# An Economic Analysis of Fresh Fruit and Vegetable Consumption: Implications for Overweight and Obesity among Higher- and Lower-Income Consumers

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This paper examines the consumption patterns of higher- and lower-income consumers for fresh fruit and vegetables. Supermarket scanner data are obtained for every fresh fruit and vegetable sold in six supermarkets over 69 weeks during 2001 and 2002. These data are collected from three inner-city stores (lower income) and three suburban stores (higher income) in Columbus, Ohio. These data are segmented into eight sub-categories of fruit and six sub-categories of vegetables. An error correction model consisting of 14 equations is specified and estimated using the time series cross-section regression procedure in SAS. Results show lower-income consumers to be more price-sensitive and more careful shoppers, as compared to higher-income shoppers. Lower-income shoppers are shown to make larger purchases from the lower-priced sub-categories of fruit and vegetables and they invariably pay lower prices. These purchase patterns suggest that income constrains the purchase behavior of lower-income consumers and, if higher consumption of fresh fruits and vegetables is critical to alleviating overweight and obesity among lower-income Americans, the analyses suggest a need for some type of market intervention to make fresh fruits and vegetables more affordable (e.g., price subsidies).

A large body of literature has emerged on the causes and consequences of overweight and obesity in the United States (Balusu 2006; Malik, Schulze, and Hu 2006; Ledikwe et al. 2006; Sisson 2002; Office of the Surgeon General 2001; Nestle and Jacobson 2000). Poor diets, as represented by excessive consumption of soft drinks and inadequate consumption of fresh fruits and vegetables, are among the leading causes. Insufficient physical activity, as represented by extreme involvement of children in video games and unacceptable hours of television viewing, also fall into the category of leading causes. Some consequences include premature deaths and an acceleration of deaths from heart disease, strokes, and cancer; a rapid rise in the number of obese children and a shortened lifespan for them; and an alarming increase in health care costs. While these causes and consequences apply to all Americans, studies show that the highest rates of obesity occur among population groups with the highest poverty rates and the least education (Drewnowski and Specter 2004). Drewnowski and Darmon (2005) surveyed the literature, and their results show an absence of obesity for consumers with diets rich in fresh fruits and vegetables.[1] Thus one a motivating factor for this research is to ascertain whether higher- and lower-income consumers exhibit major differences in their purchase and consumption of fresh fruits and vegetables.

If purchases and consumption of fresh fruits and vegetables are similar for lower- and higher-income consumers, then disparities in overweight and obesity for the two groups are likely to be related to factors other than fruit and vegetable consumption. Since overweight and obesity have been shown to be inversely related to high levels of fruit and vegetable consumption, disparities in consumption for the two groups could help explain disparities in body weights (Ledikwe et al. 2006). Such explanations would be relevant even though it is known that few Americans follow the recommended five to nine daily servings of fresh fruits and vegetables. Indeed, a fairly recent study shows that adults consume an average of just 3.9 daily servings of fruits and vegetables (Jetter, Chalfont, and Summer 2004). Increased consumption to five to nine daily servings could lower overweight and

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[1] A focus on fresh fruits and vegetables is not meant to de-emphasize the importance of canned, frozen and other forms of produce as healthy foods. Fresh produce is emphasized because its high water content offers consumers the greatest potential for reducing their overall food consumption. That is, consumers are more likely to feel full on fewer calories (Rolls 2000).

obesity problems for all Americans, particularly since fresh fruits and vegetables are low-energy-density foods with the potential for decreasing total intake of calories (Ledikwe et al. 2006). Although current reports show obesity to be a problem for all Americans, this study has a more limited focus of examining disparities in fruit and vegetable consumption for two income groups.

## Data

Supermarket scanner data are used in all the analyses for this study. Census-tract data are presented simply to describe geographic areas from which stores are selected. These census-tract data do not enter into any analyses, as they are cross-sectional data, collected at a single point in time. They are presented in this study to corroborate the supermarket chain's identification of its stores as higher- and lower-income. This nomenclature does not imply income homogeneity among households, but it describes an important characteristic of the most dominant group of households for a given location. Over time the supermarket chain has come to recognize significant differences in market basket purchases by store locations. Some products, such as fine wines and premium ice creams, are not stocked in lower-income stores because their prices are beyond the reach of most shoppers. All stores are part of a common pricing zone, meaning identical product prices across all stores. Table 1 provides some summary statistics for the six stores selected for this study. Two of these statistics deserve special emphasis because of their significance for segmenting consumers: a fairly large percentage of higher-income consumers (34.1 percent) have in-

**Table 1. Household Demographic Data for Six Stores (Percentage).**

| | Higher-income consumers | | | | Lower-income consumers | | | |
|---|---|---|---|---|---|---|---|---|
| Demographic information | Store 1 | Store 2 | Store 3 | Average | Store 4 | Store 5 | Store 6 | Average |
| Household income | | | | | | | | |
| Under $10,000 | 3.8 | 5.0 | 3.8 | 4.2 | 13.8 | 12.9 | 9.3 | 12.0 |
| $10,000−$49,999 | 32.8 | 41.8 | 37.7 | 37.4 | 57.6 | 58.3 | 54.1 | 56.7 |
| $50,000−$74,999 | 27.4 | 20.9 | 24.6 | 24.3 | 18.5 | 18.2 | 22.4 | 19.7 |
| $75,000−$99,999 | 17.5 | 12.1 | 15.3 | 15.0 | 6.5 | 6.3 | 8.4 | 7.1 |
| $100,000 + | 18.8 | 20.2 | 18.2 | 19.1 | 3.8 | 4.3 | 5.9 | 4.7 |
| Race | | | | | | | | |
| White | 95.4 | 92.4 | 93.1 | 93.6 | 59.2 | 83.6 | 85.7 | 76.2 |
| Black | 2.3 | 3.2 | 5.0 | 3.5 | 38.6 | 14.4 | 12.1 | 21.7 |
| Others | 2.6 | 4.6 | 1.9 | 3.0 | 2.1 | 2.0 | 1.8 | 2.0 |
| Education | | | | | | | | |
| Grade school | 4.1 | 2.0 | 2.5 | 2.9 | 7.3 | 10.0 | 11.1 | 9.5 |
| Some high school | 11.6 | 5.0 | 8.6 | 8.4 | 21.3 | 25.4 | 25.8 | 24.2 |
| High school gradate | 28.2 | 16.2 | 27.0 | 23.8 | 33.5 | 36.7 | 37.6 | 35.9 |
| Some college | 26.2 | 26.6 | 28.2 | 27.0 | 24.3 | 19.2 | 17.8 | 20.4 |
| College graduate | 29.9 | 50.6 | 33.5 | 38.0 | 13.8 | 8.8 | 7.5 | 10.0 |

Source: 2000 Census Data and a national supermarket chain.

comes above \$75,000, and a fairly large percentage of higher-income consumers are college graduates (38 percent). Differences in these two factors—income and education—among households provide the justification for segmenting the stores and shoppers by income.

Studies suggest that people shop within close proximity to their residences, and therefore store location provides the mapping for identifying shoppers as higher- and lower-income shoppers. This study is focused on the purchases and consumption of fresh fruits and vegetables, so scanner data were collected from six supermarkets in the Columbus, Ohio area (Table 1). These data are time-series, covering 69 weeks from January 2001 to April 2002. Purchases for individual shoppers would have been preferred, but only store-level aggregate data were available. Aggregate purchases for any given week within a store located in a lower-income area are expected to reflect the dominant purchases of lower-income shoppers; likewise, aggregate purchases for any given week within a store located in a higher-income area are expected to reflect the dominant purchases of higher-income shoppers. A key objective of this comparative analysis is to determine differences in price sensitivities for the two groups of shoppers. More specifically, own-price elasticities of demand are estimated and the relative magnitudes of these elasticities are compared to evaluate cost constraints on purchasing behavior. Even though the USDA has estimated the cost of purchasing five servings of fresh fruits and vegetables and found this cost to be as low as \$.39 per day, the estimated own-price elasticities from this study go beyond the implications of the USDA's simple calculations. They shed insights on the effects of prices on consumer purchases and the consequences of these purchases on health outcomes (Reed, Frazao, and Itskowitz 2004).

Analyses conducted in this study employ the standard classification used by the USDA and the produce industry. Fruit is segmented into eight sub-categories: apples, bananas, berries, citrus, fresh-cut fruit, grapes, melons, and soft fruit. Vegetables are segmented into six sub-categories: Chinese vegetables (vegetables frequently purchased by Chinese restaurants), collards, and other greens, fresh-cut salads (bagged), major vegetables (corn, potatoes, and tomatoes), salad vegetables (cucumbers, lettuce, etc.) and yellow vegetables (Table 2).[2] Note that quantity shares of both fresh-cut fruit and yellow vegetables are quite low, less than one percent of total produce sales (Ficures 1 and 2). When fresh-cut fruit is analyzed as a share of all fruit, its percentage remains below one percent. One reason this percentage is so low is that a large amount of fresh-cut fruit is pre-ordered through deli departments and these sales are seldom scanned as fresh-cut produce. Yellow vegetables, as a share of all vegetables, total 1.4 percent (Figures 3 and 4). Berries and fresh-cut fruit are the most expensive fruit; fresh-cut salads and Chinese vegetables are the most expensive vegetables (Figures 5 and 6).

## Theoretical Framework and Testable Hypotheses

Economic theory posits that consumers attempt to maximize their utility subject to a budget constraint and product prices. Within a two-good, x-y world in which indifference curves represent the willingness of consumers to substitute good x for good y, utility is maximized when a consumer's budget line, as dictated by income and product prices, is tangent to the highest attainable indifference curve. Tastes and preferences play a major role in determining the shape of utility functions, but product prices and income constrain product purchases. For a specified market basket of goods, lower-income consumers are expected to show higher price sensitivity because purchasing the market basket requires a larger share of their income (Nagle and Hogan 2006). This relationship leads to testable Hypothesis One ($H_1$): Lower-income shoppers are expected to have own-price elasticities that are larger (absolute value) than those of higher-income shoppers.

For goods that are highly desirable in consumption but whose consumption is severely limited by budget constraints, consumers are expected to increase their consumption of these goods as their incomes rise. With respect to fresh fruit and vegetables, researchers argue that their relatively higher prices compared to cheaper energy-dense foods serve to dissuade lower-income consumers from purchasing them (Darmon and Drewnowski

[2] Listed commodities are provided as examples for each sub-category, not as complete listings. As an example, the complete list of commodities in the greens sub-category includes Brussels sprouts, collards, celery cabbage, green cabbage, kale, mixed greens, mustard greens, red cabbage, and turnips.

