Testing for a Change in Consumer Tastes for Fresh Fruits and Vegetables: A Structural Latent Variable Approach

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Many epidemiological studies have established a close link between dietary patterns and various chronic diseases. Moreover, these studies have also shown that adopting a diet low in fat, saturated fat, cholesterol, salt, and sugar and high in fruits and vegetables can substantially reduce the incidence of these diet related diseases. In particular, antioxidants and phytochemicals available in fruits and vegetables such as quercitin in onions, lycopene in tomatoes, anthocyanins in red grapes, myricetin in spinach, and ficetin in strawberries have strong protective effects against various diseases.

Based on the premise that knowledge shapes behavior meaning that as consumer become aware of the consequence of unhealthy eating habits on health they abandon them in favor of healthy ones to prevent future illness many public and private institutions are conducting nutrition information and promotion campaigns (Nestle et al.). Although empirical studies have shown that the level of public awareness has increased substantially over time and the consumption of food items that contain high percentage of fat and cholesterol such as eggs and oils has declined (Variyam et al., 1996), it is not yet clear whether this trend has been successful in augmenting the share of various fruit and vegetable commodities in the American diet. In this light, this study uses a structural latent variable approach to examine whether the increased supply of health information has been successful in improving consumer taste and preference towards fruits and vegetables and if it has been successful in doing so, how this change in taste and preference is affecting the consumption of various produce commodities.

Structural latent variable models have been used to examine the impact of change in consumer tastes and preferences on meat demand (Gao and Shonkwiler), potatoes, bread, rice, and corn demand (Gao), fresh fruits consumption (Richards, Gao, and Patterson), and non-alcoholic beverage demand (Miao) but none of the existing studies, to our best knowledge, have examined all major fresh fruit and vegetable commodities that are rich in antioxidants and phytochemicals.

Following Gao and Shonkwiler and Miao we use two stage estimation procedure. In the first stage, a structural latent variable model is used to measure the change in consumer taste and preference. Since taste is a latent variable, indicators such as consumer expenditure on food away from home, per capita consumption of poultry, eggs, and low fat milk are used to measure consumer tastes. On the other hand, consumer taste and preference towards fruits and vegetables are expected to change as they become more aware of health benefits of consuming fresh fruits and vegetables (diet-disease relationship), as their need for convenience changes, and their family structure changes. Therefore, the latent variable is defined as a function of fruit and vegetable information index (health information), percentage of working wife (convenience), and the number of children under 5 years of age (demographic factor).

In the second stage, two separate LAIDS demand systems for fruit (apples, bananas, oranges, peaches, strawberries, melons, and other fruits) and vegetable (broccoli, cauliflower, carrot, cucumber, green peppers, lettuce, onions, and tomatoes) commodities are estimated including the taste variable obtained from the first stage as one of explanatory variable (see Miao; Gao and Shonkwiler; Richards, Gao, and Patterson for details).

As expected, the results from the first stage show that the taste variable is negatively related to egg consumption and positively related to poultry and low fat milk consumption. Moreover, the latent taste construct is positively associated with all three cause variables including fruit and vegetable information index. The second stage results show that consumer taste change has increased the consumption of crucifers, cucumbers, green peppers, strawberries, and melons significantly.

Model Specification

Since consumer taste and preferences for fresh fruits and vegetables are not directly observable, conventional econometric models cannot be used to examine the empirical relationship between consumer taste and product demand. Therefore, taste is treated as a latent variable and estimated using structural equation model. The structural equation model, in general, consists of two components – a system of structural and measurement equations (Bollen). While the first part shows the relationship among latent variables, η's and ξ's,

$$\eta = B\eta + \Gamma\xi + \varsigma , \quad (1)$$

the second component establishes the link between observed variables (x and y) and the latent constructs,

$$y = \Lambda_y \eta + \varepsilon$$

$$x = \Lambda_x \xi + \delta , \quad (2)$$

where ε's and δ's are measurement errors, ς's are structural disturbance terms, and B, Γ, Λ_y, and Λ_x are parameters to be estimated. The multiple indicators and multiple causes (MIMIC) model, used in the study, is a special case of structural equation model with a single latent variable. A simple MIMIC model can be expressed as

$$y = \Lambda_y \eta + \varepsilon ,$$

$$\eta = \gamma' x + \varsigma , \quad (3)$$

where $y' = (y_1, y_2, \ldots, y_p)$ are indicators of the latent variable η, and $x' = (x_1, x_2, \ldots, x_q)$ are the causes of η.

