Factors Driving Fruit and Vegetable Expenditures and Consumption Frequency in Lesser Developed Country: an Analysis of Urban Households from the Republic of Uganda

Padmanand Madhavan Nambiar, Wojciech J. Florkowski, Manjeet S. Chinnan and Anna V. A. Ressurrecion

University of Georgia

Author Contact Information

Padmanand Madhavan Nambiar, Graduate Student

University of Georgia,

306 Conner Hall,

Athens, GA 30602

Wojciech J. Florkowski, Professor

University of Georgia, Griffin Campus

1109 Experiment Street

Griffin, GA 30223-1797

E-mail: wojciech@uga.edu

Manjeet S. Chinnan

Professor, Department of Food Science and Technology, University of Georgia

Address: 1109 Experiment Street, Griffin, GA 30223-1797

E-mail: Chinnan@uga.edu

Phone: 770-412-4758

Anna V. A. Ressurrecion

Professor, Department of Food Science and Technology, University of Georgia

Address: 1109 Experiment Street , Griffin, GA 30223-1797

E-mail: annaresurreccion@gmail.com

Phone: 770-412-4758

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Abstract

Factors affecting fresh fruit and vegetable expenditures in urban households of Uganda are analyzed employing the censored quantile regression. Results indicate that income elasticity of expenditure for fresh fruits exceeds one in 25^{th} quantile, and reduces drastically in upper quantiles; for fresh vegetables income is relatively inelastic across different quantiles.

Keywords: Republic of Uganda, censored quantile regression, multivariate probit, ncome elasticity of expenditures, fresh fruits and vegetables

JEL Classifications: Q12, Q13

Background and objectives

The Republic of Uganda is a developing country in East Africa. It has been reported that some population segments experienced malnutrition (Kikafunda et al., 1998). However, contrary to expectations, the overweight and obesity among its population are on the rise. In 2008, the obesity and overweight rates were 4.3% and 19.9%, respectively (WHO, 2011). Many clinical studies show a strong association between the occurrence of overweight or obesity, and the incidences of cardiovascular diseases, certain types of cancers, diabetes, and hypertension. WHO and FAO estimate that 27% of all deaths that occur in East Africa is due to low intake of fresh fruits and vegetables (lhucha, 2011). Generally, in African countries, most people consume less than one serving of fruit per day (Oniang et al., 2003). According to Lock et al. (2005), increased fruit and vegetable consumption has a significant role in reducing the incidence of non-communicable diseases (NCDs), a main reason for almost 25% of all deaths in Uganda (Ihucha, 2011). Although Uganda produces a substantial volume of fruits and vegetables, the average daily fruit and vegetable consumption is only 50% (200g) of the daily intake of 400g recommended by the WHO (lhucha, 2011).

In addition to the problem of NCDs, malnutrition and related deaths are common, especially among children (Kikafunda et al., 1998; Bachou et al., 2006). According to a World Bank report (2009), 28% of preschool children and 23% of pregnant women are found to be deficient in vitamin A. Fruits and vegetables are rich in vitamins and minerals. Additionally, a higher consumption of the same can also alleviate the problem of widely prevalent malnutrition.

The risks of disease and death due to NCDs and malnutrition will be higher in households with low consumption of fruits and vegetables given the WHO and FAO conclusions (lhucha, 2011). Yet, the general statements provide little guidance for targeting specific groups or regions

in a given country. The detailed analysis is commonly prevented by the lack of micro-level data, but Moreover, the presence of the phenomenon of weight management problem and malnutrition in a developing country seems counterintuitive and tends to be ignored. Both problems pose a challenge to policy makers and commonly are addressed by different types of policies. However, the increased fruit and vegetable consumption is recommended for the weight management problem, vitamin deficiency, and the overall health improvement. Therefore, the examination of how fruit and vegetable consumption is distributed across households fills the knowledge gap with respect to policy decisions, program formulation and implementation aimed at increasing consumptions of these foods. Further, knowledge about the characteristics of households that regularly consume of some of the commonly available fresh fruits and vegetables guides the implementation of programs aimed at increasing their consumption.

The following objectives are formulated to identify household groups in terms of their weekly fruit and vegetable expenditures, and to classify households according to the self-reported regular consumption of selected fresh fruits and vegetables. Both objectives account for the household location to discover possible regional variations. The first objective is the examination of fruit and vegetable expenditure pattern among urban households in Uganda. The realization of this objective identifies socioeconomic and demographic factors influencing fruit and vegetable consumption providing insights needed to selectively target the vulnerable groups. The study analyzes the expenditure pattern in detail by examining the distribution of expenditures in question, rather than limiting the investigation to changes in conditional mean of the distribution. To achieve this objective the censored quantile regression approach is employed. It is considered that influence of income can vary across different points in the distribution of expenditures. The approach supercedes the alternative estimation techniques in its policy-

relevance in determining the importance of income in increasing fruit and vegetable consumption in households with low fresh fruit and vegetable consumption. The second objective is to determine factors that influence the self-reported regular consumption of commonly available fruits and vegetables by Ugandan households using the multivariate probit regression method.