**Table 2. Sub-Categories of Fruit and Vegetables: Three Illustrative Commodities within Each Sub-Category.**

| Fruit | Vegetables |
|---|---|
| Citrus | Greens |
| Oranges | Collards |
| Grapefruits | Kale |
| Tangelos | Swiss chard |
| | |
| Apples | Fresh-cut salad |
| Brabeburn 88s | Romaine |
| Fuji 100s | Spinach |
| Jonagold 64s | Veggie blend |
| | |
| Berries | Salad vegetables |
| Blackberries | Broccoli |
| Strawberries | Celery |
| Blueberries | Radishes |
| | |
| Soft Fruit | Major vegetables |
| Nectarines | Potatoes |
| Peaches | Sweet corn |
| Plums | Tomatoes |
| | |
| Bananas | Chinese vegetables |
| Yellow | Bok choy |
| Nino | Snow peas |
| Plantain | Watercress |
| | |
| Melons | Yellow vegetables |
| Cantaloupe | Butternut squash |
| Santa Claus | Spaghetti squash |
| Watermelon | Yellow crookneck squash |
| | |
| Grapes | |
| Black seedless | |
| Green seeded | |
| Red seedless | |
| | |
| Fresh-cut fruit | |
| Citrus salad | |
| Pineapple cubes | |
| Tropical salad | |

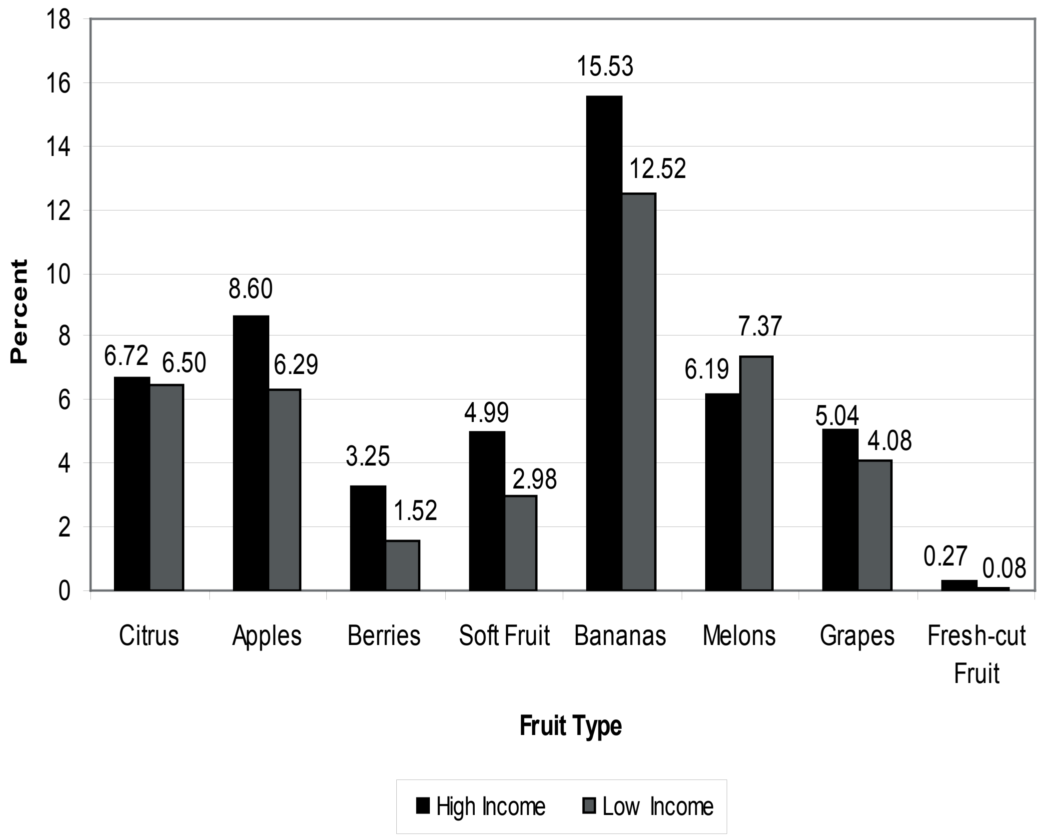


**Figure 1. Quantity-Share Comparison of Total Produce.**

2008). As lower-income consumers realize higher incomes, they are expected to show higher expenditure elasticities for higher-quality foods, especially fresh fruit and vegetables. This relationship leads to testable Hypothesis Two ($H_2$): Lower-income shoppers are expected to have positive expenditure elasticisties that are larger in value than those of higher-income shoppers.

To reduce the share of income spent on a market basket of goods, one option available to consumers is greater information search for lower product prices. Search theory suggests that lower-income consumers are more likely to engage in information search because their opportunity cost of time is much lower. With respect to the 14 sub-categories of fruits and vegetables, this theory suggests that lower-income consumers are likely to acquire the most information about price variations across varieties. To the extent that information acquisition includes both price and quality information, it means that lower-income consumers are likely to obtain the most knowledge of product prices and quality variations. Extending this relationship to its logical outcome, it suggests testable Hypothesis Three ($H_3$): Lower-income shoppers are expected to pay lower per unit prices than higher-income shoppers.

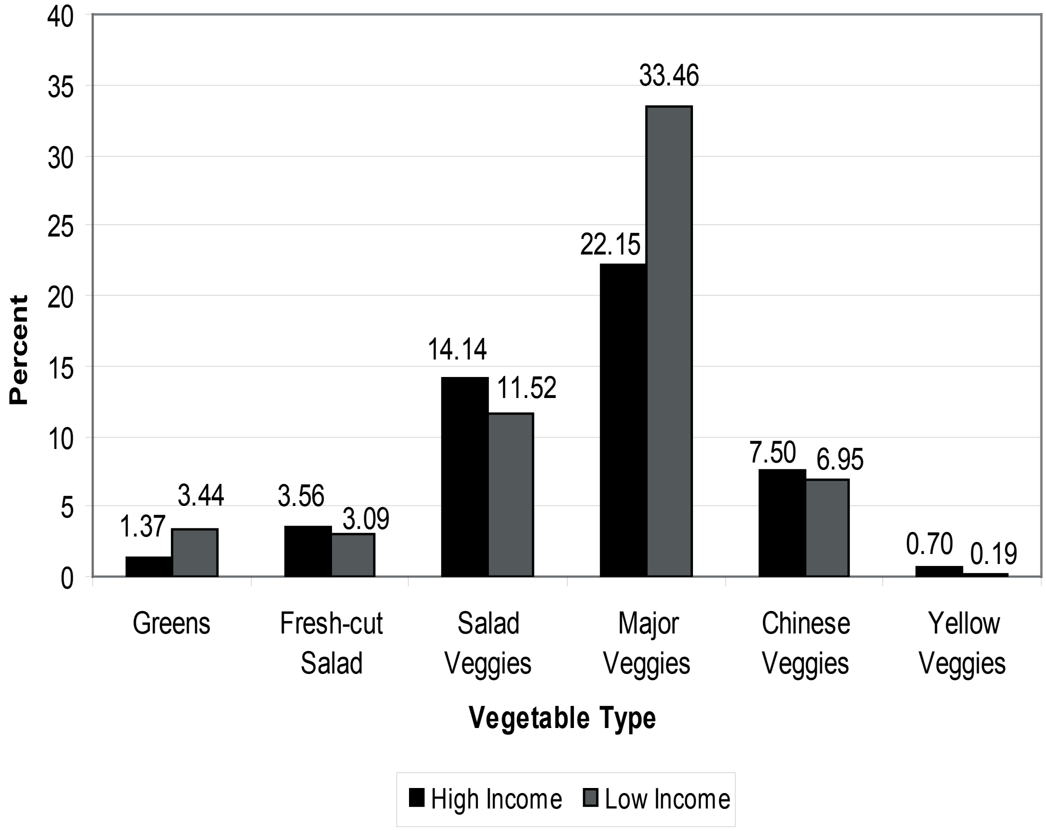


**Figure 2. Quantity-Share Comparison of Total Produce.**

**Descriptive Statistics**

Price and quantity data for the 14 sub-categories of fruit and vegetables for each store are provided in cents per ounce, total ounces, and total dollar sales (Table 3). This discussion is intended to share some insights on these data as well as other data omitted from this table. Relative to produce sales, Store 1 is the largest, averaging $42,300 worth of produce sales per week. Store 3 averaged $37,800 per week, Stores 2 and 4 averaged just over $28,000, and Stores 5 and 6 averaged $21,400. With respect to dollar sales on produce, lower-income Store 4 is comparable in size to higher-income Store 2 but the other two lower-income stores are much smaller than a typical higher-income store. These differences in dollar sales reflect overall store size. Quantity differences, as shown in Table 3, show similar size effects, but Store 2 is now more comparable to Store 5 than it is to Store 4. That is, both Store 2 and Store 5 had average weekly sales of 480,000 ounces (30,000 pounds) of produce, but Store 2 generated $6,000 more in dollar sales. These differences show that higher- and lower-income shoppers purchase different bundles of produce. That is, if purchased bundles are similar, then comparable dollar sales

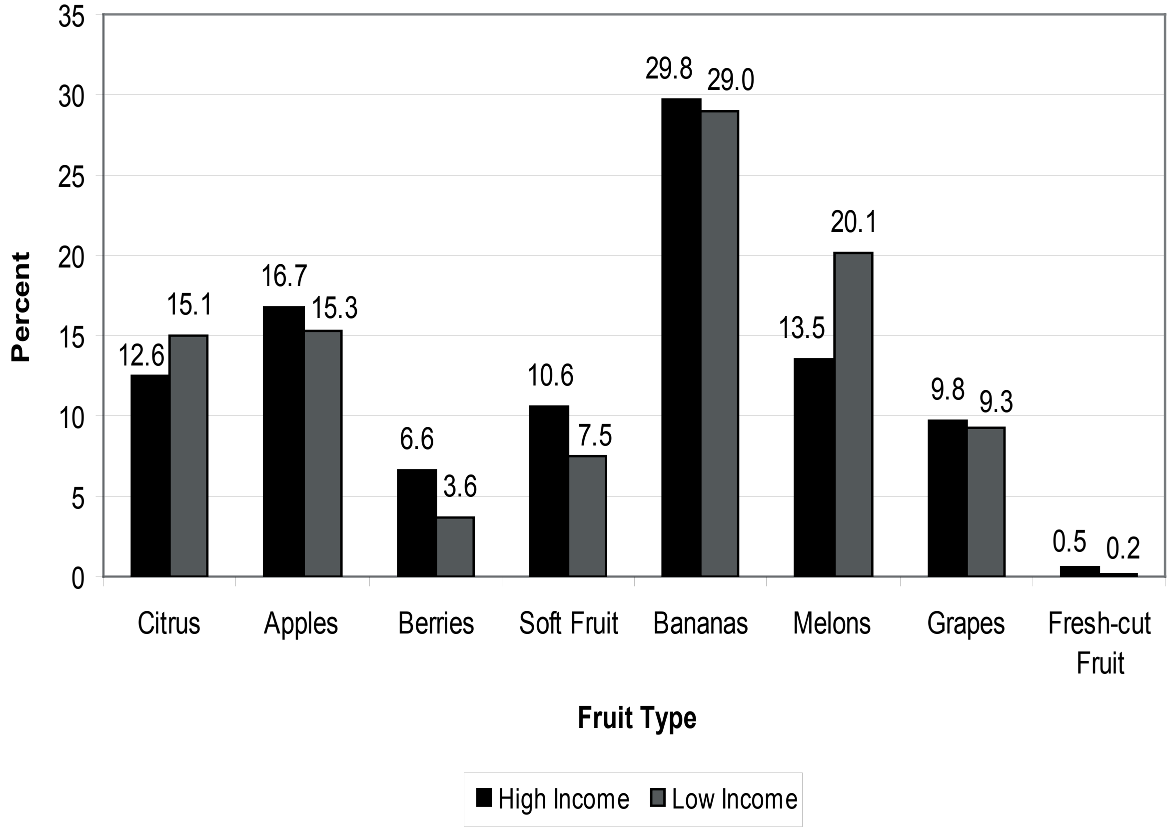


**Figure 3. Quantity-Share Comparison of Fruit.**

should lead to comparable quantity sales. This expectation stems from the fact that all stores belong to a common pricing zone and therefore prices are identical across all stores.

Data utilized for this study but not included in any of the tables are total store sales and customer counts. These data show customers of higher-income stores spending an average of $1.76 on fresh fruits and vegetables per shopping trip, compared to $1.16 for customers of lower-income stores. This difference is partly explained by different product combinations and larger store expenditures per visit for higher-income shoppers ($29.21 vs. $25.34). Yet the difference in expenditure per shopper suggests that lower-income consumers make fewer purchases of fresh fruits and vegetables.

