A COMPREHENSIVE ANALYSIS OF HOUSEHOLD EXPENDITURES IN URBAN AREAS OF THE REPUBLIC OF UGANDA

by

PADMANAND MADHAVAN NAMBIAR

(Under the Direction of Wojciech J. Florkowski)

ABSTRACT

This comprehensive analysis aims to determine socioeconomic, demographic, and location factors that influence various household expenditures in urban households in the Republic of Uganda. The three essays in this dissertation examine different categories of expenditures. The first essay analyses different household expenditures like food, fuel, education, clothing, transportation, etc., employing multivariate Tobit estimation to determine important influential factors. Second essay examines specific food expenditures, i.e., fresh fruit and vegetable expenditures using censored quantile regression to arrive at suitable policy implications. The last one examines the importance of socioeconomic factors in variation in the pattern of peanut paste consumption frequency by applying zero inflated Negative Binomial model. Results conclude that income elasticity of expenditures for fuel, education, and transportation are much higher, while that for food is very low. Income elasticity of expenditure for fresh fruits for households that fall in 25^{th} quantile is slightly above one, indicating that an income support/ price discount may increase fresh fruit consumption in such households. Other factors like education, employment type, location, etc., also influence household expenditures. The household profiles created out of these results help policy decision

makers both in public and private sectors to target segments of their interest when implementing programs.

INDEX WORDS: Food expenditure, education expenditure, fresh fruit and vegetable expenditure, peanut paste consumption, multivariate tobit, censored quantile regression, negative binomial, Republic of Uganda, income elasticity of expenditure, multivariate probit regression

A COMPREHENSIVE ANALYSIS OF HOUSEHOLD EXPENDITURES IN URBAN AREAS OF THE REPUBLIC OF UGANDA

by

PADMANAND MADHAVAN NAMBIAR

B.S., Kerala Agricultural University, India, 1991

M.S., University of Georgia, 2010

A Dissertation Submitted to the Graduate Faculty of The University of Georgia in Partial Fulfillment of the Requirements for the Degree

DOCTOR OF PHILOSOPHY

ATHENS, GEORGIA

2015

A COMPREHENSIVE ANALYSIS OF HOUSEHOLD EXPENDITURES IN URBAN AREAS OF THE REPUBLIC OF UGANDA

by

PADMANAND MADHAVAN NAMBIAR

Major Professor: Wojciech J. Florkowski

Committee: Octavio Ramirez
Michael E. Wetzstein

Electronic Version Approved:

Suzanne Barbour
Dean of the Graduate School
The University of Georgia
August 2015

DEDICATION

Dedicated to my parents who are the reason for my existence and who are watching me from above, and to my wife, Shaku, my greatest inspiration.

ACKNOWLEDGEMENTS

I would like to thank the following persons who were instrumental in making this endeavor successful.

First and foremost, my major advisor Dr. Wojciech J. Florkowski for offering this great opportunity and giving me sufficient support, challenge and encouragement to pursue it along with all my other commitments, and more than that for being a kind human being, and a friend. Thank you Sir! I would not have earned this degree in this manner without you. I will treasure our association for the rest of my life.

Dr. Michael Wetzstein, for patient and critical review of my work and valuable suggestions throughout the period of our association. Your presence on my committee has greatly helped build and develop my perspectives about my subject.

Dr. Octavio Ramirez, for his solid support and encouragement of my project, as well as expert comments and suggestions to improve my work.

The Department of Agricultural and Applied Economics, University of Georgia for the excellent coursework and so many opportunities for professional interactions and development.

Special thanks to my friends Finto, Xiao Fei, Sam, Tina and Xuedong for their help and suggestions, and my family for their relentless encouragement and support in everything I do.

TABLE OF CONTENTS

Page

CHAPTER 1

INTRODUCTION AND LITERATURE REVIEW

One of the main indicators of development of a nation is the improvement in welfare of its people. This is especially true in the case of developing countries. In such countries, policies and programs for increasing the welfare of people are always a priority.

1.1 Background

The Republic of Uganda is a developing country from East Africa. It is divided into four regions comprising 112 districts, with about 18 different ethnic groups. The capital of Uganda is Kampala, which is situated in the central region, inhabited by five % of the total population. Over the past decade, the Ugandan economy has grown at an average rate of 5.4%% per year. This relatively high economic growth rate has been accompanied by a significant reduction in poverty. For example, over the past eight years preceding 2010, poverty has decreased from 38.8 % to 24.5 % according to the Uganda National Household Survey (Uganda Bureau of Statistics, 2010). Urban areas experienced a 5.3 % point decrease in poverty whereas in rural areas the decline was 15.5 % points. Examining regional poverty rates, eastern and northern Uganda have had the highest reduction in poverty rates (21.7 and 16.8 % points, respectively) compared to an 11.1 % point decline in Western Uganda. These statistics reveal that though Uganda has made significant leap toward economic growth and poverty reduction since the late 1980s, this achievement was not equally felt among regions or between rural and urban areas (Fan et al., 2004).

In 2009, around 37.7% of the people were below the international poverty line of the $1.25/day (World Bank, 2012). The national poverty line is described as $ 119/ person/ year. This can be translated to approximately UGS (Ugandan Schillings) 25600/person/month (at the rate of UGS 2583 per one $ as of 30th June 2011). In Uganda, 44% of the population earns less than UGS 60000 per month (only about $23). Even though there were signs of development and poverty reduction, the Republic of Uganda still faces a number of challenges including malnutrition, especially among children, who are the future of the nation. A very recent study, called "The Cost of Hunger in Africa" reveals that Uganda loses some UGS 1.8 trillion ($899 million) annually (approximately 5.6 % of its Gross Domestic Product) due to the effects of malnutrition (WFP, 2013). The study found that treating diarrhea, anemia, respiratory infections and other clinical conditions related to malnutrition costs Uganda UGS 526 billion ($254 million). Losses in productivity reached UGS 417 billion ($201 million) in manual sectors, such as agriculture, and UGS 241 ($116 million) in non-manual activities, due to lower educational levels. In the educational sector, the study estimated that 7 % of all repetitions in school are associated with stunting. This represented 134,000 repetitions for an estimated cost of UGS 20 billion ($9.5 million), for the government and the families.

All these alarming statistics indicate that welfare of the people might be at stake. Since the welfare can, to a certain extent, be studied by examining the patterns of household expenditures, a thorough analysis of household expenditures would be beneficial in locating the areas where welfare measures should be focused. According to the Uganda Bureau of Statistics (2003), the expenditures on food are the main share in total expenditures, representing a range of average monthly expenditure of 41% in the

eastern and 56% in the northern regions, respectively. However, in 2009, the lowest expenditure was in the central (38%) and highest in the northern (55%) region (UBS, 2010), respectively. That year, the mean annual income was highest in the central region (higher than the mean annual income in the eastern region), while it was the lowest in the northern region (Okurut et al., 2002). The expenditures on fuel, rent and power ranged from 16% in the northern to 20% in the central region (UBS, 2003), respectively. Expenditures on clothing are almost the same across these four regions and amount to around 4%, whereas both educational and transportation expenditures are highest in the central region (8%) and lowest in the northern region (4%). Similarly, health and other expenditures are also highest in the central (7%) and lowest in the northern region (5%). Also, all expenditure categories vary among the rural and urban population, especially in the case of food expenditures (UBS, 2003).

Among the food expenditures, expenditures on certain commodities, like fruits and vegetables require additional attention. This is because the consumption of such foods not only reduces the incidences of certain non-communicable diseases like cardiovascular diseases, certain cancers and diabetes, but also helps reducing the incidence of malnutrition. Another food that is consumed very frequently in Uganda is various peanut products. It has the potential to become a food that can be fortified with vitamin A, which is very important in the context of widely prevalent vitamin A deficiency in Uganda. Therefore, a comprehensive analysis of household expenditures on various categories may be helpful in planning the undertaking of welfare measures to alleviate the above mentioned problems. In this country, the household consumption contribution to GDP composition by end-use is about 86.3% (CIA Fact book, 2012), which is higher than that

in two neighboring East African countries, i.e., Kenya and Tanzania, and also most other countries in the world. Generally, consumption expenditures have been utilized to examine welfare condition of people in a country and such studies have been conducted in Uganda as well (for example, Appleton, 2001; Appleton and Ssewanyana, 2003).

1.2 Objectives

The three main objectives of this study are represented by three separate analyses that form the basis for each of the three essays. The first analysis determines various factors that influence the household expenditures in various categories, such as food, fuel, education, clothing, transportation, and others that include items such as medical, entertainment, social obligation, etc. The second essay examines factors that affect the expenditures on fresh fruits and vegetables, a regular consumption of which can contribute to the reduction of the problem of malnutrition. The final essay is about analyzing the characteristics of households with respect to the frequency of peanut paste / butter consumption.

1.3 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 food, fuel, education, or

other services as one good and all other goods and services as a composite good, household's preferences are represented by a utility function (Deaton and Muellbauer, 1980):

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

where F = food, fuel, education or other services, 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 food, fuel, education or other services and the composite good serves as numeraire. Utility maximization leads to the demand function

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

and Q_F = quantity of food, fuel, education or other services 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).

1.4 Data

The data are from a household survey conducted in 5 cities in the Republic of Uganda between April and June 2011. These are Kampala from the central, Gulu and Lira from the northern, and Soroti and Mbale from the eastern region. Kampala is the

capital and is the biggest city in Uganda. A total of 1,646 households were surveyed during this period.

1.4.1 *Information collected*

The questionnaire for the survey of urban households in Uganda was developed under the project supported by the Peanut CRSP - USAID. The questionnaire was developed and tested in October 2012 (Florkowski, 2013; personal communication). The data collection was performed by a private market research company after the enumerator training workshop held at the Uganda Industrial Research Institute monitored by Dr. W. J. Florkowski. Subsequently, due to, first the coming holiday season, and second, due to the approaching national presidential elections in January 2011, the survey was implemented between April and June 2011. In the period just prior and after the elections, urban respondents could be influenced in their responses as a result of the abnormal level of information and promotions, therefore, the data collection was delayed. The safety of enumerators was also considered.

The first part of the questionnaire probed for information on socioeconomic and demographic characteristics of households that were surveyed. Gender of household head, gender, age, marital status, education, and employment status of respondent were collected. Household information collected included sources of household income, income from each of these sources, household composition that included number of members gender- and age-wise. The second part has collected information on household food shopping and preparation habits, such as the frequency of food purchase from different types of sellers, distance to the nearest shopping center, time taken for food preparation, type of the fuel used for cooking, etc. The third part of the questionnaire

included questions asking respondents about details on expenditures under different categories, like food, fuel, clothing, education, transportation, others (includes medical, entertainment, social obligation, etc.), fresh fruits and vegetables, peanut paste/butter, and bulkfoods (i.e., rice, beans, millets, etc.). The fourth part asked about the attitudes of respondents toward fortification of foods. The next part of the questionnaire contains details on different forms of peanut consumption, including peanut paste/butter and opinions about various attributes of peanut products.

The last part of the questionnaire provided a list of foods identified as eaten by many urban residents in Uganda. A respondent was to mark what foods or items from a food category she ate "regularly" where the term "regularly" implied a food that is consumed relatively frequently such as more than three times a week. Due to budget constraint, seasonality of production or supply, varying accessibility and preference these foods may be eaten regularly although not necessarily as often as by consumers in high income countries. The identification of regularly eaten foods was intended not only as a measure of consumed food variety with possible implications for the suppliers and marketers, but also as a source of insights into preferences and balanced nutrition.

1.5 Empirical Models

The first objective is to analyze household expenditures in different categories. However, there are zero expenditures reported by some households during the survey period. The OLS estimation excludes zero observations from the analysis. The omission can lead to bias in estimations. Another issue in the analysis of household expenditures is that usually the household expenditures on different categories are made simultaneously (Fan and Lewis, 1999), and, therefore, the equations for different expenditure categories

may be correlated through errors. In such situations, the analyses should be done simultaneously for a system of equations, rather than individually. An accepted solution is the employment of multivariate tobit estimation. The multivariate tobit method estimates M-equation tobit models, by the method of maximum simulated likelihood (MSL) (Cappellari and Jenkins, 2006).

The second objective examines the pattern of fruit and vegetable to identify households that should to be targeted for the promotion of fruit and vegetable consumption assuming that the reported fresh fruit and vegetable expenditure correctly capture the typical purchase pattern. Therefore, to accomplish the stated objective, the quantile regression is applied, rather than just the conditional mean regression to accurately describe households for policies and programs aimed at increasing the fruit and vegetable expenditures. Some of the food expenditure and demand analysis studies using QR include Deaton (1997), Gustavsen & Rickertsen (2006) and Bagarani, Forleo, & Zampino (2009), but the current study also accounts for expenditure censoring. Many households in this study have not purchased fruits and vegetables during the survey period, the censored quantile regression is employed in the lowest quantile estimation. In addition, to broaden the insights into the fruit and vegetable consumption, the multivariate probit analysis is employed to determine the factors that influence the regular consumption of certain fruits and vegetables. The multivariate probit regression method has been applied for data analysis in diverse fields (for example, Gibbons and Wilcox-Gők, 1998; Cheng and Wen, 2011; Samal et al., 2011; Baskaran et al., 2013). The profile of households regularly eating certain fruits and vegetables complements the knowledge of households reporting fresh produce purchase.

The third objective focuses on finding factors that determine the frequency of peanut paste/butter consumption, a commonly consumed food item in Uganda. A count data model is employed because the dependent variable represents counts in this case. The Negative Binomial regression has been selected from the available count data model specifications, since there is overdispersion in the data and negative binomial model is preferred over Poisson model (Yen and Adamowicz, 1993). The ordinal logistic regression is also applied to determine the factors that affect the frequency of peanut paste/butter consumption along with four different kinds of food, i.e., vegetables, meat or fish, bread, and other foods.

1.6 Implications

As a developing country, the Republic of Uganda is in search of efficient policies and programs to increase the welfare of its citizens. The knowledge about how households spend money on various activities is important for formulating these policies and programs. The proposed three separate analyses to be undertaken in this study provide guidance for the formulation and directions at which the concerned policies and programs should be targeted, by way of the construction of consumer segments or profiles. The identification of segments or profiles helps producers and marketers as well in planning the production and marketing.

1.7 References

Appleton, Simon. "Poverty in Uganda, 1999/2000: Preliminary estimates from the UNHS." *Nottingham, UK: University of Nottingham* (2001).

Appleton, Simon, and Sarah Ssewanyana. "Poverty Estimates from the Uganda National Household Survey II, 2002/2003." *Kampala, Uganda: Economic Policy Research Centre (EPRC)* (2003).

Baskaran, R., Managi, S., & Bendig, M. (2013). A public perspective on the adoption of microgeneration technologies in New Zealand: A multivariate probit approach. *Energy Policy, 58* (C), 177-188.

Bagarani, M., Forleo, M., & Zampino, S. (2009). Households food expenditures behaviours and socioeconomic welfare in Italy: A microeconometric analysis. In *113th European Association of Agricultural Economists Seminar: "A resilient European food industry and food chain in a challenging world", September 3 - 6, 2009*. Crete, Greece.

Buse, R. C., & Salathe, L. E. (1978). Adult equivalent scales: An alternative approach. *American Journal of Agricultural Economics, 60* (3), 460-468.

Cappellari, Lorenzo, and S. Jenkins. "MVPROBIT: Stata module to calculate multivariate probit regression using simulated maximum likelihood [Statistical Software Components, Boston College Department of Economics]." (2006).

Cheng, T.-C., & Wen, W.-J. (2011). Determinants of performing arts attendance in Taiwan: A multivariate probit analysis. *Applied Economics Letters, 18* (15), 1437-1442.

CIA. (2012). The World Factbook. Uganda. Central Intelligence Agency. https://www.cia.gov/library/publications/the-world-factbook/geos/ug.html. Accessed 12 March 2014

Deaton, A. (1997). *The analysis of household surveys: A microeconometric approach to development policy. World Bank Publications.* Baltimore: The Johns Hopkins University Press for the World Bank.

Deaton, A., & Muellbauer, J. (1980). *Economics and consumer behavior*. New York: Cambridge University Press.

Fan, J.X., and J.K. Lewis. 1999. "Budget allocation patterns of African Americans." *Journal of Consumer Affairs* 33: 134-164.

Gibbons, R. D., & Wilcox-Gök, V. (1998). Health service utilization and insurance coverage: A multivariate probit analysis. *Journal of the American Statistical Association, 93* (441), 63-72.

Gustavsen, G. W., & Rickertsen, K. (2006). A censored quantile regression analysis of vegetable demand: The effects of changes in prices and total expenditure. *Canadian Journal of Agricultural Economics, 54* (4), 631-645.

Nayga, R. M. (1995). Determinants of US household expenditures on fruit and vegetables: A note and update. *Journal of Agricultural and Applied Economics, 27* (2), 588-594.

Okurut, F.N., J.O. Odwee, and A. Adebua. 2002. *Determinants of regional poverty in Uganda*: Research Paper No. 122, African Economic Research Consortium, Nairobi.

Samal, P., Pandey, S., Kumar, G., & Barah, B. (2011). Rice ecosystems and factors affecting varietal adoption in rainfed coastal Orissa: A multivariate probit analysis. *Agricultural Economics Research Review, 24* (1), 161-167.

Uganda Bureau of Statistics. (2003). http://www.ubos.org/. Accessed 10 February 2014

Uganda Bureau of Statistics. (2010). http://www.ubos.org/. Accessed 10 February 2014

World Bank. (2012). World Development Indicators. http://databank.worldbank.org/data/views/variableSelection/selectvariables.aspx?source=world-development-indicators#c_u. Accessed 10 February 2014

Yen, S. T., & Adamowicz, W. L. (1993). Statistical properties of welfare measures from count-data models of recreation demand. *Review of Agricultural Economics, 15*(2), 203-215.

CHAPTER 2

DETERMINANTS OF VARIOUS HOUSEHOLD EXPENDITURES IN URBAN AREAS: A MULTIVARIATE TOBIT APPROACH

2.1 Background and Objectives

The Republic of Uganda is a developing country in East Africa that is in the process of formulating and modifying various policies and strategies aimed at improving the living standards of its population. In this country, the household consumption contribution to GDP composition by end-use is about 86.3% (CIA Fact book, 2012), which is higher than that in two neighboring East African countries, i.e., Kenya and Tanzania, and also most other countries in the world. Generally, consumption expenditures have been utilized to examine welfare condition of people in a country and such studies have been conducted in Uganda as well (for example, Appleton, 2001; Appleton and Ssewanyana, 2003).

The share of food expenditures, on an average, is close to 50% of the total expenditures, and is higher in the northern region and lower in the central region. According to the Uganda Bureau of Statistics (2012), the expenditures on food account for the main share in total expenditures, representing a range of average monthly expenditure of 41% in the eastern and 56% in the northern regions. However, in 2009, the lowest food expenditure was in the central (38%) and highest in the northern (55%) region (UBS, 2010). The mean annual income was highest in the central region (higher than the mean annual income in the eastern region) and lowest in the northern region (Okurut et al., 2002).

The expenditures on fuel, rent and power ranged from 16% in the northern to 20% in the central region (UBS, 2012). Clothing expenditures are almost the same across these four regions with around 4%, share in total expenditures where as both educational and transportation expenditures are highest in the central region (8%) and lowest in the northern region (4%). Similarly, health and other expenditures are also highest in the central (7%) and lowest in the northern region (5%). Also, these expenditures vary among the rural and urban population, especially in the case of food expenditures (UBS, 2012).

The Republic of Uganda is witnessing urbanization at the rate of around 5.5% (Nyakaana et al., 2007). However, inadequate infrastructure and social services remain challenging problems even in the capital city, i.e., Kampala (Nyakaana et al., 2007). Along with the rapid urbanization process, the issue of urban food security and urban poverty also demand intervention by the government authorities in Sub-Saharan African cities (Maxwell, 1999). Maxwell (1995) in an analysis of urban households from Kampala concludes that urban residents who have access to land and urban farming have higher levels of food security and child nutrition. Cohen and Garrett (2010) stress the importance of targeting urban poor to improve their living conditions. Among other expenditures, health expenditure is crucial, since households with higher health related expenses tend to reduce other basic expenditures to a low level over a period of time (Xu, 2003).

With these features, it is worthwhile and timely, from the perspective of policy decisions, to study the pattern of household expenditures on different commodities across different segments of the population, especially since the Republic of Uganda is a

developing country that is in the process of formulating various policies and strategies aimed at improving the living standards of its population. Therefore, the main objective of this essay is to identify and quantify the effects of different socioeconomic and demographic factors to account for the variations in food expenditures and non-food expenditures across urban households. After quantifying the effects, the study develops profiles of different population segments that may require particular attention and should be a focus of government implemented policies. Such profiles assist policy makers and marketers to target households that need assistance to change the expenditure patterns to a desired level.

2.2 Empirical Specification

Six equations are specified to determine respective factors that influence the amount of each of six expenditure categories. The monthly expenditures are the respective dependent variables in each of six equations. The application of expenditure data presents a major issue, namely the presence of non-purchasing households during the survey period. The presence of households that did not report expenditure in the month preceding the data collection month may lead to the potential sample selection bias, which causes inconsistent and biased estimates when the OLS is used. Under such circumstances, specification and estimation of a Tobit model, with left censored dependent variable (censored at 0), gives consistent estimates (Tobin, 1958).

Another issue in the analysis of household expenditures is that usually the household expenditures on different categories are made simultaneously (Fan and Lewis, 1999), and, therefore, the equations for different expenditure categories may be correlated through errors. In such situations, the analyses should be done simultaneously for a

system of equations, rather than individually. A multivariate TTobit regression approach would be appropriate in such instances (Huang, 1999; Trivedi and Zimmer, 2005). The multivariate Tobit method estimates M-equation Tobit models, by the method of maximum simulated likelihood (MSL) (Cappellari and Jenkins, 2006).

A multivariate Tobit model with m equations can be represented as (Anastasopoulos et al., 2012):

$$Y^{*}_{im} = X'_{im}\,\beta_m + \varepsilon_{im}, \quad i = 1,2, \ldots, N, \tag{1}$$

$$Y_{im} = Y^{*}_{im} \quad \text{if } Y^{*}_{im} > 0$$

$$Y_{im} = 0 \quad \text{if } Y^{*}_{im} \leq 0$$

where N is the number of observations and m is the number of equations. Y_{im} is the observed dependent variable, and Y^{*}_{im} is the latent (unobserved) variable for the m^{th} equation; β_m represents the vector of parameters, and ε_{im} are the error terms for the m^{th} equation that are distributed multivariate normally with a mean of zero, variance σ^2, and correlation coefficient ρ. Variance co-variance matrix is:

$$\begin{pmatrix} \sigma^2_{\varepsilon_1} & \rho_{\varepsilon_2}\rho_{\varepsilon_1}\sigma_{\varepsilon_2}\sigma_{\varepsilon_1} & \cdots & \rho_{\varepsilon_m}\rho_{\varepsilon_1}\sigma_{\varepsilon_m}\sigma_{\varepsilon_1} \\ \rho_{\varepsilon_1}\rho_{\varepsilon_2}\sigma_{\varepsilon_1}\sigma_{\varepsilon_2} & \sigma^2_{\varepsilon_2} & \cdots & \rho_{\varepsilon_m}\rho_{\varepsilon_2}\sigma_{\varepsilon_m}\sigma_{\varepsilon_2} \\ \vdots & & & \vdots \\ \rho_{\varepsilon_1}\rho_{\varepsilon_m}\sigma_{\varepsilon_1}\sigma_{\varepsilon_m} & \rho_{\varepsilon_2}\rho_{\varepsilon_m}\sigma_{\varepsilon_2}\sigma_{\varepsilon_m} & \cdots & \sigma^2_{\varepsilon_m} \end{pmatrix}$$

The estimation is done using the simulated maximum likelihood method proposed by Cappellari and Jenkins (2006). This is implemented in STATA software using the MVTOBIT package. The dependent variable and all the continuous variables are transformed into logarithmic form to create a double log functional form. Such transformation allows the interpretation of results as elasticities. Income elasticities of various expenditure categories are very popular among policy decision makers, because they can easily understand % changes in various expenditures due to % changes in the household income.