Theoretical Framework

Generally, the analysis of household expenditures, based on cross sectional data, highlights the Engel curve specification. An Engel curve describes the variation in expenditure on a good such as food in relation to the variations in total resources available to the household, such as income or total expenditure. Apart from variation in household income, socioeconomic and demographic factors cause consumer preferences to vary (Nayga, 1995), which, in turn, influence the pattern of spending across households. Given that preferences are not observable, socioeconomic and demographic factors must proxy for variation in preferences. By considering fresh vegetables or fresh fruits as one good and all other goods as a composite good, we can represent a household's preferences by a utility function (Deaton and Muellbauer, 1980):

$$U = f(F, X; T),$$

where F = fresh vegetables or fruits, and X = composite good, and T represents tastes and preferences. This utility is maximized subject to the budget constraint which is,

$$I = P_F * F + X,$$

where I = household income, P_F = price of fresh fruit or fresh vegetable and the composite good serves as numeraire. The utility maximization leads to the demand function

$$Q_F = f(P_F, I; T),$$

where Q_F = quantity of fresh vegetables or fruits demanded. . Given price and quantity demanded, the expenditure function becomes

$E_F = P_F * Q_F = P_F * f(P_F, I; T)$,

where E_F= expenditure on food, fuel, education or other services. In studies applying cross-sectional data prices are assumed constant across households and expenditure function becomes E_F= f (I; T). Socioeconomic and demographic variables represent the tastes and preferences (Buse and Salathe, 1978).

Data

The descriptive statistics of the variables used in this analysis are given in Table 1. Further, the weekly and per capita fresh fruit and vegetable expenditures in four quantiles are shown in Table 2. From data in Table 2 it is clear that in all quantiles, and also on average, fresh fruit expenditures are lower than fresh vegetable expenditures. Table 3 provides information on these expenditures across two income categories that are constructed based on the average monthly household income in $, i.e., one below or equal to and the other above the average income of $237. The households with more than average income reported more expenditure on fresh fruits in all quantiles, compared to households with average or lower income. However, the difference in fresh vegetable expenditures is very distinct in the lowest qunatile, i.e., 25th quantile. These differences indicate that there is a strong positive relationship between fresh fruit and vegetable expenditures and monthly household income.

A common problem associated with household expenditure surveys is the presence of households with zero expenditure. In the data set used in this study, there are 102 observations (6.3%) with zero values in the case of fresh vegetable expenditures, and 352 observations

(21.4%) in the case of fresh fruit expenditures. A censored regression method is used to handle this problem, and is discussed in the empirical section that follows.

Empirical specification

To achieve the first objective of determining factors that influence the pattern of fresh fruit and vegetable expenditures across the whole distribution of expenditures, a censored quantile regression (CQR) is employed. To accomplish the second objective of how regular consumption of selected fresh fruits and vegetables varies across households, a multivariate probit regression is used. The following sections explain the econometric theory behind these methods.

Censored quantile regression

Quantiles are points on the cumulative distribution function of a random variable that divide the distribution into two parts. For example, using the information from the dataset that is given in Table 2, the 25^{th} quantile of weekly fresh vegetable and fruit expenditures are $0.58 and $0.19, respectively. These indicate that 25% of all households in the dataset spent at least $0.58 and $0.19 for purchasing fresh vegetables and fruits, respectively, and 75% of households spent more than these amounts. The influence of various factors on these expenditures may vary across these quantiles, which will not be evident if the analysis is limited to an examination at the conditional mean of the distributions. From a policy implementation perspective, it is desirable to have more information on the effects of socioeconomic and demographic factors on different distribution levels of expenditures, rather than just on the conditional mean of expenditures.

The information about how factors influence expenditures across their whole distribution can be gathered by employing the quantile regression (QR) approach introduced by Koenker and Bassett (1978). Here, different conditional quantiles are chosen according to the purpose of study, and each of these quantiles is modeled as a function of covariates. Therefore, the effects of covariates on different parts of the population can be analyzed to arrive at conclusions that are more reliable and practical as far as formulation and implementation of policies are concerned. Some of the food expenditure and demand analysis studies using QR include Deaton (1997), Gustavsen and Rickertsen (2006) and Bagarani et al. (2009). [NOTE: these are potential reviewers, so very carefully re-read their papers and see if we do everything correctly; seek advice from Stat profs if needed; I want to submit this paper for publication very soon after it is posted, and we want to aim for a solid journal]

For estimating the conditional mean using OLS, the sum of squares of the residuals are minimized to get the estimated coefficients that are close to the original parameters. However, in QR, absolute values of residuals are minimized as shown in the following function:

$$Min_{\beta_p}\left[p\sum_{y_i \geq x_i^{'}\beta_p}\left|y_i - x_i^{'}\beta_p\right| + (1-p)\sum_{y_i \geq x_i^{'}\beta_p}\left|y_i - x_i^{'}\beta_p\right|\right]$$

Here, β_p represents the set of parameters in a particular quantile that is to be estimated. This estimation uses the weighted data of the whole sample, with *p* as the quantile chosen. First component of the sum in the above function is the total of vertical distances of data points that lie above the fitted line ($x_i^{'}\beta_p$), and the second component of the sum is for the data points that lie below the fitted line, with respect to a particular quantile. The QR estimator (β_p),for a particular

quantile (p), is found by an algorithm that minimizes the weighted function shown above. If the quantile is 0.5, it becomes the conditional median function. The quantile estimator is also known as the least absolute deviation estimator (LAD). For other quantiles, observations above the regression line are given a weight of p, while those below that line have a weight of 1-p.