Once the taste constructs ($\Xi(\tau)$) are obtained from the MIMIC model, the impact of a change in taste on demand can be modeled as follows. Assuming that different food groups, such as fresh fruits, vegetables, and meats, are weakly separable, consumer's optimization problem (for a group of commodities) can be expressed as

$$\text{Maximize} \quad u = u(q, \Xi(\tau))$$

$$\text{Subject to} \quad p'q = m, \tag{4}$$

where p and q are price and quantity vectors, respectively and m is total expenditure (Gao and Shonkwiler). In this framework, a single taste measure can be used to measure the impact on a group of goods, such as fresh fruits, because factors determining consumer taste for fruits affect all fruits simultaneously. Solving (4) yields demand function

$$q_i = q(p, m, \Xi(\tau)). \tag{5}$$

Equation 5 can be estimated using a number of theoretically plausible functional forms. This study uses a linear approximate version of the AIDS (LAIDS) of Deaton and Muellbauer to estimate the demand system. LAIDS is one of the most popular and widely used demand systems (Richards, Gao, and Patterson; Hayes, Wahl, and Williams; Blanciforti and Green; Chang and Kinnucan). The LAIDS provides a flexible complete demand system, which is derived from an expenditure function of Gorman polar form. It is affine in utility and aggregates consistently across consumers (Green). The LAIDS model that accounts for consumer taste change can be specified as

$$w_i = \tau_i \Xi + \sum_j \gamma_{ij} \ln p_j + \beta_i \ln(m / P),$$

where Ξ is the latent taste and information variable, p_j is the price of good j, P is the Stone's price index: $P = \Sigma_i w_i \ln p_i$ and w_i is the budget share of good i.

Data and Methods

This study uses annual data from 1970-2002 on consumption of fresh fruits (apples, bananas, orange, grapefruits, strawberries, grapes, watermelons, honeydew, cantaloupe, and peaches) and vegetables (broccoli, cauliflower, lettuce, carrots, cucumbers, onions, bell peppers, and tomatoes), which were obtained from USDA's *Fruit and Tree Nuts: Yearbook*. Retail price were obtained from the annual report of the Bureau of Labor Statistics' *Consumer Price Index: Monthly Summary*.

In order to keep the model as parsimonious as possible, fruit group was reduced to 7 commodities by creating two composite variables citrus and melons. While citrus is a composite of two citrus fruits, oranges and grapefruits, melon represents watermelons, honeydew, and cantaloupe. Similarly, vegetable group was reduced to 7 commodities by combining broccoli and cauliflower as a composite representing crucifers. The price index for these three composite variables was constructed using Stone's price index, which uses expenditure shares as weights.

The data used in the MIMIC model come from a variety of sources. The information on the proportion of food expenditure consumed away from home is from the various issues of the *Food Marketing Review*. The data on per capita consumption of poultry, eggs, and low fat milk was obtained from the USDA's *Food Consumption Data System*. The percentage of married couple with wife working came from the Census Bureau's *Current Population Survey, Annual Demographic Supplement* and the percentage of children under five years of age came from various issues of *Economic Report of the President*. Similar to Brown and Schrader's cholesterol index, a fruit and vegetable information index was created by counting the number of citations supporting the link between health and fruit or vegetable consumption in the medical journals minus the number of citations arguing against the link.

In the MIMIC model, per capita consumption of poultry (Poultry), eggs (Eggs), low fat milk (Lowm), and the percentage of food expenditure on away-from-home (AWAY) serve as the indicators of consumer taste change. Among these four indicators, per capita consumption of poultry, eggs, and low fat milk reflect consumer's response to health concerns. While consumption of poultry and low fat milk is increasing because these food items contain less total and saturated fats than their close substitutes, consumption of eggs is declining mainly because of the concern about high cholesterol content in eggs. Therefore, while poultry and low fat milk consumptions are expected to have a positive association with the latent taste construct, egg should reflect reverse relationship. On the other hand, the AWAY variable reflects consumers convenience concern and should be positively associated with the latent variable.