2.3 Data

The study applies data collected from urban households in Uganda in the first half of 2011. Once the survey instrument was drafted, the data collection was outsourced to a market company selected through the bidding procedure. The chosen market company had experience in implementing household surveys in Uganda for international organizations. Following the market company selection, the company and the researchers held a workshop to train enumerators. The workshop was immediately followed by a pilot study conducted in a selected Kampala neighborhood in October 2010. The debriefing of enumerators did not reveal problems in understanding questions by respondents or respondents having difficulty providing answers. To implement the survey in towns other than Kampala, additional enumerators fluent in local dialects or languages were recruited and trained. The data were collected in Gulu, Lira, Soroti/Serere, Mbale, and Kampala. A total of 1,638 households were interviewed. About one half of them, 844 were located in Kampala, and 200, 201, 193, and 200 in Gulu, Lira, Soroti/Serere, and Mbale, respectively. Respondents provided insights about their household expenditures in

various categories and shared information about the socio-demographic characteristics of the household.

Table 1 provides the descriptive statistics of the collected data. The expenditure and income reported by respondents have been converted into United States dollars ($) at the exchange rate reported in June 2011 (Bank of Uganda, 2011), the month when the data collection ended. One dollar equaled 2,583 Uganda shillings (UGS). The average weekly food expenditure was about $18. Among the average monthly expenditures, education expenses were the highest ($133), and transportation expenditure was the lowest ($8.50). The average monthly household income is $237. Regarding employment status, about 37 % are self-employed, while a little over 13 % have permanent employment contracts. In approximately 30 % of households the main source of income is salary, while in another 30 % income comes from trading. Remaining households derive their income mainly from "other categories" such as farming.

About 71 % of household heads are males and nearly 70 % of the respondents are married. The average respondent is about 35 years old. About 35 % of respondents have upper higher secondary or higher education. The average household consisted of 2.3 adults and about three children. Almost 55 % of households have children of age three years or less, 67 % have children of age four to 12 years, and 48 % have children of ages between 13 and 18 years. Almost 52 % of households are located in Kampala, while the remaining households are distributed almost evenly among the other four cities included in the survey.

2.4 Estimation Results

The Breusch-Pagan test results (chi2 = 146.63; prob > chi2 = 0.0000) reveal that errors from six equations are correlated with each other, justifying the employment of a multivariate estimation approach. The results are discussed separately for each of the expenditure equations estimated as a system (Table 2).

Food expenditures

The income elasticity of food expenditure is around 0.2, and is the lowest among all elasticities of the six expenditure categories. The result implies that a 1% increase in income will result in 0.2% increase in food expenditure. This low magnitude suggests that an increase in income is not likely to increase food expenditure by a significant amount.

The education of respondent is found to have a positive effect on food expenditure. This result implies that an upper higher secondary or higher education will bring about an increase in food expenditure. High level of education, in addition to creating more income for the household, creates increased awareness about the need of adequate consumption of nutritive foods than low education level. Selection of nutritive foods may increase food expenditure within a household.

Employment type has a significant influence on determining the food expenditure pattern in urban households. Being permanently employed or self-employed brings about food expenditure increase compared to respondents with the employment status classified as “other category”. The magnitude of this effect is larger in households of the permanently employed respondents.

The effect of age of respondent is significant and negative. As the age of a respondent increases, household expenditure on food decreases. The age elasticity is almost 0.13, which is of relatively low magnitude and might be related to the natural decrease in food intake for older people, but it may also represent a threat of inadequate consumption.

Household composition significantly affects food expenditure. An increase in number of adults increases the food expenditure in households. Similarly an increase in the number of children also increases food expenditure. The elasticities for both of these categories are almost of the same magnitude, and this magnitudes are not so large.

Household location in Gulu, Lira, Soroti and Mbale leads to lower food expenditures than those located in Kampala. The highest difference is between Lira and Kampala, while the lowest is between households in Mbale and those in Kampala. Being a capital city, Kampala has a larger number and variety of retail outlets that sell food and residents have easy access to these outlets than those who live in other cities considered in this study.

Fuel expenditures:

Fuel expenditure encompasses all fuel used by a household ranging from cooking fuel to fuel used to light the home after darkness and fuel for mechanical equipment including motorcycles or cars. Cooking fuel includes various types, but fuel for household owned vehicles is the type of fuel that is most desired. Uganda imports oil-based fuels and because it is a land-locked country, any fuel has to be transported a long distance from a harbor. Supplies of fuel from its neighboring countries are limited because they lack capacity to process own oil into fuels.

The income elasticity of fuel expenditure is 0.85, and is the highest among all the expenditure elasticities. This magnitude implies that a 1% increase in household income can bring about 0.85% increase in household fuel expenditure. The high income elasticity reflects high priority respondents and reflects the full dependence on privately operated transportation. As city population grows (at 5.52 annual rate), the distance from a house to jobs, schools, shopping areas and service providers including government offices and health clinics increases. Residents either resign to walk or purchase motorbikes enabling them to become more mobile.

If the main source of income is salary the fuel expenditure increases, compared to those households where the main source of income is from sources other than salary and trading. A salary likely permits a purchase of own motorbike or car, leading to higher fuel expenditures.

Households with respondents that have at least an upper higher secondary education have higher fuel expenditure, relative to those households where respondents have lesser education. Fuel expenditure increases in response to employment status in households, where respondents are permanently or self-employed, compared to those households with respondents of the in other employment category. The magnitude of this effect is more in the case of self-employed respondents who are more likely to travel using own vehicles as they work.

Age of the respondent has a negative effect on fuel expenditure. The value of the elasticity in question is 1.37, making it noticeably high. A possible explanation for this can be that older people use fuel more judiciously than their younger counterparts.

Households with children of age three or less have lesser fuel expenditure relative to those households without such young children.

Households located in cities other than Kampala, have lower fuel expenditure. In urban conditions of many African countries, a capital city is known for higher living expenses and also due to the generally shorter distances and heavy traffic that increase own fuel consumption in Kampala. Also, many people living in a capital city have appliances requiring more energy and this, in turn, increases fuel expenditure.

Education expenditures:

The income elasticity of expenditure is 0.74, therefore, a 1% increase in household income brings about 0.74% increase in educational expenses. This high magnitude of elasticity is intuitive. Children from households with higher income usually go to reputed (private) schools, where the expenses are higher compared to other (government) schools. In households where the main source of income is salary, the education expenses are higher compared to households where the main income originates from other sources. The permanent nature of salaried employment enables a household to demarcate a specified amount for educating children. However, households with income from other sources also allocate expenditures for child education. Self-employed respondents have higher education expenses, compared to respondents classified with "other" employment status.

Household composition is a major determining factor with regard to variation in education expenses across urban households in Uganda. An increase in the number of adults brings about an increase in education expenses. Similarly, an increase in number of children also increases education expenses. The elasticity of expenditure is obviously

higher for children, slightly greater than 2.0, whereas in the case of adults this value is a slightly greater than 1. These two elasticity values suggest that education might still be a luxury for urban poor in Uganda, though the net enrollment ration in primary education in 2009/10 was around 83% (UBS, 2012). Introduction of universal primary education and then universal secondary education has increased enrollment in those institutions. Public private partnership policy in higher educational institutions (UBS, 2012) might also have affected urban poor adversely, as they have to pay more for studying at private institutions. Households with children aged three or less will have lesser education expenses, as could be expected. Presence of children in the age range of four to twelve increase educational expenses. Similarly, households with children in the age range of thirteen to eighteen also have higher educational expenses. This effect is higher in households with children of age between four and twelve.

Clothing expenditures:

The income elasticity of expenditure is 0.51. A 1% increase in household income brings about 0.5% of increase in clothing expenses. The relative size of income elasticity in case of clothing expenditure is considerably larger than in the case of food expenditure, supposing a relatively higher priority is given to clothing. If the main source of income is trading this expenditure decreases. The reason might be the fluctuating income from trading. Households with respondents employed permanently have higher clothing expenditure. This is plausible because permanent employees, whether in private or public institutions, are likely to adhere to explicit or implicit dress code and incur additional expenditure on clothing. The age of respondent has a significant and negative effect on clothing expenditure. The magnitude of age elasticity is 2.3, which means that a

1% increase in age can bring about 2.3% reduction in clothing expenditures. The effect of age on clothing expenditure is dramatic and suggests that age is a major factor in shaping expenditure on clothing.

Households from Gulu, Mbale, and Soroti have higher clothing expenditure, compared to households from Kampala. This result is unexpected, but suggests a relatively higher demand for clothing outside the capital. This difference is the highest in households located in Gulu and Soroti. A possible explanation is that in those cities the number of outlets selling clothware may be less compared to Kampala resulting in non-competition among outlets and charging higher prices. Whereas Gulu is in the region that until recently suffered from military conflict (it is in proximity to South Sudan) and the needs for some items, including clothing may be higher than in other urban areas of Uganda.

Transportation expenditures:

The income elasticity of expenditure is 0.77, i.e., a 1% increase in household income brings about 0.77% increase in household transportation expenditure. Those households where the main source of income is salary spend more on transportation compared to households reporting "other sources" as the main income source. Similarly, households with main source of income from trading also have higher transportation expenditures. The difference is highest in households with salary as the main source of income. Such households with an assured income like to spend more on travel needs. A respondent who is in trading may have to travel a lot for needs that are connected to his/her business.

If respondents have at least an upper higher secondary education then such households have higher transportation expenditure. Higher education usually leads to

jobs requiring regular commute to distant places. Households with respondents who are permanently employed have higher transportation expenditures, compared to households with respondent in "other categories" of job. Similarly, households with self-employed respondents also have higher transportation expenditures. This expenditure is higher with permanently employed respondents. When a respondent is permanently employed he/she may have to commute to work place regularly using some mode of transportation. Self-employed respondents also have to travel, though they may not need to frequently do it.

Transportation expenditures are higher in households headed by man then women. Men are more likely to travel to a job or in search of a job. Men may also travel for other purposes more often than women in urban setting in Uganda. Women, especially if raising children tend to stay within the neighborhood and are more likely to walk to buy food, fuel, or other necessary goods or services.

Respondents from households of married individuals are likely to spend less on transportation as compared to households of non-married respondents. Marriage stabilizes relationship and changes the lifestyle making trips less preferred. The non-married, especially young singles are more likely to travel for work or leisure having relatively larger transportation expenditures than the married respondents

It was expected that respondents from cities other than the capital city have smaller transportation expenditures because the differences in area covered by each city. Moreover, the availability of companies offering transportation is fewer in cities outside Kampala. The effect of location was statistically confirmed in case of Lira and Mbale, where the transportation expenditures are lower than in Kampala. Both cities are much smaller and allow residents to walk to numerous sites although bicycles and motor bikes

are also used. Kampala is surrounded by other municipalities creating an agglomeration and the high demand for transportations services results in booming bus and motorbike taxi services.

Other expenditures:

The income elasticity is 0.59. A 1% increase in household income increases expenditure in other category to 0.59%. This category of expenditure includes all other expenses incurred at households, including medical, recreational, and social obligations.

"Other expenditure' decreases if as reported the main source of household income is trading. It is plausible that experienced and skillful traders barter some goods or services limiting the actual expenditure measured in money, especially as compared to the benchmark main income source.

Not surprisingly, the increase in the number of children three years old or younger increases "other expenditure". Needs of households with small children differ from other households because of the difference in required care. Households located in all cities other than Kampala have higher expenditures in other category, relative to households from Kampala. The result is very important and suggests that there are likely considerable differences across cities in terms of "other expenditure" reflecting different needs of urban residents outside Kampala. Because the category is broad and encompasses expenditures not classified in earlier categories, further research may be needed to discern the nature of "other expenditure" starting, perhaps with Soroti, which has a particularly strong effect.

2.5 Discussion

This study examines the household expenditures in the Republic of Uganda, which is a sub-Saharan African country. Uganda has an estimated per-capita GDP (at PPP) of $1800 in 2014 (CIA Factbook, 2014), and it was ranked 209th place among the list of 230 countries. The World Bank (2012) has included Uganda in the list of heavily indebted poor countries (HIPC), which has 39 countries in it. Though Uganda is a relatively poor country, urbanization happens at a faster rate ((Nyakaana et al., 2007). But, infrastructure and social services are inadequate even in the capital city, i.e., Kampala (Nyakaana et al., 2007). Therefore, a detailed examination of various household expenditures helps in locating urban population segments that need more attention. Policy makers in public sector are concerned with the welfare of the people, and therefore, the pattern of food and education expenditures may be more relevant to them, along with transportation and medical expenses. The private sector would be interested in knowing the variation of expenditures in transportation and medical categories, along with food and fuel expenses.

An important finding from this study is the variation in the magnitudes of income elasticities of expenditures. The income elasticity of expenditure is the lowest in food and highest in fuel categories. The magnitude of this elasticity is less than half of the next lowest one, i.e., clothing expenditures. Therefore, this means that additional income will increase expenditures in other categories at a relatively faster pace than in food category. This is not surprising given the fact that in Uganda share of food expenditures is already almost 50% of total expenditures (UBS, 2012). However, this inelasticity points to challenges that occur with food price increases, especially in towns other than the capital. The outlying areas appear to be more vulnerable to consequences of food price increases

than Kampala households. Jayne et al. (2006) advocates increased coordination between public and private market decision makers for maintaining stable price levels.

An examination of magnitudes of other elasticities reveal that households prefer to spend additional income more on fuel, followed by transportation and education expenditures. This is a highly relevant result for public policy makers, especially to those who are concerned with expanding educational infrastructure. These magnitudes reveal priority of urban households for expenditures in categories other than food, which is a good indication for public policy makers that deal with the welfare of people.

The effects of main sources of income are also analyzed. When the main source of income in households is salary, then such households have increased expenditures on fuel, education, and transportation. This effect is highest in transportation, and lowest in fuel expenditures. A stable source of income such as salary enables households to spend more on categories that have relatively higher income elasticities of expenditures, like fuel and education. If the main source of income is trading there is an increase in expenditures on transportation, while there is a decrease in expenditures in clothing, and other categories. Persons associated with trading usually travel a lot, leading to an increase in expenses associated with transportation. These two main sources have been compared to the reference category, which is main source of income from categories other than salary and trading.

Education of the respondent has a significant effect on three categories, i.e., food, fuel, and transportation. All these effects are positive. However, the magnitude of this effect is highest in transportation expenditures, and lowest in food expenditures. The higher transportation and fuel expenditures may be associated with increased travel needs

of persons in households who have been undergoing higher education. Employment status is also found to have significant and positive effects on most of the categories. A permanent employment increases expenditures on food, fuel, clothing, and transportation categories. The magnitude of effect is highest in clothing, and lowest in food expenditures. Presence of self-employed respondents in households enhances expenditures in food, fuel, education, and transportation categories. This effect is highest in fuel and education, and lowest in food expenditures. Here also, the spending will be more on categories with higher income elasticities.

The number of children and presence of children of different age groups have significant effects on some expenditure categories. The child elasticity of expenditure is of high magnitude in education expenditure category, which is an anticipated result. However, this elasticity is very low in the case of food expenditure. Presence of children of age three or less has negative effect on fuel and education expenditures in a household. Children in such age group will be at home being taken care of by mothers, and their food may not need extensive cooking that might need more fuel burning. Also, these children may not need formal education at that age, and therefore, may not incur any educational expenses. However, presence of such children increases other expenditures, including medical expenses. This result is also quite obvious, since children of this age group need frequent medical attention, leading to an increase in medical expenses. Presence of children of age between 4 and 12, and between 13 and 18 has significant positive effect on education expenditures. Such children will be school and college going children, and this in turn will increase education expenses in households. The magnitude of this effect is higher in households with children of age between 4 and 12.

The age of respondent has negative effect on food, fuel, and clothing expenditures. The age elasticity is highest in clothing expenditure (>2), followed by fuel expenditure (>1), and relatively inelastic with food expenditure. The number of adults has significant positive effect on food and education expenditures, with higher elasticity in the case of latter.

Location has significant effects on all expenditure categories, except education. Food expenditures in all other cities are lower, compared to the capital city of Kampala. This difference is highest in Lira, and lowest in Mbale. Similarly, fuel expenditures are also lower in all cities, with the difference being highest in Soroti, and lowest in Lira. Transportation expenditures are lower in Lira and Mbale, relative to Kampala. Lira has the lowest transportation expenditure. Households in Gulu, Mbale, and Soroti have higher clothing expenditures than those in Kampala. The difference is highest in Gulu, and lowest in Mbale. All cities have higher expenditure in other category, compared to Kampala. Among these four cities, Soroti has the highest expenditure, and Gulu has the lowest expenditure in other category.

The results from this study will benefit policy makers by way of providing a clearer picture of the segments of population where interventions are required to balance the various household expenditures. An issue of concern to urban households is the food security. Cohen and Garrett (2010) emphasize the importance of implementing necessary policy measures to help urban poor to withstand the consequences of food price increases. Maxwell (1995) concludes urban farming is becoming a major source of food for urban population in Africa. However, availability of land is a serious constraint in such populations. He also suggests that wherever land is available and farming is done

higher levels of household food security and child nutrition are found in such households, compared to households that lack cultivable land.

D'Agostino et al. (2015) in their study on charcoal expenditure in Tanzania, another East African country, stresses the importance of knowing socioeconomic determinants of such expenditures in the effective formulation and implementation of policy measures. They conclude that although income is associated with an increase in charcoal expenditure, the household size is not a determining factor. In Uganda also income is found to be an important determining factor, with the highest income elasticity of expenditure. Household composition, except the presence of children of age three or less, does not have significant effect on fuel expenditures. All other cities have less fuel expenses, compared to Kampala.

Education expenditure also has a relatively higher income elasticity of expenditure, i.e., 0.74, stressing the need for some assistance especially for urban poor to realize their children's higher education. Households with children above four years of age have higher education expenses. Johnstone (2004) studied structure and implementation of tuition fees and student loans in sub-Saharan African countries. The author concluded with some suggestions to be implemented like cost sharing from parents and also students by way of providing well monitored student loans, which should be recollected once a student starts working and earning.

The expenditures vary across different urban centers. For example, food and fuel, expenditures are lower, while clothing expenditure is higher in Soroti than those in Kampala, offering insights into the effects of income increase on a particular category. The relatively higher income elasticity in the case of education expenditure suggests

relatively higher benefits from increasing income and school access outside the capital. Knowledge about the expenditures on education and its interaction with other expenditure categories is very important because academic achievements are not that promising, even after the introduction of universal primary education in the Republic of Uganda in 1997 (Acham et al., 2012). The food vs. education issue is important for Ugandan households and, from the standpoint of the environmental impact, the expenditures on fuel are also relevant because the primary fuel is wood-based charcoal. Finally, there is a relatively large demand for expenditures in the 'other' category, which offers wide opportunities for stimulating regional economies because those expenditures are relatively more important to urban households outside Kampala.

2.6 References

Acham, H., Kikafunda, J. K., Malde, M. K., Oldewage-Theron, W. H., & Egal, A. A. (2012). Breakfast, midday meals and academic achievement in rural primary schools in Uganda: implications for education and school health policy. *Food & nutrition research*, *56*.

Anastasopoulos, Panagiotis Ch, Venky N. Shankar, John E. Haddock, and Fred L. Mannering. "A multivariate Tobit analysis of highway accident-injury-severity rates." *Accident Analysis & Prevention* 45 (2012): 110-119.

Appleton, Simon. "Poverty in Uganda, 1999/2000: Preliminary estimates from the UNHS." *Nottingham, UK: University of Nottingham* (2001).

Appleton, Simon, and Sarah Ssewanyana. "Poverty Estimates from the Uganda National Household Survey II, 2002/2003." *Kampala, Uganda: Economic Policy Research Centre (EPRC)* (2003).

Cappellari, Lorenzo, and S. Jenkins. "MVPROBIT: Stata module to calculate multivariate probit regression using simulated maximum likelihood [Statistical Software Components, Boston College Department of Economics]." (2006).

CIA Factbook, 2012. Available at https://www.cia.gov/library/publications/download/download-2012/index.html

CIA Factbook, 2014. Available at https://www.cia.gov/library/publications/resources/the-world-factbook/geos/ug.html

Cohen, Marc J., and James L. Garrett. "The food price crisis and urban food (in) security." *Environment and Urbanization* 22, no. 2 (2010): 467-482.

D'Agostino, Anthony L., Johannes Urpelainen, and Alice Xu. "Socio-economic determinants of charcoal expenditures in Tanzania: Evidence from panel data."*Energy Economics* 49 (2015): 472-481.

Fan, J.X., and J.K. Lewis. 1999. "Budget allocation patterns of African Americans." *Journal of Consumer Affairs* 33: 134-164.

Huang, H. C. R. (1999). Estimation of the SUR Tobit Model via the MCECM Algorithm. *Economics Letters*, *64*(1), 25-30.

Jayne, Thorn S., Ballard Zulu, and J. J. Nijhoff. "Stabilizing food markets in eastern and southern Africa." *Food Policy* 31, no. 4 (2006): 328-341.

Johnstone, D. Bruce. "Higher education finance and accessibility: Tuition fees and student loans in sub-Saharan Africa." *Journal of Higher Education in Africa*2, no. 2 (2004): 11-36.

Maxwell, Daniel G. "Alternative food security strategy: A household analysis of urban agriculture in Kampala." *World Development* 23, no. 10 (1995): 1669-1681.

Maxwell, Daniel. "The political economy of urban food security in Sub-Saharan Africa." *World Development* 27, no. 11 (1999): 1939-1953.

Nyakaana, J. B., H. Sengendo, and S. Lwasa. "Population, urban development and the environment in Uganda: the case of Kampala city and its environs."*Faculty of Arts, Makerere University, Kampala, Uganda* (2007).

Okurut, F.N., J.O. Odwee, and A. Adebua. 2002. *Determinants of regional poverty in Uganda*: Research Paper No. 122, African Economic Research Consortium, Nairobi.

Tobin, J. (1958). Estimation of relationships for limited dependent variables. *Econometrica: journal of the Econometric Society*, 24-36.

Trivedi, P.K. and Zimmer, D.M., 2005, Copula modeling: An introduction for practitioners. Foundations and Trends in Econometrics 1(1), 1-111.

Uganda Bureau of Statistics. 2010. Available at http://www.ubos.org/.

UBo, Statistics. "Uganda population and housing census." (2012).

UNdata. Available at https://data.un.org/CountryProfile.aspx?crName=Uganda

World Bank, 2012. Available at http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTDEBTDEPT/0,,contentMDK:20260049~menuPK:64166739~pagePK:64166689~piPK:64166646~theSitePK:469043,00.html

Xu, Ke. "Understanding household catastrophic health expenditure." In*International Health Economics Association Meetings, San Francisco, CA*. 2003.

Table 1. The sample descriptive statistics

Variable	Mean	Std. Dev.	Min	Max	Description
Dependent					
Foodexp	18.36	17.55	0	271.00	Weekly food expenditure in $
Fuelexp	10.73	13.70	0	177.42	Monthly fuel expenditure in $
Educexp	133.13	253.02	0	3484.32	Monthly education expenditure in $
Clothexp	9.80	18.47	0	271.00	Monthly clothing expenditure in $
Transexp	8.47	22.12	0	348.43	Monthly transportation expenditure in $
Otherexp	22.58	39.50	0	592.33	Monthly other expenditures in $
Independent					
Totalincome	237.01	771.76	0.39	25938.83	Total monthly household income in $
Permanent	0.1343	0.3410	0	1	Permanent job
Self	0.3718	0.4834	0	1	Self employed
Others	0. 4915	0. 5001	0	1	Other type of jobs*
Sousalary	0.3027	0.4586	0	1	1 if the main income source is salary
Soutrading	0.3021	0.4593	0	1	1 if the main income source is trading
Souother	0.3952	0.4891	0	1	1 if the main income source is from “other
Education	0. 3451	0. 4755	0	1	1if upper secondary or higher
Headgender	0.2784	0.4483	0	1	1 if the household is a male; 0 if female
Age	35.3391	12.3556	17	89	Age of the respondent in years
Married	0.6923	0.4617	0	1	1if married
Adults	2.2930	1.4136	0	15	Number of adults in the household
Child	3.0188	2.1115	0	12	Number of children in the household

Child3dum	0.5488	0.4978	0	1	1 if a household has children 3 years old or
Child12dum	0.6722	0.4696	0	1	1 if a household has children 4 to 12 years old
Child18dum	0.4822	0.4998	0	1	1 if a household has children 13 to 18 years
Gulu	0.1215	0.3268	0	1	Residence in Gulu (1)
Lira	0.1221	0.3275	0	1	Residence in Lira (1)
Mbale	0.1215	0.3268	0	1	Residence in Mbale (1)
Soroti	0.1172	0.3218	0	1	Residence in Soroti (1)
Kampala	0.5152	0.4999	0	1	Residence in Kampala (1)*

* Reference category
Note: $1=2583 UGS, June, 2011.