Even though prices are identical across all stores, Table 4 shows that lower-income shoppers pay lower prices for all fruit and vegetables except bananas and yellow vegetables. For these two sub-categories, lower-income shoppers pay either slightly higher or statistically identical prices. These price data suggest that lower-income shoppers make a special effort to purchase the lowest-priced commodities within a given sub-category. For example, a lower price can be realized for potatoes by pur-

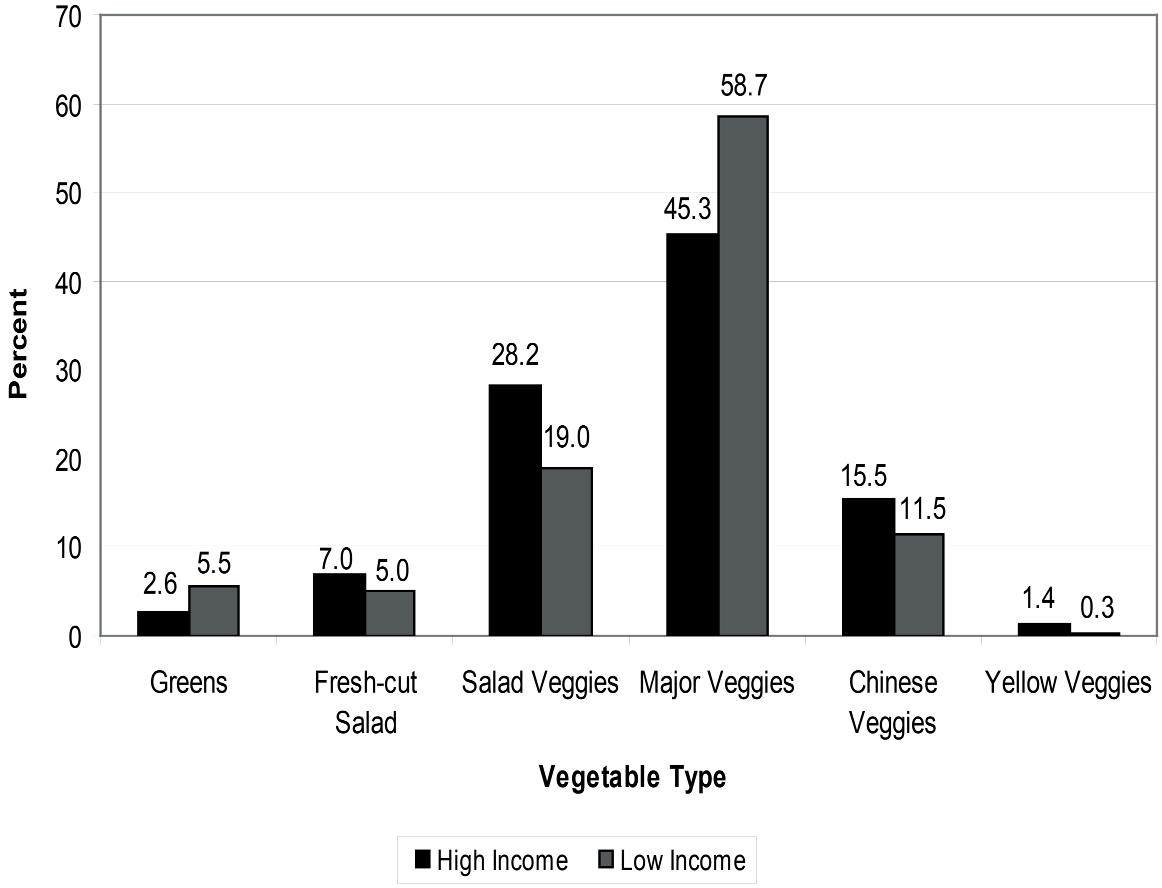


**Figure 4. Quantity-Share Comparison of Vegetables.**

chasing pre-sorted bags of potatoes instead of self-selecting potatoes from bulk bins. Similar tradeoffs can be made for commodities like apples and citrus. A statistical analysis of apples by variety is provided in Table 5; these results show the process by which lower-income shoppers can realize lower prices per pound without sacrificing product quality.[3]

[3] Quality refers to the uniform buying standards of the retailer. Bagged apples are smaller, but the retailer specifies the same quality standards for bulk and bagged apples. Shoppers, admittedly, may face a higher probability of experiencing a bad apple when making bagged purchases versus bulk purchases, yet one has to assume that experienced shoppers are able to assess the utility tradeoffs between bagged and bulk apples.

The six stores in this study offer 17 varieties of apples. The top five varieties for the higher-income stores are Red Delicious (26.6 percent), Gala (21.0 percent), Golden Delicious (15.3 percent), Granny Smith (12.4 percent), and Fuji (6.0 percent). The top five varieties for the lower-income stores are Red Delicious (38.9 percent), Golden Delicious (17.7 percent), Gala (11.7 percent), Granny Smith (9.4 percent), and Rome (8.0 percent). For the combined 17 varieties, the statistical analyses in Table 4 show higher-income consumers paying an average of $1.18 per pound and lower-income consumers paying $1.01 per pound. The relevant question ad-

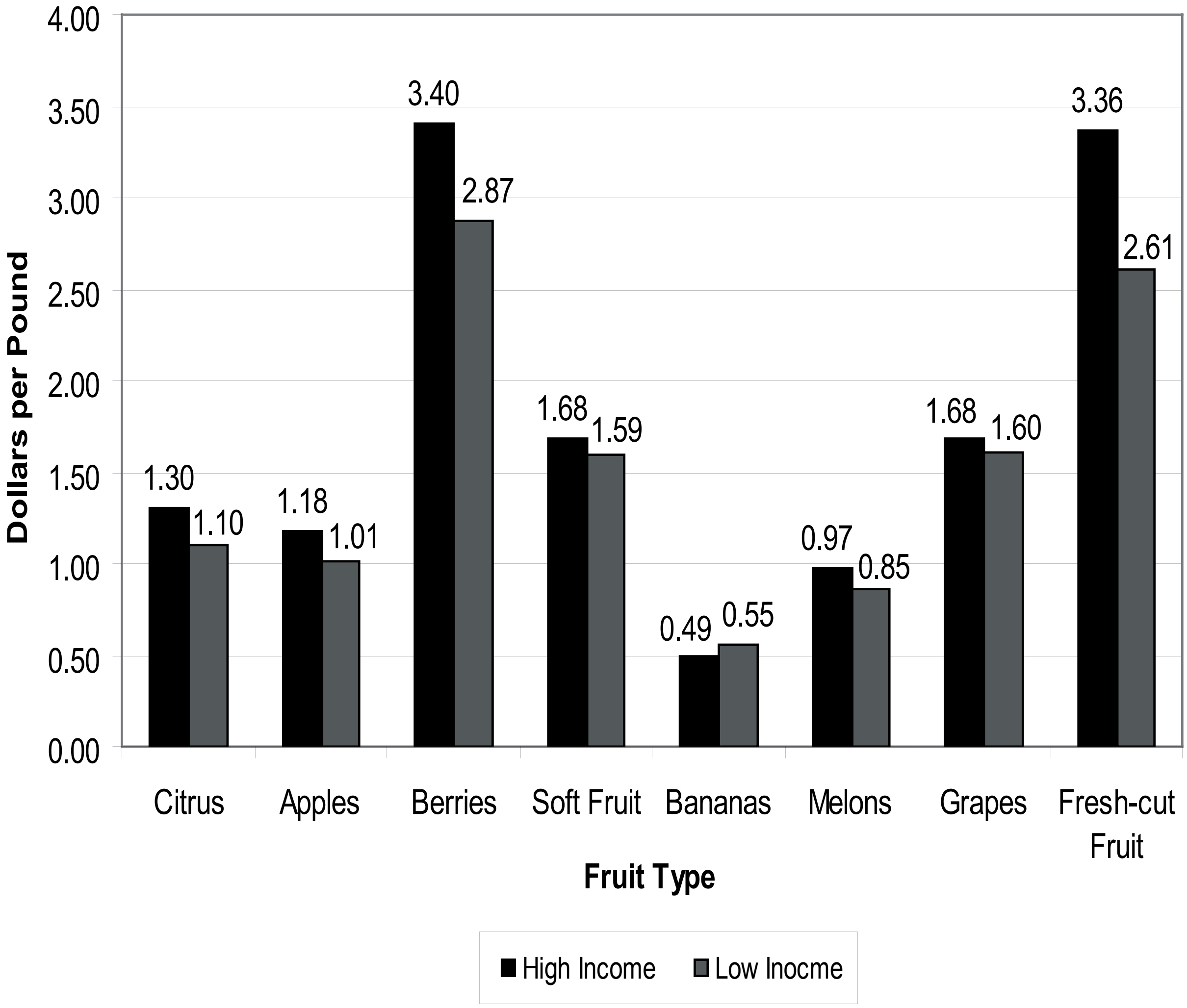


**Figure 5. Comparison of Prices Paid for Fruit.**

dressed here is whether this $1.01 is realized from purchasing lower-quality apples. Answering this question required the disaggregation of apples by variety (Table 5). Consumers have many purchase options for apples, as they are sold in bags ranging from three to eight pounds and in bulk displays with size ranging from small to jumbo. While bagged apples are generally smaller in size than those sold from bulk bins, the retailer providing these data used the same quality standards for purchasing bagged and bulk apples. These standards led lower-income shoppers to make 65 percent of their apple purchases (quantity) as bagged and the other 35 percent as bulk; by contrast, higher-income shoppers made 41 percent of their apple purchases (quantity) as bagged and the other 59 percent as bulk. Prices across all stores averaged $.66 per pound for bagged apples and $1.10 per pound for bulk apples.

The third hypothesis, $H_3$, states that lower-income shoppers are expected to pay lower per unit prices than are higher-income shoppers; this hypothesis is supported by the selection of apples

