Demand for Fruit and Vegetable Colors

Marie Steele
Michigan State University
Agricultural, Food & Resource Economics
steele37@msu.edu

Dave Weatherspoon, PhD
Michigan State University
Agricultural, Food & Resource Economics
weathe42@msu.edu

Selected Paper prepared for presentation at the 2016 Agricultural & Applied Economics Association Annual Meeting, Boston, Massachusetts, July 31-August 2

Abstract

The objective of this study is to assess the demand for fruit and vegetable (F&V) colors. Consumer preferences for F&V colors have yet to be examined though nutritional health benefits are associated with color and the USDA has promoted consumption based on the F&V color. Supermarket scanner receipt data from an independent supermarket in a primarily Hispanic neighborhood in the Midwest was collected from May 2014 through January 2015 and transformed into a panel dataset of customers' two-week purchases. F&V were divided into four color classes: green, white, red/blue/purple, and yellow/orange. The Quadratic Almost Ideal Demand System adjusted to account for the large proportions of non-purchases and to control for additional explanatory variables was used for analysis. F&V weak separability was tested and failed; hence, eight color expenditure share equations (four for fruits and four for vegetables) were estimated within one model. Expenditures and prices significantly impact the demand for the F&V colors. Consumers are most price responsive to white F&V and most expenditure responsive to the red/blue/purple and yellow/orange F&V.

Introduction

The United States Department of Agriculture (USDA) has been promoting consumption of colorful fruits and vegetables (F&V) through multiple nutrition programs nationally; some examples are the Coordinated Approach to Child Health (CATCH) nutrition curriculum with a Farm to School program (Moss et al. 2013) and the Color Me Healthy program (Witt and Dunn 2012). The National Cancer Institute started the "5 A Day" campaign and the Center for Disease Control and Prevention sponsored the "Fruits & Veggies-More Matters" campaign, which both also encouraged classification of F&V by color (Pennington and Fisher 2009). Though a lot of money has been spent on promoting F&V color consumption it is not clear how effective these programs and campaigns are at affecting F&V demand. Do consumers actually consider the F&V colors when shopping for F&V?

No economic study has yet to analyze F&V demand by color. Previous F&V demand research either focused on individual F&V (Seale, Zhang, and Traboulsi 2013, Weatherspoon et al. 2013) or aggregate all fruits and all vegetables (Mhurchu et al. 2013, Reed and Levedahl 2010). In both approaches, color is disregarded. Some studies investigate the demand for specific nutrients from food (Huang 1996, Huang and Lin 2000); however, these are not focused on F&V and the average consumer likely does not know which specific nutrients are within each F&V (Guthrie, Derby, and Levy 1999). Economic studies have found that consumers often use color as an initial indicator of quality in general food products (Andrés-Bello et al. 2013). Color of the food product packaging influences demand (Ares and Deliza 2010, Murray and Delahunty 2000, Silayoi and Speece 2007), including the mesh color surrounding bundled F&V (Bix, Seo, and Sundar 2013). Previous research has also found consumers to prefer specific shades of colors for certain F&V (Barrett, Beaulieu, and Shewfelt 2010). However, the demand for fresh F&V based on color has yet to be explored; therefore, analysis of F&V by color will provide an integral contribution to our understanding of F&V demand.

The objective of this study is to explore the demand for F&V colors in a Midwestern, low-income, predominantly Hispanic community. The implications of this study are to specify a new approach to analyzing F&V demand based on color; and provide new information on consumer behavior, which will allow them to modify or create policies/programs that maximize health benefits for communities like this one. The next section will provide some background information on the color classification class used. The following sections describe the data and demand model. We then close with the results and offer discussion.

F&V Color Classification

F&V color classification is a method of translating the science of phytochemical nutrition into USDA dietary guidelines that the public can easily understand (Heber 2004). A healthy diet includes a variety of F&V of varying colors since color usually denotes the presence of specific vitamins, minerals and phytonutrients (Brown 2016, Guitart, Pickering, and Byrne 2014, Griep et al. 2011, Vaughan and Geissler 2009). Optimal color proportions depend on age, gender, health status and level of physical activity; however, the Key Recommendations in the 2015-2020 dietary guidelines for Americans from the USDA Center for Nutrition Policy and Promotion emphasize the importance of dark green, red and orange vegetables for everyone (DeSalvo, Olson, and Casavale 2016).

The color classification for this analysis groups F&V into four color classes: green, white, red/blue/purple and yellow/orange (Table 1), similar to other color classifications found in the nutrition literature (Pennington and Fisher 2010, Guitart, Pickering, and Byrne 2014, Griep et al. 2011, FNS 2016). If the peel is generally consumed, then the color of the peel determines color class (e.g. granny smith apples are green) but if the peel is not usually eaten then the edible portion determines color class (e.g. bananas are white) (PbhFoundation 2016a, Langtree 2005). Culinary traditions for whether the individual F&V are classified as a fruit or vegetable are used (e.g. tomatoes classified as vegetables).

Table 1 provides examples of the variety of phytochemicals, vitamins and minerals found in the different color classes and associated health benefits. Green F&V prevent age related macular degeneration as well as promote retinal health and boost immune system activity (Heber 2004, Garden-Robinson 2009, Guitart, Pickering, and Byrne 2014). White colored F&V help maintain healthy cholesterol levels and prevent certain types of cancer (Langtree 2005, Heber 2004). Red/blue/purple F&V provide phytochemicals that improve heart health and memory function and prevent certain types of cancer (Brown 2016, Joseph, Nadeau, and Underwood 2002, Garden-Robinson 2009). Lastly, yellow/orange F&V provide vitamins that promote vision and immune system (PbhFoundation 2016a, Joseph, Nadeau, and Underwood 2002). Although some