An advantage of QR is that it is more efficient than the OLS when there is heteroskedasticity, a commonly encountered problem with cross-sectional data sets (Deaton, 1997). Buchinsky (1998) points out that when error terms are not normally distributed or when there are outliers in the dataset, QR is more efficient than OLS.

A portion of households responding to the survey reported zero expenditure on fresh vegetables, and more, often on fresh fruit during the period preceding the survey. The presence of zero expenditure in the data set renders an ordinary ineffective as a censored method of estimation, especially at lower quantiles. In the latter method, the data are censored at zero. A commonly used method for handling the censored data is the Tobit method (Amemiya, 1984). However, since the problems of non-normality and heteroscedasticity are very common in estimations using cross-sectional data sets, in such instances, the Tobit estimates may be biased and inconsistent leading eventually to inexact policy recommendations. To prevent these problems, the censored quantile regression (CQR) is employed in this study. According to Powell (1986), the CQR estimators will be consistent in the above mentioned instances. A CQR model with censoring at zero can be written as

$$Q_\theta(y_i \mid x_i) = \max\{0,\, Q_\theta(x_i'\beta_\theta + \varepsilon_{\theta i} \mid x_i)\} = \max\{0,\, x_i'\beta_\theta\}.$$

The CQR estimator is found by solving the minimization problem proposed by Powell (1986)

$$\min_{\beta_\theta} \frac{1}{N} \sum_{i=1}^{N} [\{\theta - I(y_i < \max\{0, x_i'\beta_\theta\})\}(y_i - \max\{0, x_i'\beta_\theta\})]$$

where *I* is an indicator assuming a value of one when the expression holds and zero otherwise. If $x_i'\beta_\theta \leq 0$ for an observation, then max $\{0, x_i'\beta_\theta\} = 0$ and only observations for which $x_i'\beta_\theta > 0$ are used for minimizing the above function. Gustavsen and Rickertsen (2006) used an iterative algorithm proposed by Buchinsky (1994) to solve the minimization problem. The algorithm uses all observation to calculate predicted values, $x_i'\hat{\beta}_\theta$. Next, the observations that yield negative predicted values are deleted and the procedure is repeated until the convergence of two successive iterations.

The analysis applies the CQR in the case of the lowest quanile, i.e., 25th and the QR is employed for the remaining three quantiles, i.e., 50th, 75th, and 90th. For each quantile, there are two equations, one each for fresh fruit and fresh vegetable expenditure, respectively. The dependent variable is the weekly expenditures recorded during the survey, and the explanatory variables include the independent variables described in Table 1. The functional form used is the double-log form, because of the convenience in interpreting the estimates associated with continuous explanatory variables. The continuous variable estimates are the unit free elasticities (Gujarati and Porter, 2009). Given that there are zero expenditures in both response variables (i.e., fresh vegetable and fruit expenditure), and in such cases taking the natural logarithm will not be possible, a value of one is added to all expenditure observations in the dataset. The natural logarithm of one is zero and, therefore, the censoring can be applied as in the case of a response variable without any transformation.

Multivariate probit regression

A multivariate probit analysis is useful in empirical analysis when there are more than one equation each with a binary response variable and when it is plausible to assume that error terms could be correlated across equations. When there are 'M' such equations, each equation can be represented by a latent equation,

$y_{im}* = \beta_m' X_m + \varepsilon_{im}$, m= 1, ...,M.

However, since the latent response variable is not observed, the observed response, y_{im} will take a value of 1 if $y_{im}^{*} > 0$ or, 0. The individual error term in each equation is distributed as a standard normal variable with a mean of zero and variance of one. However, because error terms are likely to be correlated with each other, they (M error terms) have a multivariate normal distribution with mean zero and a variance-covariance matrix, V. This matrix V has a value of one on the leading diagonal and co-variances, $\rho_{jk} = \rho_{kj}$ on off diagonals.Seven equations for fresh vegetable con spinach/kale; and the eight fresh fruits are apple, banana, pineapple, orange, watermelon, mango, passion fruit, and avocado. The response variable in each of fifteen equations is binary variable that takes a value of one when the consumption of a particular vegetable or fruit was reported by a respondent as "regular" in the household, zero otherwise. Here, regular consumption implies a frequency of at least four times a week. The explanatory variables are socioeconomic, demographic and location variables described in Table 1.

Estimation Results

The results from the CQR (for 25^{th} quantile) and the QR for the other three quantiles are presented in the following two sub-sections. Fresh fruit and fresh vegetable expenditures are discussed separately. In addition, the results from the OLS are included and compared with the quantile regression results.