Table 2. Results from Multivariate Tobit estimation

Factor	Foodexp	Fuelexp	Educexp	Clothexp	Transexp	Otherexp
lninc	0.214***	0.846***	0.744***	0.505*	0.771***	0.587***
	(0.0192)	(0.0928)	(0.133)	(0.264)	(0.158)	(0.103)
lnage	-0.125*	-1.368***	0.347	-2.289***	0.116	-0.341
	(0.0657)	(0.316)	(0.456)	(0.916)	(0.539)	(0.350)
headgender	0.0107	-0.00982	-0.00719	0.793	0.753*	-0.0333
	(0.0528)	(0.252)	(0.365)	(0.722)	(0.432)	(0.281)
married	0.0440	-0.262	-0.196	-0.146	-0.829*	-0.0240
	(0.0522)	(0.250)	(0.361)	(0.713)	(0.425)	(0.278)
permanent	0.194***	0.695***	0.389	1.640**	0.887*	0.0133
	(0.0604)	(0.289)	(0.418)	(0.815)	(0.487)	(0.321)
selfemploy	0.137***	0.663***	0.660**	0.0197	0.579*	0.206
	(0.0399)	(0.192)	(0.278)	(0.550)	(0.325)	(0.213)
education	0.141***	0.464***	0.216	0.607	0.634*	0.314
	(0.0409)	(0.196)	(0.284)	(0.558)	(0.331)	(0.218)
sousalary	0.0358	0.552**	0.757**	-0.308	1.596***	-0.176
	(0.0483)	(0.232)	(0.336)	(0.660)	(0.393)	(0.257)
soutrading	0.0702	0.100	0.329	-1.117*	1.213***	-0.606**
	(0.0447)	(0.215)	(0.310)	(0.617)	(0.365)	(0.238)
lnadult	0.205***	0.201	1.089***	-0.314	0.362	0.170
	(0.0379)	(0.182)	(0.262)	(0.523)	(0.309)	(0.202)
lnchild	0.190***	-0.237	2.059***	-0.292	0.148	-0.171
	(0.0441)	(0.212)	(0.306)	(0.607)	(0.361)	(0.235)
Child3dum	-0.0352	-0.365*	-1.105***	0.300	-0.310	0.429*
	(0.0418)	(0.201)	(0.288)	(0.575)	(0.342)	(0.223)

Child12dum	-0.0690	0.0347	3.662***	-0.478	-0.473	-0.0452
	(0.0509)	(0.245)	(0.355)	(0.699)	(0.415)	(0.272)
Child18dum	0.00909	0.0776	0.928***	-0.239	0.126	0.300
	(0.0468)	(0.224)	(0.323)	(0.644)	(0.382)	(0.249)
Gulu	-0.259***	-1.184***	-0.491	3.094***	-0.119	0.575*
	(0.0614)	(0.296)	(0.426)	(0.835)	(0.501)	(0.327)
Lira	-0.412***	-1.105***	0.303	1.028	-1.947***	0.668**
	(0.0538)	(0.258)	(0.372)	(0.740)	(0.447)	(0.286)
Mbale	-0.176***	-1.707***	0.599	1.893**	-1.338***	0.796***
	(0.0573)	(0.275)	(0.395)	(0.788)	(0.471)	(0.305)
Soroti	-0.219***	-1.986***	0.396	2.905***	0.293	1.186***
	(0.0587)	(0.283)	(0.405)	(0.796)	(0.476)	(0.313)
_cons	7.875***	3.330**	-6.869***	4.483	-4.734*	2.405
	(0.325)	(1.566)	(2.254)	(4.448)	(2.665)	(1.734)

Note: Standard errors are in parentheses
*, **, and *** denote significance at 10%, 5% and 1% levels

CHAPTER 3

FACTORS DRIVING FRUIT AND VEGETABLE EXPENDITURES AND CONSUMPTION FREQUENCY IN A LESSER DEVELOPED COUNTRY: AN ANALYSIS OF URBAN HOUSEHOLDS FROM THE REPUBLIC OF UGANDA

3.1 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 25th quantile, and reduces drastically in upper quantiles. This result suggests that an income support or price discounts for fresh fruits may increase the consumption of fresh fruits in low spending households. However, fresh vegetable expenditures have lower income elasticities, indicating that a similar support may not increase fresh vegetable consumption. Other factors such as education and location also have influence on pattern of these expenditures. Results from multivariate probit regression show that education, age, gender, number of children, and location are important factors determining regular consumption. Knowledge of these factors provides guidance for policy makers in public and private institutions for targeting specific segments of the population in urban locations for effective implementation of programs promoting fruit and vegetable consumption.

3.2 Background and objectives

The risks of disease and death due to non-communicable diseases (NCDs) and malnutrition are higher in households with low consumption of fruits and vegetables given the WHO and FAO conclusions (lhucha, 2011). Increased fruit and vegetable consumption can significantly reduce the incidence of NCDs (Lock, Pomerleau, Causer, Altmann, & McKee, 2005). In addition to the incidence of NCDs, vitamin deficiencies and related deaths are common, especially among children (Kikafunda, Walker, Allan, & Tumwine, 1998; Bachou, Tylleskär, Kaddu-Mulindwa, & Tumwine, 2006). Yet, many Africans consume less than one serving of fruit per day (Oniang'o, Mutuku, & Malaba, 2003). According to a World Bank report (2011), in the Republic of Uganda, 28% of preschool children and 23% of pregnant women are found to be deficient in vitamin A. Fruits and vegetables are rich in vitamins, including vitamin A, and minerals. Therefore, a higher consumption of fresh fruits and vegetables can alleviate the problem of widely prevalent malnutrition and nutritional deficiencies in Uganda.

General statements about the desired fruit and vegetable consumption provide little guidance for targeting specific groups or regions in a given country. 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 Uganda, NCDs are a main reason for almost 25% of all deaths (Ihucha, 2011). The detailed analysis of fruit and vegetable consumption is commonly prevented by the lack of micro-level data. Therefore, the examination of how fruit and vegetable consumption is distributed across households fills the knowledge gap. Policy decisions aimed at increasing fruit and vegetable consumption directly benefit

from insight generated by the study and are offered the opportunity to effectively lower the scale of unbalanced diet and its detrimental, lasting consequences. Further, knowledge about the characteristics of households that regularly consume some of the commonly available fresh fruits and vegetables guides the formulation and implementation of programs aimed at increasing consumption to directly benefit their members and, through improved health, the society at large. Increased fruit and vegetable consumption is recommended for the weight management problem and the overall health improvement. This is another benefit linked to fruit and vegetable consumption and well documented in developed economies (Bazzano et al., 2002; Flood et al., 2002; Lin & Morrison, 2002). Keatinge et al. (2010) report that vitamin A, iron, zinc, and iodine are the four major causes of micronutrient deficiencies in Africa. Therefore, regular consumption of fresh fruits and vegetables which are rich sources of two of these nutrients (vitamin A and iron) is important in improving the health conditions of people living in this continent.

Some population segments experience malnutrition in Uganda (Kikafunda, Walker, Allan, & Tumwine, 1998). Consequently, the simultaneous presence of malnutrition and weight management problem seems counterintuitive, but is present in Uganda. The overweight and obesity among its population are on the rise and the obesity and overweight rates were 4.3% and 19.9%, respectively (WHO, 2011), in 2008. Fruit and vegetable consumption varies between rural and urban residents (for example, Florkowski et al., 2014). Whereas rural population may have access to fruits grown in own fields or gardens and in the wild, urban residents are dependent on formal suppliers. The consumption of urban households is closely associated with the purchases of fruits

and vegetables, and in an economy such as Uganda, the purchase refers to mostly unprocessed fruits and vegetables. Processed fruits and vegetables tend to be relatively more expensive than unprocessed fresh produce.

The described benefits support associated with fruit and vegetable consumption in a lesser developed country has not been matched by the studies or factors associated with their intake. The current study examines 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 about the vulnerable groups. To that end the study applies the censored quantile regression (CQR) approach. The selection of that particular approach anticipates that effects of the same factors including household income can vary across different points in the expenditure distribution, i.e., in households with different income levels. This makes the CQR approach particularly policy relevant. The estimation accuracy further justifies the use of CQR because, in the applied sample, some households did not report expenditure on fruits and vegetables during the period under consideration.

The study's second objective is to determine factors that influence the self-reported regular consumption of commonly available fruits and vegetables to Ugandan households using the multivariate probit regression method. In Uganda, the benefits of fruit and vegetable consumption are particularly important because their nutrients can reduce the consequences of naturally occurring toxins. Kaaya & Warren (2005) report that the presence of aflatoxins, toxic metabolites produced by certain species of fungi (*Aspergillus*), is very common in Uganda. Aflatoxins are toxic to humans and animals, affecting various organs, especially the liver. A study by Alpsoy et al. (2009) concludes

that vitamins A, C, and E inhibit the toxic effects of aflatoxin B_1 (AFB_1) in humans. Therefore, regular consumption of fruits and vegetables which are rich in these vitamins can provide protection from the consequences of aflatoxin B_1.

An examination of how the regular consumption of common fruits and vegetables varies across urban households identifies those potentially deficient in vitamins and minerals. Programs formulated to eradicate actual or potential vitamin and mineral deficiencies found in Uganda can utilize the results of this study. The study accounts for the household location in search for possible regional policy variations and effective focus of the spatial scope of remedial efforts.

3.3 Theoretical Framework

Generally, the analysis of household expenditures, based on cross sectional data, highlights the Engel curve specification. An Engel curve is a function that describes the variation in expenditure on a food item or food category in relation to the variations in total resources available to the household, such as income or total expenditure, while prices are fixed. This function can be represented by $q_i = f_i(y, z)$, where q_i is the quantity consumed of good i, y is income, wealth, or total expenditures on goods and services, and z is a vector of other socioeconomic characteristics of the consumer, like age, education and household composition (Lewbel, 2006). Engel curves can be regarded as Marshallian demand functions with the prices of all goods fixed (Lewbel, 2006).

Ernst Engel used Belgian data on working class families to study the variation of household expenditures across different levels of income (Lewbel, 2006). While he concluded that food expenditures increase with income, he also found that food budget shares decrease with an increase in income. This is the essence of the famous Engel's

law, and has been successfully applied in many studies. Engel curves are useful for calculating the income elasticity of goods (Giles & Hampton, 1985), and classifying them into inferior, necessities, and luxuries if the income elasticity is less than zero, between zero and one, and more than one respectively. Engel found that food is a necessity; however, since elasticities can vary across income, a particular good that is a necessity for well-off households can turn out to be a luxury for poor households (Lewbel, 2006). This interpretation will be more evident when examining the income elasticities of fresh fruit expenditures across different quantiles.

Apart from variation in household income, socioeconomic and demographic factors cause consumer preferences to vary (Nayga, 1995). This, in turn, influences the pattern of spending across households. Preferences per se and their variation are not observable and socioeconomic and demographic factors proxy for preference variation. Considering fresh vegetables or fresh fruits as a single good and all other goods as a composite good, the household's preferences are captured by a utility function (Deaton & 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

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

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

3.4 Data

The study applies data collected from urban households in Uganda in the first half of 2011. Once the survey instrument was drafted, the data collection was outsourced to a market company selected through the bidding procedure. The chosen market company had experience in implementing household surveys in Uganda for international organizations. Following the market company selection, the company and the researchers held a workshop to train enumerators. The workshop was immediately followed by a pilot study conducted in a selected Kampala neighborhood in October 2010. The debriefing of enumerators did not reveal problems in understanding questions by respondents or respondents having difficulty providing answers. To implement the survey in towns other than Kampala, additional enumerators fluent in local dialects or languages were recruited and trained. The data were collected in Gulu, Lira, Soroti/Serere, Mbale, and Kampala. A total of 1,638 households were interviewed. About one half of them, 844 were located in Kampala, and 200, 201, 193, and 200 in Gulu, Lira, Soroti/Serere, and Mbale, respectively. Respondents provided insights about their food shopping habits and

preferences for selected foods, consumption of selected foods, and shared information about the socio-demographic characteristics of the household.

About 72 % of respondents are females and nearly 70 % are married (Table 1). The average respondent is about 35 years old. About 37 % are self-employed, while a little over 13 % are having permanent employment contracts. About 35 % of respondents have upper higher secondary or higher education. The average household consisted of 2.3 adults and about three children. Almost 55 % of households have children of age three or less, 67 % have children of ages between four and 12, and 48 % have children of ages between 13 and 18. The average distance to the nearest shopping place is about 573 meters. Almost 52 % of households are located in Kampala, while the remaining households are distributed almost evenly among the other four cities.

The expenditure and income reported by respondents have been converted into United States dollars ($) at the exchange rate reported in June 2011 (Bank of Uganda, 2011), the month when the data collection ended. One dollar equaled 2,583 Uganda shillings (UGS). Monthly income figures allowed the calculation of per capita income in each household. The average monthly household income is $237. To arrive at per capita expenditures the study employs the OXFORD/OECD adult equivalence rate (Deaton, 1997). The measure assigns a value of 1 to the first adult member, 0.7 to each additional adult, and a value of 0.5 to each child.

The weekly and per capita fresh fruit expenditures are lower than fresh vegetable expenditures in all quantiles (Table 2). The weekly fresh fruit expenditures represent 25, 40, 49, and 44 % of the combined weekly fresh fruit and vegetable expenditures, respectively, in the 25^{th}, 50^{th}, 75^{th}, and 90^{th} quantiles. The expenditures calculated on a

per capita basis using the adult equivalence rate indicate that the weekly per capita fruit expenditures are 23, 42, 42, and 42 %, respectively, of the combined weekly per capita fruit and vegetable expenditures. Although the share is the same across the three quantiles, the actual per person fruit expenditures vary substantially. The calculated values show clearly that fresh fruit expenditures per person are less than fresh vegetable expenditures per person in all quantiles under study, although the total fresh fruit expenditures in the 75th quantile are close to total fresh vegetable expenditures. This difference in responses of expenditures of fruits and vegetables to total expenditures was found in a study of sub-Saharan Africa by Ruel et al. (2005). They found that expenditure elasticities of fruits and vegetables in Uganda were 1.28 and 0.52 respectively.

Table 3 provides weekly expenditures of fresh fruits and vegetables across two income categories, i.e., one category with less than or equal to the average income of $237, and the other category with the above average income. The households with above average income reported higher expenditures on fresh fruits in all quantiles, compared to households with average or below average income. However, the difference with regard to fresh vegetable expenditures is very distinct only in the lowest quantile. Therefore, the low spending households can be classified as relatively poor households, and this is supported in a study by McGregor & Borooah (1992).

Fresh fruits regularly consumed by respondents are fairly rich in vitamin A, vitamin C, calcium, iron, and dietary fiber (Table 4). The % daily value (%DV) of vitamin A per serving is the highest in passion fruit, followed by watermelon and mango. Orange, passion fruit, mango, pineapple, and watermelon are rich sources of vitamin C, with highest %DV in orange. Passion fruit is an exceptionally rich source of iron and dietary

fiber as the %DV suggests. But, other fruits are also good sources of dietary fiber. Unfortunately, the proportion of households that report the regular consumption of the listed fruits is less than 50 %, except for avocado, banana, and mango (Table 4).

Among fresh vegetables, kale has the highest vitamin A content in terms of %DV value, followed by carrot and spinach (Table 4). Vitamin C is abundant in broccoli, pepper, kale, and cabbage. All listed fresh vegetables have high dietary fiber content. As in the case of fresh fruits, the proportion of households reporting regular vegetable consumption is less than 50 %, except for potato, cabbage, and tomato. The proportions are much less for cauliflower/broccoli and spinach/kale, which have the highest content of vitamins A and C. The content of essential vitamins and minerals, stresses the importance of the selected fresh fruits and vegetables (along with other fresh fruits and vegetables) in alleviating malnutrition, and offsetting the toxic effects of aflatoxin.

A common problem associated with household expenditure surveys is the reported zero expenditure on a good in question during the period of observation. In the data set used in this study, there are 102 observations (6.3%) with zero values in case of fresh vegetable expenditures, and 352 observations (21.4%) in case of fresh fruit expenditures. The censoring is minor in case of fresh vegetable expenditure, but more pronounced in case of fruit expenditure. Because the reported expenditures refer only to the week preceding the interviews, the absence of reported expenditure does not imply a household does not spend on fresh fruit or vegetables at all. To address the problem of missing expenditure the current study applies the censored regression method (CQR). The section that follows details this approach.

3.5 Empirical Specification

The censored quantile regression (CQR) is used to determine factors that influence the fresh fruit and vegetable expenditure pattern across the whole distribution of expenditures reported in the sample. The multivariate probit regression is employed to accomplish the second objective of variation in regular consumption of selected fresh fruits and vegetables in urban households in Uganda.

3.5.1 Censored quantile regression

A quantile is a point on the cumulative distribution function of a random variable that divides the distribution into two parts. For example, based on information in Table 2, the 25^{th} quantiles of weekly fresh vegetable and fresh fruit expenditures are $0.58 and $0.19, respectively. The bottom 25% of the surveyed households spent a maximum of $0.58 and $0.19 on fresh vegetable and fruit purchases, respectively, 75% of households spent more than these amounts. The variation across quantiles results from the influence of various factors. Such differential influence is not evident if the analysis limits the examination to the conditional mean of the distributions discouraging the use of the OLS technique. From a policy development and implementation perspective, the effectiveness in determining the most vulnerable sections of the population to nutrient deficiency will be weakened if the solutions are limited to "an average" consumer or household. It is desirable to detail the effects of socioeconomic and demographic factors at specific distribution levels of expenditures.

The effect of factors on expenditures across their whole distribution is quantified by employing the quantile regression (QR) approach introduced by Koenker & Bassett (1978). Here, the purpose of the study determines choices of different conditional

quantiles, and each of the quantiles is modeled as a function of covariates. Therefore, the effects of covariates on different parts of the population are specific to a subgroup and therefore, highly reliable and practical for policy purposes. Some of the food expenditure and demand analysis studies using QR include Deaton (1997), Gustavsen & Rickertsen (2006) and Bagarani, Forleo, & Zampino (2009), but the current study also accounts for expenditure censoring.

The OLS application to estimate the conditional mean involves the minimization of the sum of squares of the residuals. The estimated coefficients are close to the original parameters. However, the QR, minimizes the absolute values of residuals:

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

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 chosen quantile. The first component of the sum in the above expression is the total of vertical distances of data points that lie above the fitted line ($x_i'\beta_p$). The second component of the minimized sum is for the data points that lie below the fitted line, with respect to a particular quantile. The observations above the regression line are given a weight of *p*, while those below that line have a weight of 1-*p*. The QR estimator (β_p), for a particular quantile (*p*), is found by an algorithm that minimizes the weighted expression 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)

The advantage of QR is that it is more efficient than the OLS when heteroscedasticity, a commonly encountered problem associated with analyses applying cross-sectional data, is present (Deaton, 1997). Moreover, Buchinsky (1998) points out

that QR is more efficient than OLS when error terms are not normally distributed or when there are outliers in the dataset.

A portion of households responding to the survey reported zero expenditure on fresh vegetables, and, more often, on fresh fruits during the period preceding the interview. The presence of zero expenditure in the data renders an ordinary quantile regression ineffective in comparison to a censored method of estimation. The latter method, censors the data 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 common in estimations using cross-sectional data, in such instances, the Tobit estimates may be biased and inconsistent. Results obtained using the Tobit approach may lead eventually to inexact policy recommendations. To prevent such problems, the current study employs the censored quantile regression (CQR).

According to Powell (1986), the CQR estimator is consistent in the above mentioned instances of non-normality and heteroscedasticity. 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) use an iterative algorithm proposed by Buchinsky (1994) to solve the minimization problem. The algorithm uses all observations 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 current study applies the CQR to the lowest quantiles, i.e., the 25th, and the 50th, and the QR in case of the remaining two quantiles, i.e., the 75th, and 90th. For each quantile, there are two equations, one each for fresh fruit and fresh vegetable expenditure, respectively. The dependent variables are the household weekly expenditures recorded during the interviews, 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 unit free elasticities (Gujarati and Porter, 2009). The presence of zero expenditures in both response variables (i.e., fresh vegetable or fruit expenditure) prevents taking the natural logarithm, and a value of one is added to all expenditure observations. The natural logarithm of one is zero and, therefore, the censoring can be applied as in case of a response variable without any transformation.

3.5.2 Multivariate probit regression

In its second objective, this study investigates the variation in the regular consumption of selected fresh fruits and vegetables across surveyed households. The selection criterion was the content of vitamins and other important nutrients. The selected seven fresh vegetables are cauliflower/broccoli, spinach/kale, pepper, carrot, Irish potato, cabbage, and tomato; and eight fresh fruits are apple, watermelon, pineapple, orange, passion fruit, mango, sweet banana, and avocado.

The regular consumption of one fresh fruit may not be independent of regular consumption of other fresh fruits being considered. A similar condition applies to fresh vegetable consumption. Therefore, a method that accounts for the regular correlation errors across equations is considered in estimating equations of regular consumption of the selected fresh fruits and vegetables. The response variable is a binary variable. A multivariate probit regression method is suitable in such instances and has been applied for data analysis in diverse fields (for example, Gibbons and Wilcox-Gők, 1998; Cheng and Wen, 2011; Samal et al., 2011; Baskaran et al., 2013).

Suppose there are M equations to be estimated, each with 'n' number of observations (which can be different for each of the equations), then each can be written as:

$$Y_{mi}* = \beta_m' X_m + \varepsilon_{mi},$$

where m = 1, 2, ..., M, and i = 1, 2, ..., n. Since $Y_{mi}*$ is a latent response variable, which cannot be observed, an observable binary response variable, Y_{mi} is created and takes the values:

$$Y_{mi} = 1 \text{ if } Ymi* > 0, \text{ or}$$

$$Y_{mi} = 0 \text{ otherwise.}$$

The error term of each of the M equations has the standard normal distribution with mean zero and variance of one. However, because of the presence of correlation across error terms, the M error terms have a multivariate normal distribution with mean zero and a variance-covariance matrix, say V. The matrix V has a value of one on the leading diagonal (variance of error terms) and co-variances, $\rho_{jk} = \rho_{kj}$ on off- diagonals, where $j \neq k$, with j, k = 1, 2, …, M.

The response variable in each of fifteen equations is a binary variable, assuming a value of one when a household consumed a particular vegetable or fruit "regularly", zero

otherwise. The regular consumption is interpreted as taking place during most days of the week. The cautious estimate implies a frequency of at least four times a week. The explanatory variables are socioeconomic and demographic features, and household location described in Table 1.

3.6 Estimation Results

The following two sub-sections discuss estimation results for fresh fruit and fresh vegetable expenditure equations from the CQR estimation for $25^{th,}$ and 50^{th} quantiles and the QR estimation for the other two quantiles, i.e., 75^{th} and 90^{th}. The results from the OLS estimation are included along the quantile regression results in Tables 5 and 6 to illustrate the difference of evaluating the effects of individual variables at the mean and contrast them with the CQR/QR results. The OLS results, are not discussed at length.

3.6.1 Expenditure on Fresh Fruits

The last column of Table 5 shows the results of F-test and the corresponding p-values. The F-test verifies whether the effect of an independent variable significantly differs across quantiles under study. The results show that the effect of income, education, age, and all household locations vary across different quantiles, suggesting the need for the application of quantile regression method in this study.

Among the socioeconomic factors (Table 5) the household income has a significant and positive effect on fresh fruit expenditure. Several previous studies, e.g., Cook (1990); He, Huang, & Houston (1995); Nayga, (1995); Weatherspoon et al. (2013); Weerahewa, Rajapakse, & Pushpakumara (2013), and Revoredo & Florkowski (2013), also report a similar result for developed economies, and Ruel, Minot, & Smith (2005) find the same result for sub-Saharan African countries. In the current study, the

household income is significant in all quantiles. Fresh fruits are confirmed to be a normal good for urban Ugandan households, in accordance with the theory-based expectations captured by the Engel curve. The magnitude of the income elasticity of expenditure is the highest in 25th quantile, and, surprisingly, it is more than double the elasticity magnitude in other quantiles. This result has substantial practical implications, because previous studies suggest price discounts for fruits and vegetables (Jetter, 2011; Waterlander, de Boer, Schuit, Seidell, & Steenhuis, 2013), provision of fruits and vegetables at competitive prices (Weatherspoon et al., 2013; Stewart, Blisard, & Jolliffe, 2003), or income assistance (Young et al., 2013) increase the consumption of fruits and vegetables. The income elasticity of expenditure of 1.04 in the 25th quantile (Table 5) and a one % increase in monthly household income can increase the weekly fruit expenditure by slightly more than one %. The change in response to income increase is crucial considering the benefits of eating an adequate daily volume of fresh fruits, especially in a country like Uganda. The elasticity value is slightly higher than one, possibly implying that fresh fruits are a luxury for same households in 25th quantile. An earlier study by Ruel, Minot, & Smith (2005) about sub-Saharan African countries reports that the expenditure elasticity of fresh fruits is 1.28 in Uganda, a much higher value. 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 current study. A research report by Bear and Goldman (2005) also concludes that in Uganda and increase in income leads to an increase in fresh fruit and vegetable expenditures. However, according to them this relationship is stronger with middle and upper income groups, compared to low income group.

