The Economics of Eating Fresh Fruits and Vegetables: Recognizing Discernible Patterns for Obesity Differences among Lower- and Higher-Income Consumers

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Abstract

Fresh fruits and vegetables are perceived to be nutritious and healthy, but more costly than some less nutritious foods. Supermarket scanner data are used to analyze the purchase behavior of higher- and lower-income consumers for produce. Eight sub-categories of fruit are identified; six of vegetables. A SUR model is specified and used to estimate a series of own-price and cross-price elasticities. Prices paid per ounce in each sub-category are calculated and these prices show lower-income consumers paying lower prices for every sub-category except bananas. Lower-income consumers are also shown to have higher own-price elasticities.

Keywords: Fresh Fruits, vegetables, low-income shoppers, high-income shoppers, obesity

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Introduction

Several studies have suggested that an inverse relationship exists between obesity and the consumption of fresh fruits and vegetables. This relationship seems plausible in light of the fact that fruits and vegetables are naturally low in calories and fat. These commodities are nutrient dense and, in 1988, accounted for just 8 percent of the calories and 1 percent of the fat in Americans' diets (Guthrie et al., 1992). Moreover, studies have shown that foods such as fresh fruits and vegetables have high water contents and are therefore likely to promote a sense of fullness at fairly low volumes of intake (Rolls et al., 1998; Drewnowski and Specter, 2004). Further, studies have shown that consumers' ability to pursue healthy diets, such as those rich in fresh fruits and vegetables, is influenced by socioeconomic status (Wilde et al., 2005). In essence, a healthy diet is perceived to be more costly that a less healthy one.

Since fresh fruits and vegetables are perceived to be a major component of a healthy diet, it seems reasonable to compare purchase behaviors of higher- and lower-income consumers for these commodities. An understanding of these purchase behaviors could shed some insight on overweight and obesity since Drewnowski and Specter (2004) conclude that the highest rates of obesity occur among population groups with the highest poverty rates and the least education. So, this study examines the purchase behavior of higher- and lower-income consumers for every fruit and vegetable purchased in two supermarkets during 69 weeks of January 2001 through April 2002. The socioeconomic status of individual shoppers is not observed, but purchasing behaviors are observed for shoppers selected from a high-income suburban location and a low-

income inner-city location. And since studies show that shoppers tend to patronize stores within close proximity of their residence, statistical reasoning would suggest that the observed purchasing behaviors for the two stores are indeed those for two distinct income groups.

Data and Demographic Information

A leading supermarket chain in the Columbus, Ohio metropolitan area provided scanner data on the sales of fresh fruits and vegetables for six supermarkets: three in higher-income suburban areas and three in the lower-income inner city of Columbus. Each store represents approximately 25,000 observations and therefore it is fairly time-consuming to convert these data into usable formats. To date, three of the stores are complete, but only two are reported in this paper. For the higher-income store reported here, an average of 5.0 percent of the residents has household income less than $10,000 annually. At the higher end of the income spectrum, an average of 32.3 percent of residents has annual household incomes exceeding $75,000. Comparative percentages for the lower-income store are 13.8 percent and 10.3 percent, respectively. Differences exist not only in income, but also with respect to education and race. Just 13.8 percent of the prospective shoppers for the lower-income store are college graduates, as compared to 50.6 percent of prospective shoppers for the higher-income store. The lower-income area also has considerable racial heterogeneity among its prospective shoppers, whereas one race represents 92.4 percent of shoppers for the higher-income area.

A factor constraining the use of all six stores in this study was insufficient time to convert all units to a standard unit of measurement. As any observant shopper has witnessed, many fruits and vegetables are sold in various units of measurement: pounds, quantity (2 oranges for $1; 3 potatoes for $2; etc), and size. For meaningful analyses, these units must be converted to a standard unit of measurement. For this study, this unit of measurement is ounces. Because of

the numerous fresh fruits and vegetables sold in each of the supermarkets, it was necessary for this researcher to rely upon the supermarket chain and various store managers to assist with the conversion process.

Data and Methods

Analyses conducted in this study employ the standard classification used by USDA and the produce industry. Fruit is segmented into 8 sub-categories: apples, bananas, berries, citrus, fresh-cut fruit, grapes, melons and soft fruit. Vegetables are segmented into 6 sub-categories: Chinese vegetables, collars and other greens, fresh-cut salads (bagged), major vegetables (corn, potatoes and tomatoes), salad vegetables (cucumbers, lettuce, etc.) and yellow vegetables. Berries and fresh-cut fruit are the most expensive fruit; fresh-cut salads and Chinese vegetables are the most expensive vegetables. Quantity shares of both fresh-cut fruit and yellow vegetables are below 1% and, as the analyses are completed for the other four stores, it is possible that these sub-categories will be merged with other sub-categories.