Table 1: Color Classification and Benefits

Color Group	Fruits and Vegetables in Group	Phytochemicals, Vitamins and Minerals they Contain	Associated Health Benefits and Reference Examples
Green	**Fruits:** Green Grapes, Limes, Green Pears, Kiwi, Chayote, Honeydew, Avocado, Green Apples **Vegetables:** Asparagus, Broccoli, Brussels Sprouts, Celery, Greens, Collard Greens, Muster Greens, Turnip Greens, Spinach, Green Beans, Green Peppers, Cabbage, Zucchini, Packaged Salad Bags, Lettuce, Okra, Cucumbers	Lutein Glucosinolates Folate Isothiocyanates Vitamin K folic acid potassium chlorophyll Vitamin C	Prevent macular degeneration, boost immune system, maintain healthy bones and teeth (Heber 2004, Garden-Robinson 2009, Guitart, Pickering, and Byrne 2014, FNS 2016)
White	**Fruits:** Bananas, Coconuts, Bosc Pears **Vegetables:** Plantain, Cauliflower, White Onions, Mushrooms, Turnips, Russet Potatoes, Idaho Potatoes, Jicama, Yuca	Allyl Sulfides Allicin Potassium	Prevent certain cancers; maintain cholesterol levels (Langtree 2005, Heber 2004, FNS 2016)
Red / Blue / Purple	**Fruits:** Cherries, Strawberries, Grapefruit, Watermelon, Blueberries, Plums, Red Grapes, Black Grapes, Red Apples **Vegetables:** Beets, Radish, Tomatoes, Red Peppers, Red Onions	Lycopene Anthocyanins Calcium Vitamin D Flavonoids Resveratrol Vitamin C Folates	Reduce tumor growth and cancer and stroke risk, Promotes memory function, healthy aging, heart, and prostate health (Heber 2004, Garden-Robinson 2009, Joseph, Nadeau, and Underwood 2002, Brown 2016, FNS 2016)
Yellow / Orange	**Fruits:** Apricots, Cantaloupe, Pineapple, Yellow Apples, Oranges, Tangerines, Peaches, Mango, Nectarines, Lemons **Vegetables:** Carrots, Corn, Pumpkin, Yams, Squash, Yellow Peppers	Alpha-Carotene Beta-Carotene Vitamin A Vitamin C folate	Promote vision and immune system; reduce cancer risk, and heart disease (PbhFoundation 2016b, Joseph, Nadeau, and Underwood 2002, Brown 2016, FNS 2016)

of the benefits overlap across colors, all are necessary to ensure a diverse spectrum of phytochemicals, vitamins and minerals to maximize potential health outcomes (Guitart, Pickering, and Byrne 2014).

Data

This study analyzes receipt scanner data from a supermarket located in a primarily Hispanic, low-income, Midwestern urban community (Office of Social and Economic Data Analysis 2010). In this location, residents experience low availability of fresh, nutritious, affordable food and primarily rely on convenience, liquor or other non-mainstream grocery stores (Budzynska et al. 2013). The Congressional District in which this supermarket is located has 89,788 (35%) households receiving Supplemental Nutrition Assistance Program (SNAP) benefits, as of 2013, with 60% of its residents below the poverty line (USDA 2015).

In general, there are distinct differences in food price and expenditure elasticities among different ethnicities and income groups (Huang and Lin 2000, Park et al. 1996). The Hispanic population is the largest ethnic minority in the US and is continually growing (Colby and Ortman 2015). Hispanics consume more F&V than most Americans (pbhFoundation 2015), but Hispanics who have migrated to the U.S. often perceive fresh F&V to be expensive and of low quality (Cason, Nieto-Montenegro, and Chavez-Martinez 2006, Gray et al. 2005). Research on communities with the other similar characteristics find alarming results. Low-income households fall significantly below recommended F&V consumption (Dong and Lin 2009) and urban minority neighborhoods face many barriers to access fresh F&Vs in retail outlets (Hosler et al. 2008). There are fewer people in the Midwest consuming adequate F&V than other regions (Blanck et al. 2008). Consequently, this unique population can provide useful insights into consumer F&V demand.

Scanner data for the produce department from May 2014 through January 2015 are analyzed. The entire dataset has 373,714 purchase transactions over the 9-month period, with 113,873 including fruits and/or vegetables. Roughly 68.5% of transactions were paid for with cash as compared to only 17% on average for the nation (FMI 2016); 20.4% of the transactions were SNAP; 10% were debit; 1% were Women, Infants and Children (WIC), and 1% were credit. The number of monthly supermarket transactions are roughly equal, ranging from 39,166 to 42,464.

Per transaction average store spend was $22.41 and among those who purchased F&V, the average vegetable (fruit) expenditure was $3.77 ($3.51).

The transactions are aggregated up to two-week purchases for each consumer with a unique identifier (41% of the transactions had either loyalty card, credit card, debit card, SNAP or WIC). The final dataset is pooled, with a total of 55,920 observations, each representing the purchases of a consumer for a two-week period. For the remainder of the article, a transaction refers to a costumer's two-week aggregated purchases. All produce items sold by the piece are converted into pounds. Prices for each fruit and vegetable color class are calculated as a weighted average of each fruit (vegetable) price that was available at the store during the two-week period. Each fruit or vegetable i price on week t, P_{it}, is weighted by the average expenditure share of that fruit or vegetable i throughout the entire dataset and remains constant throughout. This calculation gives importance to the individual fruit or vegetable based on their popularity versus using equal weights. This price index varies by week (since the individual prices do) but not by customer.

$$\mathrm{weight}_i = \frac{p_i\, q_i}{\sum_{i=1}^{n} p_i\, q_i} \tag{1}$$

Table 2 provides some color descriptive statistics. The first column is the average two-week color price. Among the fruits, white have the lowest average price, which is less than half the highest average fruit color price (yellow/orange). For vegetables, the green color class has the highest average price and white has the lowest. The white color class is the cheapest color for both F&V because their most commonly purchased individual fruit or vegetable is very inexpensive compared to all other individual F&V items in the store (bananas for fruits and potatoes for vegetables) and their popularity heavily weights the white F&V prices down. Though not shown in Table 2, it is interesting to note that the yellow/orange fruits and red/blue/purple vegetables have the largest price variation and range among the F&V classes over the nine months.

Next Table 2 displays the average customer quantities purchased, both conditional and unconditional on the color class being purchased. The red/blue/purple fruit have the highest conditional quantity purchased but the lowest unconditional quantity purchased, meaning that red/blue/purple fruits are not purchased often but when they are, a lot is purchased. The ranking among the colors for the unconditional quantities is the same for fruits as for vegetables (from highest to lowest: green, white, yellow/orange then red/blue/purple). Then for expenditure statistics, the F&V expenditures (both conditional and unconditional on purchase), as well as the expenditure shares (of all F&V) are reported. There is small variation in conditional color expenditures for vegetables, meaning that whenever a vegetable color class is purchased roughly the same amount is spent, no matter which color it is that is purchased. This relationship is not true for fruits, in fact there is quite a large spread among the fruit color conditional expenditures. Red/blue/purple fruit expenditure, conditional on purchase, is the highest; however, the red/blue/purple fruits are also the least frequently purchased, making their expenditure share lower. Green fruits and green vegetables represent 24% and 16% of all F&V expenditures, respectively, while yellow vegetables only comprise 4.6% of F&V expenditures. Lastly, Table 2 displays the frequency of purchase from this supermarket by color class. Green vegetables are by far the most commonly purchased color class (based on the number of transactions), followed by the red/blue/purple vegetables. As mentioned earlier, the Dietary Guidelines for Americans emphasize the importance of dark green, red and orange vegetables. Based on the descriptive statistics the green and red vegetables are not of as much concern as the orange since the orange vegetables are amongst the lowest ranking in expenditure, expenditure share, and frequency of purchase.