Education of a respondent has a positive effect in all quantiles. The magnitude of this effect is particularly high in the 25th quantile, and decreases across the upper quantiles. Ruel, Minot, & Smith (2005) also report that Ugandan households with at least one member who received secondary education have higher demand for fruits than households without a member who received that much education. 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 (Price, Price, & West, 1980; He, Huang, & Houston, 1995; Nayga, 1995). Educated adults plausibly influence the diet of Ugandan urban households by including more fresh fruits in the diet as is the case in developed countries. The magnitude of the estimate of coefficient of education at the 25th quantile, which includes households with the lowest fresh fruit expenditures and low income, is about 600% more than its magnitude at the 90th quantile. The large differential effect of education is visible because of the application of the CQR and clearly differ from the effect estimated using the OLS (Table 5).

The occupation of a respondent is statistically significant in 25th and 50th quantiles. Respondents reporting a permanent job have higher fresh fruit expenditures than households where a respondent classified his/her job as "other". The magnitude of the occupation effect is the largest in 25th quantile. Those households with respondents who are self-employed also report a positive effect in 25th, 50th, 75th, with the largest magnitude in 75th quantile. Respondents with jobs classified as "other" might experience uncertainty with regard to income flow as compared to those having permanent jobs or the self-employed.

The effects of demographic variables vary across quantiles. Age of the respondent has negative effect on fresh fruit expenditure in the two lowest quantiles. According to this result, as a person becomes older, tends to spend less on fresh fruits, especially in households classified in the bottom two quantiles. This result contradicts some of the earlier studies for developed economies (for example, Blisard, Lin, Cromartie, & Ballenger, 2002; Bittencourt, Teratanavat, & Chern, 2002), which report a positive effect of age, because older people might become more aware of health benefits from fresh fruit consumption.

As the number of adults increases the expenditure increases in 50^{th}, 75^{th}, and 90^{th} quantiles. The outcome which is consistent with the results from a study about fresh fruit consumption in the United States by He, Huang, & Houston (1995). The adults may have experience reading articles and listening to professional talks about the health benefits of consuming fresh fruits. An increase in the number of children increases the fresh fruit expenditure, but, only in the two highest, i.e., 75^{th} and 90^{th}, quantiles. The result is consistent with expectations that the fruit purchase is restricted and may be considered unnecessary in households in lower quantiles. At the same time, the result raises the suspicion of possible risk of vitamin deficiencies that are widely prevalent among children in Uganda. Children in low income households are first fed other foods before the households spend on fresh fruit. Some of the common domestic fruit, for example, passion fruit, watermelon or mango are a good source of vitamin A that is consumed in insufficient amount by many Ugandans.

The presence of children in a household, indicated by dummy variables for various age categories, significantly influences expenditure only in the 90^{th} quantile. Such

outcome confirms the special status of the purchased fruit in the diet of urban households. Households with children three years old or younger, spend more on fresh fruit than households without children in this age category. This is a positive signal to policy makers and public health educators to emphasize eating fresh fruits and vegetables that are a source of vitamins, minerals, and antioxidants among households from lower quantiles. However, households with children of age between four and 12 spend less on fruit purchase than households without children of that age. The children in that age range are at risk of nutrient deficiency and do not learn healthy habits of consuming enough fruits and vegetables throughout their life (WHO, 2003). Therefore, efforts to increase the consumption of fresh fruits and vegetables in such households should be considered at the stage of formulation and, later, in implementation of relevant policies.

The gender of the respondent matters in terms of significant influence on fresh fruit expenditures. Households of male respondents spend less on fruit compared to households where a respondent is a female. The gender effect is significant in the 25^{th} and 50^{th} quantiles, and in conditional mean of the distribution. Smith, Ramakrishnan, Ndiaye, Haddad, & Martorell (2003) report that when women are in charge of household spending decisions, the expenditures on fruits and vegetables tend to be higher. Ruel, Minot, & Smith (2005) confirm such tendency in their study on sub-Saharan African countries.

The distance to the nearest retail outlet has a positive effect in the 25^{th} and 50^{th} quantiles, and at conditional mean. As the distance to the nearest retail outlet increases, the expenditure on fresh fruit increases. This result is not intuitive. Perhaps, households with a distant retail outlet visit that outlet infrequently and purchase a relatively larger

fruit volume, compared to households located closer to a retail outlet. Because households with nearby retail shops can purchase fresh fruits when needed, they have relatively lower weekly expenditures. Also, some nearby outlets might not include fresh fruits and vegetables in their product-mix.

A dummy variable indicates household location in four cities, i.e., Gulu, Lira, Mbale, and Soroti. Kampala, the capital city, serves as a reference location. Results confirm clear regional differences. The households in Lira spend less on fresh fruits, compared to Kampala residents. The location effect is significant in 25^{th}, 50^{th}, and 75^{th} quantiles and at the mean supporting that only households with the higher income do not differ in patterns of fruit expenditure between two cities. The households from Mbale spend more than Kampala households, in the 90^{th} quantile. Similarly, households in the 75^{th} and 90^{th} quantiles from Soroti also outspend the households from Kampala. These findings are beneficial to the concerned agencies when policies are formulated and implemented for enhancing the consumption of fresh fruits and vegetables. For example, households located in Lira and are projected to be in lower quantiles, i.e., 25^{th} and 50^{th}, may be targeted to increase fresh fruit consumption. Also, households in capital city of Kampala may also be observed to find reasons for lower consumption compared to cities like Mbale and Soroti.

3.6.2 Expenditure on Fresh Vegetables

Table 6 shows the CQR estimation results from fresh vegetable expenditure equation. The last column provides the results of F-test conducted to verify whether the effects of independent variables significantly differ across various quantiles. The p-values confirm

that the effects of education, age, presence of adult females, and locations at Mbale, and Soroti significantly differ across quantiles.

Among the socioeconomic factors, monthly household income has a highly significant and positive effect on fresh vegetables expenditure at all four quantiles. The estimates are income elasticities of expenditures with values ranging from 0.13 in the 25th quantile to 0.19 in the 90th quantile, indicating different effects of income in fresh vegetable and fresh fruit expenditures in Ugandan households. The elasticity at conditional mean is 0.23, and is higher than the elasticities in any of the quantiles. The result regarding the effect of income on vegetable expenditure is consistent with several previous studies (e.g., Capps & Love, 1983; Nayga, 1995; Blisard, Lin, Cromartie, & Ballenger, 2002). The magnitudes of the elasticities in quantiles are very low, suggesting that an income support, like in the case of fresh fruits, might not successfully increase vegetable consumption, especially for households in the 25th quantile. Education has a positive effect in 25th, 50th, and 75th quantiles, and also in conditional mean of the distribution. It is interesting to note that education has no effect in 90th quantile, but education is particularly influential in the lowest quantile. Additional training or information delivered to households from the 25th quantile is likely to have a larger effect on vegetable expenditure than in higher income households. Education will influence food choices among urban households in Uganda. Among the job categories, being self-employed has a positive effect on fresh vegetable expenditure, that, too, only in 25th quantile.

Age of the respondent has a negative effect in the 25th, 50th, and 90th quantiles and at the 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. However, there are studies (for example, Russell, Rasmussen, & Lichtenstein, 1999; DiMaria-Ghalili & Amella, 2005), that conclude that elderly people need nutritional food to compensate for the insufficient food intake, that may include fresh vegetables like dark green colored vegetables. Number of adults has a positive effect in all quantiles and of the mean. A larger number of adults in a household require more food including vegetables leading to the positive effect of the number of adults on fresh vegetable expenditure across all quantiles. The influence of children on vegetable expenditure is not clear. The number of children in a household has a positive effect only in the 50^{th} quantile. It would seem that the number of children should 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.

The three cities may have access to fresh vegetables at an affordable cost compared to Kampala. The effect of expenditure in households from Soroti is significant in all quantiles, but, not in the conditional mean of the distribution.

The CQR results showing different significance of variables across quantiles emphasize the importance of examining the whole distribution, rather than restricting the analysis to conditional mean of the distribution. The income elasticities are clearly

different in various quantiles, with the highest value in the 25th quantile of fresh fruit expenditure, whereas with the lowest value in the 25th quantile of fresh vegetable expenditure. More importantly, these values vary from those at conditional mean of the distribution. Moreover, other variables also show different effects in four quantiles and conditional mean of distributions. The statistically confirmed differences justify the application of CQR rather than OLS in the analysis providing insights for policy.

3.6.3 Results from Multivariate Probit Estimation

The following sub-sections discuss estimation results from the multivariate probit estimation of equations depicting regular consumption for eight fresh fruits and seven fresh vegetables. The total observations utilized for estimation is 1,541 out of a total of 1,638 surveyed households. Some observations are omitted due to incomplete or missing responses. The estimated coefficients are calculated and interpreted based on the sign of estimates. The sign of estimates 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. The results are discussed below.

3.6.3.1 Regular Consumption of Selected Fresh Fruits

The results show that the model is globally significant based on the Wald Chi-square test, and the errors from individual equations are correlated based on a likelihood ratio test. The Wald Chi-square test value is 881.75 with a probability value (p>chi-square) of 0.0000, and the likelihood ratio test chi-square value is 2278.87 with a probability value of 0.0000. Therefore, the joint estimation of these eight equations is justified. The

estimated coefficients and robust standard errors are given in Table 7. The results are discussed for each of the socioeconomic and demographic factors.

Household Income

The monthly household income significantly effects the regular consumption of watermelon, suggesting an increase in income is likely to increase the regular consumption of this fruit. Overall, the absence of significant effect is not surprising, since there are fruits (like apple) that are imported and tend to be expensive. Estimation results are supported by the report on the east African fruit and vegetable sector (USAID, 2013) that concludes that consumption of vegetables does not significantly vary across various income groups in Uganda.

Employment

Households with respondents who are permanently employed are more likely to report regular consumption of apple or banana. A permanent source of income might create the perception of stability encouraging spending and consumption of expensive fruits like apple. Households with self-employed respondents, where income is less stable are less likely to have a regular consumption of nutrient-rich passion fruit.

Education

Higher level of education (at least upper-secondary level) of respondent in a household increases the likelihood of regular consumption of five out of the eight selected fresh fruits. They are apple, watermelon, pineapple, passion fruit, and banana. All these fresh fruits are fairly rich in vitamins and minerals, as listed in Table 1. Therefore, this result provides an indication of how educating people about the benefits of regular consumption of fresh fruits can influence fresh fruit consumption.

Gender

In households with a male respondent, the regular consumption of five fresh fruits is likely to be absent. These fresh fruits are watermelon, orange, passion fruit, mango, and avocado. This is a matter of serious concern, since these fruits are rich sources of essential nutrients, particularly for growing children and pregnant women. The latter consumer groups need these nutrients in adequate volume for proper growth or child development.

Age and Marital Status

An increase in age of respondents increases the chances of regular consumption of watermelon and mango. This is a desirable effect, since older people in households can influence the food consumption pattern of children in such households. Both watermelon and mango are good sources of vitamin A, which prevents night blindness.

Being married has a positive effect on regular consumption only in the case of avocado, a fruit that is reported as regularly consumed by the majority of households. Avocado is rich in unsaturated fats that also positively affect human health.

Number of Adults

The likelihood of regular consumption of six of the fresh fruits increases as the number of adults in a household increases. Watermelon, orange, passion fruit, mango, banana, and avocado are the fruits that are consumed regularly more often in such households. Since adults influence the food consumption pattern of households, this result is also important from the perspective of increasing the fruit and vegetable consumption in urban areas of Uganda. Many adults are deficient in vital nutrients and the six fresh fruits can alleviate the shortage of key vitamins and minerals.

Number of Children and Presence of Children of Different Age Groups

A very alarming result is related to the number of children. An increase in their number decreases the likelihood of regular consumption of all fresh fruits, except orange. Malnutrition and vitamin deficiencies, like vitamin A deficiency (World Bank, 2011), are common among children in Uganda. This result shows the need for corrective measures to be adopted by concerned agencies to increase consumption of fresh fruits that provide nutrients needed for proper growth and development of children.

The result with presence of children of different age groups in a household shows a different pattern, as these factors are significant in the case of selected fruits. Households with children 3 years old or younger are likely to regularly consume watermelon, a fruit that is fairly rich in vitamin A. Households with children between 4 and 12 years of age report to regularly eat watermelon and banana, whereas the regular consumption of apple, passion fruit, and banana are more likely to be reported by households with children between 13 and 18 years of age. From increased vitamin A intake standpoint, the consumption of fruits like passion fruit would be more desirable in lower age categories.

Household Location

The four household locations, i.e., Gulu, Lira, Soroti, and Mbale, are compared with Kampala, the capital city of Uganda. Households from Gulu are less likely to report regular consumption of watermelon, pineapple, banana, and avocado than Kampala residents, while at the same time they regularly consume more oranges and mangos. Similarly, households from Lira tend to report regular consumption of apple, watermelon, pineapple, banana, and avocado, with a lesser likelihood in Kampala households, whereas orange and mango are more likely to be consumed regularly at the latter town. Soroti-

based households are more likely to regularly eat orange, passion fruit, and mango, but less likely to have a regular consumption of apple, banana, or avocado. The regular consumption of oranges in households in Soroti is not a surprise, since it is one of the major areas of orange production in Uganda (USAID, 2013). Finally, Mbale residents are less likely to report regular consumption of apple, watermelon, pineapple, banana, or avocado, than Kampala-based households.

Marginal effects

The computed marginal effects are shown in Table 8. Generally, location variable has higher marginal effects. The highest positive and negative marginal effects are observed for Soroti, for orange and passionfruit, respectively. The highest negative marginal effects are for Gulu, for banana and pineapple, respectively.

3.6.3.2 Regular Consumption of Selected Fresh Vegetables

The model is globally significant based on the Wald Chi-square test, with a test value of 950.80, and a probability value (p>chi-square) of 0.0000. The likelihood ratio test value of 503.79 with a probability value of 0.0000 confirms that errors are correlated across equations and equations have to be analyzed together. The estimated coefficients and robust standard errors are given in Table 9. The results are discussed for each of the factors employed in analysis.

Household Income

A rise in household income increases the probability of regular consumption of cauliflower/broccoli. However, income has no significant effect on reported regular consumption of other fresh vegetables covered under this study. The USAID study suggests that there is no discernable income effect on vegetable consumption (USAID,

2013). However, Ruel, Minot, & Smith (2005) conclude that an increase in income in sub-Saharan African countries would bring about an increase in vegetable consumption with a magnitude more than that for fruit consumption.

Type of Employment

Permanent employment positively influences the regular consumption of pepper and Irish potato according to the obtained results. It may be that consumption of Irish potatoes reflects a consumption pattern influenced by work environment, for example meals offered in workplace cafeterias. Being self-employed increases the chances of regular consumption of spinach/kale, carrot, cabbage, as well as pepper and Irish potato. The link between self-employed and regular vegetable consumption suggests longer dependence and perhaps easier access to fresh vegetables. Self-employment includes street vendors, hawkers, or traders at numerous open-air markets where vegetables are one of many items offered for sale.

Education

Respondents with at least an upper secondary level of education are likely to increase the regular consumption of carrot and Irish potato. Since carrot has a good amount of vitamin A, it is highly desirable to have a regular consumption of that vegetable. The widespread prevalence of vitamin A deficiency in Uganda is more likely among less educated rural residents.

Gender

Male respondents report less regular consumption of spinach/kale, Irish potato, or cabbage, but are more likely to regularly consume peppers. This result resembles the

pattern associated with fresh fruit estimation results, and again is a cause of concern, because, for example, spinach and kale are good sources of vitamins A and C.

Age and Marital Status

The effect of age significantly affects only the regular consumption of spinach/kale. Leafy vegetables are easy to prepare, relatively plentiful, and do not require mastication effort. As such the attributes of leafy greens encourage their consumption among older urban residents. Married respondents in households affect only the consumption of fresh tomato equation, and that effect is negative with regard to regular consumption.

Number of Adults in Household

The probabilities of regular consumption of spinach/kale, pepper, Irish potato, cabbage, and tomato increase with an increase in the number of adults in a household. The influence of adults in promoting such behavior in households is highly desirable from the standpoint of the health of household members.

Number of Children and Presence of Children of Different Age Groups

Similar to the estimation results of fresh fruit consumption, an increase in the number of children in a household reduces the likelihood of regular consumption of cauliflower/broccoli and Irish potato. Cauliflower and broccoli are excellent sources of vitamin C, and Irish potato also has a reasonable amount of vitamin C along with good amount of dietary fiber and iron. Consumption of both fresh vegetables has a prominent place in combating malnutrition among children. The presence in households of 3-year-old or younger children, leads to increased likelihood of regular consumption of spinach/kale, pepper, and cabbage. Households with children between 13 and 18 years of

age increase the likelihood of regular consumption of cauliflower/broccoli, but, relatively few households report eating these two vegetables.

Household Location

None of the four household locations (Gulu, Lira, Soroti, and Mbale) is likely to report regular consumption of any of the fresh vegetables under study compared to Kampala. Households from all non-capital locations are less likely to regularly eat cauliflower/broccoli, spinach/kale, carrot, Irish potato, or tomato. Additionally, households from Lira, Soroti, and Mbale are less likely to have regular consumption of pepper, while households from Mbale are less likely to report regular consumption of cabbage than residents of Kampala. Since this list of fresh vegetables includes those selected as particularly good sources of vitamins and minerals that many Ugandans eat in inadequate amount, the eating frequency in households outside Kampala particularly warrants monitoring. A possible remedial action from agencies involved in informing about healthy eating may bring meaningful results there relatively fast, especially if information reaches individuals with different level of educational attainment.

Marginal effects

The marginal effects are provided in Table 10. Here also location has the highest marginal effects among all the factors considered. However, unlike in the case of fresh fruits, all the location effects are negative. The highest negative effect is for Lira with carrot, and the lowest negative effect is for Mbale for cauliflower/broccoli.

3.7 Discussion

The results from these analyses 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, Blisard, & Jolliffe (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. In contrast to the study from the developed economy, results from the current study suggest that an increase in household income, especially those at 25^{th} quantile, can increase fresh fruit consumption. A study Schady & Rosero (2008) about cash transfers in Ecuador, a lesser developed country, finds that cash transfers made to women increased general food shares in those households. 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, Blisard, & Jolliffe, 2003), the average income of households in 25^{th} quantile is found to be $142, considerably less than the sample average of $237. Therefore, the assumption that households in 25^{th} quantile of fresh fruit expenditure are also, on an average, low income households is valid (McGregor & Borooah, 1992). Another approach to increase food consumption is to provide food subsidies. A study by Powell et al. (2009) among young adults in the US conclude that fruit and vegetable subsidies can bring about increased consumption, especially among those who belong to lower socioeconomic ranks. Harold Alderman (2002) concludes that programs like food stamps encourage increased food consumption, and generally food subsidies reduce cost of living. He also suggests that food subsidies are relatively easier to administrate than income transfers.

The income elasticities of expenditures from fresh vegetable expenditure equation are very low in magnitude. Therefore, an increase in income cannot be expected to bring a modest change in fresh vegetable expenditures. As a consequence, the 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 be a better alternative, given the confirmed effects of education.

Regional differences will also need to be accounted for while implementing programs to increase fruit and vegetable consumption. For example, households in Lira spend less on both fresh fruits and fresh vegetables than other cities in the study. Boysen (2013) has computed consumer price indices (CPI) for fruits and vegetables for different cities in Uganda during September 2009 and April 2012. According to him, Lira had a higher CPI compared to Kampala and Soroti, the difference being more in comparison to CPI of Soroti. Kampala, though it is the capital city, has households that spend less on fresh fruits than households in Mbale and Soroti, and spend less on fresh vegetables than Gulu, Mbale, and Soroti. The CPI of fruits and vegetables for Kampala was higher than that for Soroti September 2009 and April 2012 (Boysen, 2013).

The results from the estimation of regular consumption of fresh fruits and vegetables also have implications that help in the successful implementation of programs aiming at enhancing consumption of fresh fruits and vegetables. Salient findings from this estimation are summarized below.

Household income influences only regular consumption of watermelon among fresh fruits, and only cauliflower/broccoli among fresh vegetables considered in the current study. USAID (2013) examined the fresh fruit and vegetable sector in three East African

countries and reports that frequency of fruit and vegetable consumption across households remains almost the same, regardless of income level. The insensitivity to income complicates the efforts to increase consumption of fresh fruits and vegetables because income support or price subsidy is unlikely to bring the desired effects. However, increasing the production of fruits and vegetables will increase the availability of these products, and naturally lead to increased consumption. Generally, the fruit and vegetable production is restricted to small holdings, and mostly under rain-fed conditions (Dijkstra, 2001). Planning and implementing projects that can produce fruits and vegetables throughout the year will increase availability and therefore, regular consumption of these products. As Uganda's climate supports the cultivation of a variety of fruits and vegetables (Dijkstra, 2001), expansion of cultivation into areas suited for such production should also be part of programs intended to increase fresh fruit and vegetable consumption.

Education plays an influential role in increasing consumption of fresh fruits and vegetables. Regular consumption of several of the fresh fruits and vegetables selected for this study is found to be positively affected by higher educational attainment level of a respondent, i.e., at least an upper secondary education. A USAID study (2013) suggests that lack of awareness about the benefits of fruits and vegetables is the major reason for low frequency of fruit and vegetable consumption in Uganda. The positive effect of education in this study may imply that respondents with higher educational level may be more knowledgeable and aware of the valuable nutrient content of fresh fruits and vegetables, leading to regular consumption of those products. Therefore, educational programs to create awareness about the importance of regular consumption of fresh fruits

and vegetables should be implemented targeting households with less educated members. A review study by Ammerman, A. S., Lindquist, C. H., Lohr, K. N., & Hersey, J. (2002) about what behavioral intervention is most suitable for increasing fruit and vegetable intake find that goal setting and small group approach are the most effective interventions among the interventions they reviewed.

Respondent's gender has an interesting result in terms of its influence on regular fruit and vegetable consumption. Male respondents tend to be less likely to regularly consume most of the fresh fruits and some of the fresh vegetables considered in the study. An increased likelihood in regular consumption is observed only for peppers in households represented by male respondents. Smith, Ramakrishnan, Ndiaye, Haddad, & Martorell (2003) report that when women are in charge of household spending decisions, the expenditures on fruits and vegetables tend to be higher. Ruel, Minot, & Smith (2005) confirm such tendency in seven (including Uganda) out of ten sub-Saharan African countries they studied, wherein female-headed households have more budget share for fruits and vegetables than male-headed households. They also conclude that this result is stronger for vegetables than for fruits. In addition, empirical analysis concludes that consumption of healthy food like green leafy vegetable is more in female-headed households.

An increase in age of respondents increases the likelihood of regular consumption of watermelon, mango, and spinach/kale. This is highly desirable because of the high vitamin A, vitamin C, and iron content of these fruits and vegetables. Blisard, Lin, Cromartie, & Ballenger (2002) and Bittencourt, Teratanavat, & Chern (2002) report a positive effect of age, as older people might become more aware of the health benefits

from fresh fruit consumption. Therefore, older people can influence the consumption pattern of fruits and vegetables in their households, which will contribute to the success of programs and policies intended to increase fruit and vegetable consumption in the country.

Another source of concern is the result associated with the number of children in households. The increase in number of children decreases the likelihood of regular consumption of almost all fresh fruits, and two of the fresh vegetables considered in the current study. Because of the widespread malnutrition among children in Uganda, this result implies a limited role of fruits and vegetables as a source of vitamins, minerals, and antioxidants in the diet. Encouraging greater consumption of fruits and vegetables in households with children will remain a challenge in the near future. Educational programs to increase nutrient intake among children have to be implemented. Educating mothers about the importance of nutrition for infants and young kids positively affects child health (Ruel et al., 2005). According to Block (2002), nutrition knowledge of mothers seems to predict child health better than formal education. An Indonesian study by Block (2004) concludes that mothers with better nutrition knowledge allocate more food budget share on foods rich in micronutrients, like fruits and vegetables. The National 5 A Day for Better Health Program and the National School Lunch Program that are implemented in the US have been able to increase fruit and vegetable intake (Heimendinger, J., Van Duyn, M. A., Chapelsky, D., Foerster, S., & Stables, G., 1996; Gunderson, 2003). Blanck, H. M., Gillespie, C., Kimmons, J. E., Seymour, J. D., & Serdula, M. K. (2008) report that programs that provide more access to fruits and vegetables at daycare centers, schools, universities can increase the consumption among

children. Similarly implementing programs like special supplemental nutrition program for women, infants, and children can also change the dietary behavior among children.