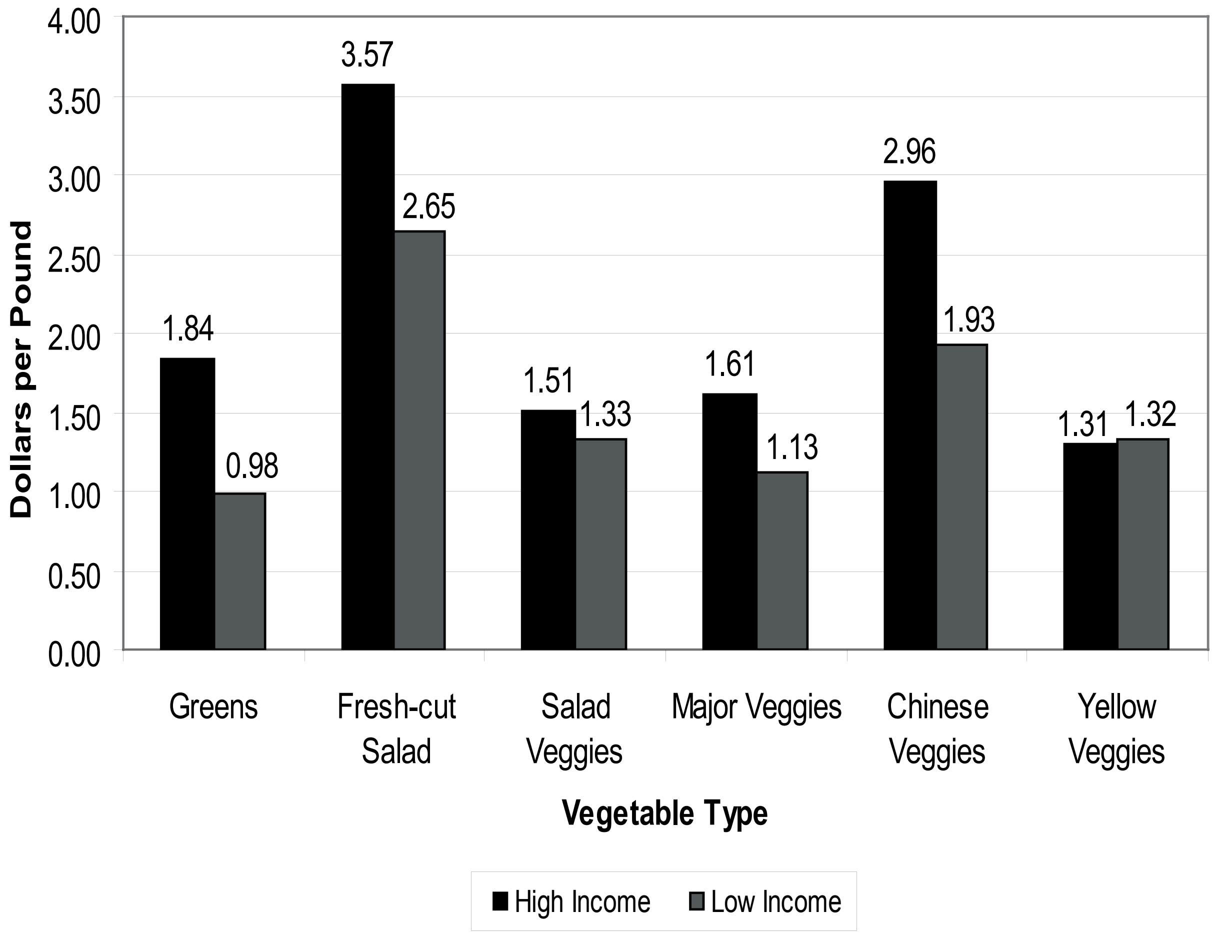


**Figure 6. Comparison of Prices Paid for Vegetables.**

consumers make from 17 varieties to maximize their volume of purchases within a budget constraint. Higher-income shoppers paid a higher price for 11 of the 17 varieties; lower-income shoppers not only paid lower prices but they purchased larger percentages of the lowest-priced varieties (Table 5). For example, lower-income shoppers paid an average of \$0.69 per pound for Red Delicious apples; higher-income shoppers paid an average of \$0.91 per pound for this same variety, a difference of \$0.22. Relative to purchase quantity, Red Delicious apples represented 38.9 percent of total apple purchases for lower-income shoppers versus just 26.6 percent for higher-income shoppers, a difference of 12.4 percent. An even greater price disparity is observed for Fuji apples, with higher-income shoppers paying \$1.37 per pound, versus \$1.08 per pound paid by lower-income shoppers, a difference of \$0.29 per pound. This variety represented just two percent of purchases for lower-income shoppers but six percent for higher-income shoppers. Similar price and purchase differences exist for other varieties. Differ-

**Table 3. Price and Quantity Comparisons across Stores (Ounces).**

| | Store type | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | High-income stores | | | | Low-income stores | | | | Differences | |
| Price | Mean Store 1 | Mean Store 2 | Mean Store 3 | Mean Avg | Mean Store 4 | Mean Store 5 | Mean Store 6 | Mean Avg | Avg Diff | Z-tests |
| Citrus | 0.080 | 0.080 | 0.084 | 0.081 | 0.070 | 0.068 | 0.067 | 0.069 | 0.013 | 7.698 |
| Apples | 0.076 | 0.074 | 0.071 | 0.074 | 0.065 | 0.062 | 0.063 | 0.063 | 0.0101 | 0.309 |
| Berries | 0.210 | 0.211 | 0.216 | 0.212 | 0.181 | 0.170 | 0.187 | 0.179 | 0.033 | 5.348 |
| Soft fruit | 0.109 | 0.103 | 0.103 | 0.105 | 0.099 | 0.092 | 0.106 | 0.099 | 0.006 | 3.076 |
| Bananas | 0.031 | 0.029 | 0.032 | 0.030 | 0.035 | 0.034 | 0.035 | 0.034 | -0.004 | -8.466 |
| Melons | 0.065 | 0.060 | 0.058 | 0.061 | 0.055 | 0.048 | 0.057 | 0.053 | 0.007 | 3.547 |
| Grapes | 0.106 | 0.102 | 0.107 | 0.105 | 0.098 | 0.105 | 0.098 | 0.100 | 0.005 | 1.306 |
| Fresh-cut fruit | 0.203 | 0.206 | 0.221 | 0.210 | 0.192 | 0.145 | 0.153 | 0.163 | 0.0471 | 4.416 |
| Greens | 0.102 | 0.095 | 0.147 | 0.115 | 0.061 | 0.058 | 0.065 | 0.061 | 0.0532 | 3.798 |
| Fresh-cut salads | 0.253 | 0.196 | 0.221 | 0.223 | 0.170 | 0.165 | 0.161 | 0.165 | 0.0582 | 4.339 |
| Salad veggies | 0.099 | 0.094 | 0.090 | 0.094 | 0.083 | 0.082 | 0.084 | 0.083 | 0.0111 | 5.146 |
| Major veggies | 0.113 | 0.094 | 0.095 | 0.101 | 0.074 | 0.069 | 0.069 | 0.070 | 0.0301 | 9.412 |
| Chinese veggies | 0.178 | 0.186 | 0.191 | 0.185 | 0.116 | 0.121 | 0.124 | 0.120 | 0.065 | 32.796 |
| Yellow veggies | 0.082 | 0.080 | 0.082 | 0.082 | 0.085 | 0.081 | 0.082 | 0.083 | -0.001 | -0.520 |

**Table 3. Price and Quantity Comparisons across Stores (Ounces) (Continued).**

| | Store type | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | High-income stores | | | | Low-income stores | | | | Differences | |
| Quantity | Mean Store 1 | Mean Store 2 | Mean Store 3 | Mean Avg | Mean Store 4 | Mean Store 5 | Mean Store 6 | Mean Avg | Avg Diff | Z-tests |
| Citrus | 42275.9 | 31946.9 | 36086.8 | 36769.8 | 39225.3 | 30761.1 | 26164.4 | 32050.3 | 4719.6 | 1.819 |
| Apples | 58049.0 | 38826.2 | 50003.4 | 48959.5 | 43453.9 | 29520.6 | 24497.6 | 32490.7 | 16468.8 | 5.823 |
| Berries | 24284.6 | 13590.1 | 20098.3 | 19324.4 | 10477.3 | 5521.9 | 7114.8 | 7704.7 | 11619.7 | 7.906 |
| Soft fruit | 38846.0 | 23216.1 | 30914.3 | 30992.1 | 17607.0 | 17035.2 | 13283.5 | 15975.2 | 15016.9 | 6.245 |
| Bananas | 93125.6 | 78883.0 | 89489.4 | 87166.0 | 72522.9 | 58498.7 | 54061.8 | 61694.5 | 25471.5 | 13.013 |
| Melons | 42105.7 | 32970.8 | 43800.8 | 39625.8 | 49465.6 | 45060.7 | 33780.0 | 42768.8 | -3143.0 | -0.577 |
| Grapes | 29354.9 | 26121.4 | 30291.9 | 28589.4 | 22901.8 | 20288.7 | 16240.5 | 19810.3 | 8779.1 | 4.331 |
| Fresh-cut fruit | 2413.9 | 1062.6 | 1128.9 | 1535.2 | 782.8 | 102.1 | 415.6 | 433.5 | 1101.7 | 18.196 |
| Greens | 8569.3 | 6686.8 | 7391.1 | 7549.0 | 14385.3 | 24467.0 | 11345.7 | 16732.6 | -9183.6 | -13.755 |
| Fresh-cut salads | 18456.2 | 18483.3 | 22946.6 | 19962.1 | 18212.2 | 12031.0 | 15721.3 | 15321.5 | 4640.6 | 11.011 |
| Salad veggies | 85998.9 | 64633.4 | 90866.0 | 80499.4 | 73230.6 | 47687.4 | 52508.4 | 57808.8 | 22690.6 | 12.041 |
| Major veggies | 122162.0 | 112909.4 | 152485.8 | 129185.7 | 213055.3 | 152839.3 | 169005.0 | 178299.8 | -49114.1 | -6.560 |
| Chinese veggies | 63947.0 | 29040.5 | 39290.7 | 44092.7 | 37672.9 | 35618.4 | 31470.6 | 34920.6 | 9172.1 | 4.324 |
| Yellow veggies | 5993.9 | 2457.7 | 3511.1 | 3987.6 | 1232.0 | 601.7 | 920.2 | 918.0 | 3069.6 | 15.369 |
| F&V total ounces | 635582 | 480828 | 618305 | 578238 | 614224 | 480033 | 456529 | 516928 | 61309 | 884 |
| F&V dollar sales | 42304 | 28123 | 37785 | 36070 | 28511 | 21811 | 21324 | 23882 | 12188 | 2.549 |
| F&V sales/F&V ounces | 6.66 | 5.85 | 6.11 | 6.21 | 4.64 | 4.54 | 4.67 | 4.62 | 1.59 | 6.589 |

**Table 4. Prices Paid in Higher- and Lower-income Stores.**

| | High income | | Low income | | Differences | | |
|---|---|---|---|---|---|---|---|
| | AVG $ | AVG $ | AVG $ | AVG $ | AVG DIFF $ | AVG DIFF $ | Z-tests |
| Price | Ounces | Pounds | Ounces | Pounds | Ounces | Pounds | (Ounces) |
| Citrus | 0.0815 | 1.3033 | 0.0686 | 1.0973 | 0.0129 | 0.2060 | 7.6984 |
| Apples | 0.0739 | 1.1818 | 0.0634 | 1.0142 | 0.0105 | 0.1676 | 10.3087 |
| Berries | 0.2125 | 3.3999 | 0.1792 | 2.8674 | 0.0333 | 0.5325 | 5.3480 |
| Soft Fruit | 0.1051 | 1.6814 | 0.099 | 1.5861 | 0.0060 | 0.0953 | 3.0756 |
| Bananas | 0.0305 | 0.4876 | 0.0345 | 0.5517 | -0.0040 | -0.0641 | -8.4657 |
| Melons | 0.0609 | 0.9745 | 0.0534 | 0.8548 | 0.0075 | 0.1197 | 3.5472 |
| Grapes | 0.1050 | 1.6800 | 0.1002 | 1.6031 | 0.0048 | 0.0768 | 1.3060 |
| Fresh-cut fruit | 0.2102 | 3.3627 | 0.1632 | 2.6109 | 0.0470 | 0.7518 | 14.4157 |
| Greens | 0.1147 | 1.8357 | 0.0614 | 0.9825 | 0.0533 | 0.8533 | 23.7977 |
| Fresh-cut salads | 0.2231 | 3.5690 | 0.1654 | 2.6457 | 0.0577 | 0.9233 | 24.3390 |
| Salad veggies | 0.0943 | 1.5087 | 0.0831 | 1.3289 | 0.0112 | 0.1798 | 15.1458 |
| Major veggies | 0.1007 | 1.6113 | 0.0704 | 1.1266 | 0.0303 | 0.4847 | 19.4120 |
| Chinese veggies | 0.1851 | 2.9616 | 0.1204 | 1.9265 | 0.0647 | 1.0352 | 32.7963 |
| Yellow veggies | 0.0816 | 1.3059 | 0.0827 | 1.3234 | -0.0011 | -0.0175 | -0.5202 |

ences in prices paid offer support for $H_3$. Percentage differences on purchased varieties show the process by which lower-income consumers maximize their volume purchases within their budget constraints.

## Model Development

A key factor motivating this research is the question of whether higher- and lower-income consumers have different demand responses to changes in prices for various sub-categories of fruit and vegetables. To address this issue, an error correction model is specified and estimated. Since the data set are a cross-section of higher- and lower-income stores over a period of 69 weeks, an error component model, as developed by Fuller and Battese (1974), is considered most appropriate for this study. The general form of this model is

$$(1)\quad Y_{qr} = \sum_{s=1}^{v} X_{qrs}\beta_s + \mu_{qr} \qquad q = 1, 2, ..., N; \; r = 1, 2, ..., T,$$

where $N$ is the number of cross-sections and $T$ is the length of the time series for each cross-section.