Table 2: Two-week Average Price, Customer Quantity Purchased (Conditional and Unconditional on Purchase), Customer Expenditure (Conditional and Unconditional on Purchase), Customer Expenditure Shares and Store Number of Purchases by Color Class

Fruits	Price ($/lb.)	Quantity if Purchased (lbs.)	Unconditional Quantity (lbs.)	Expenditure if Purchased ($)	Unconditional Expenditure ($)	F&V Expenditure Shares (%)	Number of Purchases
Green	0.96	3.28	0.38	3.15	0.58	16.08	17618
White	0.63	2.92	0.29	1.98	0.31	12.39	14685
Red/Blue/Purple	1.20	4.32	0.10	4.45	0.29	5.78	6303
Yellow/Orange	1.60	2.20	0.18	3.70	0.28	5.61	7051
Vegetables							
Green	1.65	2.44	0.41	2.96	0.78	24.18	25380
White	0.95	3.27	0.35	2.75	0.49	15.84	16162
Red/Blue/Purple	1.23	2.24	0.12	2.92	0.59	15.57	18780
Yellow/Orange	1.29	2.77	0.28	2.35	0.17	4.56	6765

Prior Elasticity Expectations

Prior research has found that the demand for food is relatively inelastic (Andreyeva, Long, and Brownell 2010). In general, the more broadly defined the food group is, the more inelastic demand is, meaning the F&V color classes are expected to be more inelastic than the individual F&V classification but more elastic than the aggregated F&V classifications, found in the literature. Examining Table 2 can provide some insights into expectations around relative elasticities across the color classes. One could argue that white and green fruits and red/blue/purple and green vegetables are expected to be more price inelastic than the other colors since these are the most commonly purchased colors at this store and as a good becomes subject to habitual consumption, consumers become less sensitive to its price. Red/blue/purple fruits and yellow/orange F&V are expected to be more expenditure elastic than the other colors since are relatively more expensive and not purchased often, making them appear to be viewed as luxury. None the F&V color classes are expected to be viewed as inferior goods (have negative expenditure elasticities) since previous literature has not found F&V, in general, to be classified as inferior.

Model

There are several consumer demand systems used to analyze F&V demand, the most widely applied are the Rotterdam Model (Theil 1965), Translog Demand System (Christensen, Jorgenson, and Lau 1975), Almost Ideal Demand System (AIDS) Model (Deaton and Muellbauer 1980) and the Linear (Blanciforti and Green 1983) and Quadratic (Banks, Blundell, and Lewbel 1997) variants of the AIDS Model. This study analyzes F&V demand using a modified Quadratic AIDS (QUAIDS) approach that has the ability to control for large numbers of non-purchases and has the flexibility to incorporate variables other than income and prices.

The QUAIDS model assumes a consumer has m dollars to spend on the goods in the model. The indirect utility function for consumer demand is then (Banks, Blundell, and Lewbel 1997):

$$\ln \mathrm{V}(\mathbf{p}, \mathrm{m}) = \left[\left\{\frac{\ln \mathrm{m} - \ln \mathrm{a}(\mathbf{p})}{\prod_{\mathrm{i}} \mathrm{p}_{\mathrm{i}}^{\beta_{\mathrm{i}}}}\right\}^{-1} + \sum_{\mathrm{i}} \lambda_{\mathrm{i}} \ln \mathrm{p}_{\mathrm{i}}\right]^{-1} \tag{2}$$

Where the $\ln \mathrm{a}(\mathbf{p})$ term is the transcendental log function

$$\ln a(\mathbf{p}) = \alpha_0 + \sum_i \alpha_i \ln p_i + \frac{1}{2} \sum_i \sum_j \gamma_{ij} \ln p_i \ln p_j$$

The p_i represents the price of the i^{th} color class, m is total F&V expenditure and the Greek letters are the parameters to estimate, with the exception of the α_0's, which in practice are often given a value slightly less than the lowest natural logged expenditure value in the data (-3.01) (Poi 2012).

Additional variables are incorporated into the QUAIDS model by using a scaling technique (Ray 1983, Poi 2012, Poi 2002). Consumer grocery shopping behaviors that have been found to affect food demand and are controlled for in this analysis are: payment method (captured through four indicator variables: cash, credit / debit, SNAP and WIC); total store expenditure; non-F&V store expenditures (total store expenditure minus the F&V expenditure); and frequency of store visits (number of visits the customer made in the two-week period) (Wilde and Ranney 2000). A time trend variable is also included in the model.

There are many customers in the dataset who did not purchase any F&V during the two-week period blocks. Three main reasons have been cited to explain the lack of purchase: (1) the household does not ever purchase F&V from this store, (2) the household did not purchase F&V from this store during the two-week period, or (3) the household determines it is optimal not to purchase any F&V at this store at with current prices and income constraints. The cause of the zeros is not known; hence, a two-stage method originally proposed by Heien and Wesseils (1990), later revised by Shonkwiler and Yen (1999) is used here, as has been used in many previous demand studies with many zeros (Tafere et al. 2010, Stewart et al. 2004, Lambert et al. 2006, Balié, Magrini, and Morales Opazo 2016).

The first stage is to estimate a Probit model for each color, to calculate the probability a given household purchases that color fruit or vegetable (Shonkwiler and Yen 1999, Heien and Wesseils 1990). Next the cumulative distribution and probability density functions for the normal distribution ($\Phi\left(z_{ih}'\widehat{\theta_\imath}\right)$ and $\phi(z_{ih}'\widehat{\theta_\imath})$) are calculated and used to estimate the following system of observed color budget shares

$$w_i^* = \Phi\left(\widehat{\theta_\imath}'z\right) w_i + \delta_i \phi\left(\widehat{\theta_\imath}'z\right) \tag{3}$$

where

$$w_i = \alpha_i + \sum_j \gamma_{ij} \ln p_j + (\beta_i + \eta_i'z) \ln\left(\frac{m}{(1+\rho'z)a(\mathbf{p})}\right) + \frac{\lambda_i}{\left[\prod_i p_i^{\beta_i}\right]\left[\prod_j p_j^{\eta_j'z}\right]} \left[\ln\left\{\frac{m}{(1+\rho'z)a(\mathbf{p})}\right\}\right]^2.$$