Sixty-nine weeks of data for 14 sub-categories of fruits and vegetables are used to estimated a series of own-price and cross-price elasticities. All sub-categories of fruits and vegetables appear in each equation, since studies show that most fruits and vegetables are important sources of vitamins and minerals. Equations are specified as a Seemingly Unrelated Regression (SUR) model and estimated in SAS. Weighted prices are derived for each sub-category and these weights represent the relative sales of products within each sub-category. In the estimation process, these weighted prices are converted to a per ounce basis. Hence, the dependent variable, quantity, is expressed in the same units as the independent variables.

A total of 14 equations are specified for each of the two stores and each equation is estimated separately, and then as a system of equations. Total ounces of each fruit or vegetable

constitute the dependent variable and all fruit and vegetable prices are included as independent variables. Included also as independent variables are the lagged dependent variable and total sales of fresh fruit and vegetables. This latter variable is included as a proxy for income. That is, an increase in total produce sales are hypothesized to reflect changes in income for shoppers in a given store area. All variables are expressed in log form and therefore elasticities are provided directly as parameter estimates.

The literature supports the hypothesis that higher- and lower-income consumers exhibit different shopping behavior and sensitivity to price changes (e.g., Jones and Mustiful, 1996, Huang, et al., 2006). Lower-income shoppers are hypothesized to have higher price sensitivity than higher-income shoppers because prices have been shown to be an important guide in purchasing decisions. Further, many empirical studies have verified price elasticity differences. Jones and Mustiful (1996) found lower-income shoppers to be as much as twice as sensitive as higher-income shoppers to price changes for some brands of cereals. Moreover, these shoppers tended to make larger purchases of the lower-priced private label cereals. Similarly, Huang, et al. (2006) found lower-income shoppers to have higher price sensitivity for cheese and a much stronger preference for lower-priced cheese. These results suggest that lower-income shoppers of fresh fruits and vegetables will not only show greater price sensitivity than higher-income shoppers, but they will show the greatest price sensitivity for the highest-priced fruits and vegetables.

Descriptive Statistics

Graphs 1 through 6 display some important statistics on the purchase behavior of fruits and vegetables by higher- and lower-income shoppers. As shown in Graphs 1 and 2, bananas and major vegetables (corn, potatoes and tomatoes) represent the largest purchase of fruits and

vegetables for both higher- and lower-income shoppers. However, bananas and major vegetables represent 43.7 percent of total produce consumption for lower-income shoppers, as compared to 33.6 for higher-income shoppers. Adding the sub-category with the next highest level of consumption for both groups, salad vegetables, these three sub-categories represent 54.1 of total produce consumption for lower-income shoppers and 47.3 percent for higher-income shoppers. In essence, three of the fourteen sub-categories constitute a large percentage of total produce consumption for both income groups, but the distribution of this consumption among the three sub-categories is quite glaring. Major vegetables are far more prominent in the diets of lower-income shoppers and salad vegetables are more prominent in the diets of higher-income shoppers.

Whereas Graphs 1 and 2 display each sub-category relative to total produce purchases, Graph 3 compares fruit purchases for the two income groups and Graph 4 compares vegetable consumption for the two groups. As shown in Graph 3, bananas, as a share of total fruit purchases, are roughly the same for both groups. Considerable disparity between the two groups is shown for melons, berries and soft fruit. Lower-income shoppers purchase a much higher share of melons and higher-income shoppers purchase much higher shares of berries and soft fruit. Of course, relative to the sub-categories of fruits purchased by lower-income shoppers, berries are also the highest-priced fruit and soft-fruit is practically tied for third. Fresh-cut fruit is the second highest-price sub-category, but lower-income shoppers make less than one-tenth of one percent of their purchases from this category. In essence, these disparities are more likely to reflect income differences than taste differences.

Graph 4 shows a pattern for vegetable purchases that is somewhat similar to that shown for fruit purchases in Graph 3. That is, lower-income shoppers show strong preferences for two

specific sub-categories of vegetables, whereas higher-income shoppers show strong preferences for two entirely different sub-categories. Of course, the preferences expressed by lower-income shoppers for collars and other greens and major vegetables are clearly driven by economics. As shown in Table 1 and Graph 6, these products represent the lowest per unit prices paid of all sub-categories of vegetables. Higher-income shoppers show strong preferences for salad vegetables and Chinese vegetables, and this latter sub-category is one of the more expensive one. In short, while economic theory suggests that tastes and preferences play a major role in consumer purchase decisions, it seems apparent from the revealed preferences in Graphs 1 though 4 that income serves to constrain preferences.