Expenditure on Fresh Fruits

Table 4a shows the estimation results from the fresh fruit expenditure equation across four different quantiles (i.e., 25th, 50th, 75th, and 90th) and from the OLS regression. Among the socioeconomic factors, the household income has a significant and positive effect on fresh fruit expenditure. The result is in accordance with the results from previous studies (e.g., Cook, 1990; He et al., 1995; Nayga, 1995; Weatherspoon et al, 2012; Weerahewa et al., 2013). The household income is significant in all quantiles and conditional mean. The positive relationship is expected because fresh fruits are considered normal goods. However, the magnitude, i.e., the income elasticity of expenditure, is the highest in 25th quantile, where it is more than double the magnitude in other quantiles. This result is very important, since usually policies that are formulated to increase fruit consumption aim to provide income support to households with low consumption. The income elasticity of expenditure of 1.04 in 25th quantile means that a one percent increase in monthly household income can increase the weekly fruit expenditure by more than one percent., The change in response to income increase is important considering the benefits of having an adequate volume of fresh fruits in the daily diet, especially in a country like Uganda. The value of 1.04 is slightly higher than one, and implies that fresh fruits might be considered luxury goods by households in 25th quantile. The special nature of fresh fruits is indirectly reflected in the noticeably higher proportion of households reporting zero fresh fruit expenditure as compared to zero fresh vegetable expenditure In the other three quantiles, the magnitude of elasticity is less than that in the conditional mean of the distribution.

Another socioeconomic factor that significantly influences the expenditure is education of a respondent, which has a positive effect in all quantiles and conditional mean. The magnitude of this effect is the highest in 25th quantile, and decreases across the upper quantiles.

In developed countries, more educated persons are more likely to be exposed to information about the health benefits of consuming fresh fruits than their less educated counterparts. It appears that in lesser developed coutries the effect of formal education is similar. Educated adults plausibly influence the diet of the households by including more fresh fruits in the diet. The result is very compelling, especially because the effect is the highest (more than 600% increase, compared to 90th quantile) in 25th quantile, which includes households with the lowest fresh fruit expenditures and low income.

The occupation of a respondent is statistically significant in some quantile equations. The households with respondents who report having a permanent job have higher fresh fruit expenditures than those households with respondents in "other" jobs. The effect is significant only in 25th and 50th quantiles and conditional mean. The magnitude of this effect is highest in 25th quantile. Those who are self-employed also have a positive effect in 25th, 50th, 75th , and conditional mean of the distribution. Those who are in other jobs might experience uncertainty with regard to income flow as compared to those who are in a permanent job or are self employed.

The effects of demographic variables are different among quantiles and between qunatiles and the conditional mean. Age of the respondent has negative effect on fresh fruit expenditure only in 25th and 50th quantiles. This means that as a person becomes older, she tends to eat less fresh fruits, especially those in households that are in the bottom two quantiles. An increase in the number of adults increases the expenditure in 50th, 75th, and 90th quantiles. An increase in the number of children also increases the fresh fruit expenditure, but, only in the two highest, 75th and 90th, quantiles. This result is consistent with expectations that the effect of income suggestsfruit to be a luxury good for low income households. At the same time, the result

confirmins the suspicion of higher risk of malnutrition to be widely prevalent among children in Uganda. Children in low income households are first be fed other foods before the households spend on fresh fruit. The results using dummy variables indicating the presence of children in different categories of age are significant only in 90th quantile and confirm the status of the fruit as a luxury. Households with children of 3 or less years of age, spend more than those households without such children, while those households with children of age between 4 and 12 spend less than the households without such children. If the respondent is male, then such households spend less on fruit, compared to those households with a female respondent. This effect is significant in 25th, and 50th quantiles, and also in conditional mean of the distribution. Marital status is significant only in 90th quantile, where the households with married respondents spend less.The distance to the nearest retail outlet has a positive effect in 25th and 50th quantiles, and also at cond to that outlet only once in a week or less than that, and they make more purchases in such instances, compared to those households that have nearby retail outlets. Because households with nearby retail shops can purchase fresh fruits as when they are needed, such households have lower weekly expenditures.

The location is indicated by dummy variables for four cities, i.e., Gulu, Lira, Mbale, and Soroti. Kampala, the capital city, is used as a reference location. Clear regional differences are confirmed by the results. The households from Lira spend less on fresh fruits, compared to those from Kampala, and this result is significant in 25th, 50th, and 75th quantiles and at the mean. The households from Mbale spend more than Kampala households, in 90th quantile, and similarly households, in 75th and 90th quantiles, from Soroti also spend more than the households from Kampala.

Expenditure on Fresh Vegetables

Table 4b shows estimation results from this equation[?]. Among the socioeconomic factors, monthly household income has a highly significant and positive effect on fresh vegetables expenditure at all four quantiles. The OLS estimate is also statistically significant with a magnitude higher than all the quantile estimates. The estimates are income elasticities of expenditures with values between zero and oneindicating fresh vegetable contrasts with fresh fruit expenditure in Ugandan households. The result regarding vegetable expenditure is consistent with several previous studies (e.g., Capps and Love, 1983; Nayga, 1995; Blisard et al., 2002). The magnitudes of these elasticities are very low, suggesting that an income support like in the case of fresh fruits might not be successful for increasing vegetable consumption, especially for households in the 25^{th} quantile. Since the average household income of $165 in the sample is more than the average income of households in 25^{th} quantile of fresh fruit expenditure, such households might have been purchasing sufficient quantities of fresh vegetables. Education has a positive effect in 25^{th}, 50^{th}, and 75^{th} quantiles, and also in conditional mean of the distribution. It is interesting to note that education has no effect in 90^{th} quantile. Among the job categories, only respondents who are self employed have a positive effect on fresh vegetable expenditure, that too only in 25^{th} quantile.