The w_i is the share of total F&V expenditure m allocated to color class i, and z is a vector of explanatory variables. As earlier, the Greek letters are the parameters being estimated. Since the disturbance terms are often heteroscedastic in these models (Tafere et al. 2010), robust standard errors clustered at the customer level are used. Clustering the standard errors also addresses any possible autocorrelation present in the model (Wooldridge 2015). The model coefficient estimates are then used to calculate the color own-price, cross-price and expenditure elasticities. The uncompensated price elasticity of color class i with respect to changes in color class j are calculated using

$$\epsilon_{ij} = -\delta_{ij} + \frac{1}{w_i}\left(\gamma_{ij} - \left[\beta_i + \eta_i' z + \frac{2\lambda_i}{\left[\prod_i p_i^{\beta_i}\right]\left[\prod_j p_j^{\eta_j' z}\right]} \ln\left\{\frac{m}{(1+\rho' z)\, a(p)}\right\}\right] \right.$$
$$* \left(\alpha_j + \sum_l \gamma_{jl} \ln p_l\right) - \left.\frac{(\beta_j + \eta_j' z)\lambda_i}{\left[\prod_i p_i^{\beta_i}\right]\left[\prod_j p_j^{\eta_j' z}\right]}\left[\ln\left\{\frac{m}{(1+\rho' z)\, a(p)}\right\}\right]^2\right) \Phi(\hat{\theta}_i' z)$$
$$+ \phi(\hat{\theta}_i' z)\, \theta_{ij} \left(1 - \frac{\delta_i}{w_i}\right) \tag{4}$$

where δ_{ij} is the Kronecker delta (δ_{ij} =1 if i=j and δ_{ij}=0 otherwise). Expenditure (income) elasticity for color class i are calculated using

$$\mu_i = 1 + \frac{1}{w_i}\left[\beta_i + \eta_i' z + \frac{2\lambda_i}{\left[\prod_i p_i^{\beta_i}\right]\left[\prod_j p_j^{\eta_j' z}\right]} \ln\left\{\frac{m}{(1+\rho' z)\, a(\mathbf{p})}\right\}\right] \Phi(\hat{\theta}_i' z). \tag{5}$$

Compensated price elasticities can be calculated from the Slutsky Equation $\epsilon_{ij}^C = \epsilon_{ij} + \mu_i w_j$ (Balié, Magrini, and Morales Opazo 2016). The delta method is used to compute the standard errors of the computed elasticities (Poi 2012, Ray 1983, Shonkwiler and Yen 1999).

Many papers assume separability between F&V and use separate demand models for F&V. If the weak separability assumption fails there is endogeneity present in the model due to missing variables, yielding biased regression coefficients which are then used in the elasticity calculations, causing them to be biased as well. To avoid this, non-homothetic weak separability is tested using the method developed by Moschini, Moro, and Green (1994). Weak separability between F&V implies that the marginal rate of substitution between two fruit (vegetable) color classes is independent of the amount of vegetables (fruits) purchased (Sellen and Goddard 1997). Implying that the ratio of price elasticities between two fruit (vegetable) with all vegetables (fruits) equals the ratio of expenditure elasticities of the two fruits (vegetables) (Moschini, Moro, and Green 1994, Lakkakula, Schmitz, and Ripplinger 2016)

$$\frac{\epsilon_{ik}}{\epsilon_{jk}} = \frac{\mu_i}{\mu_j} \tag{6}$$

where i and j are the fruit (vegetable) color classes and k is aggregated vegetables (fruits). The Wilcoxon signed rank test (Lambert et al. 2006), results strongly reject weak separability; hence, the fruit colors and vegetable colors are analyzed as one system. The demand system is a set of eight equations, four for fruits and four for vegetables; one equation for each color class. Due to the large dataset, there are no degrees of freedom concerns.

To address the potential unobserved heterogeneity within the system, Correlated Random Effects (CRE) probit regressions are run in the first stage and the CRE variables (means of time varying variables) are included as explanatory variables in the second stage system. The theoretical restrictions derived from utility theory; homogeneity ($\sum_j \gamma_{ij} = 0$) and Slutsky symmetry ($\gamma_{ij} = \gamma_{ji}$), are imposed during estimation. The traditional adding up restrictions are adjusted based on Shonkwiler and Yen (1999) changes to the expenditure share equations. Lastly, it is assumed that the consumers buy their F&V from this supermarket, since no data was collected from any other food retail outlets.

Results

Many of the explanatory variable parameters estimated are significant revealing that the budget shares are affected by them; hence their inclusion is necessary. It should also be noted that most of the censoring corrections included in the model are also significant, justifying the need to address the abundance of zeros in this dataset. The probit model coefficient results (first stage) are reported in the Appendix (Table A.1).

The two main drivers of demand for a good are income and prices. Income is replaced with expenditure in this analysis since customers' incomes are not known but F&V expenditures are. The expenditure elasticities represent how responsive the quantity demanded by consumers is to expenditure changes. The expenditure elasticities shown in the last column of Table 3 are all positive and statistically significant. The green, red/blue/purple and yellow/orange fruits and the red/blue/purple and yellow/orange vegetables are all classified as superior in this community. As F&V expenditure increases, more of it goes toward these color classes than the others. The yellow/orange fruits are the most affected by an F&V expenditure increase, as F&V expenditure increases by 1%, the quantity purchased of yellow/orange fruits increases by 1.15%. The white vegetables class is the least affected by the F&V expenditure increase, as F&V expenditure increases by 1%, the quantity purchased of white vegetables increases by 0.79%.

When a price increases there are two effects that can impact the quantity purchased: (1) the substitution to a relatively cheaper product (substitution effect); and (2) the decrease in real income from the inability to purchase as much (income effect) and vice versa with a price decrease. Table 3 shows the uncompensated price elasticities. The uncompensated price elasticities reflect both income and substitution effects of a price change while the compensated elasticities capture solely substitution effects. None of the significant compensated elasticities have an uncompensated counterpart with the opposite sign; hence only the uncompensated elasticities will be discussed and the compensated elasticities are displayed in the Appendix (Table A.2).