Prices paid per pound by higher- and lower-income shoppers for fruits and vegetables are shown in Graphs 5 and 6. More than anything else, these graphs show the impacts of income constraints on consumers' purchase behavior. Identical prices exist in both stores, but the graphs show that lower-income shoppers paid lower prices per pound for all sub-categories except bananas. Interestingly, bananas are the lowest-priced fruit available to consumers and many studies have shown that consumers are less price sensitive to the lowest-price product in a given product category. However, given the fact that bananas are comparatively priced in both supermarkets, the lower prices paid by lower-income shoppers would suggest that the purchase rate is such that store managers never have to discount bananas to stimulate sales and minimize product losses. By contrast, higher banana prices paid by higher-income shoppers suggest that managers are required to use price to stimulate product movement. Stated differently, high purchase rates in the lower-income store obviate the need for discounting to sell over-ripe and over-mature bananas, but slower purchase rates in the higher-income store mandate the use of discounting. With respect to bananas, it is interesting that Leibtag and kaufman (2003) observed

that lower-income households make higher purchases of bananas because they are relatively inexpensive.

Empirical Results

Own-price elasticities, as shown in Table 2, are the focus of this study, but it should be emphasized that cross-price elasticities as well as expenditure elasticities were estimated. Substitute relationships were typically found for the following fruits: berries and fresh-cut fruit; citrus and grapes; citrus and soft fruit; and apples and melons. The most common complementary relationship among fruits was found for bananas and soft fruit. Among vegetables, substitute relationships were typically found for greens and salad vegetables; greens and Chinese vegetables; and major vegetables and yellow vegetables. The most common complementary relationship among vegetables was found for Chinese vegetables and yellow vegetables. Relative to expenditure elasticities, all but one (fresh-cut fruit) of the 14 expenditure elasticities was positive and statistically significant for the lower-income store. Within the higher-income store, 5 of the 14 expenditure elasticities were statistically insignificant. These were: bananas, grapes, fresh-cut fruit, greens and Chinese vegetables.

As economic theory would predict, lower-income shoppers are shown to be far more price sensitive than higher-income shoppers (Table 2). This pattern is shown for all but two of the 14 sub-categories in Table 2. For these two, Chinese vegetables and salad vegetables, one of the store elasticities for Chinese vegetables is statistically insignificant and cannot be compared and the two elasticities for salad vegetables are so close that the difference is likely to be statistically insignificant. In essence, the elasticitices shown in Table 2 provide strong support for the hypothesized theoretical relationship of higher price elasticity for lower-income shoppers. Relative to magnitude, differences in elasticities between the two groups of shoppers are not

necessarily highest for the highest-priced sub-categories. Indeed one of the highest-priced fruits, fresh-cut fruit, has a positive own-price elasticity in the lower-income store and one of the highest-priced vegetables, Chinese vegetables, is not statistically significant in this same store. The positive sign for fresh-cut fruit is likely to reflect its small share of total produce purchase for lower-income shoppers. But, as shown in Graph 5, lower-income shoppers paid a lower price per unit for the small share that they purchase. In essence, the positive elasticity estimate is over-ruled by the purchasing behavior revealed in Graph 5.

Clearly the results presented in this paper show that lower-income consumers are more careful shoppers and more price sensitive. A relevant question, of course, is what does this mean for overweight and obesity. Drewnowski and Darmon (2005) stated that no study to date has been able to link high consumption of fresh fruits and vegetables with obesity. Yet, studies show that obesity is likely to be highest among lower-income groups. To the extent that income constrains the purchase of fresh fruits and vegetables by lower-income consumers and lead to increased health care costs for society in the form of higher outlays for the treatment of obesity, it is conceivable that subsidized consumption of fresh fruits and vegetables could have positive benefits for society. Moreover, this analysis is limited to what consumers spend at supermarkets. If consumption of fresh fruits and vegetables by lower-income shoppers is further constrained by higher prices and limited availability at neighborhood and convenience stores, the benefits of subsidized consumption of fresh fruits and vegetables could be even larger than what is implied by these analyses. This latter observation is especially relevant if a lack of available produce lead to the consumption of energy-dense foods that contribute to rapid weight gain and obesity. Analyses of the remaining four stores will shed some additional insights on the behavior of lower-income consumers, but these analyses alone suggest that income definitely constrains

fresh fruit and vegetable purchases by lower-income consumers. As a minimum, it seems reasonable to suggest a subsidy at least in proportion to the current cost of treating obesity among lower-income consumers. Of course, education would have to be a crucial component of such a subsidy, as consumers must be educated on the importance of a diet rich in fresh fruits and vegetables.

References

Drewnowski, Adam and N. Darmon. “The Economics of Obesity: dietary Energy Density and Energy Cost.” *American Journal of Clinical Nutrition*, Vol. 82, pp. 265S-273S, 2005.

Drewnowski, Adam and S.E. Specter. “Poverty and Obestiy: The Role of Energy Density and Energy Costs.” *American Journal of Clinical Nutrition*, Vol. 79, pp. 6-16., 2004.

Guthrie, Joanne F., Claire Zizza and Nancy Raper. Fruit and Vegetables: Their Importance in the American Diet” Food Consumption, Vol. 15, 1. USDA, ERS, Jan.- June, 1992, pp. 35-39.