With regard to locations, the results compare the effect between households located in four cities and households in Kampala. Even though Kampala is the capital city, households in that city do not regularly consume orange and mango, two fruits that are good sources of vitamins, minerals, and dietary fiber (Table 1). Moreover, Kampala residents are also less likely to regularly consume passion fruit compared to households from Soroti. A serious concern is the regular consumption of selected fresh fruits and vegetables in other cities compared to Kampala. Those cities have less regular consumption of all fresh vegetables and five out of eight fresh fruits. (For example, orange, passion fruit, and mango). Therefore, location specific programs are essential to increase frequency of fresh fruit and vegetable consumption and, thereby, decrease the consequences of vitamin and mineral deficiency among urban populations. Pineapple and mango are the commonly cultivated crops in Uganda, and generally fruit cultivation is restricted to small holdings concentrated in southern, central, and eastern regions (Uganda Investment Authority). Implementing programs to increase the cultivation of fruit and vegetable crops in these areas and other potential areas will lead to increased availability of fresh fruits and vegetables, and consequently increased consumption by households.

Based on the results from CQR estimation, 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 11. 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. Such a profile helps policy decision makers to target that audience while implementing programs that are essential for increasing fruit and vegetable consumption. According to Pinstrup-Andersen and Watson II (2011) transfer programs may help improve health and nutrition, by providing subsidized healthy foods like fruits and vegetables through distribution of vouchers for food (like food stamps). While distributing such vouchers authorities may want to target specific segments, like poor households, or households with children that experience malnutrition problems. The above discussed profile constructed based on results from this study provides such a segment to be targeted.

3.8 References

Ammerman, A. S., Lindquist, C. H., Lohr, K. N., & Hersey, J. (2002). The efficacy of behavioral interventions to modify dietary fat and fruit and vegetable intake: a review of the evidence. Preventive medicine, 35(1), 25-41.

Alderman, H. (2002). Subsidies as a social safety net: effectiveness and challenges. *Social Safety Net Primer Series, Discussion Paper*, *224*.

Alpsoy, L., Yildirim, A., & Agar, G. (2009). The antioxidant effects of vitamin A, C, and E on aflatoxin B1-induced oxidative stress in human lymphocytes. *Toxicology and Industrial Health*, *25*(2), 121-127.

Amemiya, T. (1984). Tobit models: A survey. *Journal of Econometrics, 24* (1), 3-61.

Bachou, H., Tylleskär, T., Kaddu-Mulindwa, D. H., & Tumwine, J. K. (2006). Bacteraemia among severely malnourished children infected and uninfected with the human immunodeficiency virus-1 in Kampala, Uganda. *BMC Infectious Diseases, 6* (1), 160-167.

Bagarani, M., Forleo, M., & Zampino, S. (2009). Households food expenditures behaviours and socioeconomic welfare in Italy: A microeconometric analysis. In *113th European Association of Agricultural Economists Seminar: "A resilient European food industry and food chain in a challenging world", September 3 - 6, 2009*. Crete, Greece.

Bank of Uganda. (2011). Foreign Exchange Rates, June 2011. Retrieved from https://www.bou.or.ug/bou/collateral/interbank_forms/2011/Jun/Major_30Jun11.html. In.

Baskaran, R., Managi, S., & Bendig, M. (2013). A public perspective on the adoption of microgeneration technologies in New Zealand: A multivariate probit approach. *Energy Policy, 58* (C), 177-188.

Bazzano, L. A., He, J., Ogden, L. G., Loria, C. M., Vupputuri, S., Myers, L., & Whelton, P. K. (2002). Fruit and vegetable intake and risk of cardiovascular disease in US adults: the first National Health and Nutrition Examination Survey Epidemiologic Follow- Study. *The American journal of clinical nutrition*, *76*(1), 93-99.

Bear, M. A., & Goldman, R. H. (2005). Enhancing local sourcing of fresh fruits and vegetables in Uganda's domestic market. Business Service Market Development. DFID. Kampala, Uganda.

Bittencourt, M., Teratanavat, R. P., & Chern, W. S. (2002). Determinants of changes in Japanese food consumption under life-cycle hypothesis using cross sectional data. In *Midwest Econometric Group 12th Annual Meeting, Columbus, Ohio*.

Blanck, H. M., Gillespie, C., Kimmons, J. E., Seymour, J. D., & Serdula, M. K. (2008). Trends in fruit and vegetable consumption among US men and women, 1994–2005. Preventing chronic disease, 5(2).

Blisard, N., Lin, B.-H., Cromartie, J., & Ballenger, N. (2002). America's changing appetite: Food consumption and spending to 2020. *Food Review-Washington DC, 25* (1), 2-9.

Block, S. (2002). Nutrition knowledge versus schooling in the demand for child micronutrient status (No. 10). Friedman School of Nutrition Science and Policy.

Block, S. A. (2004). Maternal nutrition knowledge and the demand for micronutrient-rich foods: Evidence from Indonesia. Journal of Development Studies, 40(6), 82-105.

Boysen, O. (2013, June). High Food Prices and their Implications for Poverty in Uganda From Demand System Estimation to Simulation. In *2013 Annual Meeting, August 4-6, 2013, Washington, DC* (No. 150700). Agricultural and Applied Economics Association.

Buchinsky, M. (1994). Changes in the US wage structure 1963-1987: Application of quantile regression. *Econometrica: Journal of the Econometric Society, 62* (2), 405-458.

Buchinsky, M. (1998). Recent advances in quantile regression models: A practical guideline for empirical research. *Journal of Human Resources, 33* (1), 88-126.

Buse, R. C., & Salathe, L. E. (1978). Adult equivalent scales: An alternative approach. *American Journal of Agricultural Economics, 60* (3), 460-468.

Capps, O., & Love, J. M. (1983). Determinants of household expenditure on fresh vegetables. *Southern Journal of Agricultural Economics, 15* (1), 127-132.

Cheng, T.-C., & Wen, W.-J. (2011). Determinants of performing arts attendance in Taiwan: A multivariate probit analysis. *Applied Economics Letters, 18* (15), 1437-1442.

Cook, R. (1990). Challenges and opportunities in the US fresh produce industry. *Journal of Food Distribution Research, 21* (1), 67-74.

Deaton, A. (1997). *The analysis of household surveys: A microeconometric approach to development policy. World Bank Publications.* Baltimore: The Johns Hopkins University Press for the World Bank.

Deaton, A., & Muellbauer, J. (1980). *Economics and consumer behavior*. New York: Cambridge University Press.

Dijkstra, T. (2001). Export diversification in Uganda: developments in non-traditional agricultural exports.

DiMaria-Ghalili, R. A., & Amella, E. (2005). Nutrition in older adults: intervention and assessment can help curb the growing threat of malnutrition. *AJN The American Journal of Nursing*, *105*(3), 40-50.

Flood, A., Velie, E. M., Chaterjee, N., Subar, A. F., Thompson, F. E., Lacey, J. V., ...& Schatzkin, A. (2002). Fruit and vegetable intakes and the risk of colorectal cancer in the Breast Cancer Detection Demonstration Project follow-up cohort. *The American journal of clinical nutrition*, *75*(5), 936-943.

Florkowski, W.J., Shewfelt, R.L., Brueckner, B. & Prussia, S.E. (2014). *Post-Harvest Handling: A Systems Approach* (3rd ed.). San Diego: Elsevier Inc..

Gibbons, R. D., & Wilcox-Gök, V. (1998). Health service utilization and insurance coverage: A multivariate probit analysis. *Journal of the American Statistical Association*, *93* (441), 63-72.

Giles, D. E., & Hampton, P. (1985). An Engel Curve Analysis of Household Expenditure in New Zealand*. *Economic Record*, *61*(1), 450-462.

Gujarati, D. N., & Porter, D. C. (2009). *Basic econometrics* (5th ed.). Boston: Tata McGraw-Hill Education.

Gunderson, G. W. (2003). The national school lunch program: Background and development. Nova Publishers.

Gustavsen, G. W., & Rickertsen, K. (2006). A censored quantile regression analysis of vegetable demand: The effects of changes in prices and total expenditure. *Canadian Journal of Agricultural Economics*, *54* (4), 631-645.

He, H., Huang, C. L., & Houston, J. E. (1995). US household consumption of fresh fruits. *Journal of Food Distribution Research*, *26* (2), 28-38.

Heimendinger, J., Van Duyn, M. A., Chapelsky, D., Foerster, S., & Stables, G. (1996). The national 5 A Day for Better Health Program: a large-scale nutrition intervention. *Journal of Public Health Management and Practice*, *2*(2), 27-35.

Ihucha, A. (2011). East Africa: Low Fruit, Veg Intake Killing Citizens. *The East African*, 30 October 2011. Retrieved from http://www.theeastafrican.co.ke/news/Low+fruit++veg+intake+killing+East+Africans++study+/-/2558/1264416/-/3lmid9/-/index.html.

Jetter, K. M. (2011). Using price incentives to increase the consumption of fruits and vegetables among a low-income population. In J. K. Gerald, R. R. Watson & V. R. Preedy (Eds.), *Nutrients, Dietary Supplements, and Nutriceuticals* (pp. 105-119). New York: Springer.

Kaaya, N. A., & Warren, H. L. (2005). A review of past and present research on aflatoxin in Uganda. *African J. Food Agric. Nutr. Dev.* 5, 1-19.

Keatinge, J. D., Waliyar, F., Jamnadas, R. H., Moustafa, A., Andrade, M., Drechsel, P., ... & Luther, K. (2010). Relearning old lessons for the future of food—by bread alone no longer: diversifying diets with fruit and vegetables.*Crop Science, 50* (Supplement_1), S-51.

Kikafunda, J. K., Walker, A. F., Allan, E. F., & Tumwine, J. K. (1998). Effect of zinc supplementation on growth and body composition of Ugandan preschool children: A randomized, controlled, intervention trial. *American Journal of Clinical Nutrition, 68* (6), 1261-1266.

Koenker, R., & Bassett Jr, G. (1978). Regression quantiles. *Econometrica: Journal of the Econometric Society, 46* (1), 33-50.

Lewbel, A. (2006). Engel curves. *The New Palgrave Dictionary of Economics, 2*.

Lin, B. H., & Morrison, R. M. (2002). Higher fruit consumption linked with lower body mass index. *Food review*, *25*(3), 28-32.

Lock, K., Pomerleau, J., Causer, L., Altmann, D. R., & McKee, M. (2005). The Global Burden of Disease Attributable to Low Consumption of Fruit and Vegetables: Implications for the Global Strategy on Diet. *Bulletin of the World Health Organization, 83* (2), 100-108.

McGregor, P. P., & Borooah, V. K. (1992). Is low spending or low income a better indicator of whether or not a household is poor: some results from the 1985 Family Expenditure Survey. *Journal of Social Policy*, *21*(01), 53-69.

Nayga, R. M. (1995). Determinants of US household expenditures on fruit and vegetables: A note and update. *Journal of Agricultural and Applied Economics, 27* (2), 588-594.

Oniang'o, R. K., Mutuku, J. M., & Malaba, S. J. (2003). Contemporary African food habits and their nutritional and health implications. *Asia Pacific Journal of Clinical Nutrition, 12* (3), 331-236.

Pinstrup-Andersen, P., & Watson II, D. D. (2011). *Food Policy for Developing Countries: The Role of Government in Global, National, and Local Food Systems*. Cornell University Press.

Powell, J. L. (1986). Censored regression quantiles. *Journal of Econometrics, 32* (1), 143-155.

Powell, L. M., Zhao, Z., & Wang, Y. (2009). Food prices and fruit and vegetable consumption among young American adults. *Health & place*, *15*(4), 1064-1070.

Price, D. W., Price, D. Z., & West, D. A. (1980). Traditional and nontraditional determinants of household expenditures on selected fruits and vegetables. *Western Journal of Agricultural Economics, 5* (1), 21-35.

Revoredo-Giha, C., & Florkowski, W. J. (2013). *An Analysis of the Demand for Fresh Fruit in Scotland* (No. 152212).

Ruel, M. T., Minot, N., & Smith, L. (2005). Patterns and determinants of fruit and vegetable consumption in sub-Saharan Africa: A multi-country comparison. . In

Background paper for the Joint WHO/FAO Workshop on Fruit and Vegetables for Health, 1-3 September 2004, Kobe, Japan. Geneva: World Health Organization.

Russell, R. M., Rasmussen, H., & Lichtenstein, A. H. (1999). Modified food guide pyramid for people over seventy years of age. *The Journal of nutrition*,*129*(3), 751-753.

Samal, P., Pandey, S., Kumar, G., & Barah, B. (2011). Rice ecosystems and factors affecting varietal adoption in rainfed coastal Orissa: A multivariate probit analysis. *Agricultural Economics Research Review, 24* (1), 161-167.

Schady, N., & Rosero, J. (2008). Are cash transfers made to women spent like other sources of income? *Economics Letters*, *101*(3), 246-248.

Smith, L. C., Ramakrishnan, U., Ndiaye, A., Haddad, L., & Martorell, R. (2003). *The importance of women's status for child nutrition in developing countries. Research Report # 131* (Vol. 131). Washington DC: International Food Policy Research Institute

Stewart, H., Blisard, N., & Jolliffe, D. (2003). Do income constraints inhibit spending on fruits and vegetables among low-income households? *Journal of Agricultural and Resource Economics, 28* (3), 465-480.

TheWorldBank. (2011). Uganda - Nutrition at a glance. Retrieved from http://documents.worldbank.org/curated/en/2011/04/17695370/uganda-nutrition-glance

Uganda Investment Authority ( ). Investment opportunities in Uganda's fruit and vegetable sector. Retrieved from

http://www.tgais.com/wp-content/uploads/2014/03/UIA-Fruits-Vegetable-Sector.pdf

USAID. (2013, May 29). *The fresh fruit and vegetable markets of East Africa - An assessment of regional value chain actors, activities and constraints in Kenya, Tanzania and Uganda.* Retrieved from http://www.competeafrica.org/Files/FFV_Markets_of_East_Africa_July_2013.pdf

U.S.Foodand DrugAdministration (FDA). (2011). Nutrition information for raw fruits, vegetables, and fish. Retrieved from http://www.fda.gov/food/ingredientspackaginglabeling/labelingnutrition/ucm063367.htm.

Waterlander, W. E., de Boer, M. R., Schuit, A. J., Seidell, J. C., & Steenhuis, I. H. (2013). Price discounts significantly enhance fruit and vegetable purchases when combined with nutrition education: a randomized controlled supermarket trial. *American Journal of Clinical Nutrition, 97* (4), 886-895.

Weatherspoon, D., Oehmke, J., Dembélé, A., Coleman, M., Satimanon, T., & Weatherspoon, L. (2013). Price and expenditure elasticities for fresh fruits in an urban food desert. *Urban Studies, 50* (1), 88-106.

Weerahewa, J., Rajapakse, C., & Pushpakumara, G. (2013). An analysis of consumer demand for fruits in Sri Lanka. 1981–2010. *Appetite, 60* (1), 252-258.

World Health Organization (WHO). (2003). Diet, nutrition and the prevention of chronic diseases. Report of a Joint WHO/FAO Expert Consultation. In *WHO technical report series* (Vol. 916). Geneva: World Health Organization.

World Health Organization (WHO). (2011). NCD Country Profiles: Uganda. Retrieved from http://www.who.int/nmh/countries/uga_en.pdf.

Young, C. R., Aquilante, J. L., Solomon, S., Colby, L., Kawinzi, M. A., Uy, N., & Mallya, G. (2013). Improving fruit and vegetable consumption among low-income customers at farmers markets: Philly Food Bucks, Philadelphia, Pennsylvania, 2011. *Preventing Chronic Disease, 10,* 1-8

Table 1

The sample descriptive statistics

Variable	Mean	Std. Dev.	Min	Max	Description
Dependent					
Vegexp	1.784	2.319	0	32.907	Weekly vegetable expenditure in $
Fruitexp	1.264	1.936	0	32.520	Weekly fruit expenditure in $
Independent					
Totalincome	237.01	771.76	0.39	25938.83	Total monthly household income in $
Permanent	0.134	0.341	0	1	Permanent job
Self	0.371	0.483	0	1	Self employed
Others	0. 491	0. 500	0	1	Other type of jobs*
Education	0. 345	0. 475	0	1	1=upper secondary or higher
Respgend	0.278	0.448	0	1	1= male; 0 = female
Age	35.339	12.355	17	89	Age of the respondent in years
Married	0.692	0.461	0	1	1= married
Adults	2.293	1.413	0	15	Number of adults in the household
Child	3.018	2.111	0	12	Number of children in the household
Child3dum	0.548	0.497	0	1	1= if a household has children of 3 years old or
Child12dum	0.672	0.469	0	1	1= if a household has children of age between 4
Child18dum	0.482	0.499	0	1	1= if a household has children of age between 13 and 18 years old
Shopdist	573.099	1925.962	0	50000	Distance to the nearest retail outlet in meters
Gulu	0.121	0.326	0	1	Residence in Gulu (=1)
Lira	0.122	0.327	0	1	Residence in Lira (=1)

Mbale	0.121	0.326	0	1	Residence in Mbale (=1)
Soroti	0.117	0.321	0	1	Residence in Soroti (=1)
Kampala	0.515	0.499	0	1	Residence in Kampala (=1)*

* Reference category
Note: $1=2583 UGS, June, 2011.

Table 2

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

Weekly expenditure	Quantiles				Mean
	0.25	0.5	0.75	0.90	
Household fresh vegetable expenditure	0.58	1.16	1.94	3.87	1.78
Household fresh fruit expenditure	0.19	0.77	1.90	3.10	1.26
Fresh vegetable expenditure per person	0.17	0.35	0.72	1.29	0.61
Fresh fruit expenditure per person	0.05	0.25	0.53	0.94	0.42

Note: $1 = 2583 UGS in June, 2011.

Table 3

Household weekly and per household member fresh vegetable and fruit expenditures in four quantiles in two income categories[a], in $

Weekly expenditure	Quantiles				Mean
Equal to or less than the mean income <= $237	0.25	0.5	0.75	0.90	
Fresh vegetable	0.39	1.16	1.94	3.87	1.69
Per member fresh vegetable	0.15	0.33	0.70	1.23	0.61
Fresh fruit	0.00	0.58	1.36	2.32	1.04
Per member fresh fruit	0.00	0.21	0.46	0.85	0.37
Income higher than the mean income > $237					
Fresh vegetable	0.77	1.16	2.32	4.07	2.03
Per member fresh vegetable	0.22	0.39	0.73	1.36	0.60
Fresh fruit	0.50	1.16	1.94	3.87	1.84
Per member fresh fruit	0.16	0.35	0.72	1.21	0.56

[a] households having a monthly income higher than $237, and lower or equal to $237.
Note: $ 1 = 2583 UGS (according to June, 2011 exchange rate)

Table 4

Proportion of households reporting regular consumption of selected fresh fruits and vegetables in the survey of urban households in Uganda, 2011

Fresh fruit	Proportion of households reporting regular consump-tion	% daily values (%DV) based on 2,000 calorie diet[a] per serving					Serving size in ounces (oz) (1oz = 28.35g)
		Vit A	Vit C	Calcium	Iron	Dietary fiber	
Apple*	0.20	2	8	2	2	20	8.0
Watermelon*	0.33	30	25	2	4	4	10.0
Pineapple*	0.45	2	50	2	2	4	4.0
Orange*	0.46	2	130	6	0	12	5.5
Passion fruit**	0.47	60	118	3	21	98	8.3
Mango**	0.52	25	76	2	1	12	5.8
Sweet banana*	0.60	2	15	0	2	12	4.5
Avocado*	0.63	0	4	0	2	4	1.1
Cauliflower/ broccoli*	0.10	0/6	100/220	2/6	2/6	8/12	3.5/5.3
Spinach/ Kale*	0.18	56/206	14/134	3/9	5/6	3/5	1.1/2.4
Pepper**	0.20	4	190	2	4	3	5.3
Carrot*	0.41	110	10	2	2	8	2.8
Irish potato*	0.56	0	45	2	6	8	5.3
Cabbage**	0.68	0	70	4	2	9	3.0
Tomato*	0.85	20	40	2	4	4	5.3

*U.S. Food and Drug Administration (http://www.fda.gov/food/ingredientspackaginglabeling/labelingnutrition/ucm063367.htm).

** http://nutritiondata.self.com/facts/fruits-and-fruit-juices/1952/2

Table 5

Estimation results from the fresh fruit expenditure equation

Variables/ quantiles	25	50	75	90	OLS	F-test[#] value
Income elasticity of expenditure	1.04300[3]	0.41300[3]	0.34300[3]	0.35300[3]	0.67300[3]	2.29[1]
	(0.32202)	(0.05619)	(0.06050)	(0.04015)	(0.09806)	(0.0766)
Permanent	1.44646[3]	0.26508[2]	0.09848	0.01921	0.73036[2]	1.82
	(0.70790)	(0.10784)	(0.12663)	(0.17669)	(0.28944)	(0.1423)
Selfemploy	0.82557[3]	0.29341[3]	0.16080[1]	0.15994	0.56797[3]	0.52
	(0.40610)	(0.08962)	(0.08941)	(0.11400)	(0.19453)	(0.6694)
Education	1.64073[3]	0.59155[3]	0.36395[3]	0.26238[2]	0.95600[3]	4.32[3]
	(0.53904)	(0.10732)	(0.08019)	(0.11242)	(0.21044)	(0.0048)
Respgender	-0.72530[3]	-0.27213[2]	0.02856	-0.02244	-0.45357[2]	1.93
	(0.49514)	(0.12508)	(0.09801)	(0.15484)	(0.21109)	(0.1228)
Log (age)	-1.32447[2]	-0.36855[2]	0.04790	-0.02708	-0.46531	2.13[1]
	(0.55990)	(0.16228)	(0.10024)	(0.13803)	(0.32920)	(0.0946)
Married	-0.06521	-0.12206	-0.12947	-0.18509[1]	0.01751	0.24
	(0.29316)	(0.08531)	(0.11252)	(0.09295)	(0.20775)	(0.8710)
Log (adults)	0.18482	0.26916[2]	0.27244[3]	0.29508[3]	0.27135	0.05
	(0.29638)	(0.11676)	(0.10084)	(0.08292)	(0.20691)	(0.9836)
Adultfdum	0.17269	-0.00208	0.16443	-0.08685	0.15300	0.77
	(0.66543)	(0.14428)	(0.15110)	(0.18753)	(0.33136)	(0.5089)
Log (children)	-0.15729	0.18412	0.17948[1]	0.20012[2]	0.17312	0.34
	(0.22500)	(0.13752)	(0.09492)	(0.09133)	(0.22238)	(0.7937)
Child3dum	-0.20434	0.07184	0.11142	0.16711[1]	0.05167	0.16
	(0.35103)	(0.11634)	(0.10393)	(0.09955)	(0.21140)	(0.9207)
Child12dum	-0.10106	-0.09291	-0.26976	-0.23923[2]	-0.38861	0.62
	(0.52189)	(0.14061)	(0.16932)	(0.09595)	(0.25808)	(0.5993)
Child18dum	-0.12840	-0.08375	-0.13903	-0.12312	-0.17826	0.15
	(0.21381)	(0.13205)	(0.09116)	(0.11535)	(0.23712)	(0.9290)
Log (shopdist)	0.31576[1]	0.05663[1]	0.00370	-0.00557	0.15120[3]	2.59[1]
	(0.16345)	(0.02892)	(0.02923)	(0.02240)	(0.05457)	(0.0515)
Gulu	-2.11635	-0.05609	-0.09124	0.04665	-0.52092	2.10[1]
	(2.53328)	(0.16002)	(0.13767)	(0.24574)	(0.32886)	(0.0991)
Lira	-3.57295[3]	-0.40349[1]	-0.29097[2]	-0.08248	-1.18820[3]	4.68[3]
	(1.48259)	(0.22596)	(0.11723)	(0.16291)	(0.28865)	(0.0029)
Mbale	-1.75715	-0.06021	0.17157	0.45657[3]	-0.48778	2.96[2]
	(1.07715)	(0.23484)	(0.16964)	(0.12427)	(0.30725)	(0.0315)