Among the three cause variables, fruit and vegetable index (Fnv) measures the development and spread of health information that links the consumption of fresh fruits and vegetables to better health and is expected to measure taste change due to consumer health concerns. The percentage of married working women (Wom) reflects the changes in the family structure and affects the demand for convenience (Gao and Shonkwiler). On the other hand, the percentage of children under five years of age (Age5) measures the taste change due to a change in demographic composition of the society (Miao).

The estimation of the MIMIC model differs from the conventional econometric approach. The econometric procedure minimizes the squared difference between observed and predicted values of dependent variables. However, when some of the dependent and/or independent variables are not observable, these differences cannot be estimated. Therefore, rather than minimizing the sum of squared residuals, the structural equation procedure minimizes the difference between observed (or sample) covariance and the covariance predicted by the model

(Bollen; Gao and Shonkwiler). Thus, the latent variable approach is based on the hypothesis that the covariance matrix of observed variables is a function of a set of structural parameters.

Results

The structural equation model results are reported in Table 1. As expected, the measurement model results show that the variables AWAY (proportion of expenditure on food consumed away from home), Lowm, and Poultry are positively associated with the latent taste variable. On the other hand, Egg is negatively associated with the taste index. All factor loadings of these latent taste indicators are highly significant. The significance of the error variances in the Poultry, AWAY and Eggs indicator equations implies that inclusion of these variables into the demand system without accounting for measurement errors would violate one of the basic assumption of least square and result in biased parameter estimates.

In the structural equation model, all of the coefficients are positive but only Fnv and Wom coefficients are significant indicating that both health and convenience concerns play an important role in shaping consumer taste. These results are consistent with prior studies (Gao and Shonkwiler; Miao).

The Vegetable Model

The LAIDS parameters for fresh vegetable groups are reported in Table 2. All own price parameters except for crucifers are significant at one percent level. Out of 42 cross price coefficients, 36 of them are significant. The Marshallian and Hicksian demand elasticities were estimated using these parameters (Table 3). All Marshallian own price elasticities are negative except for lettuce. The cross price elasticities indicate that there is a strong substitute relationship between crucifers and cucumbers. On the other hand, onions and lettuce show a strong complementary relationship. The Hicksian elasticity estimates show a strong substitute relationship of i) crucifers with carrots and cucumbers, ii) carrots with cucumbers, onions, and tomatoes, and iii) cucumber and green papers. Moreover, all expenditure elasticities are positive and significant at one percent level implying that vegetables are normal goods.

The taste elasticities are positive for all vegetables except for lettuce and tomatoes. Taste index has a significantly positive impact on the budget share of crucifers, cucumbers, and green peppers. In particular, the latent taste construct shows the largest positive impact on demand for crucifers and green peppers. However, the taste effect is significantly negative in lettuce budget share equation. These elasticity estimates show that taste change has increased annual per capita consumption of crucifers, green peppers, and cucumbers by 17.5, 10.8, and 5.4 percent, respectively and reduced lettuce consumption by 4.6 percent (Table 4).

The Fruit Model

The LAIDS parameters for fruit groups are presented in table 5. The own price coefficients are significant for apples, bananas, strawberries, and melons. The own price elasticities are negative and significant in all budget share equations except for bananas (Table 6). Although the own price elasticity for banana is positive, it is not significantly different from zero. Among cross price elasticities, a relatively strong substitute relationship is observed between the demand for strawberries and the price of bananas. Out of 42 Marshallian cross price elasticities, only 11 of them are significant and all of them show a complemetary relationship between fruit demand and prices. However, Hicksian cross price elasticities show that significant net substitute relationship do exists between fruit demand and prices.

Based on the magnitude of the cross price elasticity, citrus demand shows a strongest substitute relationship with grape price. Substitute relations are also observed between strawberry demand and peach price, grape demand and citrus price, strawberry demand and apple price, melon demand and strawberry price, citrus demand and apple price, and citrus demand and strawberry price. Moreover, all of the expenditure elasticities are highly significant and carry expected sign indicating that these fruit groups are normal goods. The expenditure elasticities for apples, bananas, grapes, and melons are greater than one (elastic).