All of the uncompensated own-price elasticities are negative and statistically significant, as expected. The majority of the color classes are inelastic (own-price elasticities less than 1) indicating a less than proportional demand response. Customers respond most to changes in price of white fruits followed by white vegetables, a 1% increase in the white fruits (vegetables) price is associated with a 1.88% (1.09%) decrease in the quantity purchased. The white F&V are the cheapest color classes and most have the least variation (in prices) over the nine-month period, which seems appropriate given they are so responsive to their prices. Customers are least responsive to the green fruits and the red/blue/purple fruits prices, a 1% increase in the green (red/blue/purple) fruit price is associated with a 0.46% (0.53%) decrease in the quantity purchased. The most responsive and three least responsive own-price elasticities are the four fruit colors while all the vegetable own-price elasticities are in between; meaning there is more variation in how consumers respond to the fruit color classes than to the vegetable color classes.

Among the 56 cross-price elasticities, 15 are significantly positive and 15 are significantly negative and 26 are not significant. The 15 positive cross-price elasticities represent substitute relationships between the two color classes, so as the price of one increases the quantity demanded of the other increases. For example, as the white fruit price increases by 1% the quantity demanded of the red/blue/purple fruits, yellow/orange fruits, white vegetables and red/blue/purple vegetables increases by 1.55%, 0.32%, 0.26% and 0.16%, respectively. The 15 negative cross-price elasticities represent complement relationships between the two color classes, so as the price of one increases the quantity demanded of the other decreases. For example, as the green fruit price increases by 1% the quantity demanded of the red/blue/purple fruits, yellow/orange fruits, and red/blue/purple vegetables decreases by 1.32%, 1.52%, and 0.38%, respectively. The 26 cross-price elasticities that are not significant, represent no relationship between the two color classes. The green vegetable price affects only the green vegetable quantity and the red/blue/purple fruit quantity, so the remaining color classes are all independent of the green vegetable price. Of interest is that vegetable prices and quantities have only negative significant cross-price elasticities, implying that among the vegetable colors there are no substitution relationships.

For each of the vegetable color classes the own-price effect is the strongest effect (largest elasticity magnitude out of all price elasticities). However, this is not true among the fruits, in fact three of the fruit color classes' quantity demanded are more affected by a change in a different color class than its own-price (a cross-price elasticity higher magnitude than own-price): green, red/blue/purple and yellow/orange. For example, a 1% increase in white fruit price increases the quantity demanded of red/blue/purple fruits roughly three times as much as a 1% decrease in the red/blue/purple fruit price.

Table 3: Uncompensated Price and Expenditure Elasticities

	Green Fruit	White Fruit	Red / Blue / Purple Fruit	Yellow / Orange Fruit	Green Veg	White Veg	Red / Blue / Purple Veg	Yellow / Orange Veg	Expenditure Elasticity
Green Fruit	**-0.459* (0.246)**	-0.137 (0.129)	-0.439*** (0.104)	-0.510*** (0.077)	0.194 (0.135)	0.483*** (0.171)	-0.355*** (0.084)	0.156 (0.096)	1.022*** (0.022)
White Fruit	-0.086 (0.168)	**-1.877*** (0.185)**	0.788*** (0.224)	0.188 (0.123)	0.013 (0.205)	0.394 (0.274)	0.299** (0.127)	-0.214 (0.136)	0.963*** (0.287)
Red / Blue / Purple Fruit	-1.315*** (0.289)	1.553*** (0.203)	**-0.525** (0.223)**	0.269** (0.123)	-1.146*** (0.205)	-0.721*** (0.274)	-0.034 (0.127)	0.276** (0.136)	1.102*** (0.085)
Yellow / Orange Fruit	-1.517*** (0.220)	0.316* (0.169)	0.288** (0.126)	**-0.737*** (0.149)**	-0.195 (0.194)	0.231 (0.217)	-0.149 (0.126)	0.373*** (0.114)	1.148*** (0.163)
Green Veg	0.148* (0.089)	-0.052 (0.071)	-0.233*** (0.049)	-0.021 (0.045)	**-0.860*** (0.107)**	-0.016 (0.084)	0.084 (0.054)	-0.003 (0.045)	0.927*** (0.104)
White Veg	0.526*** (0.173)	0.258** (0.125)	-0.215** (0.100)	0.112 (0.077)	-0.001 (0.128)	**-1.092*** (0.216)**	-0.212*** (0.081)	-0.231*** (0.088)	0.788** (0.332)
Red / Blue / Purple Veg	-0.380*** (0.087)	0.159** (0.074)	0.016 (0.047)	-0.039 (0.045)	0.084 (0.083)	-0.263*** (0.082)	**-0.737*** (0.080)**	0.015 (0.052)	1.072*** (0.047)
Yellow / Orange Veg	0.546 (0.337)	-0.655*** (0.245)	0.381** (0.173)	0.476*** (0.140)	-0.053 (0.241)	-0.843*** (0.307)	0.059 (0.177)	**-1.013*** (0.235)**	1.023*** (0.019)

Row names represent Quantities and Column names represent Prices.
Standard errors (delta method) are in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Discussion

This study is focused on a unique subset of the population; hence is not representative of the entire US. The ranges for color own-price elasticities for F&V are within the ranges from literature for U.S. F&V demand (Andreyeva, Long, and Brownell 2010), indicating reliability of calculations for this novel approach.

The results lead to implications for program/policy, consumers, and supermarkets. First, there is a preference for green and white colors (most purchased and highest expenditure shares). However, increasing F&V expenditures leads to higher purchases in all the F&V colors but with higher proportions on the colors least purchased (red/blue/purple and yellow/orange). This implies that policies related to increasing F&V expenditure (e.g. the Double Up Food Bucks program) will be effective at increasing F&V color diversity. Second, the results suggest that the importance of F&V color diversity is not reaching this community well. Peer nutrition education has been found to have a positive effect on overall nutrition knowledge and dietary intake behaviors among Latinos (Pérez-Escamilla et al. 2008); so nutrition education should find community members to help motivate F&V color importance. Also dietetic professionals should emphasize common Latino dishes which include a lot of vegetables or promote how to use more F&V in common traditional dishes to increase F&V. Interventions should be mindful that increasing F&V color diversity is done in conjunction with increasing overall F&V consumption.

Hispanics have higher rates of diet-related chronic diseases than the general U.S. population (Drobot 2014) and Hispanics have a 50% greater chance of dying from diabetes or liver disease than Caucasians (CDC 2015). The low purchases of yellow/orange F&V imply vitamin A, vitamin C, and folate may be lacking within their diets. According to previous research, these nutrients are among those likely to be inadequate based on the average Mexican-American diet (highest proportion of the Hispanic/Latino population at this store) (Ohioline 2010); hence, should be targeted.