Soroti	-1.06654	0.04325	0.20019[2]	0.30260 [3]	-0.25129	3.87[3]
	(2.11172)	(0.11300)	(0.08563)	(0.08942)	(0.31350)	(0.0090)
Constant	-5.39154	2.76442	3.27482	4.03059	-1.93177	
	(5.22004)	(1.02672)	(0.96550)	(0.75255)	(1.68915)	

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

[#] p-value is given in parantheses

Table 6

Estimation results from the fresh vegetable expenditure equation

Variables/ quantiles	25	50	75	90	OLS	F-test value[#]
Income elasticity of expenditure	0.1330***	0.1630***	0.1930***	0.1630***	0.2330***	1.01
	(0.0251)	(0.0428)	(0.0347)	(0.0446)	(0.0655)	(0.3884)
Permanent	0.1485	0.1200	0.0509	0.0986	0.3129	0.04
	(0.0927)	(0.0751)	(0.0768)	(0.1049)	(0.1932)	(0.9909)
Selfemploy	0.2837***	0.1423	0.0704	0.1190	0.2071	0.71
	(0.1083)	(0.0870)	(0.0696)	(0.0764)	(0.1299)	(0.5460)
Education	0.4930***	0.2341***	0.15950***	-0.0178	0.3240**	3.99***
	(0.1592)	(0.0693)	(0.0605)	(0.0762)	(0.1405)	(0.0077)
Log	-0.6090***	-0.2739	-0.2448**	-0.2596***	-0.8342***	3.19**
	(0.1297)	(0.1684)	(0.0999)	(0.0934)	(0.2198)	(0.0231)
Respgender	-0.0661	0.0147	0.0355	0.1195	-0.2515*	0.59
	(0.0617)	(0.0844)	(0.1105)	(0.0925)	(0.1409)	(0.6230)
Married	-0.0235	-0.0406	-0.0301	0.0045	-0.0356	0.38
	(0.1244)	(0.0719)	(0.0877)	(0.0922)	(0.1387)	(0.7657)
Log (adults)	0.3665[3]	0.2271[3]	0.3586[3]	0.3029[3]	0.3483[2]	1.43
	(0.1415)	(0.0824)	(0.0579)	(0.0866)	(0.1381)	(0.2315)
Adultfdum	0.2686	0.2659[2]	-0.1169	-0.1140	0.1099	2.99[2]
	(0.1946)	(0.1133)	(0.1798)	(0.2441)	(0.2212)	(0.0301)
Log (children)	0.1383	0.1942[1]	0.0509	0.1306	0.2112	0.50
	(0.2079)	(0.1174)	(0.1006)	(0.0850)	(0.1485)	(0.6837)
Child3dum	0.1231	0.0563	0.1980[2]	0.2589[3]	0.2465[1]	1.11
	(0.0833)	(0.0922)	(0.0846)	(0.0696)	(0.1411)	(0.3433)
Child12dum	-0.02044	-0.07863	-0.01224	-0.08266	0.00870	0.27
	(0.09657)	(0.13103)	(0.15398)	(0.09806)	(0.17230)	(0.8436)
Child18dum	0.08983	-0.02456	0.05206	-0.00542	0.12666	1.99
	(0.15310)	(0.09616)	(0.11065)	(0.09199)	(0.15831)	(0.1133)
Log (shopdist)	-0.00006	-0.00233	0.02125	0.00176	0.02466	0.71
	(0.02013	(0.02225)	(0.01623)	(0.01724)	(0.03643)	(0.5450)
Gulu	0.52141[3]	0.33180[3]	0.26699	0.34225[2]	0.00418	0.31
	(0.14688	(0.09428)	(0.17199)	(0.14282)	(0.21955)	(0.8185)
Lira	-0.42291[3]	-0.37807[3]	-0.33534[3]	-0.44638[3]	-0.81139[3]	0.66
	(0.16377	(0.13226)	(0.08469)	(0.10621)	(0.19270)	(0.5756)
Mbale	0.35148[3]	0.54355[3]	0.74491[3]	0.83858[3]	0.59888[3]	3.43[2]
	(0.17800)	(0.10264)	(0.10063)	(0.09949)	(0.20512)	(0.0165)

Soroti	0.43794[3]	0.75508[3]	0.84557[3]	0.94100[3]	0.12458	2.75[2]
	(0.17951)	(0.11136)	(0.08706)	(0.14305)	(0.20929)	(0.0415)
Constant	6.54574	6.02261	6.37436	7.26287	6.40491	
	(1.35921)	(0.73704)	(0.54251)	(0.76719)	(1.12769)	

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

Table 7

Estimation results for regular consumption of fresh fruits.

factor / fruit	Apple	Water melon	Pineapple	Orange	Passion fruit	Mango	Banana	Avocado
totalinc	1.87e-08	6.43e-08*	6.39e-08	-9.06e-10	1.04e-08	2.90e-08	1.06e-08	3.34e-08
	(1.93e-08)	(3.68e-08)	(4.17e-08)	(1.70e-08)	(1.76e-08)	(2.00e-08)	(1.18e-08)	(2.46e-08)
permanent	0.278**	0.164	0.114	0.0830	-0.0883	0.00206	0.335***	0.102
	(0.121)	(0.110)	(0.111)	(0.110)	(0.111)	(0.109)	(0.118)	(0.110)
selfemploy	0.0833	-0.0486	0.105	-0.106	-0.139*	-0.110	0.0395	0.0705
	(0.0831)	(0.0735)	(0.0720)	(0.0720)	(0.0713)	(0.0714)	(0.0740)	(0.0736)
education	0.290***	0.237***	0.267***	0.115	0.306***	0.109	0.228***	0.0742
	(0.0855)	(0.0757)	(0.0756)	(0.0748)	(0.0745)	(0.0740)	(0.0790)	(0.0766)
respgend	-0.00376	-0.196*	-0.0907	-0.217***	-0.336***	-0.205***	0.0657	-0.238***
	(0.0915)	(0.0817)	(0.0775)	(0.0783)	(0.0782)	(0.0790)	(0.0814)	(0.0790)
age	-0.00201	0.00793***	-0.000339	0.00241	-0.00196	0.00806***	-0.000301	-0.00338
	(0.00347)	(0.00296)	(0.00291)	(0.00298)	(0.00296)	(0.00303)	(0.00302)	(0.00295)
married	0.109	-0.0333	0.0565	-0.00750	0.00645	0.0406	0.0262	0.154**
	(0.0854)	(0.0772)	(0.0758)	(0.0749)	(0.0748)	(0.0754)	(0.0782)	(0.0761)
adults	0.0206	0.0475*	0.0335	0.0545**	0.0444*	0.0687***	0.0719***	0.0962***
	(0.0266)	(0.0265)	(0.0249)	(0.0242)	(0.0248)	(0.0259)	(0.0265)	(0.0256)
child	-0.0622**	-0.0932***	-0.0626**	-0.0233	-0.0553**	-0.0407*	-0.0671***	-0.0440**
	(0.0302)	(0.0264)	(0.0302)	(0.0249)	(0.0224)	(0.0221)	(0.0234)	(0.0222)
child3dum	0.0734	0.149*	0.0849	0.0812	0.00889	0.0874	0.121	0.0521
	(0.0875)	(0.0788)	(0.0779)	(0.0759)	(0.0746)	(0.0754)	(0.0792)	(0.0764)
child12dum	0.0355	0.153*	0.139	0.0160	0.0802	0.0102	0.170*	0.119
	(0.101)	(0.0895)	(0.0918)	(0.0874)	(0.0851)	(0.0844)	(0.0905)	(0.0865)
child18dum	0.177*	-0.00492	0.0325	-0.0420	0.140*	-0.0419	0.177**	0.102
	(0.0963)	(0.0862)	(0.0908)	(0.0844)	(0.0819)	(0.0822)	(0.0851)	(0.0838)
gulu	0.102	-0.441***	-0.196*	0.307***	0.0710	0.353***	-0.791***	-0.294***
	(0.118)	(0.118)	(0.113)	(0.112)	(0.113)	(0.114)	(0.115)	(0.113)
lira	-0.621***	-0.494***	-0.585***	0.417***	0.0721	0.420***	-1.313***	-0.792***

	(0.135)	(0.109)	(0.0985)	(0.0994)	(0.0995)	(0.103)	(0.105)	(0.104)
soroti	-0.667***	-0.0222	0.0419	0.832***	0.289**	0.761***	-0.881***	-0.375***
	(0.137)	(0.120)	(0.118)	(0.121)	(0.119)	(0.124)	(0.118)	(0.115)
mbale	-0.684***	-0.669***	-0.805***	-0.164	-0.130	-0.0316	-1.050***	-0.282***
	(0.134)	(0.110)	(0.114)	(0.108)	(0.104)	(0.104)	(0.106)	(0.106)
_cons	-0.882***	-0.606***	-0.191	-0.391***	-0.0941	-0.466***	0.375**	0.282**
	(0.160)	(0.142)	(0.142)	(0.143)	(0.141)	(0.142)	(0.148)	(0.141)

Note: Standard errors in parentheses. *, **, and *** represent significance at 10%, 5%, and 1%, respectively.

Table 8

Marginal effects computed for fresh fruit consumption.

factor / fruit	Apple	Water melon	Pineapple	Orange	Passion fruit	Mango	Banana	Avocado
totalinc	-3.27E-07	-2.40E-07*	-1.61E-07	-2.12E-07	-1.83E-07	-1.49E-07	-8.41E-08	-6.06E-08
permanent	0.0236**	0.0242	0.0200	0.0156	-0.0106	0.0035	0.0413***	0.0118
selfemploy	0.0068	-0.0074	0.0126	-0.0144	-0.0199*	-0.0144	0.0040	0.0083
education	0.0237***	0.0298***	0.0370***	0.0155	0.0465***	0.0165	0.0297***	0.0120
respgend	0.0016	-0.0249*	-0.0111	-0.0289***	-0.0493***	-0.0270***	0.0077	-0.0289***
age	-0.0002	0.0009***	-0.0001	0.0003	-0.0002	0.0012***	8.64E-06	-0.0003
married	0.0090	-0.0039	0.0066	-0.0019	0.0019	0.0058	0.0041	0.0194**
adults	0.0025	0.0059*	0.0052	0.0073**	0.0068*	0.0091***	0.0081***	0.0111***
child	-0.0055**	-0.0118***	-0.0094***	-0.0020	-0.0077**	-0.0051*	-0.0076***	-0.0051**
child3dum	0.0092	0.0188*	0.0105	0.0082	0.0003	0.0117	0.0101	0.0040
child12dum	0.0004	0.0200*	0.0221	0.0008	0.0122	0.0022	0.0222*	0.0168
child18dum	0.0164*	0.0003	0.0048	-0.0090	0.0193*	-0.0082	0.0193**	0.0110
gulu	0.0099	-0.0495***	-0.0255*	0.0487***	0.0175	0.0514***	-0.0976***	-0.0412***
lira	-0.0586***	-0.0732***	-0.0917***	0.0683***	0.0119	0.0671***	-0.1743***	-0.1062***
soroti	-0.0554***	0.0047	0.0059	0.1117***	0.0416**	0.0990***	-0.1113***	-0.0505***
mbale	-0.0572***	-0.0871***	-0.1136***	-0.0265	-0.0205	-0.0048	-0.1374***	-0.0351***

Table 9

Estimation results for regular consumption of fresh vegetables.

factor / vegetable	cauli	spinach	pepper	carrot	potato	cabbage	tomato
totalinc	3.91e-08**	1.54e-08	1.07e-08	5.86e-09	5.58e-08	1.93e-08	2.61e-08
	(1.64e-08)	(1.44e-08)	(1.10e-08)	(1.37e-08)	(3.97e-08)	(1.91e-08)	(2.74e-08)
permanent	0.0745	0.162	0.244	0.0835	0.322***	-0.0539	0.0780
	(0.154)	(0.136)	(0.132)	(0.122)	(0.115)	(0.109)	(0.133)
selfemploy	-0.0527	0.149*	0.142*	0.173**	0.191**	0.139*	0.0515
	(0.101)	(0.0879)	(0.0844)	(0.0760)	(0.0739)	(0.0748)	(0.0895)
education	0.122	0.153	0.153	0.207**	0.296***	-0.0570	0.0626
	(0.108)	(0.0934)	(0.0878)	(0.0815)	(0.0800)	(0.0788)	(0.0940)
respgend	-0.0126	-0.252**	0.301***	-0.136	-0.172**	-0.147*	0.000384
	(0.123)	(0.106)	(0.0940)	(0.0864)	(0.0813)	(0.0808)	(0.0965)
age	-0.000240	0.00762**	0.00116	-0.00388	-0.00157	-0.000118	0.000804
	(0.00489)	(0.00361)	(0.00364)	(0.00319)	(0.00312)	(0.00300)	(0.00394)
married	0.150	0.113	0.0112	0.108	0.0545	-0.0341	-0.189**
	(0.110)	(0.0891)	(0.0862)	(0.0806)	(0.0776)	(0.0777)	(0.0959)
adults	0.0229	0.109***	0.0678**	0.0366	0.0436*	0.0446*	0.0540*
	(0.0495)	(0.0272)	(0.0277)	(0.0262)	(0.0260)	(0.0249)	(0.0295)
child	-0.102***	-0.0484	0.00310	-0.0266	-0.0633***	0.00994	-0.0267
	(0.0381)	(0.0306)	(0.0295)	(0.0244)	(0.0244)	(0.0242)	(0.0284)
child3dum	0.148	0.156*	0.161*	0.0608	0.103	0.151*	-0.0685
	(0.109)	(0.0903)	(0.0889)	(0.0824)	(0.0771)	(0.0777)	(0.0936)
child12dum	0.200	-0.0107	-0.00804	-0.0276	0.142	-0.0365	0.106
	(0.122)	(0.103)	(0.102)	(0.0899)	(0.0887)	(0.0885)	(0.104)
child18dum	0.233**	-0.0183	0.0169	0.0667	0.0252	0.0265	0.156
	(0.117)	(0.103)	(0.100)	(0.0890)	(0.0862)	(0.0857)	(0.104)
gulu	-1.198***	-1.434***	-0.0107	-0.826***	-0.625***	-0.0707	-0.725***
	(0.233)	(0.214)	(0.116)	(0.116)	(0.112)	(0.112)	(0.129)
lira	-1.117***	-1.594***	-0.606***	-1.699***	-0.982***	-0.0644	-0.483***

	(0.209)	(0.237)	(0.133)	(0.142)	(0.113)	(0.112)	(0.130)
soroti	-1.209***	-0.866***	-1.251***	-1.039***	-0.604***	-0.132	-0.912***
	(0.239)	(0.148)	(0.168)	(0.122)	(0.114)	(0.110)	(0.130)
mbale	-0.565***	-0.847***	-1.588***	-1.236***	-0.878***	-0.441***	-0.606***
	(0.156)	(0.148)	(0.241)	(0.120)	(0.108)	(0.106)	(0.130)
_cons	-1.224***	-1.148***	-1.144***	0.150	0.270	0.370*	1.322***
	(0.206)	(0.171)	(0.164)	(0.151)	(0.147)	(0.146)	(0.177)

Note: Standard errors in parentheses. *, **, and *** represent significance at 10%, 5%, and 1%, respectively.

Table 10

Marginal effects computed for fresh vegetables.

factor / vegetable	cauli	spinach	pepper	carrot	potato	cabbage	tomato
totalinc	6.60E-09**	4.98E-09	4.01E-09	2.26E-09	2.11E-08	8.39E-09	4.25E-09
permanent	-0.0057	0.0143	0.0307	0.0086	0.1170***	-0.0284	0.0136
selfemploy	-0.0138	0.0342*	0.0388*	0.0590**	0.0706**	0.0586*	0.0241
education	0.0035	0.0240	0.0289	0.0722**	0.0836***	-0.0252	0.0195
respgend	-0.0364	-0.1087**	0.0430***	-0.0732	-0.1004**	-0.0936*	-0.0152
age	-0.0012	0.0009**	-0.0005	-0.0016	-0.0023	-0.0009	-0.0004
married	0.0071	0.0015	-0.0276	0.0234	-0.0049	-0.0373	-0.0551**
adults	0.0031	0.0152***	0.0088**	0.0065	0.0200*	0.0141*	0.0167*
child	-0.0151***	-0.0022	0.0073	-0.0029	-0.0205***	0.0056	-0.0076
child3dum	0.0024	0.0123*	0.0295*	0.0101	0.0214	0.0506*	-0.0107
child12dum	0.0054	-0.0452	-0.0437	-0.0350	0.0195	-0.0393	0.0228
child18dum	0.0321**	-0.0269	-0.0086	0.0084	0.0007	0.0029	0.0396
gulu	-0.1239***	-0.2697***	0.0827	-0.2268***	-0.1569***	0.0444	-0.1298***
lira	-0.1185***	-0.2703***	-0.0686***	-0.5494***	-0.3001***	0.0698	-0.0497***
soroti	-0.1172***	-0.1133***	-0.2414***	-0.2860***	-0.1350***	0.0419	-0.1796***
mbale	-0.0382***	-0.1170***	-0.2937***	-0.3727***	-0.2640***	-0.0869***	-0.0953***

Table 11

Average characteristics of households and respondents in the 25th quantile of expenditures

Characteristic	Expenditure	
	Fresh fruit	Fresh vegetable
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 children of 3 or less years of age	56	54
% of households with children of age between 4 &12	72	66
% of households with children of age between 13 &18	51	43
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	6	7
% of households of the self employed	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

CHAPTER 4

PEANUT PASTE/BUTTER CONSUMPTION FREQUENCY IN THE REPUBLIC OF UGANDA: COUNT DATA MODEL APPROACH

4.1 Abstract

Peanut paste/butter consumption frequency in the Republic of Uganda is analyzed using household survey data from five urban cities. Estimation results from Zero-inflated Binomial regression conclude that education, household location, color of peanut paste, etc. are important. The ordinal logistic results conclude that peanut paste/butter consumption with vegetables is the most preferred option among the different forms. Location of households, income, education, and employment status are important in explaining the variation in consumption with different kinds of foods. The results help locating segments of population that consume high amounts of peanut paste/butter, which in turn can be used to identify aflatoxin contamination and also explore the possibility of vitamin A fortification of peanut paste/butter.

4.2 Background and Objectives

The Republic of Uganda is an East African nation with agriculture as the main occupation. Primary agricultural crops vary across regions due to the natural resource endowment, but include corn, sorghum, plantain, bananas, cassava, and peanuts (CIA Fact book, 2012). Peanuts are grown in the central, eastern and northern parts of the country. In 2009, Uganda produced 327 thousand tons of peanuts (UBS, 2012). Peanuts and peanut products are an important part of the daily diet for many Ugandans (Kaaya and Warren, 2005). Peanut paste obtained from lightly roasted and ground (or pounded)

peanut kernels is the most popular product. Peanuts are good sources of protein, micronutrients, vitamin E, fiber and antioxidants. A risk associated with peanut consumption is the presence of aflatoxins, and this is very common in Uganda (Kaaya and Warren, 2005).

In 2009, around 38% of the Ugandan population lived below the international poverty line of US $1.25/day (World Data Bank, 2012). Poverty, along with limited access to nutritious foods (FANTA, 2010), adversely affect the well-being of children and adults. Two conditions commonly found among Ugandan population are the protein-energy imbalance and vitamin A deficiency. Monitor-Uganda (2009) reports that about 425,000 child deaths are estimated to occur in Uganda between 2006 and 2016 resulting from protein-energy malnutrition disorders such as marasmus, kwashiorkor, and stunting. On the other hand, vitamin A deficiency weakens the immune system, and may also lead to blindness and death. It is reported that vitamin A deficiency contributes to more than half a million deaths among children in Africa (UNICEF, 2004), and in Uganda (Monitor-Uganda, 2009) the estimated 157,000 child deaths between 2006 and 2016 would be the result of vitamin A deficiency. The World Bank (2009) reports that 28 % of preschool children and 23 % of pregnant women are found to be deficient in vitamin A in the Republic of Uganda.

Peanuts contain about 26 % of protein and approximately 49% of fat, including both saturated and unsaturated fat with a dominance of the latter (USDA, 2014). Consequently, peanuts can contribute to alleviation of malnutrition reducing the protein-energy imbalance in the diet of many Ugandans. Furthermore, the experiences from other countries in the region, such as Sudan (Balla et al., 2006), or in Asia, for example the

Philippines (USAID, 2006), indicate that peanut butter (or peanut paste) may be fortified with vitamin A and made available for public consumption to lessen the disease burden resulting from its inadequate intake. Vitamin A fortified peanut butter would expand earlier efforts to address the deficiency through fortification of sugar with vitamin A (Kawuma, 2002) or consumption of orange-flesh sweet potato (Yanggen and Nagujja, 2006).

However, the major practical issue in alleviating malnutrition is the acceptance of the particular product. In the past, high lysine corn was not welcomed by farmers and consumers in Mexico because of yellow rather than the preferred white kernel color. In Uganda, the preferred color of sweet potatoes is creamy or white (which is associated with low vitamin A content) (Chowdhury et al., 2011) and orange sweet potatoes are being accepted rather slowly by consumers. Sugar, although Uganda is a sugar producer and exporter, tends to be expensive. Moreover, the nutritional value of sugar is low and excess consumption quickly leads to other health problems. Under these circumstances, peanut paste fortified with vitamin A would likely be a more appropriate product, because it is commonly accepted and used in daily diet. It can be made of safe, domestically grown peanuts, because aflatoxin-contaminated peanut kernels can be effectively removed through sorting. Kaaya et al. (2006) reports that a training workshop held in Uganda demonstrated that sorting reduces aflatoxin below the allowable limit (4 ppb for processed peanut products).

This study focuses on determinants of current peanut paste consumption. Specifically, to gain knowledge about the feasibility of reducing vitamin A deficiency through peanut paste fortification, this study examines the peanut paste consumption frequency in urban

Ugandan households. To further augment the knowledge of peanut paste consumption, the study assesses factors that influence consumption of peanut paste along with other foods. Earlier studies (Sarkar et al., 1994; Jubert et al., 2009) suggest the importance of peanut paste consumption along with vegetables because chlorophyll and chlorophyllin found in almost all green plant parts can reduce the consequences of aflatoxin ingestion. Knowledge of the factors influencing the peanut paste consumption and the identified consumer profile serves as the basis for calculating the potential exposure to aflatoxin contamination through consumption of peanuts and peanut products assuming the consumed portion size. Results from these analyses are applied to create consumer profiles with different consumption frequencies, which assist government and other agencies involved in vitamin A deficiency reduction efforts, while also reducing aflatoxin contamination.

4.3 Empirical Model

Peanut paste/butter consumption frequency analysis

The empirical model specification is driven by the stated objectives conditioned by available survey data, which includes responses to questions on peanut paste consumption. These responses have been selected from a list of frequencies provided in the questionnaire ranging from twice or more often a day to less often than once a month. and they have been converted into number of times a respondent consumes peanut paste in a month. Since these can be considered counts, a count data regression model is the appropriate choice for analyzing factors associated with variation in peanut paste consumption frequency across households in the sample. The properties of the

distribution of dependent variable determine the choice of a specific count data model from available alternatives such as Poisson or negative binomial count data models.

The Poisson Model

This is the simplest among count data models, where the dependent variable is assumed to follow a Poisson distribution implying the equality of mean and variance. The probability of observing a specific count, y, is

$$\Pr(Y = y) = \frac{\lambda^{y} e^{-\lambda}}{y!} \qquad (1)$$

where λ is the parameter, accounting for the mean and variance of the distribution. The conditional mean function is written as $E[y_i|X_i] = \lambda_i = \exp(X_i'\beta)$, where X_i a vector of explanatory variables and β is a vector of the corresponding coefficients. The natural logarithmic transformation of both sides results in a log-linear model. The Poisson model assumption of the mean and variance equality (equidispersion) is very restrictive. A review of the descriptive statistics (Table 1) indicates that in the data sample, the variance substantially exceeds the mean indicating the presence of overdispersion. Once the equidispersion assumption fails, the estimated standard errors of the coefficients are biased downwards, though the estimated coefficients are consistent. In the case of overdispersion a negative binomial model is more appropriate than the Poisson model (Yen and Adamowicz, 1993).

Negative Binomial Model

Here, the count dependent variable is assumed to have a negative binomial distribution written as:

$$P(Y = y) = \left(\frac{r}{r+\lambda}\right)^{r} \frac{\Gamma(r+y)}{\Gamma(y+1)\Gamma(r)} \left(\frac{\lambda}{r+\lambda}\right)^{y}. \qquad (2)$$

In the above equation, the mean is λ, but the variance is $\lambda + \frac{\lambda^2}{r}$, where r is the dispersion parameter. The negative binomial regression model allows the prediction of the probabilities in addition to modeling the mean.