Six cross-sections and 69 observations per cross-section are included in the specified model for this study. Fourteen equations are specified and estimated using the time series cross-section regression (TSCSREG) procedure in SAS. The equations and included variables are specified as

$$(2)\quad Q_{ikt} = f(p_{ikt}, p_{jkt}, s, p_{mkt}, SDUM_{kt}, TEXP_{kt}, TEXP_{kt^s},$$

where $Q_{ikt}$ is total ounces of sub-category $i$ for store $k$ in week $t$; $i = 1, ..., 14$; $k = 1, ..., 6$; $t = 1, ..., 69$; $P_{ikt}$ is a weighted-average price of sub-category $i$ for store k in week $t$; $P_{kt^s}$ represents weighted-average prices for competing sub-categories for store $k$ in week $t$; $P_{mkt}$ is identical to $P_{ikt}$ for lower-income Stores 4, 5, and 6 but 0 for all other stores (it is intended to capture price elasticity differences for higher- and lower-income stores); $SDUM_{kt}$ are zero-one dummy variables intended to capture store differences; $TEXP_{kt}$ represents total expenditures on

**Table 5. Prices Paid per Pound for Apples by Store and Variety.***

| | High-income stores (H) | | | | Low-income stores (L) | | | | H — L |
|---|---|---|---|---|---|---|---|---|---|
| | Store 1 | Store 2 | Store 3 | | Store 4 | Store 5 | Store 6 | | |
| Apple variety | Weighted price per pound | Weighted price per pound | Weighted price per pound | Avg | Weighted price per pound | Weighted price per pound | Weighted price per pound | Avg | Avg diff |
| Braeburn | 1.31 | 1.29 | 1.33 | 1.31 | 1.15 | 1.20 | 1.28 | 1.21 | 0.10 |
| Cameo | 1.08 | 1.20 | 1.04 | 1.11 | 1.26 | 1.25 | 1.21 | 1.24 | -0.13 |
| Empire | 0.60 | 0.56 | 0.51 | 0.56 | 0.42 | 0.49 | 0.57 | 0.49 | 0.06 |
| Fuji | 1.33 | 1.36 | 1.43 | 1.37 | 1.04 | 0.69 | 1.52 | 1.08 | 0.29 |
| Gala | 0.91 | 0.79 | 0.90 | 0.87 | 0.88 | 0.65 | 0.86 | 0.80 | 0.07 |
| Ginger Gold | 0.62 | 0.59 | 0.63 | 0.61 | 0.62 | 0.59 | 0.61 | 0.61 | 0.01 |
| Gold Delicious | 1.05 | 1.02 | 1.06 | 1.04 | 0.92 | 0.91 | 0.93 | 0.92 | 0.12 |
| Granny Smith | 1.23 | 1.21 | 1.25 | 1.23 | 1.18 | 1.10 | 1.14 | 1.14 | 0.09 |
| Jonagold | 1.26 | 1.10 | 0.84 | 1.07 | 1.00 | 1.18 | 0.68 | 0.95 | 0.11 |
| Jonathan | 0.65 | 0.64 | 0.59 | 0.63 | 0.64 | 0.65 | 0.63 | 0.64 | -0.01 |
| Mcintosh | 0.64 | 0.63 | 0.65 | 0.64 | 0.63 | 0.65 | 0.63 | 0.64 | 0.00 |
| Pacific Rose | 1.12 | 1.02 | 1.31 | 1.15 | 1.20 | 1.10 | 1.29 | 1.20 | -0.05 |
| Paula Red | 0.96 | 0.73 | 0.68 | 0.79 | 0.50 | 0.96 | 0.94 | 0.80 | -0.01 |
| Pink Lady | 1.71 | 1.25 | 1.10 | 1.35 | 1.30 | 1.21 | 0.95 | 1.15 | 0.20 |
| Courtland | -- | 0.69 | 0.68 | 0.69 | 0.68 | -- | 0.66 | 0.67 | 0.02 |
| Red Delicious | 0.94 | 0.91 | 0.89 | 0.91 | 0.71 | 0.59 | 0.78 | 0.69 | 0.22 |
| Rome | 0.52 | 0.52 | 0.49 | 0.51 | 0.52 | 0.55 | 0.53 | 0.53 | -0.02 |

* Price differences of $0.06 or greater are statistically significant.

fruit and vegetables for store $k$ in week $t$ (intended as a proxy for consumer income); and $TEXP_{kt^s}$ is identical to $TEXP_{kt}$ for lower-income Stores 4, 5, and 6, but 0 for all other stores (it is intended to capture differences in expenditure elasticities for higher- and lower-income shoppers). Descriptive statistics for dependent and independent variables are provided in Table 3.

Prices are determined by expressing each fruit or vegetable sale as a ratio of all fruit and vegetables sales within a given sub-category. Specifically, weighted prices for sub-category $i$ in each time period are given by

$$(3)\quad P_t = \sum_j W_{ij} P_{ij},$$

where $W_{ij} = (P_{ij}Q_{ij}) / (\sum_j P_{ij}Q_{ij})$ and $j$ denotes the commodities in the same sub-category. Because each fruit or vegetable is a potential substitute for, or complement with, other fruit and vegetables, all sub-categories are included in each equation.

Since price elasticities of demand are a primary focus of this research, each equation is specified in its double logarithmic functional form to give direct demand elasticities. Given that economic theory suggests a link between income and demand responsiveness, Hypotheses 1 and 2 are expected to apply. That is, lower-income consumers will show higher price and expenditure elasticities than will higher-income consumers. Stated differently, the variables $P_{mkt}$ and $TEXP_{kt^s}$ in Equation 2 are expected to be negative and positive, respectively, and statistically significant.

## Empirical Results for Fruit

Estimated results for all sub-categories of fruits and vegetables are provided in Table 6. Store variables and other independent variables are included in this table but this discussion is focused on own-price and expenditure elasticities for the eight sub-categories of fruit. It should be noted that statistically significant differences are found for three to five of the six stores for each sub-category of fruit. For example, Store 1, a higher-income store, is used as the reference store; the results for citrus show that purchases of citrus for Stores 4, 5, and 6 are lower and statistically significant from those of store 1. That is, relative to Store 1, the intercepts shift downward for stores 4, 5 and 6. Furthermore, produce sales ($TEXP_{kt}$), a proxy for income, show that all fruit sub-categories have positive and statistically significant expenditure elasticities.

Own-price elasticities for all but one of the eight sub-categories of fruit are negative and statistically significant. Fresh-cut fruit is the one exception, but its statistical insignificance is easily explained by the fact that this sub-category represents less than one percent of total fruit consumption. Consistent with $H_1$, demand elasticities for the other seven sub-categories are statistically different for higher- and lower-income shoppers, berries being the one exception. For citrus, own-price elasticity differences are −2.12 versus −1.41 for lower- and higher-income shoppers respectively.[4] This price elasticity difference coupled with differences in prices paid, as shown in Table 4 and Figure 5, show the overall price sensitivity of lower-income for citrus. As a percentage of total fruit consumption, lower-income shoppers are shown to purchase a higher percentage than higher-income shoppers (15.1 percent versus 12.6 percent). Consistent with $H_2$, lower-income shoppers are shown to have a larger expenditure elasticity for citrus (0.81 vs. 0.43). These factors suggest that lower-income shoppers are inclined to spend a larger percentage of an income increase on citrus despite their sensitivity to price changes.

Differences in own-price elasticities for other sub-categories of fruit consumed by higher- and lower-income shoppers are not as great as that for citrus. For apples, the difference is −1.81 versus −1.54. This greater price sensitivity, as hypothesized in $H_1$, led lower-income shoppers to pay a lower price per pound for apples ($1.01 vs. $1.18). As a share of both total produce consumption and total fruit consumption, lower-income shoppers are shown to lag behind higher-income shoppers in their apple consumption (Figures 1 and 3). Even more dramatic differences are shown for berries. Much of this difference is undoubtedly due to the high price of berries. Indeed, berries are shown to be the highest-priced fruit of the eight sub-categories (Table 4 and Figure 5). Yet, consistent with Hypotheses $H_1$ and $H_2$, higher- and lower-income shoppers are shown to have common own-price and expenditure

[4] Each equation is specified to give the overall own-price elasticity and the own-price elasticity difference for lower-income shoppers. Thus −2.12 is the sum of −1.405 and −0.822.

elasticities for berries. Additionally, it is of interest to note that sales of berries were up 13.4 percent for the first quarter of 2009, while overall produce sales are down 1.4 percent (Karst 2009a). These strong sales could suggest that berries are an important component of a healthy diet for both higher- and lower-income consumers.

Consistent with $H_3$, lower-income shoppers pay a lower price per pound for berries ($2.87 vs. $3.40). The noted increase in berry consumption for 2009 together with its common expenditure elasticity for both income groups suggests that berries are one of those commodities for which both higher- and lower-income shoppers show significant increases in consumption with modest increases in income (Johnson 2009; Karst 2009b). Given the nutritional qualities associated with berries, health concerns and rising incomes could stimulate their consumption. Indeed, the noted increase in consumption for 2009 at a time when incomes are actually declining suggests that berry consumption is driven more by health concerns than by economic concerns.

For soft fruit, estimated results are consistent with $H_1$ and $H_3$. Own-price elasticities are −1.61 and −1.25 for lower- and higher-income shoppers respectively; prices paid are $1.59 and $1.68 per pound, respectively, for these two groups (Table 4 and Figure 5). A common expenditure elasticity of 1.23 is observed for soft fruit, and thus the hypothesized expenditure elasticity difference of $H_2$ is not supported. It is of interest to note that soft fruit is offered in fewer alternative forms (seldom bagged) than are commodities such as citrus and apples. This means that lower-income consumers have fewer opportunities for minimizing differences in prices paid. As such, when lower-income shoppers attempt to maximize their volume of purchases within clearly defined budget constraints, soft fruit purchases may not be a top priority for allocating an additional dollar of income. Soft fruit consumption patterns are shown in Figures 1 and 3; these graphs show much higher consumption for higher-income consumers.

Bananas are an interesting sub-category of fruit because it is the least expensive of the eight sub-categories. It is the only category of fruit for which $H_3$ does not hold. There are two possible explanations for this outcome: (1) the mix of bananas (traditional, plantains, and red) differs from store to store, and (2) store managers at lower-income stores offer fewer specials to move over-ripening bananas. The data show a greater mix of bananas at lower-income stores, and zone pricing offers support for the latter explanation. Consistent with $H_1$, lower- and higher-income shoppers are shown to have own-price elasticities for bananas of −0.99 and −0.57, respectively. These inelastic values support findings from other studies that show consumers to be the least price sensitive for products in the lowest-priced product categories (Leibtag and Kaufman 2003). Additionally, the estimated expenditure elasticities are consistent with $H_2$.

Melons are the second lowest-priced sub-category of fruit, and lower-income shoppers are shown to purchase higher quantity shares as percentages of total produce and total fruit. The purchases show the effort lower-income shoppers make to maximize their volume of purchases within their budget constraints. Hypotheses $H_1$ and $H_3$ are supported by the estimated results, but $H_2$ is not. Results for $H_1$ are −2.26 and −1.99, respectively, and those for $H_3$ are $0.85 and $0.97, respectively. These outcomes suggest careful selections of the least expensive melons and they also suggest the role of price in influencing product selection from within a product group. As a share of both total produce and total fruit, bananas and melons are one and two for lower-income shoppers (Figures 1 and 3). For higher-income shoppers, both apples and citrus exceed the share of melons. Some of these differences in purchase percentages for the two groups are possibly due to differences in taste, but the fact that the two lowest-priced fruit categories make up the largest purchased categories for lower-income shoppers confirms their efforts to maximize volume purchases within their income constraints.