Limited availability of culturally specific F&V are a barrier to F&V consumption among Latinos (Grigsby-Toussaint et al. 2010), so supermarkets serving large Latino communities should be sure to carry a variety of cultural F&V. The price elasticity results indicate both substitute and complementary price relationships are present among the color classes but fruit prices have more significant cross-price effects than the vegetable prices. Consider an increase in the lowest priced color class, white fruits, this would increase the demand for four other color classes; therefore, attention to pricing mechanisms can lead to increased F&V profit potential. The color class complementarity can also guide the produce department organization in the store (the colors which are complements displayed close while the substitute colors far from each other).

There are a few limitations in the study. First, there are individual F&V that were not available at this store throughout the entire 9-month period examined (honeydew, asparagus, Brussel sprouts, okra, coconuts, turnip roots, jicama, blueberries, cherries, beets, radishes, apricots, peaches and pumpkin). The fact that these were not available could have also influenced purchasing behavior. Though it is common for supermarkets in the U.S. to sell the majority of F&V year-round, due to artificial harvesting conditions (green houses) and supply from other countries, the (perceived) quality varies across the year, which could affect the purchases of individual F&V as well as color classes. This and other seasonality effects on F&V color demand are not explored here and should be investigated in future research. Lastly, perishability across the different individual F&V and across the color classes could affect elasticities but is not captured in this analysis.

Using actual store receipt data, this study provides an objective view of consumer F&V color demand. In order to develop more definitive conclusions to recommend nutrition programs, future research on other low-income areas need to also estimate the demand for the F&V colors. Additionally, the other classifications for F&V should be explored.

References

Andrés-Bello, A, VIVIAN Barreto-Palacios, Purificación García-Segovia, J Mir-Bel, and Javier Martínez-Monzó. 2013. "Effect of pH on color and texture of food products." *Food Engineering Reviews* 5 (3):158-170.

Andreyeva, Tatiana, Michael W Long, and Kelly D Brownell. 2010. "The impact of food prices on consumption: a systematic review of research on the price elasticity of demand for food." *American journal of public health* 100 (2):216-222.

Ares, Gastón, and Rosires Deliza. 2010. "Studying the influence of package shape and colour on consumer expectations of milk desserts using word association and conjoint analysis." *Food Quality and Preference* 21 (8):930-937.

Balié, Jean, Emiliano Magrini, and Cristian Morales Opazo. 2016. Cereal price shocks and volatility in Sub-Saharan Africa: What does really matter for farmers' welfare? : Diskussionspapiere, Department für Agrarökonomie und Rurale Entwicklung.

Banks, James, Richard Blundell, and Arthur Lewbel. 1997. "Quadratic Engel curves and consumer demand." *Review of Economics and statistics* 79 (4):527-539.

Barrett, Diane M, John C Beaulieu, and Rob Shewfelt. 2010. "Color, flavor, texture, and nutritional quality of fresh-cut fruits and vegetables: desirable levels, instrumental and sensory measurement, and the effects of processing." *Critical reviews in food science and nutrition* 50 (5):369-389.

Bix, Laura, Wontae Seo, and Raghav Prashant Sundar. 2013. "The Effect of Colour Contrast on Consumers' Attentive Behaviours and Perception of Fresh Produce." *Packag. Technol. Sci* 26:96-104.

Blanciforti, Laura, and Richard Green. 1983. "An almost ideal demand system incorporating habits: an analysis of expenditures on food and aggregate commodity groups." *The Review of Economics and Statistics*:511-515.

Blanck, Heidi Michels, Cathleen Gillespie, Joel E Kimmons, Jennifer D Seymour, and Mary K Serdula. 2008. "Trends in Fruit and Vegetable Consumption Among US Men and Women, 1994–2005." *Preventing Chronic Disease*.

Brown, Alicia. 2016. "Taste A Rainbow . . . Of Fruits and Veggies." http://www.fruitsandveggiesmorematters.org/taste-a-rainbow-of-fruits-and-veggies.

Budzynska, Katarzyna, Patricia West, Ruth T Savoy-Moore, Darlene Lindsey, Michael Winter, and PK Newby. 2013. "A food desert in Detroit: associations with food shopping and eating behaviours, dietary intakes and obesity." *Public health nutrition* 16 (12):2114-2123.

Cason, Katherine, Sergio Nieto-Montenegro, and America Chavez-Martinez. 2006. "Food choices, food sufficiency practices, and nutrition education needs of Hispanic migrant workers in Pennsylvania." *Topics in Clinical Nutrition* 21 (2):145-158.

CDC. 2015. "Hispanic Health ". http://www.cdc.gov/vitalsigns/hispanic-health/.

Christensen, Laurits R, Dale W Jorgenson, and Lawrence J Lau. 1975. "Transcendental logarithmic utility functions." *The American Economic Review* 65 (3):367-383.

Colby, Sandra L, and Jennifer M Ortman. 2015. "Projections of the size and composition of the US population: 2014 to 2060." *Current Population Reports* (P25-1143).

Deaton, Angus, and John Muellbauer. 1980. *Economics and consumer behavior*: Cambridge university press.