The selectivity problem plagues count data models and it arises with excessive numbers of zeros in the data. In the current study, 137 out of the total 1638 households report zero consumption frequency of peanut paste per month. Households that do not report consumption are included in the usual negative binomial regression estimation. In the current study, a portion of zeroes may result from not eating peanut paste in the month preceding the survey, while other zeros may reflect a less-than-monthly consumption frequency or a complete absence of peanut paste consumption. The negative binomial model does not distinguish between zeroes originating from different processes. However, the zero-inflated negative binomial (ZINB) regression model distinguishes such differences and permits the estimation of the coefficients accordingly (Lewsey and Thomson, 2004).

Zero-inflated Negative Binomial Model

The regression model consists of two parts. The first part distinguishes households that consume peanut paste (even though often less-than-once-in-a-month, and, therefore, report zero consumption) from those that do not want to consume (certain zeroes). The estimation of the first part is accomplished by specifying a logit model. The second part is estimated using the negative binomial regression. Separate regressors can be used for the estimation of either part.

Several tests are available to help choose the appropriate model among all the explained models. To choose between a Poisson and negative binomial model first

requires fitting both models to the data and then, the application of the likelihood ratio test to verify advantages, if any, of the negative binomial over Poisson model. A similar approach is adopted to choose between the zero-inflated Poisson (ZIP) and ZINB models. The Vuong test identifies superior performance of the ZINB over the standard negative binomial model. In the current study, all tests are performed to arrive at the final model.

Analysis of Different Forms of Peanut Paste/Butter consumption

Here, the dependent variables in four equations that are to be estimated assume more than two values. The ordinal logistic regression, an extension of the binary logistic regression, accounts for the ordering of responses used in this study. Each of the four dependent variables is constructed based on a response to the question about the frequency of eating peanut paste along with vegetables, meat or fish, bread, or other foods, respectively. Responses are recorded in four categories, progressing from the least frequent to the most frequent option i.e., 1 or almost never, 2 or not often, 3 or often, and 4 or very often, resulting in four categories for the dependent variable. The modeling of an event includes following odds of Y taking a value of 1, 2, or 3:

Y_1 = prob (value = 1) / prob (value > 1);

Y_2 = prob (value = 1 or 2) / prob (value > 2); and

Y_3 = prob (value = 1 or 2 or 3) / prob (value > 3).

The fourth (last) category does not have odds because the cumulative probability of having a value of 1, 2, 3 or 4, is one (Norušis, 2011).

The general form of the ordinal logistic model is $Y_i = \alpha_i - b_j x_j$, where, i represents the number of categories (here 1, 2 and 3) except the last one, and indicates the specific explanatory variable. The set of explanatory variables is the same in the count and ordinal

regression models, but the former includes the peanut paste attributes. If the estimated coefficient for a particular explanatory variable has a positive sign, it suggests that the likelihood of higher categories of the dependent variable are more likely to occur. In contrast, a negative sign indicates that, lower categories of the dependent variable are more likely to occur (given a unit increase in the value of that explanatory variable if it is a continuous variable, or a change from the value of zero to one in case of a binary variable). The results are interpreted based on the marginal effects and predicted probabilities draw practical recommendations.

4.4 Data

This study applies data from a household survey conducted in Uganda between February and June 2011. It was preceded by a pilot test in October 2010 performed in Kampala. Following the pilot test, and enumerator debriefing the developed questionnaire was deemed suitable. The survey was implemented by a hired market research company. The survey covered five administrative districts of the Republic of Uganda: Kampala, the capital city, from the central region, Gulu and Lira from the northern region, and Soroti and Mbale from the eastern region. The data includes a total of 1,646 households. Respondents shared information about various socioeconomic and demographic factors, peanut consumption, and opinions and views about several attributes of peanut paste. The dependent variable for peanut paste consumption frequency is constructed based on the responses to the question "how often do you eat peanut paste/butter?" (Table 1). In addition, four categorical dependent variables (each with four categories) constructed from responses about different forms of peanut paste consumption are used in equations that analyze different forms of peanut paste consumption.

All socioeconomic or demographic variables and household characteristics selected in this empirical study are supported by either the economic theory or previous food consumption studies. In this dataset, about 71% household heads are males. Gender of the household head has been used as an explanatory variable in earlier studies including peanut consumption analyses (Duhaime et al., 2002; Jolly et al., 2008), and its significant influence on consumption behavior has been reported. The average age of a respondent is 35 years. Age of the respondent was found to be a significant factor in peanut consumption (Jolly et al., 2008), as well as in other consumption studies (Reynolds, 1990; Nayga, 1995).

Average number of adults per household is 2.3 and more than 90% of the households have children. Household composition has also been a regularly analyzed factor in consumption studies. Presence and number of adults (for example, Capps and Love, 1983; Ruel et al., 2005) and presence of children (Nayga, 1995) are found to affect household consumption pattern. Presence of children under 3 years of age has been included in this analysis, because an earlier study about peanut allergy in children (Toit et al., 2008) reports an interesting result that supports infant feeding infants with peanut products to avoid peanut allergy.

Educational attainment level has been redefined into two levels. Respondents with the base level "lower higher secondary or below" are compared with "upper higher secondary or above". Educational level is a consistently used explanatory variable in consumption behavioral studies, and it is found to have significant influence both in peanut consumption (Jolly et al., 2008) and other household consumption analyses (Nayga, 1995; Blisard et al., 2002; Bertail and Caillavet, 2008).

Employment status has three levels with "other categories" as the reference category. Self-employment category constitutes 37% of the sample, permanent employment is reported by 13%, whereas employment in "other categories" has the highest share (49%). The employment status is an influential factor in household consumption studies (Capps and Love, 1983; Cook, 1990; Ruel et al., 2005).

Main sources of the household income are salary and trading, and the average monthly household income is 612,291 Ugandan shillings ($214 at the exchange rate as on June, 2011). The well-known Engel curve explains the relationship between income and food expenditures (Reynolds, 1990). Household income is a very consistently considered factor in consumption studies (He et al, 1995; Nayga, 1995), including peanut consumption analyses (Moon et al., 1999; Jolly et al., 2008).

Average distance to the nearest shopping center is 573 meters. Distance to shopping center has also been included as an explanatory factor in household consumption analyses (for example, Kyureghian et al., 2013; Pitts et al., 2013; Spilkova et al., 2013). Among the surveyed households, 52% are in Kampala, the capital city, while the remaining households are distributed evenly among the other four cities, i.e., Gulu, Lira, Mbale, and Soroti. Regional differences are found to be a significant determinant of consumption behavior (Han and Wahl, 1998; Roos et al., 1998; Ruel et al., 2005), including that of peanut consumption (Moon et al., 1999).

Since peanut paste can be prepared at home rather than purchased, a variable indicating whether a household prepares peanut paste at home is also included. About 52% of the households in the sample prepare peanut paste at home at least occasionally. A set of binary variables represents the importance of peanut paste attributes to the

respondent, i.e., color, taste, thickness and oil separation. Similarly, three categorical variables for capturing the frequency of problems experienced by the respondents, such as rancid taste, bad aroma and presence of foreign matter, are also constructed from the responses obtained during the survey. On average, respondents attach importance to color (74%), taste (89%), thickness (81%) and absence of oil separation from the purchased peanut paste (61%), whereas majority of respondents did not experience problems such as rancidity (70%), bad aroma (72%) or presence of foreign matter (55%). The product attributes have been found to be significant in explaining variation in peanut product consumption (Jolly et al., 2003). Various attributes of food like color, taste, aroma, etc., have been also employed by several previous studies (Shutz et al., 1986; Glanz et al., 1998; Hinds et al., 2003).

4.5 Results

The likelihood ratio test result confirms the overdispersion ($chi^2 = 1.1e+04$; $pr>chi^2 = 0.0000$). The Poisson model that assumes the data is equidispersed does not generate correct estimates. Therefore, the selection involves a choice of a negative binomial model. The Vuong test result for verifying if the ZINB is preferred, has a statistically significant value ($Z=2.27$; $Pr>Z=0.0117$) at 0.05 level leading to the application of the Zero-Inflated Negative Binomial regression method, which is preferred among these models. Therefore, the results from the Zero-Inflated Negative Binomial Regression are presented.

Factors influencing peanut paste/butter consumption

The interpretation of the estimation results can be done based on the estimated coefficients (Table 2) or with the use of the Incidence Rate Ratio (IRR). The IRR is

similar to odds ratios from a logistic regression, but easier to interpret. The interpretation that follows is based on the IRRs. For example, if the IRR is more than 1/less than 1, the likelihood of having more consumption frequency will be higher/lower with respect to a particular factor. That is, when IRR is more than 1 for a continuous factor, consumption frequency will be higher/lesser, when there is a one unit increase/decrease in the factor, or vice versa. For a binary variable, the frequency increases/decreases with a change from zero to 1, corresponding to an IRR of higher/lesser than 1. An IRR of 1 means there would be no effect of that particular variable.

Only the distance to shopping center is statistically significant in the inflated part of the regression (Table 2; columns 2 and 3). The result supports that presence of zeroes, or the absence of peanut paste consumption in a month preceding the survey will decrease if the distance to a shopping outlet increases.

The results from the count part of the model (columns 4 and 5 from Table 2), are interpreted based on IRRs. Among the demographic factors, the presence of children 3 years old or younger in a household tends to decrease peanut paste consumption by 0.91 times than in households without children in this age category. A study by Du Toit et al. (2008) concludes that it may be possible to avoid peanut allergy, if infants are given peanut products at a very early stage. Since peanut allergy in children is a serious problem (Macdougall et al., 2002; Clark and Evan, 2003), this result has a far-reaching positive consequences.

Respondents with an education of upper higher secondary or higher level have peanut paste consumption frequency 1.17 times more than those with a lower higher secondary or less education. It is plausible that those who receive more formal education are more

aware of the nutritional value of peanuts as compared to those with less education and, therefore, eat peanut paste more often. With regard to household location in one of the towns, respondents from Gulu, Lira, Soroti, or Mbale are more likely to report higher peanut paste consumption frequency than those households in Kampala, the capital city. The rate is largest in Gulu (2.27 times), followed by Soroti (1.79 times), Lira (1.71 times) and Mbale (1.52 times).

Respondents provided answers to the question about the peanut paste consumption frequency, but not about its source. Some households use purchased and homemade paste. Households that make own peanut paste are 1.32 times more likely to have high consumption frequency than those that do not report making peanut paste at home. Making paste at home appears to increase its accessibility and encourage consumption.

Among the attributes of peanut paste, only color is found to be significant in determining the frequency of consumption. The respondents who consider color of the peanut paste to be important are 1.23 times more likely to have higher consumption frequency than those who view paste color as unimportant. Schutz et al. (1986) concluded that sensory attributes are positively correlated with % of food expenditures, while according to Jolly et al. (2003), product attributes affect peanut consumption. Another interesting result is that respondents who are interested in consuming vitamin A fortified foods are more likely (1.28 times) to have higher peanut paste consumption frequency than respondents who show disinterest in vitamin A fortification. As the vitamin A deficiency is especially high in pre-school children and pregnant women, peanut paste with vitamin A fortification can be highly desirable. According to the current study, households with small children eat peanut paste less often and therefore,

additional scrutiny about the causes for such lower consumption in these households is needed.

Factors influencing the frequency of peanut paste/butter consumption with different foods

The likelihood ratio tests show that all the four models are globally statistically significant with the rejection of the respective null models (Table 3). The low value of McFadden's pseudo R-square is not uncommon in cross sectional studies. Several previous studies also report low values of this measure, for example, Brierley (2008) or Hank and Schaan (2008). Following are the results presented separately for each of the four equations accounting for the form of peanut paste consumption (Table 3).

Frequency of peanut paste consumption with vegetables

An increase in the number of adults in a household increases the likelihood of having higher frequency of consumption of peanut paste with vegetables. This is a reasonable result because peanut paste is a major ingredient of peanut sauce poured over vegetables and a starchy staple. Having upper higher secondary or higher education lowers the frequency of peanut paste consumption with vegetables as compared to those with lower higher secondary or less education. Although better educated consumers eat peanut paste more often (Table 2), eating paste with vegetables is less preferred by that group. The presence of adults also reduces the frequency of peanut paste consumption along with vegetables.

Households located in Gulu, Lira, Soroti and Mbale are more likely to have greater frequency of eating vegetables with peanut paste than households in Kampala. Kampala-based households have greater access to a variety of foods and the traditional dish of

vegetables with peanut sauce and starch is less frequently eaten. The households that prepare peanut paste at home are more likely to eat peanut paste with vegetables than those which do not prepare peanut paste. Home-made peanut paste is an indication that a household is thrifty and chooses to allocate income away from foods it can prepare. Eating peanut paste with vegetables also implies that eating it with other foods may be less frequent, especially if such foods require purchase.

Frequency of consumption with meat or fish

An increase in age of the respondent decreases the likelihood of eating peanut paste along with meat or fish. The lower frequency may be attributed to the generally lesser consumption by older people as compared to the younger individuals. Jolly et al. (2008) found that older people tend to eat less peanut products than younger people in Ghana. The reason for this low frequency with meat/fish can be attributed to the avoidance of meat by older people for health reasons and the generally low consumption of meat in African countries (Speedy, 2003). Households with self-employed respondents are more likely to have increased frequency of eating peanut paste with fish or meat than households with respondents in other jobs. Similarly to earlier results, households in Gulu, Lira and Mbale are less likely to have higher consumption frequency than the Kampala-based households. Households that prepare peanut paste at home are more likely to eat peanut paste with meat or fish more frequently than households not reporting the making of peanut paste at home.

Frequency of consumption with bread

An increase in the number of adults increases the likelihood of having higher consumption frequency of peanut paste on bread. Those who have upper higher

secondary or higher education have higher likelihood of having more frequency of consumption than those with lesser education. Respondents with permanent or self-employment are more likely to have higher frequency of eating peanut paste on bread than those in other jobs. It is possible that the two former employment types are associated with different lifestyles that encourage eating peanut paste with bread

Total monthly household income increases the chances of a higher consumption frequency of peanut paste with bread. Jolly et al. (2008) also report that consumption of peanut paste with bread increases with an increase in income. If the main source of income is salary, the likelihood of having peanut consumption along with bread increases, where as if the income source is trading, this likelihood decreases.

Increase in the distance to the nearest shopping center is found to increase the possibility of having peanut paste consumption along with bread. This may be due to the highly perishable nature of vegetables, especially commonly consumed leafy vegetables, meat or fish that are bought from a distant shopping center to a household that lacks refrigeration. Households without a refrigerator may use up these perishable items faster than the of bread, leaving the bread alone to be consumed along with peanut paste. Also, bread might be available in nearby locations and can be purchased more frequently.

With regard to regional location, households in Gulu have higher likelihood of having higher frequency of peanut paste consumption with bread, as compared to households located in Kampala. However, the households in Mbale and Soroti have less likelihood of having higher frequency than households located in Kampala.

Frequency of consumption with other foods

If the household head is a male, then the frequency of consumption of peanut paste with meat or fish is likely to decrease compared to households with a female head. Households with children are more likely to have an increased consumption frequency. Households with permanently employed respondents are more likely to have increased frequency. Households located in Gulu are less likely, while those in Lira, Mbale and Soroti are more likely to have an increased frequency of consumption with other foods. Also, households that prepare peanut paste are more likely to consume peanut paste with other foods more often. Those respondents who are interested in consuming vitamin A fortified foods are likely to have higher frequency of peanut paste consumption along with other foods.

4.6 Discussion

The information obtained from the analysis of factors that influence peanut paste/butter consumption frequency in the Republic of Uganda will help the concerned policy makers with their policy formulations in at least two ways. The generated knowledge will assist in the implementation of programs intended to reduce aflatoxin intake through the consumption of peanut paste/butter, through the creation of profile of households that are likely to have more peanut paste consumption. For example, those households having respondents with at least upper higher secondary education, those that prepare peanut paste at home, those located in Gulu, Lira, Soroti and Mbale, those with respondents who consider the color of the peanut paste an important attribute, or those with respondents who are interested in consuming vitamin A fortified foods are more likely to have higher peanut paste/butter consumption frequency. Educating these

households about how to reduce the aflatoxin contamination in the peanut paste/butter they buy, or prepare at home will bring down the consequences of aflatoxin intake by this population segment. This becomes important, since some studies have concluded that peanut butter consumption is a risk factor in liver cancer incidence (Omer et al., 2001; Williams et al., 2004).

However, importance of peanut products in alleviating malnutrition problems, especially among children and pregnant women cannot be overlooked in a country like Uganda, where malnutrition is a widely prevalent problem. At this juncture, one of the results from the analysis about peanut paste consumption frequency is worth considering. This result reveals that households with children of 3 years or less are more likely to have lower frequency of peanut consumption. This finding assumes importance against the backdrop of a study, which concludes that if infants are exposed to peanuts at a very early stage the incidence of peanut allergy may be reduced (Du Toit et al., 2008). Peanut products are a common cause of food allergies among children (Macdougall et al., 2002; Clark and Evan, 2003), and if exposing infants to peanut products can prevent the development of peanut allergy in children, then that would significantly contribute to the success of programs aimed at preventing both malnutrition, and food allergies.

In addition to the above mentioned benefits of the results of this study, the profiles created out of this analysis will also help in implementing programs that target the reduction of vitamin A deficiency among people, especially among pre-school children and pregnant women. Fortification of peanut paste/butter with vitamin A can be a good option, and, according to the results from this study, households with respondents who are interested in consuming vitamin A fortified foods have higher peanut paste/butter

consumption. Interestingly, about 94% of the respondents in the survey sample are interested in consuming such foods. Therefore, steps to produce peanut paste/butter fortified with vitamin A and popularize it among regions where vitamin A deficiency is common can effectively contribute to the programs aimed at reducing incidence of vitamin A deficiency.

Results from the study that determined factors affecting the consumption frequency of peanut paste/butter along with different types of foods, namely, vegetables, meat or fish, bread and other foods are also of benefit to policy makers. Location of households is found to be the main factor that influences these various forms of consumption. In the case of consumption with bread, income, education and employment status are also found to be important in explaining variations in the consumption frequency. Though education is positively related to peanut consumption frequency, yet it is negatively related to the frequency of peanut consumption with vegetables. Some studies (Sarkar et al., 1994; Jubert et al., 2009) have concluded that chlorophyll and chlorophyllin content found in most green plant parts can reduce the consequences of aflatoxin contamination. Therefore, encouraging the consumption of a lot of green vegetables like spinach, kale, cabbage, etc., along with peanut paste may bring down the negative consequences of aflatoxin contamination.

The profiles created out of this estimation help in targeting segments that consume peanut paste along with a particular food according to the objective of a policy that is implemented. For example, while implementing programs related to the reduction of consequences of aflatoxin contamination, segments that have less consumption frequency along with vegetables can be targeted to increase the consumption frequency of peanut

paste along with vegetables. Probabilities of consumption frequency in these different groups can be calculated utilizing the results from this estimation, and one such profile is discussed below.

The probabilities of having a particular form of consumption frequency calculated at mean values of the explanatory variables are given in Table 4. The cumulative probabilities of consuming peanut paste/butter with a particular food "often" or "very often" are 0.78, 0.66, 0.45 and 0.61 in the case of vegetables, meat/fish, bread and other foods, respectively. Figure 1 graphically illustrates these probabilities. The presence of binary variables, suggests that probabilities are also calculated based on a hypothetical scenario. The hypothesized scenario involves respondents that are from households with a male head and with a monthly income of 612,290 Ugandan shillings ($214); their main source of income is salary; they are 35 years old; they have permanent employment; they have upper higher secondary or more education; their households prepare peanut paste at home; their households have children; their households are from the city of Gulu; and they are interested in consuming vitamin A fortified foods. The probabilities have changed to 0.85, 0.62, 0.81 and 0.61 for vegetables, meat/fish, bread and other foods, respectively (Figure 2). The probability for higher consumption frequency with bread nearly doubled. Other probabilities remain roughly the same. Such probabilities can be calculated for any desired combination of consumer characteristics, so that policy decision makers and implementers can target a particular region and a particular segment of population within that region.

4.7 References

Balla, H. M., Babiker, I. A., & Elobied, T. E. (2006). Peanut butter as a vehicle for vitamin A fortification. *Ahfad Journal, 23*(2), 143-148.

Bertail, P., & Caillavet, F. (2008). Fruit and vegetable consumption patterns: A segmentation approach. *American Journal of Agricultural Economics, 90*(3), 827-842.

Blisard, N., Lin, B. H., Cromartie, J., & Ballenger, N. (2002). America's changing appetite: Food consumption and spending to 2020. *Food Review, 25*(1), 2-9.

Brierley, J. A. (2009). The influences on the frequency with which product costs are used in decision making. *International Business Research, 1*(3), 149-157.

Capps, O., & Love, J. M. (1983). Determinants of household expenditure on fresh vegetables. *Southern Journal of Agricultural Economics, 15*(2), 127-132.

Chowdhury, S., Meenakshi, J., Tomlins, K. I., & Owori, C. (2011). Are consumers in developing countries willing to pay more for micronutrient-dense biofortified foods? Evidence from a field experiment in Uganda. *American Journal of Agricultural Economics, 93*(1), 83-97.

CIA. (2014). The World Factbook. Uganda. Central Intelligence Agency. https://www.cia.gov/library/publications/the-world-factbook/geos/ug.html. Accessed 12 March 2014

Clark, A. T., & Ewan, P. W. (2003). Food allergy in childhood. *Archives of disease in childhood, 88*(1), 79-81.

Cook, R. (1990). Challenges and opportunities in the US fresh produce industry. *Journal of Food Distribution Research, 21*(1), 67-74.

Du Toit, G., Katz, Y., Sasieni, P., Mesher, D., Maleki, S. J., Fisher, H. R., Fox, A.T., Turcanu, V., Amir, T., & Zadik-Mnuhin, G. (2008). Early consumption of peanuts in infancy is associated with a low prevalence of peanut allergy. *Journal of Allergy and Clinical Immunology, 122*(5), 984-991.

Duhaime, G., Chabot, M., & Gaudreault, M. (2002). Food consumption patterns and socioeconomic factors among the Inuit of Nunavik. *Ecology of Food and Nutrition, 41*(2), 91-118.

FANTA. (2010). The analysis of the nutrition situation in Uganda. Food and Nutrition Technical Assistance II Project, Washington DC. http://www.fantaproject.org/sites/default/files/resources/Uganda_NSA_May2010.pdf. Accessed 10 March 2014

Glanz, K., Basil, M., Maibach, E., Goldberg, J., & Snyder, D. (1998). Why Americans eat what they do: Taste, nutrition, cost, convenience, and weight control concerns as influences on food consumption. *Journal of the American Dietetic Association, 98*(10), 1118-1126.

Han, T., & Wahl, T. I. (1998). China's rural household demand for fruit and vegetables. *Journal of Agricultural and Applied Economics, 30*(1), 141-150.

Hank, K., & Schaan, B. (2008). Cross-national variations in the correlation between frequency of prayer and health among older Europeans. *Research on Aging, 30*(1), 36-54.

He, H., Huang, C. L., & Houston, J. E. (1995). US household consumption of fresh fruits. *Journal of Food Distribution Research, 26*(2), 28-38.

Hinds, M., Jolly, C., Nelson, R., Donis, Y., & Prophete, E. (2003). Comparative study of properties and acceptability of Haitian and US honey-roasted peanuts. *International Journal of Consumer Studies, 27*(2), 157-167.

Jilcott Pitts, S. B., Wu, Q., McGuirt, J. T., Crawford, T. W., Keyserling, T. C., & Ammerman, A. S. (2013). Associations between access to farmers' markets and supermarkets, shopping patterns, fruit and vegetable consumption and health indicators among women of reproductive age in eastern North Carolina, USA. *Public Health Nutrition, 16*(11), 1944-1952.

Jolly, C. M., Awuah, R. T., Fialor, S. C., Agyemang, K. O., Kagochi, J. M., & Binns, A. D. (2008). Groundnut consumption frequency in Ghana. *International Journal of Consumer Studies, 32*(6), 675-686.

Jolly, C. M., Hinds, M. J., Lindo, P., Ham, C., & Weiss, H. (2003). Modeling consumer preference for roasted peanuts and products containing roasted peanuts. *Journal of International Food & Agribusiness Marketing, 13*(4), 43-60.

