is little different from the estimated own-price elasticity of oranges (-0.567). The group of other non-citrus fruits includes mainly pears, peaches, grapes, and berries. Elasticities of income and own price of the non-citrus fruits consumption are 0.278 and -0.633, respectively, and both values are larger (in absolute terms) than those of disaggregated non-citrus fruits - apples and bananas.

Based on equation (2), the estimated own-price and income elasticities are decomposed into two components that reflect the elasticities of market participation and conditional consumption, respectively. As shown in Table 3, the results suggest that the market participation effect plays a dominant role in consumption responses due to changes in price and income. This implies that any changes in the marketing strategy are likely to have much greater impacts on market participation than on conditional consumption level. For instance, if a retail store wants to promote sales of fresh fruits by reducing their prices, this action would have a greater impact on attracting more consumers to purchase fresh fruits than inducing the consumers to purchase larger quantities because of lower prices. Conversely, if the price increases, more consumers would exit the market, or purchase the individual fruits less frequently, than decrease their level of consumption. Similarly, as household income increases, most of the observed increases in fresh fruit consumption would be accounted for by increasing probabilities of households purchasing fresh fruits instead of increasing the level of consumption.

Conclusions and Implications

Consumption of fresh fruits, in aggregate, has increased dramatically over the last 20 years, although the magnitudes differ for specific fresh fruits. Changing consumption patterns have important implications for the food industry and government. Business and policy decision making require reliable measures of these changes and the impacts of factors that may have influenced these changes. A Tobit model was specified to estimate these influences for three selected individual fruits - oranges, apples, and bananas - and two aggregated fruit groups - other citrus and other non-citrus. Overall, the Tobit results seem reasonable and consistent with previous research.

Generally, an increase in the standard of living (income) results in an increase in the consumption of fresh produce. Compared with previous studies, we generally obtain smaller elasticities of income for the consumption of individual fresh fruits - oranges, apples and bananas. This suggests that consumption of these individual fresh fruits might have become less responsive to income changes than in previous periods. Own prices of fresh produce remain important factors in fresh fruit consumption, while cross-price effects are generally weak and insignificant among individual fruits. More importantly, the results suggest that changes in price and household income affect fruit consumption primarily on the probabilities of purchasing rather than on the level of conditional consumption.

Age/gender classes have a significant and positive effect on most households' fresh fruits consumption. Especially, the number of adults in the age group 18-64 is a significant determinant of household fresh produce consumption. Sources of nutrition information appear to have different effects on most fresh fruits consumption. Results show that nutrition professionals and government have a consistently significant and positive influence, while friends and relatives are a weak and insignificant source of information. Time pressure is a significant but negative factor that affects the consumption of most fresh fruits, except for apples. This seems to counter a general perception that fresh fruits are convenient goods and that time-pressured households would tend to consume more of them. Also, the time pressure effect appears to be more prominent in this study, suggesting its influence has increased during recent years.

Since the food industry is increasingly consumer-driven, information on new trends of consumption are vital to its market strategy planning. Based on the empirical evidence, some practical implications can be derived for fresh fruits producers, processors, and retailers. For example, the study finds that consumption behavior differs among Whites, Blacks, and other race households. This suggests that retailers could target specific ethnic subgroups around their location to promote fresh fruits sales. Thus, retailers near a black community should allocate more shelf space to citrus fruits, while retailers close to a predominantly white community would emphasize stocks of apples, bananas, and non-citrus fruits.

Although price and income remain important to individual shoppers of fresh fruits, their priorities in consumer perceptions may be fading. It seems that quality, nutrition, and convenience have become dominant themes (Senauer et al.). The food industry needs to change its strategies to accommodate these trends. Furthermore, this study finds that government, health organizations and food industry play an important role that influences household consumption of fresh fruits. Results show that these organizations are the most important sources for nutrition information that have positive and significant effects on fresh fruit consumption. Thus, in order to promote consumption of fruits, the food industry should cooperate with government agents and health professionals to develop educational programs and dietary recommendations that stress the nutritional values and health benefits of increasing fruit consumption.

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