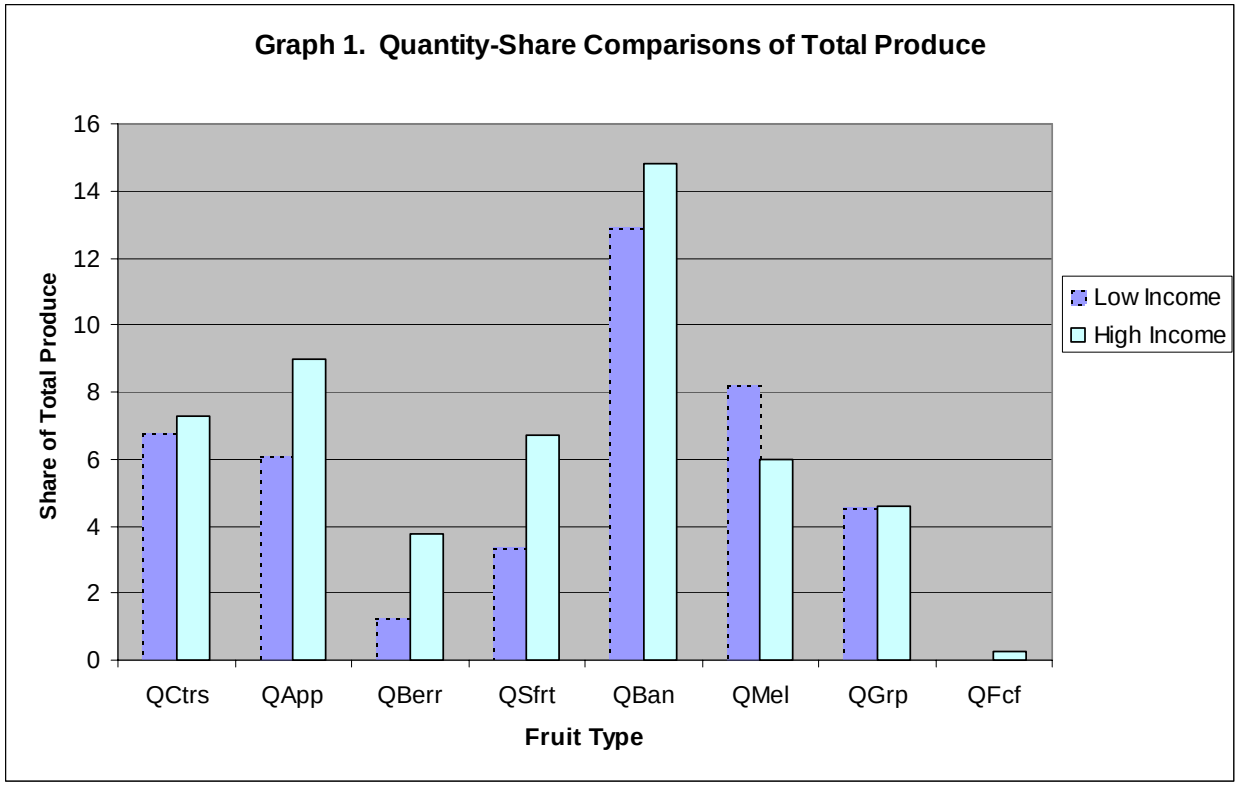
Jones, E., and B. W. Mustiful. "Purchasing Behavior of Higher- and Lower-Income Shoppers: A Look at Breakfast Cereals." *Applied Economics*, 28(1996): 131-137.