As in the case of fresh vegetable models, the elasticities of the latent taste construct carry mixed signs. While the taste elasticities in apple, banana, and peach models are negative, they are positive in citrus, grape, melons, and strawberry models. However, only the melon and strawberry taste elasticities are significantly different from zero. These elasticity estimates show that consumer taste change has increased per capita consumption of melons and strawberries by about 13 and 3 percent, respectively (Table 4).

Summary and Conclusion

This study examined the impact of prices, expenditure, and consumer taste change on fresh fruits and vegetable consumption. Since taste is unobservable, structural equation model was used to create a latent taste construct and used in LAIDS demand system to examine its impact on per capita produce consumption. Following Henneberry, Pewthongngam, and Qiang, fruit and vegetable groups are assumed to be weakly separable and estimated using iterative seemingly unrelated regression system.

The expenditure elasticity estimates suggest that all fruit and vegetable commodities examined in this study are normal goods. Moreover, most of these commodities are more sensitive to own price changes than a change in other prices. The MIMIC model results show that both health as well as convenience concerns play an important role in shaping consumer taste and preference toward fresh fruits and vegetables. These taste change results are consistent with the literature (Gao and Shonkwiler; Miao). The LAIDS results show that consumer taste change has increased the per capita consumption of fresh fruits and vegetables. In particular, the change in taste has significantly increased demand for fresh produce commodities including crucifers, cucumbers, green peppers, strawberries, and melons significantly during the study period.

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Table 1. MIMIC Model Results

Measurement Model	Indicator Equation			
	Poultry (Λ_{y11})	Lowm (Λ_{y21})	Away (Λ_{y31})	Eggs (Λ_{y41})
Λ_y (t-ratio)	1.000	0.417 (13.32)	0.582 (12.11)	-0.376 (-12.15)
θ_ε (t-ratio)	18.254 (4.06)	0.054 (0.97)	1.183 (3.97)	0.478 (3.79)
R^2	0.845	0.999	0.968	0.967
Structural Equation Model	Cause Equation			
	Fnv (Γ_1)	Age5 (Γ_2)	Wom (Γ_3)	
Γ_i (t-ratio)	0.033 (4.13)	0.500 (1.30)	1.389 (8.81)	
Ψ (t-ratio)	1.624 (3.33)			
R^2	0.984			

Table 2. LAIDS Estimators for Seven Fresh Vegetable Groups (1970-2002)

Price of:	Dependent Variable (Budget share of per capita consumption)						
	Crucifers	Lettuce	Carrots	Cucumbers	Onions	Green Peppers	Tomatoes
Cruciferous	0.0385	-0.0067	0.0003	0.0150**	-0.0028	-0.0257**	-0.0261*
	(1.59)	-(0.40)	(0.03)	(2.94)	-(0.35)	-(2.43)	-(1.88)
Lettuce	-0.0067	0.1671**	-0.0224*	-0.0156**	-0.0320**	-0.0198*	-0.0636**
	-(0.40)	(7.39)	-(2.14)	-(3.96)	-(4.86)	-(2.04)	-(5.29)
Carrots	0.0003	-0.0224*	0.0581**	-0.0140**	-0.0073	0.0069	-0.0223*
	(0.03)	-(2.14)	(5.34)	-(3.84)	-(1.39)	(0.86)	-(2.07)
Cucumbers	0.0150**	-0.0156**	-0.0140**	0.0512**	0.0049*	0.0018	-0.0339**
	(2.94)	-(3.96)	-(3.84)	(18.26)	-(2.14)	(0.44)	-(8.19)
Onions	-0.0028	-0.0320**	-0.0073	-0.0049*	0.0932**	-0.0138**	-0.0316**
	-(0.35)	-(4.86)	-(1.39)	-(2.14)	(21.17)	-(2.81)	-(4.92)
Green Peppers	-0.0257**	-0.0198*	0.0069	0.0018	-0.0138**	0.0664**	-0.0185*
	-(2.43)	-(2.04)	(0.86)	(0.44)	-(2.81)	(6.60)	-(2.22)
Tomatoes	-0.0185	-0.0706**	-0.0215*	-0.0335**	-0.0325**	-0.0158*	0.1959**
	-(1.36)	-(6.21)	-(2.08)	-(8.29)	-(5.72)	-(1.92)	(13.02)
Expenditure	-0.0088	-0.0007	0.0028	-0.0047**	0.0004	-0.0012	0.0127*
	-(1.19)	-(0.07)	(0.59)	-(2.78)	(0.14)	-(0.27)	(2.24)
Taste	0.0018**	-0.0016**	0.0002	0.0004**	0.0000	0.0011**	-0.0018**
	(5.65)	-(4.48)	(1.20)	(4.80)	(0.33)	(6.87)	-(8.20)
R^2	0.738	0.769	0.376	0.943	0.927	0.861	0.9512