Jubert, C., Mata, J., Bench, G., Dashwood, R., Pereira, C., Tracewell, W., . . . Bailey, G. (2009). Effects of chlorophyll and chlorophyllin on low-dose aflatoxin B1 pharmacokinetics in human volunteers. *Cancer Prevention Research, 2*(12), 1015-1022.

Kaaya, A., Harris, C., & Eigel, W. (2006). Peanut aflatoxin levels on farms and in markets of Uganda. *Peanut Science, 33*(1), 68-75.

Kaaya, N., & Warren, H. (2005). A review of past and present research on aflatoxin in Uganda. *African Journal of Food, Agriculture, Nutrition and Development, 5*(1), 1-19.

Kawuma, M. (2002). Sugar as a potential vehicle for vitamin A fortification: Experience from Kamuli district in Uganda. *African Health Sciences, 2*(1), 14-15.

Kyureghian, G., Nayga, R. M., & Bhattacharya, S. (2013). The Effect of Food Store Access and Income on Household Purchases of Fruits and Vegetables: A Mixed Effects Analysis. *Applied Economic Perspectives and Policy*, *35*(1), 69-88.

Lewsey, J., & Thomson, W. (2004). The utility of the zero-inflated Poisson and zero-inflated negative binomial models: a case study of cross-sectional and longitudinal DMF data examining the effect of socio-economic status. *Community Dentistry and Oral Epidemiology*, *32*(3), 183-189.

Macdougall, C. F., Cant, A. J., & Colver, A. F. (2002). How dangerous is food allergy in childhood? The incidence of severe and fatal allergic reactions across the UK and Ireland. *Archives of disease in childhood*, *86*(4), 236-239.

Monitor-Uganda. (2009). Malnutrition: A major problem in Uganda. *Monitor-Uganda (e-paper), 13 June, 2009.* http://reliefweb.int/report/uganda/malnutrition-major-problem-uganda. Accessed 9 March 2014

Moon, W., Florkowski, W. J., Beuchat, L. R., Resurreccion, A. V., Chinnan, M. S., Paraskova, P., & Jordanov, J. (1999). Effects of product attributes and consumer characteristics on attitude and behavior: The case of peanuts in a transition economy. *Agribusiness*, *15*(3), 411-425.

Nayga, R. M. (1995). Determinants of US household expenditures on fruit and vegetables: A note and update. *Journal ofAgricultural and Applied Economics*, *27*(2), 588-594.

Norušis, M. J. (2010). Chapter 4. Ordinal Regression *PASW Statistics 18 Advanced Statistical Procedures Companion* (pp 69-89). Upper Saddle River, NJ: Prentice Hall.

Omer, R. E., Verhoef, L., Van't Veer, P., Idris, M. O., Kadaru, A. M., Kampman, E., . . . Kok, F. J. (2001). Peanut butter intake, GSTM1 genotype and hepatocellular carcinoma: a case–control study in Sudan. *Cancer Causes & Control, 12*(1), 23-32.

Reynolds, A. (1990). Analyzing fresh vegetable consumption from household survey data. *Southern Journal of Agricultural Economics, 22*(2), 31-38.

Roos, E., Lahelma, E., Virtanen, M., Prättälä, R., & Pietinen, P. (1998). Gender, socioeconomic status and family status as determinants of food behaviour. *Social Science & Medicine, 46*(12), 1519-1529.

Ruel, M. T., Minot, N., & Smith, L. (2005). *Patterns and determinants of fruit and vegetable consumption in sub-Saharan Africa: a multicountry comparison. Background paper for the Joint FAO/WHO Workshop on Fruit and Vegetables for Health, 1-3 September 2004, Kobe, Japan*. WHO Geneva.

Sarkar, D., Sharma, A., & Talukder, G. (1994). Chlorophyll and chlorophyllin as modifiers of genotoxic effects. *Mutation Research/Reviews in Genetic Toxicology, 318*(3), 239-247.

Schutz, H. G., Judge, D. S., & Gentry, J. (1986). The importance of nutrition, brand, cost, and sensory attributes to food purchase and consumption. *Food Technology, 40*(11), 79-82.

Speedy, A. W. (2003). Global production and consumption of animal source foods. *The Journal of Nutrition, 133*(11), 4048S-4053S.

Spilková, J., Fendrychová, L., & Syrovátková, M. (2013). Farmers' markets in Prague: a new challenge within the urban shoppingscape. *Agriculture and Human Values, 30*(2), 179-191.

Uganda Bureau of Statistics. (2010). http://www.ubos.org/. Accessed 10 February 2014

UNICEF, & The Micronutrient Initiative. (2004). Vitamin and mineral deficiency: A global damage assessment report. http://eldis.org/vfile/upload/1/document/0708/DOC23773.pdf. Accessed 10 February 2014

USAID. (2006). Peanut Collaborative Research Support Program Project 04 (USA and Philippines) Monograph Series No. 5. Vitamin A Fortified Peanut Butter. United States Agency for International Development.

USDA. (2014). National nutrient database. http://www.ars.usda.gov/Services/docs.htm?docid=8964. Accessed 21 February 2015

Williams, J. H., Phillips, T. D., Jolly, P. E., Stiles, J. K., Jolly, C. M., & Aggarwal, D. (2004). Human aflatoxicosis in developing countries: a review of toxicology, exposure, potential health consequences, and interventions. *The American journal of clinical nutrition, 80*(5), 1106-1122.

World Bank. (2009). Nutrition at a glance: Uganda. http://siteresources.worldbank.org/NUTRITION/Resources/281846-1271963823772/Uganda.pdf. Accessed 10 February 2014

World Bank. (2014). World Development Indicators. http://databank.worldbank.org/data/views/variableSelection/selectvariables.aspx?source=world-development-indicators#c_u. Accessed 10 February 2014

Yanggen, D., & Nagujja, S. (2006). The use of orange-fleshed sweetpotato to combat vitamin A deficiency in Uganda: A study of varietal preferences, extension strategies and post-harvest utilization. *Social Sciences Working Paper Series (CIP) International Potato Center, No. 2006-2*.

Yen, S. T., & Adamowicz, W. L. (1993). Statistical properties of welfare measures from count-data models of recreation demand. *Review of Agricultural Economics, 15*(2), 203-215.

Table 1. Descriptive Statistics of Variables

Variable	Mean	Std. dev.	Min	Max	Description
Dependent					
Gnfreq	16.59	17.24	0	60	Consumption frequency per month
Pasteveg[a]	3.05	0.89	1	4	Frequency of consumption of paste with vegetables
Pastemeat[a]	2.83	0.90	1	4	Frequency of consumption of paste with meat or fish
Pastebread[a]	2.34	1.12	1	4	Frequency of consumption of paste with bread
Pasteotherfood[a]	2.32	0.97	1	4	Frequency of consumption of paste with other foods
Independent					
Headgend	0.71	0.45	0	1	Gender of the household head 1=male; 0=female
Age	35.34	12.36	17	89	Age of the respondent in years
Adults	2.30	1.41	0	15	Number of adults in the household
Child	0.92	0.28	0	1	1 = household has children
Child3	0.55	0.50	0	1	1 =presence of children 3 years old or younger
Education	0.35	0.48	0	1	1=upper secondary or higher education level
Permanent	0.13	0.34	0	1	Respondent has permanent job
Self	0.37	0.48	0	1	Self employed
Others	0.49	0.50	0	1	Respondent has other job*
Soutrading	0.30	0.46	0	1	Main source of income is trading
Sousalary	0.30	0.46	0	1	Main source of income is salary
Souother	0.37	0.48	0	1	Main source is "other"*

Totalincome	214.07	320.57	0	5613.63	Total monthly household income in $
Shopdist	573.10	1925.96	0	50000	Distance to the nearest shopping center in meters
Gulu	0.12	0.33	0	1	1 = Guluresident
Lira	0.12	0.33	0	1	1= Lira resident
Mbale	0.12	0.33	0	1	1= Mbale resident
Soroti	0.12	0.32	0	1	1= Soroti resident
Kampala	0.52	0.50	0	1	1= Kampala resident*
Homepreppaste	0.52	0.50	0	1	Prepare peanut paste at home 1=yes; 0=no
Color	0.75	0.44	0	1	Importance of the color of paste/butter[b]
Thickness	0.81	0.40	0	1	Importance of paste/butter[b] thickness/viscosity
Oilseparation	0.61	0.49	0	1	Importance of no oil separation from paste[b]
Taste	0.89	0.32	0	1	Importance of paste[b] taste
Rancidtaste	0.69	0.46	0	1	Problem of rancid taste experienced with paste[c]
Badaroma	0.72	0.45	0	1	Problem of bad aroma experienced with paste[c]
Foreignmatter	0.55	0.50	0	1	Problem of observing pieces of shells and other foreign matter in paste[c]
Vitaforti	0.94	0.24	0	1	1 if interested in consuming vitamin A fortified foods

[a] 1=almost never, 2=not often, 3=often, 4=very often.
[b] 1=important, 2=not important.
[c] 1=not experienced, 0=experienced.
[*] Reference category

Table 2. Results from the ZINB explaining variation in consumption frequency

Independent variables	Zero inflated Neg. Binomial	Incidence Rate Ratio (IRR)	Consumption frequency	Incidence Rate Ratio (IRR)
Headgend			0.0745	1.0774
			(0.0554)	
Age			-0.0007	0.9993
			(0.0023)	
Adult			0.0105	1.0105
			(0.0175)	
Child			0.0121	1.0122
			(0.0129)	
Child3	0.7650	0.7648	-0.0905*	0.9135
	(1.4130)		(0.0549)	
Education	-0.4280	-0.4279	0.161**	1.1753
	(0.8080)		(0.0570)	
Permanent	0.8070	0.8066	0.1270	1.1352
	(0.8810)		(0.0872)	
Self			-0.0458	0.9552
			(0.0558)	
Soutrading			-0.0470	0.9541
			(0.0624)	
Sousalary			0.0289	1.0294
			(0.0672)	
Totalinc	-1.08e-08	-1.08e-08	1.10e-08	1.0000
	(1.26e-07)		(1.20e-08)	
Shopdist	-0.0071**	-0.0071**	1.45e-05	1.0000
	(0.0033)		(1.35e-05)	
Gulu			0.8220***	2.2748
			(0.0889)	
Lira			0.5350***	1.7073
			(0.0870)	
Mbale			0.4160***	1.5162
			(0.0824)	
Soroti			0.5820***	1.7887
			(0.0861)	
Home preppaste			0.2760***	1.3182
			(0.0591)	
Color	0.4680	0.4675	0.2070***	1.2301
	(1.1160)		(0.0598)	
Thickness			(0.0598)	1.0015
			(0.0680)	
Oil separation			-0.0328	0.9677
			(0.0533)	

Taste			0.0225	1.0228
			(0.0852)	
Rancidtaste	0.1530	0.1527	-0.0572	0.9444
	(0.7510)		(0.0643)	
Badaroma	-0.6300	-0.6296	-0.1040	0.9012
	(0.9850)		(0.0647)	
Foreign			-0.0404	0.9604
matter			(0.0558)	
Vitaforti			0.2480**	1.2820
			(0.1110)	
Wald Chi^2	Prob=0.0000		460.0900	

***, ** and * denote 0.01, 0.05 and 0.1 significance level, respectively.

Table 3. Estimation results from the Ordinal Logistic Regression of four equations that explain variation in forms of consumption of peanut paste/butter

Depvar/ indepvar	With vegetables	With meat or fish	With bread	With other foods
Headgend	-0.1270	0.0064	0.1720	-0.4250***
	(0.1450)	(0.1370)	(0.1400)	(0.1380)
Age	0.0002	-0.0113***	-0.0009	-0.0001
	(0.0042)	(0.0041)	(0.0042)	(0.0042)
Adultdum	-0.7560**	0.0667	0.6750**	0.1400
	(0.3130)	(0.3010)	(0.3230)	(0.3060)
Child	0.2590	-0.0160	0.0253	0.4910***
	(0.1810)	(0.1790)	(0.1860)	(0.1850)
Education	-0.3720***	0.0742	0.3890***	0.1550
	(0.1140)	(0.1120)	(0.1150)	(0.1120)
Permanent	-0.2100	-0.0963	0.5680***	0.4070**
	(0.1690)	(0.1680)	(0.1720)	(0.1700)
Self	-0.0570	0.2360**	0.2350**	-0.0344
	(0.1130)	(0.1100)	(0.1120)	(0.1100)
Married	0.1180	0.1030	-0.3140**	0.1690
	(0.1430)	(0.1360)	(0.1400)	(0.1360)
Soutrading	-0.0254	-0.0064	-0.2200*	0.1660
	(0.1270)	(0.1230)	(0.1250)	(0.1240)
Sousalary	-0.1150	0.1470	0.3430**	0.0349
	(0.1360)	(0.1340)	(0.1350)	(0.1350)
Totalinc	-1.63e-08	1.02e-08	1.27e-07***	5.65e-09
	(2.09e-08)	(2.01e-08)	(3.38e-08)	(2.17e-08)
Shopdist	-3.13e-05	-1.34e-05	4.55e-05**	-4.43e-06
	(2.32e-05)	(3.01e-05)	(2.24e-05)	(2.65e-05)
Gulu	0.8420***	-0.7620***	0.6040***	0.1020
	(0.1840)	(0.1730)	(0.1740)	(0.1710)
Lira	0.3980**	-0.6200***	-0.1700	-0.5900***
	(0.1790)	(0.1680)	(0.1800)	(0.1700)
Mbale	1.0110***	-0.4950***	-0.6150***	0.4220**
	(0.1650)	(0.1570)	(0.1740)	(0.1630)
Soroti	0.3490**	0.2550	-0.6400***	0.4290**
	(0.1710)	(0.1690)	(0.1710)	(0.1680)
Homepreppaste	0.9660***	0.7500***	0.0982	0.4350***
	(0.1240)	(0.1190)	(0.1170)	(0.1130)
Vitaforti	-0.1480	0.2260	-0.0703	0.5370**
	(0.2110)	(0.2050)	(0.2180)	(0.2130)
Pseudo R2	0.0673	0.0249	0.0350	0.0263
LR Chi^2	250.3900	95.7000	136.6600	103.4800

***, ** and * denote significant at 0.01, 0.05 and 0.1 level, respectively.

Table 4. Predicted probabilities of a respondent falling into a category calculated at the mean values of explanatory variables

	Predicted probabilities of having peanut consumption with a particular food			
Category	Vegetables	Meat or fish	Bread	Other foods
1 = Almost never	0.0500	0.0700	0.3000	0.2400
2=Not often	0.1700	0.2700	0.2500	0.3300
3=Often	0.4500	0.4100	0.2800	0.3200
4 = Very often	0.3300	0.2500	0.1700	0.1100

Table 5. Predicted probabilities of a respondent falling into a category calculated based on hypothetical personal and household characteristics

	Predicted probabilities of having peanut consumption with a particular food			
Category	Vegetables	Meat or fish	Bread	Other foods
1 = Almost never	0.0310	0.0840	0.0740	0.1340
2=Not often	0.1180	0.2967	0.1137	0.2563
3=Often	0.4070	0.4056	0.2813	0.4024
4 = Very often	0.4430	0.2138	0.5302	0.2070

Situation: Respondents are from households with a male head and with a monthly income of 612290 Ugandan shillings ($214); main source of income is salary; are 35 years old; have permanent employment; have upper higher secondary or more education; households prepare peanut paste at home; households have children; households are from Gulu; interested in consuming vitamin A fortified foods

Figure 1. Predicted probabilities (calculated at the mean values of explanatory variables) of having peanut consumption with a particular food

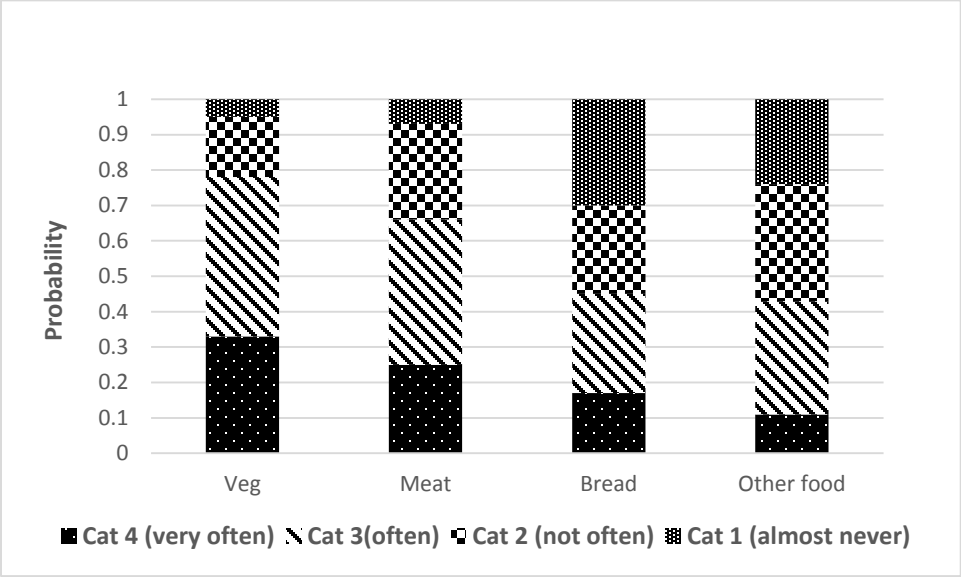
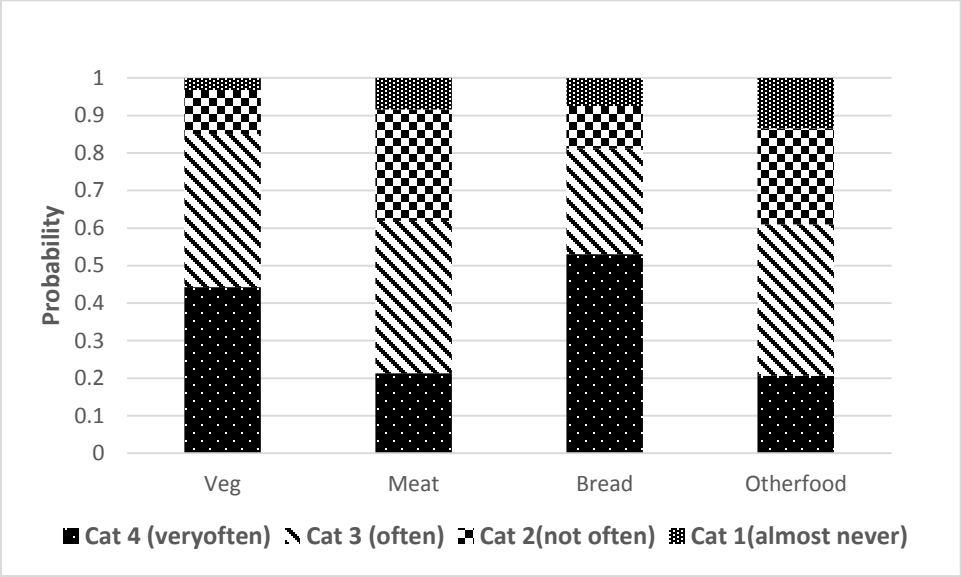


Figure 2. Predicted probabilities (calculated based on the hypothetical situation) of having peanut consumption with a particular food



CHAPTER 5

SUMMARY AND CONCLUSIONS

The Republic of Uganda is a developing country from East Africa. One of the main indicators of development of a nation is the improvement in welfare of its people. This is especially true in the case of developing countries, and policies and programs for increasing the welfare of people are always a priority. Over the past decade, the Ugandan economy has grown at an average rate of 5.4 % per year. This relatively high economic growth rate has been accompanied by a significant reduction in poverty. However, this achievement is not equally felt among regions or between rural and urban areas and the country still faces a number of challenges including malnutrition, especially among children who are the future of the nation. The welfare of a population can, to a certain extent, be studied by examining the patterns of household expenditures on different categories. This study was conducted with the broad objective of performing a thorough analysis of household expenditures which would be beneficial in locating the areas where welfare measures should be focused.

Expenditures on food account for a major share in total household expenditures in general. Among the food expenditures, expenditures on certain commodities, like fruits and vegetables require additional attention. This is because the consumption of such foods not only reduces the incidences of certain non-communicable diseases like cardiovascular diseases, certain cancers and diabetes, but also helps reducing the incidence of malnutrition. Another food that is consumed very frequently in Uganda is various peanut products. It has the potential to become a food that can be fortified with

vitamin A, which is very important in the context of widely prevalent vitamin A deficiency in Uganda. With this background, three separate analyses of household expenditures were conducted. The first analysis determines various factors that influence the household expenditures in various categories, such as food, fuel, education, clothing, transportation, and others that include items such as medical, entertainment, social obligation, etc. The second analysis examines factors that affect the expenditures on fresh fruits and vegetables, a regular consumption of which can contribute to the reduction of the problem of malnutrition. The final analysis examined characteristics of households with respect to the frequency of peanut paste / butter consumption.

The first analysis on household expenditures in various categories revealed the variation in the magnitudes of income elasticities of expenditures, which is an important finding. The income elasticity of expenditure is the lowest in food and highest in fuel categories. The magnitude of this elasticity is less than half of the next lowest one, i.e., clothing expenditures. Therefore, this means that additional income will increase expenditures in other categories at a relatively faster pace than in food category. However, this inelasticity points to challenges that occur with food price increases, especially in towns other than the capital. An examination of magnitudes of other elasticities reveal that households prefer to spend additional income more on fuel, followed by transportation and education expenditures. This is a highly relevant result for public policy makers, especially to those who are concerned with expanding educational infrastructure. These magnitudes reveal priority of urban households for expenditures in categories other than food, which is a good indication for public policy makers that deal with the welfare of people. Similarly, the effects of main sources of income, education,

employment status, household composition, location and other factors are examined. The results from this study will benefit policy makers by way of providing a clearer picture of the segments of population where interventions are required to balance the various household expenditures.

The second analysis examines factors affecting fresh fruit and vegetable expenditures in urban households of Uganda employing censored quantile regression (CQR). The selection of that particular approach anticipates that effects of the same factors including household income can vary across different points in the expenditure distribution, i.e., in households with different income levels. This makes the CQR approach particularly policy relevant. Our results indicate that income elasticity of expenditure for fresh fruits exceeds one in 25^{th} quantile, and reduces drastically in upper quantiles. This result suggests that an income support or price discounts for fresh fruits may increase the consumption of fresh fruits in low spending households. However, fresh vegetable expenditures have lower income elasticities, indicating that a similar support may not increase fresh vegetable consumption. Rather, educating people about the benefits of fresh vegetable consumption would be a better alternative, given the confirmed effects of education. Variation in the regular consumption of selected fresh fruits and vegetables is examined using multivariate probit regression. Knowledge about the characteristics of households that regularly consume some of the commonly available fresh fruits and vegetables guides the formulation and implementation of programs aimed at increasing consumption to directly benefit their members and, through improved health, the society at large. Results from multivariate probit regression show that education, age, gender, number of children, and location are important factors determining regular consumption.

Knowledge of these factors provides guidance for policy makers in public and private institutions for targeting specific segments of the population in urban locations for effective implementation of programs promoting fruit and vegetable consumption. For example, implementing programs like special supplemental nutrition program for women, infants, and children can also change the dietary behavior among children.

The final analysis was focused on determinants of peanut paste consumption specifically, to gain knowledge about the feasibility of reducing vitamin A deficiency through peanut paste fortification. Characteristics of households with respect to the frequency of peanut paste / butter consumption were examined using Zero-inflated Binomial regression. Our results indicate that that education, household location, color of peanut paste, etc. are important in its use. The ordinal logistic results conclude that peanut paste/butter consumption with vegetables is the most preferred option among the different forms of consumption. Location of households, income, education, and employment status are important in explaining the variation in consumption with different kinds of foods. The results help locating segments of population that consume high amounts of peanut paste/butter, which in turn can be used to identify aflatoxin contamination and also explore the possibility of vitamin A fortification of peanut paste/butter. The importance of peanut products in alleviating malnutrition problems, especially among children and pregnant women cannot be overlooked in a country like Uganda, where malnutrition is a widely prevalent problem. One of the results from the analysis about peanut paste consumption frequency is especially worthy of special attention because it reveals that households with children of 3 years or less are more likely to have lower frequency of peanut consumption. Peanut products are a common

cause of food allergies among children and if exposing infants to peanut products can prevent the development of peanut allergy in children as reported in an earlier study, then that would significantly contribute to the success of programs aimed at preventing both malnutrition, and food allergies.

We have also created consumer profiles applying results from each of the above three analyses, which can assist government and other agencies that are involved in consumer education efforts to combat malnutrition and promote healthy dietary habits. Our results can be used as a foundation for further research in identifying consumer habits and preferences that direct household expenditures.