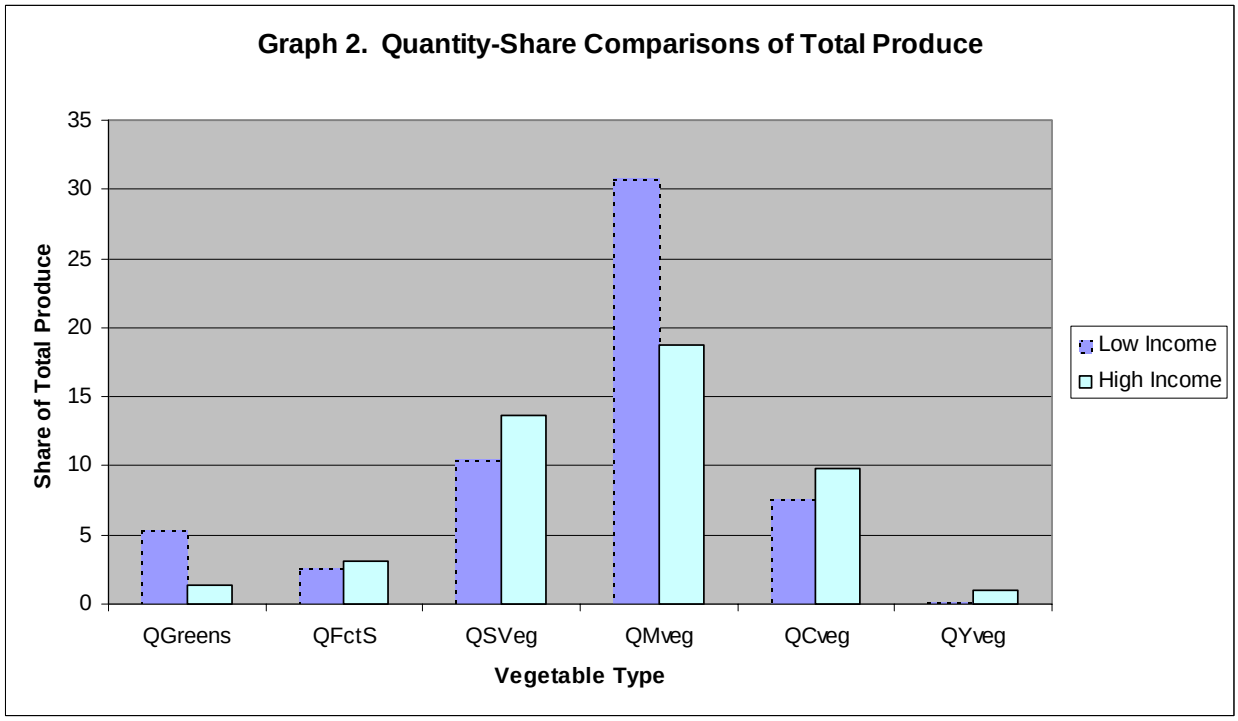
Liebtag, ES and PR Kaufman. “Exploring Food Purchase Behaviors of Low-income Housheolds.” *Current Issues in Economics of Food Markets*, AIB 747-07. Washington, DC: ERS/USDA, June 2003.

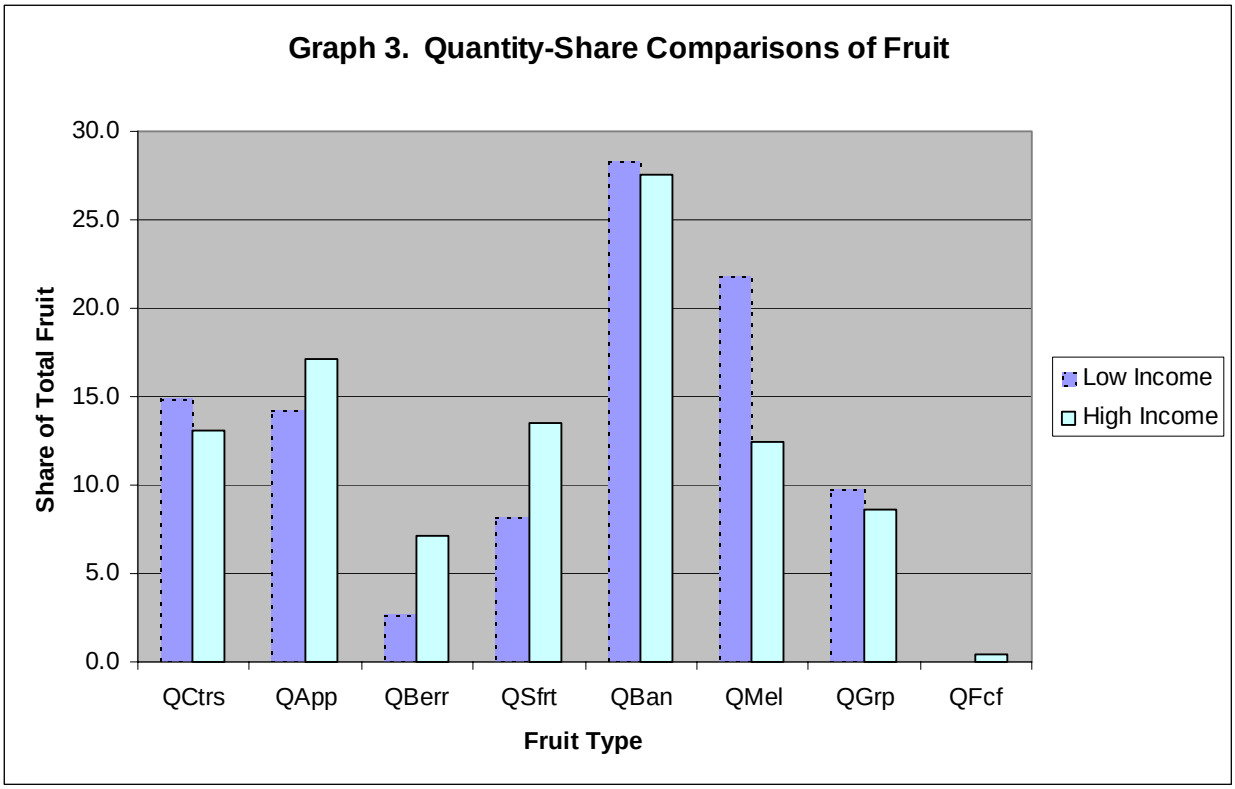
Min-Hsin Huang, Eugene Jones and David Hahn. “Determinants of Price Elasticities for Private Labels and National Brands of Cheese.” Forthcoming in *Applied Economics*, 2006.