Age of the respondent has a negative effect in 25^{th}, 50^{th}, and 90^{th} quantiles and mean. Aging respondents may need less fresh vegetables because they tend to eat less in general as the daily activities require less energy and the overall physical abilities become limited. Number of adults has positive effect in all quantiles and mean. A larger number of adults in a household requires more volume of food including vegetables leading to the positive effect of the number of adults on fresh vegetable expenditure in across all quantiles. The influence of children is not clear. The number of children in a household has a positive effect only in 50^{th} quantile. It would

seem that the number of children would have a similar effect as that as the number of adults although it can be modified by children ages, i.e., households with many very young children may not be prone to spend more on fresh vegetables, whereas those with older children could behave similarly to households with a large number of adults.

Among the locations, households from Gulu, Mbale, and Soroti spend more on fresh vegetables, while households from Lira spend less, compared to households from Kampala. These cities may have access to fresh vegetables at an affordable cost, compared to Kampala. The effect of expenditure in households from Soroti is highly significant [I was once told that it is either significan or not significant; the term 'highly significant' seems redundant; do you have any advice from Stat profs regarding this issue?] in all quantiles, but, not in the conditional mean of the distribution. This result emphasizes the importance of examining the whole distribution.

Regular consumption of selected fresh fruits and vegetables

This analysis was done with eight equations for selected fresh fruits and seven equations for selected fresh vegetables. The equations for fresh fruits and those for fresh vegetables are separately analyzed using the multivariate probit regression method. The results from these two analyzes are discussed below.

Selected fresh fruits

Table 4c shows the proportion of households that regularly eat each of the selected eight fresh fruits. Avocado, banana, and mango are the mostly consumed fresh fruits. The multivariate probit results are given in Table 4d. These results indicate the direction of the effect of statistically significant coefficients of the explanatory variables. If the sign is positive, the likelihood of regular consumption of that particular fresh fruit will be more with one unit

increase in the case of a continuous explanatory variable, and with a change from zero to one in the case of a binary explanatory variable.

An increase in household income will increase the likelihood of the regular consumption of pineapple and watermelon. An increase in the education level increases this likelihood of regular consumption all fresh fruits, except mango and avocado, two mostly regularly consumed fresh fruits. Households with the permanently employed respondents are more likely to report regular consumption of apple, banana, watermelon, and avocado, while those of the self employed respondents are more likely regularly consume only pineapple, compared to those with respondents in "other" jobs.

An increase in age of respondents increases the likelihood of the regular consumption of watermelon and mango. Also, an increase in the number of adults increases the likelihood in the case of banana, orange, mango, passion fruit, and avocado. The increasing number of children in a household decreases the likelihood of regular consumption of apple, pineapple, and watermelon. Because the malnutrition among children is widespread in Uganda, this result is a cause of concern, especially because these fruits are considered rich in vitamins, minerals, and antioxidants. Though apples are imported, the other two fruits are locally grown in Uganda. Also, the households with male respondents have lesser likelihood of the regular consumption of mango, passion fruit and avocado. Households with married respondents have a higher likelihood of consuming avocado regularly.

Regarding the household location, a binary variable assumes the value of one if a particular household is from Kampala. Therefore, the result compares the effect of being located in other cities to residents of Kampala households. The latter show a higher likelihood of regularly consuming apple, banana, pineapple, watermelon, and avocado. Households consuming

orange and mango are more likely located in any of the other four cities. An increase in the distance to the nearest retail outlet will increase the likelihood for regularly consuming avocado.

Selected fresh vegetables

Table 4e shows the proportion of households with regular consumption of the selected seven fresh vegetables. Among the seven fresh vegetables, tomato, cabbage, and Irish potato are consumed most commonly. Table 4f shows the results from the multivariate probit analysis. An increase in household income has a positive effect on the regular consumption of cauliflower/broccoli. Education has positive effect on the regular consumption of carrot, Irish potato, and spinach/kale. Spinach is a good source of vitamin A and could alleviate the possible deficiency in the population. Households with permanently employed respondents have a higher likelihood of regularly consuming Irish potato or spinach/kale, while those with the self employed respondents have a higher likelihood of the regular consumption of cabbage, Irish potato, and spinach/kale.

An increase in the age of the respondent increases the likelihood of the regular consumption of spinach/kale. An increase in the number of adults increases the likelihood in case of pepper, cabbage, and spinach/kale. As number of children increases, the likelihood of reporting a regular consumption of Irish potato, and spinach/kale decreases. This result which is similar to that from fresh fruit consumption is also of a concern to the policy makers. The households with male respondents have higher likelihood of regularly consuming pepper, while, they have less likelihood with Irish potato, and spinach/kale. Households from Kampala have higher likelihood of having regular consumption of all fresh vegetables, except pepper, compared to households located in the other four cities.