Consistent with $H_1$, lower-income shoppers are shown to be more price sensitive toward the purchase of grapes than are higher-income shoppers. Estimated values are −1.71 and −1.39, respectively. An expenditure elasticity for lower-income shoppers that is statistically smaller than that of higher-income shoppers was unexpected, especially since grapes are among the top five commodities lower-income consumers purchase when provided supplemental income for fresh fruits and vegetables (Herman, Harrison, and Jenks 2006). In essence, the reverse of $H_2$ is confirmed. With respect to prices paid, $H_3$ is confirmed. Higher- and lower-income shoppers are shown to pay $1.68 and $1.60 per pound, respectively.

**Table 6. Empirical Results for Time Series Cross−Section Regression (Double-Logarithmic Model with Price and Quantity Variables Measured in Ounces).**

| | Dependent variables[a] | | | | | |
|---|---|---|---|---|---|---|
| | Citrus | | Apples | | Berries | |
| Store variables | | | | | | |
| Store 2 | .078 | (.792) | −.028 | (−.537) | .105 | (−.801) |
| Store 3 | .31 | (.392) | −.078 | (−1.939)** | −.183 | (−2.038)** |
| Store 4 | −2.292 | (−6.612)* | −.966 | (−3.114)* | −.862 | (−2.953)* |
| Store 5 | −2.134 | (−5.904)* | −1.206 | (−3.756)* | −1.237 | (−3.704)* |
| Store 6 | −2.386 | (−6.632)* | −1.278 | (−4.001)* | −.969 | (−2.931)* |
| Other variables | | | | | | |
| Produce sales (all stores) | .4322 | .073** | .726 | (6.084)* | 1.421 | (5.821)* |
| Produce sales (lower income) | .378 | (1.844)** | .146 | (1.142) | .129 | (.423) |
| Constant | 2.142 | (1.264) | −1.229 | (−1.062) | −5.895 | (−2.168)** |
| Price variables | | | | | | |
| Citrus A[b] | −1.405 | (−14.527)* | −.013 | (−.349) | .131 | (1.364) |
| Citrus B[c] | −.822 | (−6.873)* | — | — | — | — |
| Apples A[b] | .097 | (.829) | −1.539 | (−16.231)* | .239 | (1.414) |
| Apples B[c] | — | — | −.273 | (−2.459)** | — | — |
| Berries A[b] | .155 | (2.893)* | .069 | (2.095)** | −1.968 | (−21.671)* |
| Berries B[c] | — | — | — | — | −.148 | (−1.298) |
| Soft Fruit A[b] | .206 | (2.622)* | .121 | (2.631)* | .084 | (.737) |
| Soft Fruit B[c] | — | — | — | — | — | — |
| Bananas A[b] | .051 | (.624) | .031 | (.525) | −.298 | (−2.474)* |
| Bananas B[c] | — | — | — | — | — | — |
| Melons A[b] | .159 | (3.613)* | .114 | (4.143)* | .008 | (.121) |
| Melons B[c] | — | — | — | — | — | — |
| Grapes A[b] | .159 | (3.254)* | .037 | (1.162) | .127 | (1.690)** |
| Grapes B[c] | — | — | — | — | — | — |
| Fresh-cut fruit A[b] | .090 | (1.204) | .049 | (1.451) | −.157 | (−1.501) |
| Fresh-cut fruit B[c] | — | — | — | — | — | — |
| Greens A[b] | .076 | (.954) | .039 | (.902) | .211 | (2.132)** |
| Greens B[c] | — | — | — | — | — | — |
| Fresh-cut salad A[b] | −.011 | (−.075) | −.246 | (−2.612)* | .142 | (.615) |
| Fresh-cut salad B[c] | — | — | — | — | — | — |
| Salad vegetables A[b] | .191 | (.810) | .110 | (.733) | .388 | (1.114) |
| Salad vegetables B[c] | — | — | — | — | — | — |
| Major vegetables A[b] | .232 | (2.003)** | .117 | (1.642)** | −.058 | (−.327) |
| Major vegetables B[c] | — | — | — | — | — | — |
| Chinese vegetables A[b] | −.211 | (−2.008)** | −.056 | (−.999) | .106 | (.775) |
| Chinese vegetables B[c] | — | — | — | — | — | — |
| Yellow vegetables A[b] | −.014 | (−.163) | −.151 | (−3.217)* | .539 | (4.204)* |
| Yellow vegetables B[c] | — | — | — | — | — | — |

**Table 6. Empirical Results for Time Series Cross−Section Regression (Double-Logarithmic Model with Price and Quantity Variables Measured in Ounces) (Continued).**

| | Dependent variables[a] | | | | | |
|---|---|---|---|---|---|---|
| | Soft fruit | | Bananas | | Melons | |
| Store variables | | | | | | |
| Store 2 | −.226 | (2.156)** | .032 | (1.078) | −3.55* | (−2.100)** |
| Store 3 | .001 | (.007) | .074 | (3.264)* | −.327 | (−2.731)* |
| Store 4 | −1.329 | (4.411)* | −1.440 | (−8.355)* | −1.445 | (−3.588)* |
| Store 5 | −1.238 | (3.782)* | −1.564 | (−8.911)* | −1.497 | (−3.461)* |
| Store 6 | −1.379 | (4.169)* | −1.605 | (−9.157)* | −1.246 | (−2.934)* |
| Other variables | | | | | | |
| Produce sales (all stores) | 1.232 | (5.812)* | .440 | (6.691)* | 1.892 | (5.162)* |
| Produce sales (lower income) | −.119 | (−.693) | .153 | (2.244)** | −.504 | (−1.453) |
| Constant | −5.283 | (−2.579)* | 2.615 | (4.022)* | −13.809 | (−4.420)* |
| Price variables | | | | | | |
| Citrus A[b] | .288 | (3.941)* | .037 | (1.567) | .332 | (2.424)** |
| Citrus B[c] | — | — | — | — | — | — |
| Apples A[b] | .292 | (2.018)** | −.108 | (−2.511)* | .397 | (1.878)** |
| Apples B[c] | — | — | — | — | — | — |
| Berries A[b] | .058 | (.885) | .024 | (1.238) | −.074 | (−.798) |
| Berries B[c] | — | — | — | — | — | — |
| Soft fruit A[b] | −1.254 | (−11.546)* | −.056 | (−1.929)** | −.294 | (−2.033)** |
| Soft fruit B[c] | −.353 | (−3.273)* | — | — | — | — |
| Bananas A[b] | .125 | (1.149) | −.568 | (−14.995)* | −.013 | (−.083) |
| Bananas B[c] | — | — | −.429 | (−8.985)* | — | — |
| Melons A[b] | −.109 | (−2.029)** | −.004 | (−.260) | −1.987** | (−17.804)* |
| Melons B[c] | — | — | — | — | −.271 | (−2.508)* |
| Grapes A[b] | −.124 | (−2.004)** | −.021 | (−1.169) | .030 | (.329) |
| Grapes B[c] | — | — | — | — | — | — |
| Fresh-cut fruit A[b] | −.134 | (−1.620)** | −.123 | (−4.722)* | −.044 | (−.407) |
| Fresh-cut fruit B[c] | — | — | — | — | — | — |
| Greens A[b] | −.292 | (3.647)* | −.029 | (−1.088) | −.228 | (−1.606)** |
| Greens B[c] | — | — | — | — | — | — |
| Fresh-cut salad A[b] | −.109 | (−.628) | −.032 | (−.562) | −.308 | (−1.140) |
| Fresh-cut salad B[c] | — | — | — | — | — | — |
| Salad vegetables A[b] | .087 | (.301) | −.199 | (−2.342)** | −1.183 | (−2.771)* |
| Salad vegetables B[c] | — | — | — | — | — | — |
| Major vegetables A[b] | −.367 | (−2.575)* | .139 | (3.178)* | −.354 | (−1.721)** |
| Major vegetables B[c] | — | — | — | — | — | — |
| Chinese vegetables A[b] | .077 | (.725) | −.009 | (−.262) | −.012 | (−.068) |
| Chinese vegetables B[c] | — | — | — | — | — | — |
| Yellow vegetables A[b] | .085 | (.807) | −.043 | (−1.406) | .453 | (3.442)* |
| Yellow vegetables B[c] | — | — | — | — | — | — |

**Table 6. Empirical Results for Time Series Cross−Section Regression (Double-Logarithmic Model with Price and Quantity Variables Measured in Ounces) (Continued).**

| | Dependent variables[a] | | | | | |
|---|---|---|---|---|---|---|
| | Soft fruit | | Bananas | | Melons | |
| Store variables | | | | | | |
| Store 2 | −.226 | (2.156)** | .032 | (1.078) | −3.55* | (−2.100)** |
| Store 3 | .001 | (.007) | .074 | (3.264)* | −.327 | (−2.731)* |
| Store 4 | −1.329 | (4.411)* | −1.440 | (−8.355)* | −1.445 | (−3.588)* |
| Store 5 | −1.238 | (3.782)* | −1.564 | (−8.911)* | −1.497 | (−3.461)* |
| Store 6 | −1.379 | (4.169)* | −1.605 | (−9.157)* | −1.246 | (−2.934)* |
| Other variables | | | | | | |
| Produce sales (all stores) | 1.232 | (5.812)* | .440 | (6.691)* | 1.892 | (5.162)* |
| Produce sales (lower income) | −.119 | (−.693) | .153 | (2.244)** | −.504 | (−1.453) |
| Constant | −5.283 | (−2.579)* | 2.615 | (4.022)* | −13.809 | (−4.420)* |
| Price variables | | | | | | |
| Citrus A[b] | .288 | (3.941)* | .037 | (1.567) | .332 | (2.424)** |
| Citrus B[c] | — | — | — | — | — | — |
| Apples A[b] | .292 | (2.018)** | −.108 | (−2.511)* | .397 | (1.878)** |
| Apples B[c] | — | — | — | — | — | — |
| Berries A[b] | .058 | (.885) | .024 | (1.238) | −.074 | (−.798) |
| Berries B[c] | — | — | — | — | — | — |
| Soft fruit A[b] | −1.254 | (−11.546)* | −.056 | (−1.929)** | −.294 | (−2.033)** |
| Soft fruit B[c] | −.353 | (−3.273)* | — | — | — | — |
| Bananas A[b] | .125 | (1.149) | −.568 | (−14.995)* | −.013 | (−.083) |
| Bananas B[c] | — | — | −.429 | (−8.985)* | — | — |
| Melons A[b] | −.109 | (−2.029)** | −.004 | (−.260) | −1.987** | (−17.804)* |
| Melons B[c] | — | — | — | — | −.271 | (−2.508)* |
| Grapes A[b] | −.124 | (−2.004)** | −.021 | (−1.169) | .030 | (.329) |
| Grapes B[c] | — | — | — | — | — | — |
| Fresh-cut fruit A[b] | −.134 | (−1.620)** | −.123 | (−4.722)* | −.044 | (−.407) |
| Fresh-cut fruit B[c] | — | — | — | — | — | — |
| Greens A[b] | −.292 | (3.647)* | −.029 | (−1.088) | −.228 | (−1.606)** |
| Greens B[c] | — | — | — | — | — | — |
| Fresh-cut salad A[b] | −.109 | (−.628) | −.032 | (−.562) | −.308 | (−1.140) |
| Fresh-cut salad B[c] | — | — | — | — | — | — |
| Salad vegetables A[b] | .087 | (.301) | −.199 | (−2.342)** | −1.183 | (−2.771)* |
| Salad vegetables B[c] | — | — | — | — | — | — |
| Major vegetables A[b] | −.367 | (−2.575)* | .139 | (3.178)* | −.354 | (−1.721)** |
| Major vegetables B[c] | — | — | — | — | — | — |
| Chinese vegetables A[b] | .077 | (.725) | −.009 | (−.262) | −.012 | (−.068) |
| Chinese vegetables B[c] | — | — | — | — | — | — |
| Yellow vegetables A[b] | .085 | (.807) | −.043 | (−1.406) | .453 | (3.442)* |
| Yellow vegetables B[c] | — | — | — | — | — | — |