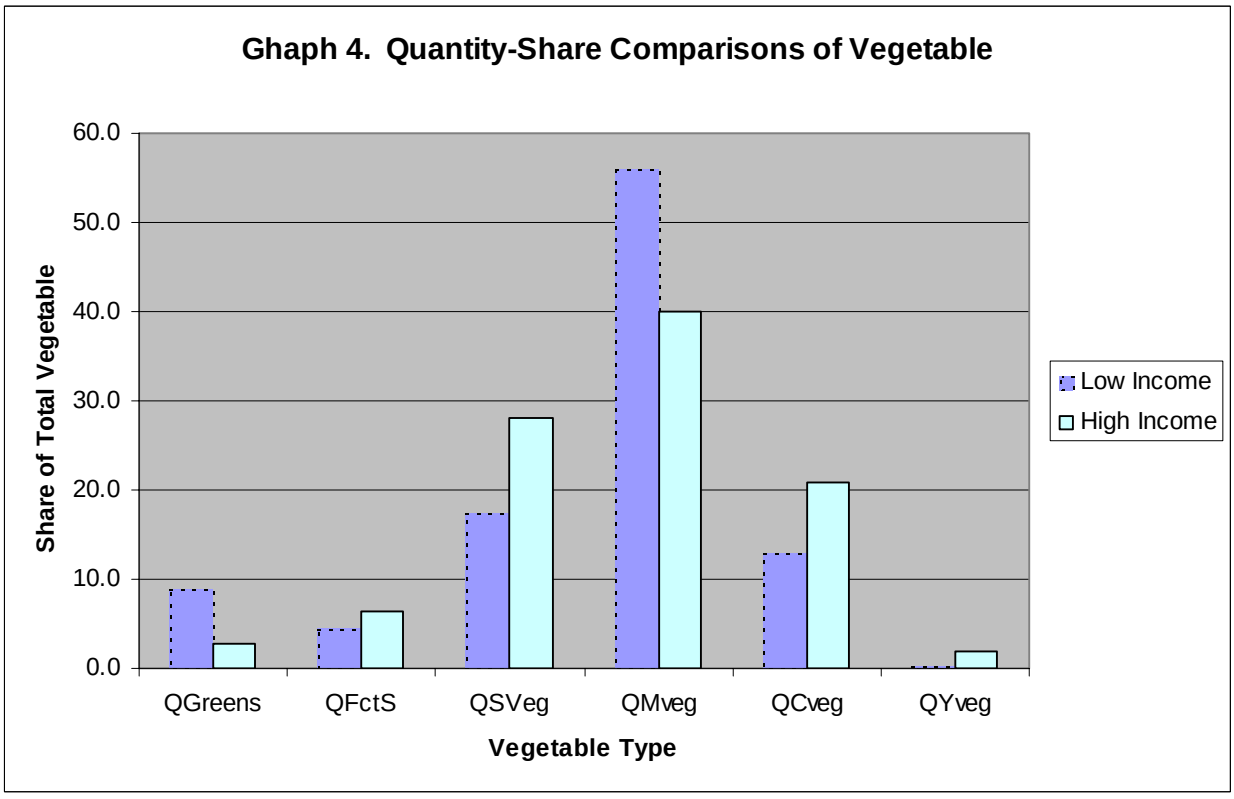
Rolls, BJ, VH Castellanos and JC Halford. “Volume of Foods Consumed Affects Satiety in Men.” *American Journal of Clinical Nutrition*, Vol. 67, pp. 1170-1177, 1998.