Discussion

The results from these analyzes have implications for formulating policy decisions and implementing programs aimed at increasing fresh fruit and vegetable consumption in the Republic of Uganda. The income elasticity of expenditures from the fresh fruit expenditure equation is very important to policy decision makers. A study by Stewart et al. (2003) about the US households regarding the effect of income on the distribution of fruit expenditures among low income households conclude that there is no income effect in low income households and therefore, and income support to such households may not increase the fruit consumption. However, this analysis tells that an increase in income of households, especially those at 25^{th} quantile, can substantially increase fresh fruit consumption. Therefore, an income support to such households can bring about an increase in fresh fruit consumption. Though in this study the data were not divided into two based on household income (see Stewart et al., 2003), the average income of households in 25^{th} quantile is found to be $142, against the total average of $237. Therefore, the assumption that households in 25^{th} quantile of fresh fruit expenditure are also, on an average, low income households can be valid.

The income elasticities of expenditures from fresh vegetable expenditure equation are very low in magnitude. Therefore, an increase in income cant be expected to bring at best a modest change in fresh vegetable expenditures. A policy of income support may not be effective in increasing the fresh vegetable consumption. Rather, educating people about the benefits of fresh vegetable consumption would a better alternative given the confirmed effects of education. Regional differences will also need to be accounted for while implementing programs.Concerns linger regarding regular consumption will be less likely in households with more number of children. This becomes more important on the backdrop of the fact that malnutrition is widely prevalent among children. a formulation and implementation of an effective programs targeting such households

remains a challenge because it may be perceived as rather unimportant in the context of a number of pressing social issues. Another concern is that household income lacks a significant effect in case of regular consumption of most of the fresh fruits and vegetables. Therefore, educational programs should be given more emphasis to increase the fresh fruit and vegetable consumption to sensitize consumers to this important health-relevant issue.

Based on the results, the characteristics of households and respondents that belong to the 25^{th} quantile will be of interest to policy makers. Such a profile is given for both fresh fruit and fresh vegetable expenditures in Table 5. Several characteristics are different between fresh fruit and vegetable expenditures in the 25^{th} quantile. For example, the monthly household income is lower in households with low expenditures on fresh fruits, compared to fresh vegetable expenditures. Also, the number of respondents with more formal education is less in fresh fruit expenditure profile. Proportions of households with children in all age ranges is more in fresh fruit expenditure profile, suggesting the importance of targeting such households for increasing fresh fruit consumption.

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Table 1. Descriptive Statistics of the Variables

Variable	Mean	Std. Dev.	Min	Max	Description
Dependent					
Vegexp	1.784468	2.31964	0	32.90747	Weekly vegetable expenditure in $
Fruitexp	1.264337	1.936468	0	32.52032	Weekly fruit expenditure in $
Independent					
Respgend	0.2783883	0.4483425	0	1	Gender of the respondent 1=male; 0=female
Married	0.6923077	0.4616794	0	1	Marital status of the respondent 1=married
Age	35.33911	12.35561	17	89	Age of the respondent in years
Permanent	0.1342649	0.3410403	0	1	Permanent job
Self	0.3718104	0.483435	0	1	Self employed
Others	0. 4914945	0. 5000796	0	1	Other jobs*
Education	0. 345079	0. 4755385	0	1	1=upper secondary or higher
Totalincome	237.01	771.76	0.39	25938.83	Total monthly household income in $at the bootm
Adults	2.2930403	1.4136391	0	15	Number of adults in the household
Child	3.018834	2.111542	0	12	Number of children in the household
Child3dum	0.54884	0.4977609	0	1	1= if a household has children of 3 years of age or younger
Child12dum	.6721612	.4695691	0	1	1= if a household has children of age between 4 and 12
Child18dum	0.4822955	0.4998391	0	1	1= if a household has children of age between 13 and 18
Shopdist	573.0996	1925.962	0	50000	Distance to the nearest retail outlet in meters
Gulu	0.1215067	0.3268145	0	1	Residence in Gulu (=1)
Lira	0.1221142	0.3275172	0	1	Residence in Lira(=1)
Mbale	0.1215067	0.3268145	0	1	Residence in Mbale(=1)
Soroti	0.1172539	0.3218204	0	1	Residence in Soroti(=1)
Kampala	0.5152625	0.4999196	0	1	Residence in Kampala (=1)*

* Reference category

Note: $1=2583 UGS

Table 2. Weekly and per capita fresh vegetable and fruit expenditures in four quantiles, in $

Weekly expenditure (in $) of	Quantiles				Mean
	0.25	0.5	0.75	0.90	
Fresh vegetables	0.58	1.16	1.94	3.87	1.78
Fresh fruit	0.19	0.77	1.9	3.1	1.26
Fresh vegetable per capita	0.17	0.35	0.72	1.29	0.61
Fresh fruit per capita	0.05	0.25	0.53	0.94	0.42

1 $ = 2583 UGS (according to the exchange rate in June 2011

Table 3. Weekly and per capita fresh vegetable and fruit expenditures in four quantiles in two income categories[a], in $,

Weekly expenditure (in $) of	Quantiles				Mean
	0.25	0.5	0.75	0.90	
Fresh vegetable (income <=$237)	0.39	1.16	1.94	3.87	1.69
Fresh vegetable (income >$237)	0.77	1.16	2.32	4.07	2.03
Fresh fruit (income <=$237)	0	0.58	1.36	2.32	1.04
Fresh fruit (income >$237)	0.5	1.16	1.94	3.87	1.84
Per capita fresh vegetable (income <=$237)	0.15	0.33	0.7	1.23	0.61
Per capita fresh vegetable (income >$237)	0.22	0.39	0.73	1.36	0.6
Per capita fresh fruit (income <=$237)	0	0.21	0.46	0.85	0.37
Per capita fresh fruit (income >$237)	0.16	0.35	0.72	1.21	0.56

$ 1 = 2583 UGS (according to June, 2011 exchange rate)

[a] i.e., higher and lower than the average monthly income of $237.