**Table 6. Empirical Results for Time Series Cross−Section Regression (Double-Logarithmic Model with Price and Quantity Variables Measured in Ounces) (Continued).**

| | Dependent variables[a] | | | | | |
|---|---|---|---|---|---|---|
| | Grapes | | Fresh-cut fruit | | Greens | |
| Store variables | | | | | | |
| Store 2 | .440 | (4.907)* | −.421 | (−3.627)* | .038 | (.538) |
| Store 3 | .349 | (5.183)* | −.593 | (−6.471)* | .105 | (1.891)** |
| Store 4 | −.655 | (−3.216)* | .040 | (.084) | .678 | (2.086)** |
| Store 5 | −.286 | (−1.267) | −1.634 | (−2.998)* | 1.438 | (4.227)* |
| Store 6 | −.519 | (−2.321)** | −.555 | (−.996) | .659 | (2.004)** |
| Other variables | | | | | | |
| Produce sales (all stores) | 1.262 | (7.396)* | .539 | (2.572)* | .362 | (2.361)** |
| Produce sales (lower income) | −.282 | (−1.654)** | −.255 | (−.813) | .569 | (4.132)* |
| Constant | −2.599 | (−1.348) | 4.887 | (2.031)** | 2.369 | (1.655)** |
| Price variables | | | | | | |
| Citrus A[b] | .098 | (1.547) | .070 | (.731) | .027 | (.525) |
| Citrus B[c] | — | — | — | — | — | — |
| Apples A[b] | .411 | (3.361)* | −.130 | (−.886) | −.009 | (−.105) |
| Apples B[c] | — | — | — | — | — | — |
| Berries A[b] | .212 | (3.851)* | −.006 | (−.091) | .031 | (.768) |
| Berries B[c] | — | — | — | — | — | — |
| Soft fruit A[b] | .077 | (.971) | .015 | (.157) | .051 | (.835) |
| Soft fruit B[c] | — | — | — | — | — | — |
| Bananas A[b] | .128 | (1.323) | −.148 | (−1.398) | .034 | (.435) |
| Bananas B[c] | — | — | — | — | — | — |
| Melons A[b] | −.002 | (−.053) | .207 | (3.517)* | .124 | (3.405)* |
| Melons B[c] | — | — | — | — | — | — |
| Grapes A[b] | −1.395 | (−24.921)* | .139 | (2.511)* | .047 | (1.108) |
| Grapes B[c] | −.312 | (−4.991)* | — | — | — | — |
| Fresh-cut fruit A[b] | .017 | (.280) | .232 | (1.577) | .013 | (.285) |
| Fresh-cut fruit B[c] | — | —.356 | (1.309) | — | — | |
| Greens A[b] | −.037 | (−.482) | −.023 | (−.223) | −.369 | (−5.047)* |
| Greens B[c] | — | — | — | —−.018 | (−.156) | |
| Fresh-cut salad A[b] | −.092 | (−.595) | .759 | (3.417)* | −.062 | (−.531) |
| Fresh-cut salad B[c] | — | — | — | — | — | — |
| Salad vegetables A[b] | −.047 | (−.199) | .454 | (1.669)** | .638 | (3.196)* |
| Salad vegetables B[c] | — | — | — | — | — | — |
| Major vegetables A[b] | .079 | (.626) | −.195 | (−1.163) | −.011 | (−.126) |
| Major vegetables B[c] | — | — | — | — | — | — |
| Chinese vegetables A[b] | −.025 | (−.253) | .146 | (.987) | −.055 | (−.742) |
| Chinese vegetables B[c] | — | — | — | — | — | — |
| Yellow vegetables A[b] | .077 | (.893) | −.233 | (−2.402)** | −.102 | (−1.514) |
| Yellow vegetables B[c] | — | — | — | — | — | — |

**Table 6. Empirical Results for Time Series Cross−Section Regression (Double-Logarithmic Model with Price and Quantity Variables Measured in Ounces) (Continued).**

| | Dependent variables[a] | | | | | |
|---|---|---|---|---|---|---|
| | Fresh-cut Salad | | Salad vegetables | | Major vegetables | |
| Store variables | | | | | | |
| Store 2 | .030 | (.866) | .026 | (.709)* | .040 | (.655) |
| Store 3 | .179 | (6.655)* | .087 | (3.248)* | .740 | (1.739)** |
| Store 4 | −.492 | (−3.141)* | −.074 | (−.264) | .580 | (2.426)** |
| Store 5 | −.730 | (−4.511)* | −.276 | (−.982) | .414 | (1.653)** |
| Store 6 | −.497 | (−3.017)* | −.138 | (−.493) | .519 | (2.066)** |
| Other variables | | | | | | |
| Produce sales (all stores) | .504 | (7.352)* | .665 | (9.492)* | .954 | (7.792)* |
| Produce sales (lower income) | .177 | (3.021)* | .188 | (2.883)* | −.011 | (−.091) |
| Constant | 2.019 | (2.750)* | 1.172 | (1.730)** | −.742 | (−.569) |
| Price variables | | | | | | |
| Citrus A[b] | −.102 | (−4.068)* | .024 | (.742) | .005 | (.111) |
| Citrus B[c] | — | — | — | — | — | — |
| Apples A[b] | −.131 | (−2.868)* | .028 | (.653) | −.219 | (−2.622)* |
| Apples B[c] | — | — | — | — | — | — |
| Berries A[b] | .031 | (1.481) | .048 | (2.251)** | .095 | (2.456)* |
| Berries B[c] | — | — | — | — | — | — |
| Soft fruit A[b] | .006 | (−.192) | .066 | (.187) | −.124 | (−2.194)** |
| Soft fruit B[c] | — | — | — | — | — | — |
| Bananas A[b] | .008 | (.238) | .019 | (.580) | −.021 | (−.319) |
| Bananas B[c] | — | — | — | — | — | — |
| Melons A[b] | .057 | (3.159)* | .039 | (2.065)** | .109 | (3.206)* |
| Melons B[c] | — | — | — | — | — | — |
| Grapes A[b] | .005 | (.252) | .006 | (.314) | .091 | (2.268)** |
| Grapes B[c] | — | — | — | — | — | — |
| Fresh-cut fruit A[b] | .101 | (3.94)* | −.011 | (−.437) | .023 | (.549) |
| Fresh-cut fruit B[c] | — | — | — | — | — | — |
| Greens A[b] | −.024 | (−.832) | −.026 | (−.832) | .088 | (1.804)** |
| Greens B[c] | — | — | — | — | — | — |
| Fresh-cut salad A[b] | −.907 | (−12.217)* | .102 | (1.819)** | −.284 | (−2.527)* |
| Fresh-cut salad B[c] | −.205 | (−2.192)** | — | — | — | — |
| Salad vegetables A[b] | .140 | (1.473) | −.938 | (−8.496)* | .135 | (.739) |
| Salad vegetables B[c] | — | — | −.043 | (−.389) | — | — |
| Major vegetables A[b] | .005 | (.109) | .035 | (.764) | −1.323 | (−12.740)* |
| Major vegetables B[c] | — | — | — | — | .098 | (1.035) |
| Chinese vegetables A[b] | .027 | (.697) | −.007 | (−.185) | −.072 | (−1.088) |
| Chinese vegetables B[c] | — | — | — | — | — | — |
| Yellow vegetables A[b] | .066 | (2.059)** | −.019 | (−5.95)* | .261 | (4.127)* |
| Yellow vegetables B[c] | — | — | — | — | — | — |

**Table 6. Empirical Results for Time Series Cross−Section Regression (Double-Logarithmic Model with Price and Quantity Variables Measured in Ounces) (Continued).**

| | Dependent variables[a] | | | |
|---|---|---|---|---|
| | Chinese vegetables | | Yellow vegetables | |
| Store variables | | | | |
| Store 2 | −.443 | (−7.169)* | −.625 | (−6.647)* |
| Store 3 | −.343 | (−6.652)* | −.397 | (−5.433)* |
| Store 4 | −.884 | (−3.566)* | −1.473 | (−5.709)* |
| Store 5 | −.741 | (−2.904)* | −2.276 | (−8.097)* |
| Store 6 | −.819 | (−3.234)* | −1.725 | (−6.291)* |
| Other variables | | | | |
| Produce sales (all stores) | .748 | (6.413)* | .723 | (4.643)* |
| Produce sales (lower income) | .063 | (.592) | −.023 | (−.163) |
| Constant | .561 | (.480) | −.923 | (−.552) |
| Price variables | | | | |
| Citrus A[b] | −.015 | (−.362) | −.094 | (−1.577) |
| Citrus B[c] | — | — | — | — |
| Apples A[b] | −.293 | (−3.868)* | .109 | (1.048) |
| Apples B[c] | — | — | — | — |
| Berries A[b] | −.009 | (−.288) | .045 | (.850) |
| Berries B[c] | — | — | — | — |
| Soft fruit A[b] | −.085 | (−1.719)** | −.004 | (−.053) |
| Soft fruit B[c] | — | — | — | — |
| Bananas A[b] | .089 | (1.418) | −.013 | (−.183) |
| Bananas B[c] | — | — | — | — |
| Melons A[b] | .015 | (.503) | −.041 | (−1.009) |
| Melons B[c] | — | — | — | — |
| Grapes A[b] | .053 | (1.605)** | .007 | (.154) |
| Grapes B[c] | — | — | — | — |
| Fresh-cut fruit A[b] | −.042 | (−1.365) | −.013 | (−.192) |
| Fresh-cut fruit B[c] | — | — | — | — |
| Greens A[b] | −.048 | (−.908) | .009 | (.144) |
| Greens B[c] | — | — | — | — |
| Fresh-cut salad A[b] | .019 | (.188) | .171 | (1.364) |
| Fresh-cut salad B[c] | — | — | — | — |
| Salad vegetables A[b] | .191 | (1.226) | .102 | (.467) |
| Salad vegetables B[c] | — | — | — | — |
| Major vegetables A[b] | −.285 | (−3.846)* | .330 | (3.061)* |
| Major vegetables B[c] | — | — | — | — |
| Chinese vegetables A[b] | −.425 | (−5.209)* | .182 | (2.145)** |
| Chinese vegetables B[c] | −.172 | (−1.468) | — | — |
| Yellow vegetables A[b] | −.097 | (−1.954)** | −1.478 | (−14.024)* |
| Yellow vegetables B[c] | — | — | −.177 | (−1.965)** |

[a] Numbers in parentheses are t-ratios for the associated parameters. [b] Indicates the price elasticity estimate for all stores. [c] Indicates the difference between the price elasticity for lower income stores and all stores.
* and ** indicate statistical significance at the 0.01 level and 0.10 levels, respectively.

As a quantity share of total fruit, grapes are shown to be fairly equal for both higher- and lower-income consumers; as a quantity share of total produce, grapes represent a much higher percentage of produce consumption for higher-income shoppers (4.99 percent vs. 3.83 percent). This disparity results from the fact that produce consumption is fairly evenly distributed between fruit and vegetables for higher-income consumers (50.7 percent vs. 49.3 percent), but skewed toward vegetables for lower-income consumers (58.8 percent vs. 41.2 percent). Since fruit is generally more expensive than vegetables, this disparity between the two groups support the premise that income serves to limit produce consumption bundles for lower-income consumers.

The final sub-category of fruit, fresh-cut fruit, provides empirical results that are somewhat inconsistent with consumption theory. The own-price elasticity is positive, but not statistically significant. Thus $H_1$ is not confirmed. The expenditure elasticity is positive and statistically significant, but the statistical difference hypothesized in $H_2$ is not confirmed. The final hypothesis, $H_3$, is confirmed, as higher- and lower-income consumers are shown to pay prices per pound of \$3.36 and \$2.61, respectively. These mixed results for fresh-cut fruit are undoubtedly due to the fact that this category represents less than one percent of total fruit consumption for both income groups.