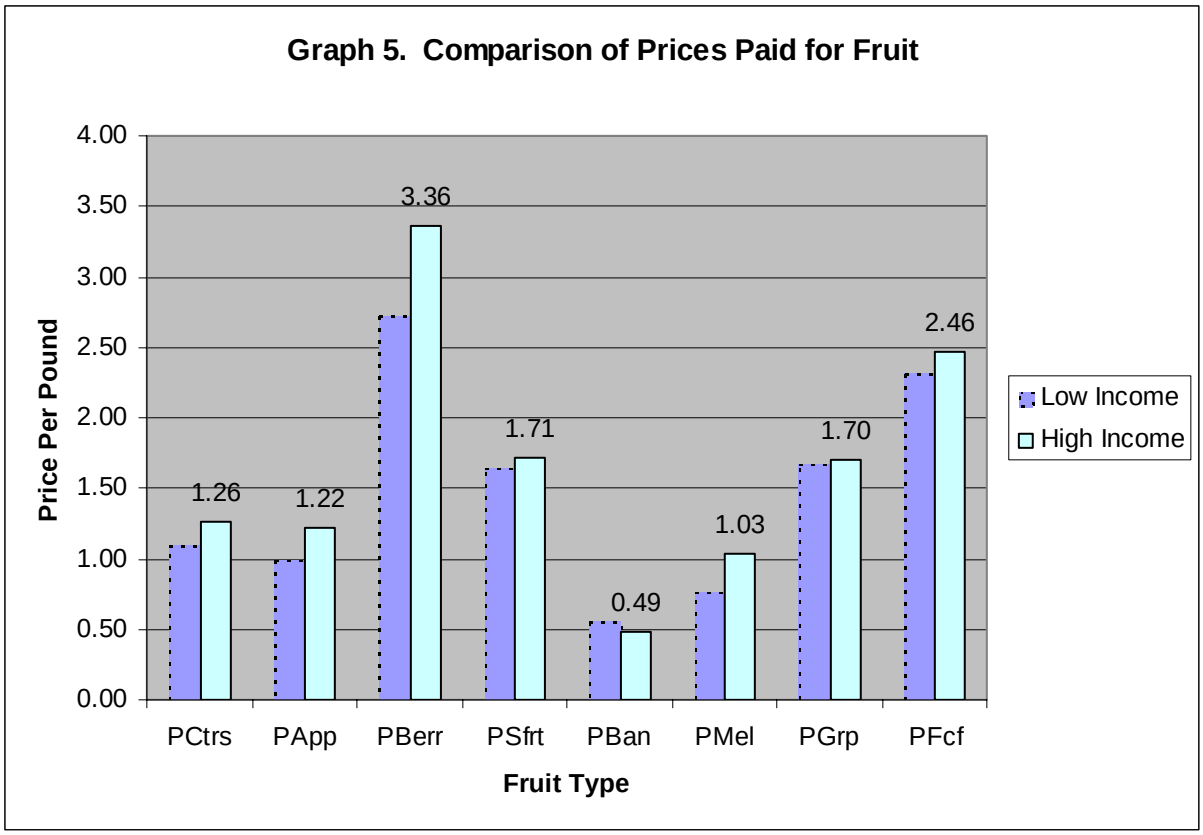
Wilde, Parke E., Paul E. McNamara and Christine K. Ranney. “The Effect of Dietary Quality of Participation in the Food Stamp and WIC Programs.” USDA, Food and Nutrition Research Report Number 9, September 2000.


Graph 1. Quantity-Share Comparisons of Total Produce
Share of Total Produce
16
14
12
10
8
6
4
2
0
QCtrs
QApp
QBerr
QSfrt
QBan
QMel
QGrp
QFcf
Fruit Type
Low Income
High Income


Graph 2. Quantity-Share Comparisons of Total Produce
Share of Total Produce
35
30
25
20
15
10
5
0
QGreens
QFctS
QSVeg
QMveg
QCveg
QYveg
Vegetable Type
Low Income
High Income


Graph 3. Quantity-Share Comparisons of Fruit
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Share of Total Fruit
QCtrs
QApp
QBerr
QSfrt
QBan
QMel
QGrp
QFcf
Fruit Type
Low Income
High Income


Ghaph 4. Quantity-Share Comparisons of Vegetable
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Share of Total Vegetable
QGreens
QFctS
QSVeg
QMveg
QCveg
QYveg
Vegetable Type
Low Income
High Income


Graph 5. Comparison of Prices Paid for Fruit
Price Per Pound
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1.26
1.22
3.36
1.71
0.49
1.03
1.70
2.46
PCtrs
PApp
PBerr
PSfrt
PBan
PMel
PGrp
PFcf
Fruit Type
Low Income
High Income