Notes: The system $R^2 = 0.99$. Numbers in parentheses are t-ratios.

[1]Crucifers represent broccoli and cauliflower.

*, ** denote significance at the 5 and 1 percent levels respectively.

Table 3. Marshallian and Hicksian Demand Elasticities for Seven Fresh Vegetable Groups

	Dependent Variable (Per capita consumption)						
Price of:	Crucifers	Lettuce	Carrots	Cucumbers	Onions	Green Peppers	Tomatoes
Marshallian							
Crucifers	-0.5389*	-0.0736	0.0323	0.1840**	-0.0219	-0.2935*	-0.1845
	-(1.88)	-(0.37)	(0.23)	(3.04)	-(0.23)	-(2.36)	-(1.13)
Lettuce	-0.1257	2.1429**	-0.4184*	-0.2925**	-0.5997**	-0.3709*	-1.3231
	-(0.39)	(5.04)	-(2.08)	-(3.86)	-(4.86)	-(2.03)	-(5.94)
Carrots	0.0004	-0.0827*	-0.7903**	-0.0522**	-0.0278	0.0243	-0.0820*
	(0.01)	-(2.15)	-(19.96)	-(3.87)	-(1.46)	(0.83)	-(2.12)
Cucumbers	0.1956**	-0.1953**	-0.1621**	-0.3437**	-0.0555*	0.0284	-0.4074**
	(3.01)	-(3.90)	-(3.50)	-(9.63)	-(1.93)	(0.54)	-(7.79)
Onions	-0.0259	-0.2873**	-0.0665	-0.0443*	-0.1630**	-0.1242**	-0.2929**
	-(0.35)	-(4.87)	-(1.42)	-(2.14)	-(4.17)	-(2.82)	-(5.57)
Green Peppers	-0.3090**	-0.2376*	0.0866	0.0233	-0.1646**	-0.1990	-0.1857*
	-(2.41)	-(2.04)	(0.90)	(0.47)	-(2.82)	-(1.64)	-(1.84)
Tomatoes	-0.0861*	-0.2037**	-0.0815**	-0.1104**	-0.1046**	-0.0618*	-0.3920**
	-(1.95)	-(5.35)	-(2.41)	-(8.33)	-(5.19)	-(2.35)	-(8.08)
Expenditure	0.8961**	0.9872**	1.0103**	0.9399**	1.0040**	0.9859**	1.0401**
	(10.22)	(5.68)	(57.93)	(43.45)	(35.67)	(19.10)	(58.04)
Taste	0.6524**	-0.1711**	0.0859	0.2012**	0.0107	0.4027**	-0.1694
	(5.65)	-(4.48)	(1.20)	(4.80)	(0.33)	(6.87)	-(8.20)
Hicksian							
Crucifers	-0.4626	-0.0260	0.2771*	0.2545**	0.0779	-0.2192*	0.0983
	-(1.62)	-(0.13)	(1.95)	(4.25)	(0.81)	-(1.76)	(0.62)
Lettuce	-0.0416	2.1954*	-0.1487	-0.2149**	-0.4898**	-0.2890	-1.0115**
	-(0.13)	(5.16)	-(0.75)	-(2.90)	-(3.96)	-(1.59)	-(4.73)
Carrots	0.0864*	-0.0289	-0.5143**	0.0272*	0.0847**	0.1081**	0.2369**
	(1.95)	-(0.75)	-(12.92)	(2.04)	(4.41)	(3.70)	(6.26)
Cucumbers	0.2757**	-0.1453**	0.0946*	-0.2698**	0.0491	0.1064*	-0.1107*
	(4.25)	-(2.90)	(2.04)	-(7.56)	(1.69)	(2.02)	-(2.15)
Onions	0.0596	-0.2339**	0.2077**	0.0347	-0.0512	-0.0409	0.0240
	(0.81)	-(3.96)	(4.41)	(1.69)	-(1.29)	-(0.93)	(0.47)
Green Peppers	-0.2250*	-0.1852	0.3559**	0.1008*	-0.0548	-0.1172	0.1255
	-(1.76)	-(1.59)	(3.70)	(2.02)	-(0.93)	-(0.97)	(1.27)
Tomatoes	0.0025	-0.1484**	0.2026**	-0.0287*	0.0112	0.0245	-0.0637
	(0.06)	-(3.90)	(5.96)	-(2.19)	(0.55)	(0.93)	-(1.34)