Table 4a. Estimation results from the fresh fruit expenditure equation

Quantiles/variables	25	50	75	90	OLS
Income elasticity of exp	1.04[3] (0.32202)	0.41[3] (.0561862)	0.34[3] (.0605007)	0.35[3] (.0401452)	0.67[3] (.0980607)
Log(age)	-1.32447[2] (0.5599)	-.3685479[2] (.1622806)	.0478971 (.100243)	-.0270822 (.1380321)	-.4653128 (.3292006)
Log(adults)	0.18482 (0.29638)	.2691642[2] (.1167609)	.2724406[3] (.10084)	.2950778[3] (.0829214)	.271349 (.2069133)
Log(children)	-0.15729 (0.225)	.1841207 (.1375198)	.1794767[1] (.0949159)	.2001161[2] (.0913338)	.1731246 (.2223791)
Child3dum	-0.20434 (0.35103)	.0718449 (.1163415)	.1114153 (.1039335)	.167105[1] (.0995467)	.0516742 (.2114029)
Child12dum	-0.10106 (0.52189)	-.092907 (.1406095)	-.2697569 (.1693244)	-.2392345[2] (.095946)	-.3886065 (.2580827)
Child18dum	-0.1284 (0.21381)	-.0837514 (.1320509)	-.1390342 (.0911553)	-.1231195 (.1153493)	-.1782602 (.2371233)
Adultfdum	0.17269 (0.66543)	-.0020758 (.1442838)	.1644346 (.1510962)	-.0868508 (.1875306)	.1529979 (.3313606)
Log(shopdist)	0.31576[1] (0.16345)	.0566326[1] (.0289171)	.0036956 (.0292292)	-.0055705 (.0224009)	.151199[3] (.0545735)
Respgender	-0.725[3] (0.49514)	-.2721301[2] (.1250796)	.0285552 (.0980065)	-.0224446 (.1548369)	-.4535658[2] (.2110897)
Married	-0.06521 (0.29316)	-.1220576 (.0853078)	-.1294711 (.1125175)	-.1850895[1] (.0929541)	.0175096 (.2077537)
Education	1.6407[3] (0.53904)	.5915546[3] (.1073206)	.3639489[3] (.0801924)	.2623763[2] (.1124209)	.956001[3] (.2104382)
Permanent	1.44646[3] (0.7079)	.2650806[2] (.107837)	.0984823 (.1266279)	.0192114 (.1766858)	.7303599[2] (.2894361)
Selfemploy	0.82557[3] (0.4061)	0.2934122[3] (.0896187)	0.160804[1] (.0894066)	.1599427 (.114)	.5679664[3] (.1945261)
Gulu	-2.11635 (2.53328)	-.0560918 (.1600212)	-.0912386 (.1376672)	.0466497 (.2457371)	-.5209174 (.3288639)
Lira	-3.57295[3] (1.48259)	-.4034907[1] (.2259551)	-.2909714[2] (.1172312)	-.0824773 (.1629081)	-1.188195[3] (.2886456)
Mbale	-1.75715 (1.07715)	-.0602084 (.2348426)	.1715714 (.1696375)	.4565715[3] (.1242733)	-.4877778 (.3072471)
Soroti	-1.06654 (2.11172)	.0432515 (.1129969)	.2001896[2] (.0856251)	.3026031[3] (.0894215)	-.2512901 (.3134953)
Constant	-5.39154 (5.22004)	2.764423 (1.026716)	3.274816 (.9654994)	4.030591 (.7525484)	-1.931769 (1.689154)

Note: [3], [2], and [1] denote significance at 1%, 5%, and 10% levels, respectively. Standard errors in parentheses