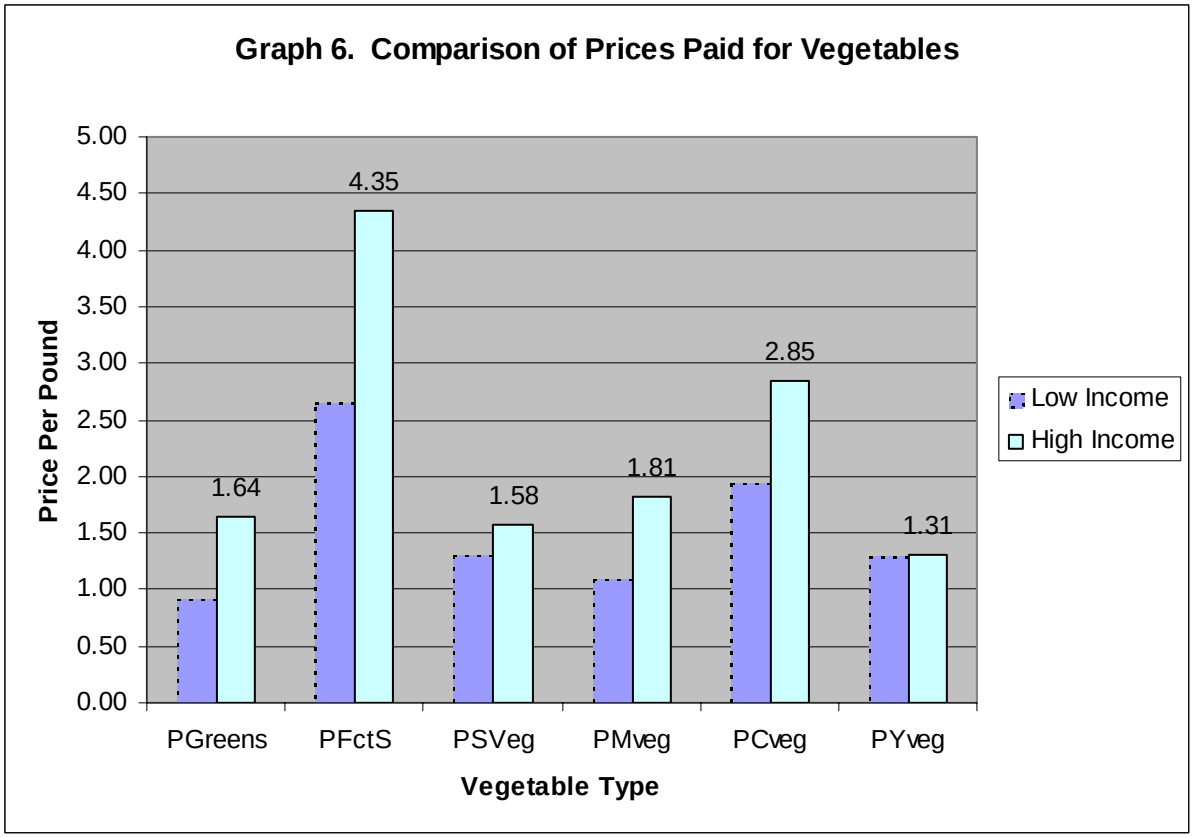

Graph 6. Comparison of Prices Paid for Vegetables
Price Per Pound
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1.64
4.35
1.58
1.81
2.85
1.31
PGreens
PFctS
PSVeg
PMveg
PCveg
PYveg
Vegetable Type
Low Income
High Income

Table 1. Comparison of Prices Paid and Z-tests of Mean Differences

	Prices Paid in Low-Income Store		Prices Paid in High-Income Store		Difference	Z-tests
	Per Ounce	Per Pound	Per Ounce	Per Pound	(Ounces)	(Ounces)
PCtrs	0.068	1.091	0.079	1.261	-0.011	-4.020
PApp	0.062	0.994	0.076	1.221	-0.014	-7.605
PBerr	0.170	2.718	0.210	3.364	-0.040	-3.747
PSfrt	0.103	1.641	0.107	1.713	-0.004	-1.334
PBan	0.034	0.547	0.031	0.489	0.004	4.225
PMel	0.048	0.767	0.065	1.033	-0.017	-4.821
PGrp	0.105	1.673	0.106	1.696	-0.001	-0.221
PFcf	0.145	2.318	0.154	2.463	-0.009	-5.449
PGreens	0.058	0.923	0.102	1.637	-0.045	-15.255
PFctS	0.165	2.641	0.272	4.352	-0.107	-34.027
PSVeg	0.082	1.307	0.099	1.577	-0.017	-13.645
PMveg	0.069	1.097	0.113	1.812	-0.045	-16.522
PCveg	0.121	1.942	0.178	2.852	-0.057	-15.622
PYveg	0.081	1.289	0.082	1.314	-0.002	-0.439

Table 2. Own-Price Elasticities for Low- and High-Income Stores

	Own-Price Elasticity		
	Low-Income	High-Income	
PCtrs	-2.83	-2.54	PCtrs = price of citrus fruit
PApp	-2.33	-1.35	Papp = price of apples
PBerr	-2.02	-1.98	Pberr = price of berries
PSfrt	-2.44	-1.91	PSfrt = price of soft fruit
PBan	-1.23	-0.59	Pban = price of bananas
PMel	-2.80	-1.98	Pmel = price of melons
PGrp	-1.87	-1.69	PGrp = price of grapes
PFcf	2.32	-0.43 (NSS)	PFcf = price of fresh-cut fruit
PGreens	-0.44	-0.14 (NSS)	Pgreens = price of collars and other greens
PFctS	-1.83	-0.73	PFctS = price of fresh-cut or bagged salads
PSVeg	-0.88	-0.91	PSVeg = price of salad vegetables
PMveg	-1.99	-1.93	Pmveg = price of major vegetables
PCveg	-.20 (NSS)	-0.58	Pcveg = Price of Chinese vegetables
PYveg	-1.82	-0.91	Pyveg = price of yellow vegetables