DeSalvo, Karen B, Richard Olson, and Kellie O Casavale. 2016. "Dietary guidelines for Americans." *Jama* 315 (5):457-458.
Dong, Diansheng, and Biing-Hwan Lin. 2009. *Fruit and vegetable consumption by low-income Americans*. Vol. 70: Citeseer.
Drobot, Rachel Clare. 2014. "Characteristics of Latino customers and reported influence of point-of-purchase promotional techniques for fruits and vegetables."
FMI. 2016. "Supermarket Facts ". http://www.fmi.org/research-resources/supermarket-facts.
FNS. 2016. "Eat A Rainbow ". http://www.fns.usda.gov/sites/default/files/colorchart.pdf.
Garden-Robinson, Julie. 2009. "What Color is Your Food? Taste a rainbow of fruits and vegetables for better heallth."
Gray, Virginia B, Jeralynn S Cossman, Wanda L Dodson, and Sylvia H Byrd. 2005. "Dietary acculturation of Hispanic immigrants in Mississippi." *Salud pública de méxico* 47 (5):351-360.
Griep, Linda M Oude, WM Monique Verschuren, Daan Kromhout, Marga C Ocké, and Johanna M Geleijnse. 2011. "Colors of fruit and vegetables and 10-year incidence of stroke." *Stroke* 42 (11):3190-3195.
Grigsby-Toussaint, Diana S, Shannon N Zenk, Angela Odoms-Young, Laurie Ruggiero, and Imelda Moise. 2010. "Availability of commonly consumed and culturally specific fruits and vegetables in African-American and Latino neighborhoods." *Journal of the American Dietetic Association* 110 (5):746-752.
Guitart, Daniela A, Catherine M Pickering, and Jason A Byrne. 2014. "Color me healthy: Food diversity in school community gardens in two rapidly urbanising Australian cities." *Health & place* 26:110-117.
Guthrie, Joanne F, Brenda M Derby, and Alan S Levy. 1999. "What people know and do not know about nutrition." *America's eating habits: Changes and consequences*:243-290.
Heber, David. 2004. "Vegetables, fruits and phytoestrogens in the prevention of diseases." *Journal of postgraduate medicine* 50 (2):145.
Heien, Dale, and Cathy Roheim Wesseils. 1990. "Demand systems estimation with microdata: a censored regression approach." *Journal of Business & Economic Statistics* 8 (3):365-371.
Hosler, AS, DT Rajulu, BL Fredrick, and AE Ronsani. 2008. "Assessing retail fruit and vegetable availability in urban and rural underserved communities." *Preventing chronic disease* 5 (4):A123-A123.
Huang, Kuo S. 1996. "Nutrient elasticities in a complete food demand system." *American Journal of Agricultural Economics* 78 (1):21-29.
Huang, Kuo S, and Biing-Hwan Lin. 2000. *Estimation of food demand and nutrient elasticities from household survey data*: US Department of Agriculture, Economic Research Service.
Joseph, James A, Daniel Nadeau, and Anne Underwood. 2002. *The color code: a revolutionary eating plan for optimum health*: Hyperion New York.
Lakkakula, Prithviraj, Andrew Schmitz, and David Ripplinger. 2016. "US Sweetener Demand Analysis: A QUAIDS Model Application." *Journal of Agricultural and Resource Economics* 41 (3):533-548.
Lambert, Rémy, Bruno Larue, Clément Yélou, and George Criner. 2006. "Fish and meat demand in Canada: Regional differences and weak separability." *Agribusiness* 22 (2):175-199.
Langtree, Ian. 2005. "Color Wheel of Fruits and Vegetables." Disabled World. http://www.disabled-world.com/artman/publish/fruits-vegetables.shtml.

Mhurchu, Cliona Ni, Helen Eyles, Chris Schilling, Qing Yang, William Kaye-Blake, Murat Genç, and Tony Blakely. 2013. "Food prices and consumer demand: differences across income levels and ethnic groups." *PloS one* 8 (10):e75934.
Moschini, Giancarlo, Daniele Moro, and Richard D Green. 1994. "Maintaining and testing separability in demand systems." *American Journal of Agricultural Economics* 76 (1):61-73.
Moss, Ashley, Sylvia Smith, Dawn Null, Sara Long Roth, and Ulrike Tragoudas. 2013. "Farm to school and nutrition education: Positively affecting elementary school-aged children's nutrition knowledge and consumption behavior." *Childhood Obesity* 9 (1):51-56.
Murray, JM, and CM Delahunty. 2000. "Mapping consumer preference for the sensory and packaging attributes of Cheddar cheese." *Food quality and preference* 11 (5):419-435.
Office of Social and Economic Data Analysis , Univ. of Missouri Outreach & Extension 2010. "MCDC Demographic Profile 3, Census, Census Tract 5256 , Wayne County, MI." http://mcdc2.missouri.edu/cgi-bin/broker?_PROGRAM=websas.dp3_2k.sas&_SERVICE=sasapp&st=26&co=163&tr=5256.00.
Ohioline. 2010. "Cultural Diversity: Eating in America—Mexican-American." http://ohioline.osu.edu/factsheet/HYG-5255.
Park, John L, Rodney B Holcomb, Kellie Curry Raper, and Oral Capps. 1996. "A demand systems analysis of food commodities by US households segmented by income." *American Journal of Agricultural Economics* 78 (2):290-300.
pbhFoundation. 2015. "State of the Plate. 2015 Study on America's Consumption of Fruits and Vegetables." http://www.pbhfoundation.org/pdfs/about/res/pbh_res/State_of_the_Plate_2015_WEB_Bookmarked.pdf.
PbhFoundation. 2016a. "Fruits and Veggies More Matters: Fruit and Veggie Color List." http://www.fruitsandveggiesmorematters.org/fruit-and-veggie-color-list.
PbhFoundation. 2016b. "What are Phytochemicals?". http://www.fruitsandveggiesmorematters.org/what-are-phytochemicals.
Pennington, Jean AT, and Rachel A Fisher. 2009. "Classification of fruits and vegetables." *Journal of Food Composition and Analysis* 22:S23-S31.
Pennington, Jean AT, and Rachel A Fisher. 2010. "Food component profiles for fruit and vegetable subgroups." *Journal of Food Composition and Analysis* 23 (5):411-418.
Pérez-Escamilla, Rafael, Amber Hromi-Fiedler, Sonia Vega-López, Angela Bermúdez-Millán, and Sofia Segura-Pérez. 2008. "Impact of peer nutrition education on dietary behaviors and health outcomes among Latinos: a systematic literature review." *Journal of nutrition education and behavior* 40 (4):208-225.
Poi, BP. 2002. "Dairy policy and consumer welfare." *Three Essays in Applied Econometrics*.
Poi, Brian P. 2012. "Easy demand-system estimation with quaids." *Stata Journal* 12 (3):433.
Ray, Ranjan. 1983. "Measuring the costs of children: an alternative approach." *Journal of Public Economics* 22 (1):89-102.
Reed, Albert J, and J William Levedahl. 2010. "Food stamps and the market demand for food." *American Journal of Agricultural Economics*:aaq069.
Seale, James L, Lisha Zhang, and Mohamad R Traboulsi. 2013. "US import demand and supply response for fresh tomatoes, cantaloupes, onions, oranges, and spinach." *Journal of Agricultural and Applied Economics* 45 (03):435-452.