Notes: Numbers in parentheses are t-ratios.

*, ** denote significance at the 5 and 1 percent levels respectively.

Table 4. Change in Annual Per Capita Consumption Due to Taste Change

Vegetables	Mean (Lbs)	Change (Lbs)	Percent Change	Fruits	Mean (Lbs)	Change (Lbs)	Percent Change
Crucifers	4.39	1.03	17.50	Apples	18.05	-0.86	-4.76
Lettuce	24.21	-1.49	-4.59	Bananas	23.47	-0.41	-1.75
Carrots	8.18	0.25	2.30	Citrus	19.87	0.45	2.25
Cucumbers	4.61	0.33	5.40	Strawberries	2.99	0.10	3.24
Onions	14.11	0.06	0.30	Grapes	5.79	0.15	2.62
Green Peppers	4.38	0.64	10.80	Melons	23.30	3.05	13.11
Tomatoes	14.74	-0.86	-4.35	Peaches	5.59	-0.48	-8.60

Table 5. LAIDS Estimators for Seven Fresh Fruit Groups (1970-2002)

Price of:	Dependent Variable (Budget share of per capita consumption)						
	Apples	Bananas	Citrus	Strawberries	Grapes	Melons	Peaches
Apples	0.1387**	-0.0216	-0.0121	-0.0194	-0.0263	-0.0162*	-0.0431**
	(4.30)	-(0.99)	-(0.66)	-(1.66)	-(1.05)	-(1.90)	-(2.46)
Bananas	-0.0216	0.0844**	-0.0245*	-0.0418**	0.0033	-0.0180*	0.0181
	-(0.99)	(2.73)	-(1.72)	-(3.39)	(0.13)	-(2.02)	(1.00)
Citrus	-0.0121	-0.0245*	0.0201	-0.0082	0.0282	-0.0049	0.0015
	-(0.66)	-(1.72)	(0.86)	-(1.10)	(1.35)	-(0.89)	(0.10)
Strawberries	-0.0194	-0.0418**	-0.0082	0.0587**	0.0015	0.0021	0.0071
	-(1.66)	-(3.39)	-(1.10)	(5.70)	(0.12)	(0.41)	(0.69)
Grapes	-0.0263	0.0033	0.0282	0.0015	-0.0076	0.0031	-0.0022
	-(1.05)	(0.13)	(1.35)	(0.12)	-(0.20)	(0.35)	-(0.11)
Melons	-0.0162*	-0.0180*	-0.0049	0.0021	0.0031	0.0287**	0.0052
	-(1.91)	-(2.02)	-(0.89)	(0.41)	(0.35)	(6.09)	(0.74)
Peaches	-0.0431**	0.0181	0.0015	0.0071	-0.0022	0.0052	0.0134
	-(2.46)	(1.00)	(0.10)	(0.69)	-(0.11)	(0.74)	(0.68)
Expenditure	0.0041	0.0077	-0.0010	-0.0015	0.0000	0.0009	-0.0103
	(0.54)	(1.27)	-(0.09)	-(0.48)	(0.00)	(0.41)	-(1.44)
Taste	-0.0012	-0.0001	0.0004	0.0006*	0.0003	0.0006**	-0.0007
	-(1.54)	-(0.16)	(0.39)	(2.02)	(0.34)	(2.63)	-(0.99)
R^2	0.886	0.520	0.916	0.974	0.906	0.834	0.4080

Notes: The system R^2 = 0.99. Numbers in parentheses are t-ratios.