**Empirical Results for Vegetables**

For each sub-category of vegetables there are statistically significant differences among the stores (Table 6). Store differences are the least for salad vegetables, with higher-income Stores 2 and 3 having higher base-level sales of salad vegetables than does higher-income Store 1. For greens, Stores 3 through 6 are shown to have higher intercepts than does Store 1. Sales of greens in Store 2 are shown to be statistically insignificant from those of Store 1. Produce sales, used as a proxy for income, are shown to have positive and statistically significant impacts on sales of all sub-categories of vegetables; lower-income shoppers have larger expenditure elasticities for three of the six sub-categories (greens, fresh-cut salads, and salad vegetables). All expenditure elasticities are less than one and therefore all sub-categories of vegetables are necessary goods.

The estimated own-price elasticity for greens is negative and statistically significant as hypothesized, but the results do not satisfy $H_1$. For lower-income shoppers, greens are the least expensive sub-category of vegetables (Table 4). This characteristic makes greens somewhat comparable to bananas in the fruit category, and this relationship may partly explain its low price elasticity (−0.37). Unlike bananas, greens do not represent the highest consumption sub-category of vegetables; this distinction is reserved for major vegetables. The highly inelastic demand for greens does not nullify $H_3$, as lower-income consumers paid an average of \$0.84 less per pound (Table 4 and Figure 5). These differences in prices paid suggest different purchased bundles, perhaps determined as much by preferences as by price. As noted, $H_2$ is confirmed, with expenditure elasticities of 0.36 and 0.93, respectively, for higher- and lower-income shoppers.

For fresh-cut salads, all three hypotheses are confirmed. Own-price elasticities for higher- and lower-income shoppers are −0.91 and −1.11, respectively; expenditure elasticities are 0.50 and 0.68, respectively; and prices paid are \$2.65 and \$3.67 per pound, respectively. These differences in prices paid could reflect different bundles of purchases, just as one would hypothesize given an inelastic demand for one group and an elastic demand for the other. For lower-income consumers, the share of fresh-cut salad vegetables is comparable to that of greens; for higher-income consumers, the share is almost three times that of greens (Figure 4). These share differences show the efforts lower-income shoppers make to maximize their volume purchases within their budget constraints.

Two of the three hypotheses, $H_2$ and $H_3$, are satisfied for salad vegetables. A common own-price elasticity of −0.94 is found for both income groups. Estimated expenditure elasticities are consistent with $H_2$; estimated expenditure elasticities for higher- and lower-income shoppers are 0.66 and 0.85, respectively. With respect to $H_3$, prices paid by higher- and lower-income shoppers are \$1.51 and. \$1.33 per pound, respectively. For major vegetables, only $H_3$ is confirmed. Own-price and expenditure elasticities are identical for higher- and lower-income consumers. In support of $H_3$, estimated results show that higher- and lower-income shoppers paid \$1.61 and. \$1.13 per pound, respectively, for major vegetables. To maximize volume purchases within their budget constraints, lower-income shoppers made 34.5 percent of their total produce purchase from this category. This compares with 22.3 percent for higher-income shoppers. This larger share of purchase of major vegetables by lower-income consumers is what explains the disparity in its purchases of fruit and vegetablees (58.8 percent vegetables vs. 41.2 percent fruit). Similarity in own-price elasticities, but dissimilarity in prices paid for higher- and lower-income consumers suggest that these groups purchase entirely different bundles of major vegetables.

Just as for major vegetables, neither $H_1$ nor $H_2$ is confirmed for Chinese vegetables. Common own-price and expenditure elasticities are −0.43 and 0.75, respectively. The final hypothesis, $H_3$, is confirmed, with higher- and lower-income shoppers paying \$2.96 and \$1.93 per pound, respectively, for Chinese vegetables. Identical own-price elasticities for the second highest-priced sub-category of vegetables are difficult to justify theoretically, but given the mix of vegetables within this category it is possible that this large category of vegetables was further segmented by the income groups. That is, price changes that influence purchases within one commodity group might be entirely irrelevant for another commodity group.

Estimated results for yellow vegetables are somewhat unique in that own-price elasticities for higher- and lower-income shoppers are statistically different, but prices paid are not. Furthermore, expenditure elasticities for the two income groups are also statistically identical. Differences in own-price elasticities are difficult to comprehend because yellow vegetables are such a small share of total produce consumption for both groups. Given limited diversity among yellow vegetables, the results suggest that both groups are purchasing near-identical market baskets and therefore paying near-identical prices.

## Implications for Overweight and Obesity

As discussed in the previous section, lower-income consumers are shown to be more price-sensitive than are higher-income consumers. This sensitivity means that a given price increase for fresh fruits and vegetables would cause lower-income consumers to decrease their consumption by a greater amount than would higher-income consumers. Likewise, a given price decrease would cause lower-income consumers to increase their consumption by a greater amount than would higher-income consumers. Given this differential in response rate, it means that rising prices will curtail the consumption of lower-income consumers more than that of higher-income ones. Falling prices would accomplish the opposite effect, but price changes over the past decade cast a dim shadow over this possibility. Thus the outlook is for continued declines in consumption of fresh fruits and vegetables by lower-income consumers and, to the extent that lower consumption and overweight and obesity are directly related, an increase in overweight and obesity. As Kessler (2009) concludes, processed foods activate our brains to eat more and more food and to gain more and more weight.

Five of the estimated expenditure elasticities show that lower-income consumers would spend a larger share of a one-dollar increase in income on fresh fruit and vegetables. This relationship means that a one-dollar subsidy on fresh fruits and vegetables for lower-income consumers could lead to significant increases in their consumption of these commodities. Implementing such a subsidy could be justified from an economic perspective if the expected benefits outweigh current costs—especially health care costs resulting from inadequate consumption of fresh fruits and vegetables. Indeed, an argument could be made that a properly implemented subsidy would not cause a market distortion because it would simply generate a socially optimal price and output level.

The store-level data set used for this study cannot be used to determine adequate consumption levels of fresh fruits and vegetables for either group of households. That is, neither desired nor existing per capita consumption levels are contained in the data. However, given national surveys that show all consumers to be below recommended levels of consumption, it seems reasonable to conclude from the comparative analyses of this study that lower-income consumers lag behind the consumption levels of higher-income consumers. Comparing fruit and vegetable sales from the bottom of Table 3 with Total Store Sales and Customer Count data (these data are not shown in any of the tables), lower-income shoppers are shown to lag behind their higher-income counterparts in several categories. Fresh fruit and vegetable sales represent six percent of total store sales for higher-income consumers, but just

4.6 percent for lower-income consumers. Assuming overweight and obesity are directly linked to purchases of fresh fruits and vegetables, a compelling argument could be made for developing initiatives to increase fruit and vegetable consumption among lower-income consumers.

While observed purchases of fresh fruits and vegetables do not speak to other components of lower-income consumers' diets, there is little empirical evidence to postulate superiority of these components over those of higher-income consumers. Indeed, utilizing the findings of Drewnowski and Specter (2004) that the highest rates of obesity occur among groups with the least education and highest poverty rate, an argument could be made that other components of lower-income consumers' diets are likely to be inferior to those of higher-income consumers. Thus market interventions to improve fruit and vegetable consumption could serve as a first step to improve diets. Although price subsidies are implied here, this does not mean that other factors cannot influence consumption patterns. Indeed, desired changes in consumption patterns are likely to be influenced by nutrition education, food-quality information, and the provision of information on food preparation techniques.

An encouraging observation from Table 6 is that lower- and higher-income consumers are shown to have similar price and expenditure sensitivities for berries. These observations are encouraging not only because berries are low in calories and rich in many other nutrients such as manganese, vitamin C, and dietary fiber, but also because current research suggests that many berries have antioxidants that can help protect humans from many forms of cancer. While consumption shares for lower-income consumers are considerably below those for higher-income consumers, similar price and expenditure sensitivities suggest that lower-income consumers are willing to purchase high-priced commodities that are known to have health benefits. Of course, it should be observed that major vegetables represent the largest purchases for both income groups and two of the commodities within this sub-category, potatoes and sweet-corn, have high levels of calories per gram (Bell and Rolls 2001).

As a share of total vegetables and total produce, major vegetables represent a consumption level for lower-income consumers that is more than ten percentage points higher than for higher-income consumers (Figures 2 and 4). This high consumption level is possibly influenced by taste preferences, but prices paid, as shown in Figure 6, suggest that an income constraint may be the most limiting factor. That is, purchases of major vegetables are possibly large because they are one of the lowest priced sub-categories of vegetables. To the extent that less-healthy consumption patterns are dictated by commodity prices, an intervention program that provides direct subsidies for more-healthy commodities, together with improved education, could serve to impact fresh fruit and vegetable consumption favorably. That is, policymakers may wish to encourage healthy eating with improved health promotions and some type of price subsidy. Based on nutritional information, some ideal commodities to target include berries, celery, cucumbers, carrots, cantaloupe, grapes, and grapefruits—all commodities that are low in energy density (Rolls 2000).

## Summary and Conclusions

A key objective of this study is to determine if higher- and lower-income consumers show similar or dissimilar own-price and expenditure elasticities for fruit and vegetables. To accomplish this objective, a time series cross-section model was specified and estimated for 14 sub-categories of produce across six cross-sections over 69 weeks. The results show lower-income consumers to have higher price sensitivities for six of eight sub-categories of fruit and two of six sub-categories of vegetables. For the remaining six categories, own-price elasticities are shown to be identical for the two income groups, the only exception being fresh-cut fruit. Price is not a statistically significant determinant of consumption for fresh-cut fruit, and this finding is attributed to its relatively small share of total produce consumption. A contributing factor to its small share is the sale of specially ordered fruit trays through the deli department as opposed to the produce department. But even if all specially-ordered fresh-cut fruit were sold as produce, it is still plausible that price would be an insignificant determinant of consumption because many fruit trays are purchased for special occasions and consumers are known to be less price-sensitive toward such purchases.

Lower-income shoppers were shown to have larger expenditure elasticities for citrus and bananas, but a smaller expenditure elasticity for grapes. No apparent explanation is available for this latter finding, but higher- and lower-income shoppers are shown to have some similarities in their purchasing behavior for grapes as reflected in prices paid and grape shares (Figures 1, 3, and 5). Statistically identical expenditure elasticities were found for all other sub-categories of fruit. Relative to vegetables, lower-income shoppers were shown to have larger expenditure elasticities for greens, fresh-cut salads, and salad vegetables, but statistically identical expenditure elasticities for all remaining vegetables. Overall, these expenditure elasticities suggest that lower-income consumers are more likely to allocate a one-dollar increase in income to vegetables rather than to fruit. Given higher prices for fruit, such an allocation would be consistent with utility maximization.

A finding more revealing than the estimated differences in own-price elasticities is the observed differences in prices paid by the two income groups. Lower-income consumers almost invariably pay lower per unit prices. Perhaps product preferences play some role in effecting these outcomes, but it seems plausible to conclude that income constraints play a larger role in dictating these outcomes. To the extent that increased consumption of fresh fruits and vegetables is critical to a healthy and nutritious diet, it seems reasonable to conclude that lower-income consumers are having more difficulty meeting this objective. Current purchasing patterns suggest that lower-income consumers are already stretching their limited budgets to purchase produce from each of the 14 sub-categories. Observed purchasing patterns suggest that lower-income consumers are more efficient shoppers, and this is indeed a desirable quality. However, unlike apples with its many varieties, it is possible that lower prices paid for some sub-categories represent a sacrifice of quality. If so, observed efficiency in shopping behavior (lower prices paid) has implications for healthy eating. While increased consumption of any type of fresh fruit or vegetable is preferable to stable consumption, it is unlikely that lower-income consumers will meet the recommended five to nine daily servings if current purchases of fresh fruits and vegetables reflect severe budget strains. To help alleviate this strain and move lower-income consumers closer to a healthier diet, some consideration could be given to the implementation of a non-distorting market intervention technique, such as price subsidies.

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