Sellen, Daniel, and Ellen Goddard. 1997. "Weak separability in coffee demand systems." *European Review of Agricultural Economics* 24.
Shonkwiler, J Scott, and Steven T Yen. 1999. "Two-step estimation of a censored system of equations." *American Journal of Agricultural Economics* 81 (4):972-982.
Silayoi, Pinya, and Mark Speece. 2007. "The importance of packaging attributes: a conjoint analysis approach." *European Journal of Marketing* 41 (11/12):1495-1517.
Stewart, H, N Blisard, S Bhuyan, and RM Nayga. 2004. "The demand for food away from home: Full-service or fast food?" *USDA Economic Research Service: Report* (829).
Tafere, Kibrom, Alemayehu Seyoum Taffesse, Seneshaw Tamiru, Nigussie Tefera, and Zelekawork Paulos. 2010. "Food demand elasticities in Ethiopia: Estimates using household income consumption expenditure (HICE) survey data." *Ethiopia Strategy Support Program II Working paper* (011).
Theil, Henri. 1965. "The information approach to demand analysis." *Econometrica: Journal of the Econometric Society*:67-87.
USDA. 2015. "Food and Nutrition Service, Office of Policy Support. PROFILE OF SNAP HOUSEHOLDS. Michigan Congressional District 13." http://www.fns.usda.gov/sites/default/files/ops/Michigan_13.pdf.
Vaughan, John, and Catherine Geissler. 2009. *The new Oxford book of food plants*: OUP Oxford.
Weatherspoon, Dave, James Oehmke, Assa Dembélé, Marcus Coleman, Thasanee Satimanon, and Lorraine Weatherspoon. 2013. "Price and expenditure elasticities for fresh fruits in an urban food desert." *Urban Studies* 50 (1):88-106.
Wilde, Parke E, and Christine K Ranney. 2000. "The Monthly Food Stamp Cycle: Shooping Frequency and Food Intake Decisions in an Endogenous Switching Regression Framework." *American Journal of Agricultural Economics* 82 (1):200-213.
Witt, Kendra E, and Carolyn Dunn. 2012. "Increasing fruit and vegetable consumption among preschoolers: evaluation of Color Me Healthy." *Journal of nutrition education and behavior* 44 (2):107-113.
Wooldridge, Jeffrey M. 2015. *Introductory econometrics: A modern approach*: Nelson Education.

Appendix

Table A1: Estimated Probit Coefficients

	G Fruit	W Fruit	R/B/P Fruit	Y/O Fruit	G Veg	W Veg	R/B/P Veg	Y/O Veg
G Fruit P	-0.703***	-0.724***	-2.382***	-0.247	-0.215	-0.129	-0.917***	0.463*
W Fruit P	-0.005	-0.391**	1.414***	0.248	-0.267*	-0.065	0.150	-0.219
R/B/P Fruit P	0.029	0.050	0.313***	-0.001	-0.158***	-0.069	0.083	-0.207***
Y/O Fruit P	-0.152***	-0.006	0.128***	0.104***	-0.043	0.010	-0.050*	0.055
G Veg P	-0.034	0.057	-0.128	-0.099	-0.113*	-0.008	-0.029	0.0806
W Veg P	-0.353**	0.200	0.969***	0.054	-0.215	-0.254	-0.612***	0.037
R/B/P Veg P	-0.247***	-0.067	-0.181***	-0.018	-0.125***	-0.240***	-0.150***	0.036
Y/O Veg P	0.070	-0.197***	0.391***	0.364***	0.073	0.083	-0.076	-0.042
Loyalty Card	0.193***	0.219***	0.087***	0.0983***	0.152***	0.144***	0.179***	0.165***
Cash	0.171***	0.145***	0.136***	0.140***	0.206***	0.168***	0.203***	0.153***
Credit / Debit	0.388***	0.226***	0.196***	0.262***	0.333***	0.298***	0.359***	0.260***
WIC	0.347***	0.744***	0.359***	0.462***	0.238***	0.041	0.3131***	0.118**
SNAP	0.218***	0.321***	0.349***	0.318***	0.441***	0.411***	0.279***	0.253***
$\overline{\text{Other Dept Exp}}$	-0.134***	-0.090***	-0.081***	-0.086***	-0.104***	-0.074***	-0.124***	-0.080***
$\overline{\text{Number of Visits}}$	0.021***	0.152***	0.014**	-0.005	0.016***	-0.007	0.025***	0.007
$\overline{\text{SubTotal}}$	0.132***	0.090***	0.080***	0.086***	0.105***	0.076***	0.123***	0.079***
Time Trend	0.022***	0.016***	0.013**	-0.004	0.015***	0.009**	0.019***	-0.002
Constant	-0.536*	-1.032***	-2.526***	-2.600***	-0.707***	-1.193***	-0.286	-2.463***
Pseudo R^2	0.140	0.103	0.106	0.115	0.113	0.089	0.129	0.097

n = 70116

*** p<0.01, ** p<0.05, * p<0.1

Table Abbreviations: G= Green, W = White, R/B/P = Red / Blue / Purple and Y/O = Yellow / Orange

Table A2: Compensated Price Elasticities

	Green Fruit	White Fruit	Red / Blue / Purple Fruit	Yellow / Orange Fruit	Green Veg	White Veg	Red / Blue / Purple Veg	Yellow / Orange Veg
Green Fruit	**-0.287** **(0.246)**	-0.005 (0.129)	-0.377*** (0.104)	-0.450*** (0.077)	0.452*** (0.134)	0.652*** (0.171)	-0.189** (0.084)	0.205** (0.096)
White Fruit	-0.006 (0.168)	**-1.816*** (0.185)**	0.817*** (0.095)	0.215*** (0.076)	0.133 (0.139)	0.472*** (0.159)	0.376*** (0.094)	-0.191** (0.090)
Red / Blue / Purple Fruit	-1.051*** (0.289)	1.756*** (0.203)	**-0.430* (0.224)**	0.361*** (0.123)	-0.749*** (0.205)	-0.461* (0.274)	0.222* (0.127)	0.351*** (0.136)
Yellow / Orange Fruit	-1.294*** (0.220)	0.488*** (0.169)	0.368*** (0.126)	**-0.659*** (0.149)**	0.141 (0.194)	0.451** (0.217)	0.068 (0.125)	0.437*** (0.114)
Green Veg	0.301*** (0.089)	0.066 (0.071)	-0.178*** (0.049)	0.033 (0.045)	**-0.630*** (0.107)**	0.135 (0.084)	0.233*** (0.054)	0.040 (0.045)
White Veg	0.663*** (0.173)	0.364*** (0.125)	-0.166* (0.100)	0.160** (0.077)	0.206 (0.128)	**-0.956*** (0.216)**	-0.079 (0.081)	-0.192** (0.088)
Red / Blue / Purple Veg	-0.196 ** (0.087)	0.301*** (0.074)	0.082* (0.047)	0.025 (0.045)	0.361*** (0.083)	-0.081 (0.082)	**-0.559*** (0.080)**	0.067 (0.052)
Yellow / Orange Veg	0.723** (0.337)	-0.518** (0.245)	0.445*** (0.173)	0.538*** (0.140)	0.214 (0.241)	-0.669** (0.307)	0.230 (0.178)	**-0.963*** (0.235)**

Row names represent Quantities and Column names represent Prices.
Standard errors (delta method) are in parentheses.
*** p<0.01, ** p<0.05, * p<0.1