[1]Melons represent watermelons, honeydew, and cantaloupes.

*, ** denote significance at the 5 and 1 percent levels respectively.

Table 6. Marshallian and Hicksian Demand Elasticities for Seven Fresh Fruit Groups

	Dependent Variable (Per capita consumption)						
Price of:	Apples	Bananas	Citrus	Strawberries	Grapes	Melons	Peaches
Marshallian							
Apples	-0.4788**	-0.0826	-0.0487	-0.0769*	-0.1018	-0.0622*	-0.1647**
	-(3.93)	-(0.99)	-(0.69)	-(1.71)	-(1.07)	-(1.91)	-(2.49)
Bananas	-0.3930	0.3976	-0.4328*	-0.7225**	0.0377	-0.3055*	0.2907
	-(1.08)	(0.77)	-(1.80)	-(3.50)	(0.09)	-(2.05)	(0.97)
Citrus	-0.0619	-0.1282*	-0.8939**	-0.0420	0.1485	-0.0255	0.0084
	-(0.64)	-(1.71)	-(7.16)	-(1.02)	(1.36)	-(0.86)	(0.10)
Strawberries	-0.0904	-0.1979**	-0.0377	-0.7198**	0.0080	0.0105	0.0344
	-(1.63)	-(3.37)	-(1.05)	-(14.69)	(0.14)	(0.43)	(0.70)
Grapes	-0.1882	0.0239	0.2016	0.0106	-1.0541**	0.0218	-0.0158
	-(1.04)	(0.13)	(1.33)	(0.12)	-(3.85)	(0.35)	-(0.11)
Melons	-0.3419*	-0.3745*	-0.1058	0.0403	0.0608	-0.4040**	0.1060
	-(1.94)	-(2.02)	-(0.90)	(0.37)	(0.34)	-(4.09)	(0.73)
Peaches	-0.4667*	0.2163	0.0401	0.1071	-0.0089	0.0655	-0.8348**
	-(2.30)	(1.03)	(0.22)	(0.88)	-(0.04)	(0.80)	-(3.66)
Expenditure	1.0157**	1.1278**	0.9947**	0.9930**	1.0002**	1.0192**	0.8814**
	(35.13)	(11.18)	(17.85)	(67.72)	(13.78)	(21.61)	(10.72)
Taste	-0.1320	-0.0485	0.0624	0.0898*	0.0725	0.3634**	-0.2385
	-(1.54)	-(0.16)	(0.39)	(2.01)	(0.34)	(2.63)	-(0.99)
Hicksian							
Apples	-0.2106*	-0.0216	0.1450*	0.1370**	0.0402	-0.0133	-0.0767
	-(1.72)	-(0.26)	(2.09)	(3.09)	(0.42)	-(0.41)	-(1.16)
Bananas	-0.0952	0.4653	-0.2177	-0.4850*	0.1954	-0.2512*	0.3884
	-(0.26)	(0.90)	-(0.91)	-(2.36)	(0.47)	-(1.70)	(1.29)
Citrus	0.2008*	-0.0685	-0.7041**	0.1674**	0.2876**	0.0224	0.0945
	(2.09)	-(0.91)	-(5.73)	(4.27)	(2.62)	(0.77)	(1.18)
Strawberries	0.1718**	-0.1383*	0.1517**	-0.5107**	0.1469**	0.0583*	0.1204**
	(3.09)	-(2.36)	(4.27)	-(10.44)	(2.53)	(2.38)	(2.44)
Grapes	0.0759	0.0839	0.3924**	0.2212**	-0.9143**	0.0700	0.0708
	(0.42)	(0.47)	(2.62)	(2.53)	-(3.33)	(1.12)	(0.50)
Melons	-0.0727	-0.3133*	0.0886	0.2549*	0.2032	-0.3549**	0.1942
	-(0.41)	-(1.70)	(0.77)	(2.38)	(1.12)	-(3.62)	(1.34)
Peaches	-0.2339	0.2692	0.2082	0.2927**	0.1144	0.1080	-0.7585**
	-(1.16)	(1.29)	(1.18)	(2.44)	(0.50)	(1.34)	-(3.31)

Notes: Numbers in parentheses are t-ratios.

*, ** denote significance at the 5 and 1 percent levels respectively.