Table 4b. Estimation results from the fresh vegetable expenditure equation

Quantiles/variables	25	50	75	90	OLS
Income elasticity of exp	0.13[3] (0.02507)	0.16[3] (0.04277)	0.19[3] (0.0347)	0.16[3] (0.04457)	0.23[3] (0.06547)
Log(age)	-0.6099[3] (0.12965)	-.2738986 (.1683983)	-.2448111[2] (.0999399)	-.2596173[3] (.0934055)	-.8342185[3] (.2197765)
Log(adults)	0.36651[3] (0.14145)	.227076[3] (.0824194)	.3586059[3] (.057912)	.3029264[3] (.086547)	.3482489[2] (.1381367)
Log(children)	0.13831 (0.20794)	.1941667[1] (.1174004)	.0509169 (.1005931)	.1306144 (.085973)	.2111842 (.1484617)
Child3dum	0.12314 (0.08327)	.0562948 (.0922356)	.1980294[2] (.0846347)	.2588673[3] (.0696302)	.2465126[1] (.141134)
Child12dum	-0.02044 (0.09657)	-.0786317 (.131025)	-.0122447 (.1539768)	-.0826607 (.0980609)	.0087047 (.1722977)
Child18dum	0.08983 (0.1531)	-.0245647 (.0961606)	.0520615 (.1106487)	-.0054166 (.0919914)	.1266558 (.158305)
Adultfdum	0.26855 (0.19455)	.265941[2] (.1132876)	-.116849 (.1798201)	-.1149714 (.2440866)	.1098828 (.2212185)
Log(shopdistance)	-0.00006 (0.02013)	-.0023264 (.0222548)	.0212501 (.0162307)	.0017644 (.0172361)	.0246619 (.0364336)
Respgender	-0.06607 (0.06169)	.0147398 (.0843987)	.0355084 (.11045)	.1195333 (.0925076)	-.2515419[1] (.1409249)
Married	-0.02345 (0.12442)	-.0406418 (.071851)	-.0300543 (.0876897)	.0044549 (.0922064)	-.0355888 (.1386977)
Education	0.49[3] (0.15924)	.2340528[3] (.0692478)	.1595003[3] (.0604867)	-.0177891 (.0762215)	.3249732[2] (.14049)
Permanentemploy	0.14849 (0.09266)	.1209914 (.0751352)	.050874 (.0767577)	.0986373 (.1048641)	.3129316 (.1932295)
Selfemploy	0.28364[3] (0.10834)	.1423431 (.0879432)	.0703909 (.0695633)	.1199928 (.0763935)	.2070468 (.1298669)
Gulu	0.52141[3] (0.14688)	.3317956[3] (.09428)	.2669879 (.1719935)	.3422465[2] (.1428188)	.0041797 (.2195517)
Lira	-0.42291[3] (0.16377)	-.3780675[3] (.1322615)	-.3353447[3] (.0846886)	-.4463843[3] (.1062067)	-.8113941[3] (.1927017)
Mbale	0.35148[3] (0.178)	.5435479[3] (.1026355)	.7449089[3] (.1006295)	.838575[3] (.0994945)	.5988808[3] (.2051202)
Soroti	0.43794[3] (0.17951)	.7550847[3] (.1113639)	.8455708[3] (.0870635)	.9409987[3] (.1430491)	.1245829 (.2092915)
Constant	6.54574 (1.35921)	6.022607 (.7370366)	6.374356 (.5425108)	7.262871 (.767192)	6.404914 (1.12769)

Note: [3], [2], and [1] denote significance at 1%, 5%, and 10% levels, respectively. Standard errors in parentheses

Table 4c. Proportion of households with regular

consumption of selected fresh fruits

Fresh fruit	Proportion of households reporting regular consumption
Apple	0.2
Watermelon	0.33
Pineapple	0.45
Orange	0.46
Passion fruit	0.47
Mango	0.52
Sweet banana	0.6
Avocado	0.63

Table 4d. Multivariate probit results related to regular consumption of fresh fruits

Explanatory variable	Apple	Banana	Pine apple	Orange	Water melon	Mango	Passion fruit	Avocado
Total income			More		More			
Age					More	More		
Education	More	More	More	More	More		More	
Permanent	More	More			More			More
Self employment			More					
Number of adults		More		More		More	More	More
Number of children	Less		Less		Less			
Respondent gender						Less	Less	Less
Kampala	More	More	More	Less	More	Less		More
Shop distance			More				More	
Married								More

Table 4e. Proportion of households with regular consumption selected fresh vegetables

Name of the fresh vegetable	Proportion of households with regular consumption
Cauliflower/broccoli	0.1
Spinach/Kale	0.18
Pepper	0.2
Carrot	0.41
Irish potato	0.56
Cabbage	0.68
Tomato	0.85

Table 4f. Multivariate probit results related to regular consumption of fresh vegetables

Explanatory variable	Tomato	Pepper	Carrot	Cabbage	Cauliflower/Broccoli	Irish potato	Spinach/ Kale
Total income					More		
Age							More
Education			More			More	More
Permanent						More	More
Self				More		More	More
Number of		More		More			More
Number of						Less	Less
Respondent		More				Less	Less
Married	Less						
Kampala	More	Less	More	More	More	More	More

Table 5. Average characteristics of households and respondents in 25th quantile of expenditures

Characteristic	Fresh fruit expenditure	Fresh vegetable expenditure
Average monthly income in $	142	165
Average age of the respondent (yrs)	37	35
Average number of adults	2.3	2.1
Average number of children	3.3	2.8
% of households with	56	54
children of 3 or less years of age		
% of households with	72	66
children of age between 4 &12		
% of households with	51	43
children of age between 13 &18		
% of households with an adult female	87	83
Average distance to the nearest shopping center (meters)	445	391
% of households with male respondents	32	26
% of households with married respondents	68	69
% of households with respondents with an education of upper higher secondary and above	19	21
% of households with permanently employed respondents	6	7
% of households with self employed respondents	32	36

% of households in Gulu	18	10
% of households in Lira	18	18
% of households in Mbale	14	9
% of households in Soroti	9	7
% of households in Kampala	41	56