THREE ESSAYS ON FOOD CONSUMPTION IN URBAN HOUSEHOLDS OF GHANA

by

TING MENG

(Under the Direction of Wojciech J. Florkowski)

ABSTRACT

The first chapter of the dissertation employs the quantile regression to identify determinants of the entire food expenditure distribution, especially the lower and upper tails, namely, households with relative low and high food expenditure. The survey data set was collected in three large cities of Ghana (i.e. Accra, Tamale, and Takoradi) in 2011. The use of quantile regression allows the examination of how the effects of socio-demographic factors vary across the different points of the food expenditure distribution. Results indicate that income, education, marital status, age, household composition, and household location have a significant influence on food expenditure. Among those factors, income and location have different effects along the food expenditure distribution. High food expenditure households are more sensitive to the increase of income than low food expenditure households and likely to spend more on food purchases. The food expenditure premium of Accra households over Tamale households is larger among high food expenditure households, and smaller among low food expenditure households.

The second chapter of the dissertation assessed the relative importance of different food retail outlets (i.e., supermarkets, open-air markets, and hawkers) in food supply system of Ghana, and identified the socio-demographic profiles of consumers associated with shopping in each retail format. Results of the study indicate open-air markets still dominate the food supply

system in Ghana, while supermarkets and hawkers play an active role as alternative food shopping outlets. Well-educated, high-income households prefer to frequent supermarkets for food shopping, while hawkers attract households with small children, likely because of convenient access.

The objective of the third chapter is to investigate how the expenditure on fresh vegetables, fresh fruits, and peanut products varies by location and, then, to find out the determinants of expenditure on these three food categories, considering the difference in household location. Results suggest that besides socioeconomic and demographic factors (including income, education, marital status, age, and household composition), the fresh vegetable and peanut product expenditure are affected by location in urbanized areas of Ghana, and establish that the location interacts with income in determining the food expenditure.

INDEX WORDS: Socioeconomic factors, Demographic factors, Income, Education, Location, Heterscedasticity, Open-air markets, Hawkers, Ordered logit model, ANOVA, Multivariate Tobit model, nutrition

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by

TING MENG

B. A., Shanxi University of Finance and Economics, China, 2008

M.S., Capital University of Economics and Business, China, 2011

M.S., The University of Georgia, US, 2013

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

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by

TING MENG

Major Professor: Wojciech J. Florkowski

Committee: Michael E. Wetzstein

J. Scott Shonkwiler

Electronic Version Approved:

Julie Coffield

Interim Dean of the Graduate School

The University of Georgia

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DEDICATION

This dissertation is dedicated to my loving husband, Xuedong, there is no doubt in my mind that without his continued support I could not completed this process; my parents, Mr. and Mrs. Meng, and my parents in law, Mr. and Mrs. Wu, for their selfless support and encouragement; my grandparents, who I always wish to get a bit of their wisdom.

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CHAPTER 1

MODELING FOOD EXPENDITURE DISTRIBUTION IN URBAN GHANA: A QUANTILE REGRESSION APPROACH

1.1 INTRODUCTION

Exploring determinants of household expenditure on food has been a continuing interest to economists, public sector, as well as private organizations (Jacobson et al., 2010). Back in 1895, Engel established that food expenditure increases with income, while the budget share of food decreases with income. This relationship between food expenditure and income is known as Engel's Law. It is well-documented that income has a significant influence on food expenditure patterns (see for example Bouis, 1994; Hoddinott and Haddad, 1995; Kirkpatrick and Tarasuk, 2003). Meanwhile, a large number of studies find that food expenditure is affected by selected demographic and socioeconomic features, including household size, age, urbanity, education, and occupation, for example (Sexauer, 1979; Kinsey, 1994; Cai, 1998).

Food expenditure is an important index of household welfare, and it is used by governments to measure the economic well-being and assess the effectiveness of food assistance programs (Blaylock and Blisard, 1989). Low food expenditure is often closely associated with inadequate food and low energy availability (Rose and Charlton, 2002). In other words, the risk of food inadequacy is greater at the lower tail of food expenditure distribution than at the mean. From the population health viewpoint, insufficient food and low energy intake are likely to stun

childern's growth and affect their hehavior/cognitive performance, and they are closely associated with low productivity and higher morbidity/mortality (Kurpad et al., 2005). In contrast, "a full stomach means more efficient HIV treatment" in some African countries (World Food Programme, 2012). Besides the lower tail, the upper tail of food expenditure distribution also attracts considerable attention, especially from private organizations Because of the increasing economic development and disposable income growth, food consumption patterns in developing countries are undergoing a huge transition (Von Braun, 2007; Meng et al., 2014). Consumers' needs are shifting from basic staple foods to higher value livestock products (Gehlhar and Coyle, 2001), with an increasing demand for safer food products with better quality (Regmi, 2001). To formulate their investment and market strategies, food producers and marketers need studies about consumer's new food eating patterns and trends, especially in households with certain purchasing power. As discussed above, public sector decision makers are more concerned about households with low food expenditure, conversely, private entrepreneuers seek consumption information about high food expenditure households. Therefore, in the view of policymakers and food marketers, two tails of food expenditure distribution rather than the mean level provide in-depth information about consumer food consumption patterns.

However, the commonly used Ordinary Least Square (OLS) may be of limited value in capturing extreme distributions (Variyam et al., 2002). OLS targets the mean of dependent variable given the explanatory variables, assuming homoscedasticity in the data. That is, the variance of the dependent variable is constant and does not depend on the explanatory variables. The use of OLS technique implies that each of the explantory variables has the same effect at every single point of the dependent variable distribution. For example, if one explantory variable

increases by a unit, the 25th, 50th, 75th quantiles, mean, and other points along the dependent variable distribution all change by the same amount. This homoskedasticity assumption does not always hold. On the contrary, the tendency of changing dispersion is fairly common in the household consumption data (Koenker and Hallock, 2001). As we know, there are several methods to fix heterscedasticity present in the data, including the robust OLS and weighted OLS (Meng et al., 2013). However, under heteroscedasticity, results obtained using these modified methods can only address the effects at the mean level, but not at other sections along the dependent variable distribution (e.g., the two tails of distribution).

Segmenting the whole sample into several subgroups is another common way to capture the determinants' varying effects in food expenditure along its distribution. For instance, McDowell et al. (1997) investigate the determinants of food expenditure by dividing the households into low-, middle-, and high-income groups. Kirkpatrick and Tarasuk (2003) explore the affordability of nutritious foods by comparing the food expenditure patterns between low- and high-income households in Canada. Jacobson et al. (2010) compare the poorest income category households to all others to examine how household size and income determine their food expenditure in Cyprus. This segmenting method works well if income is the only factor associated with the variance of food expenditure. Although the crucial role of income in determining food expenditure is well-documented (Bouis, 1994; Hoddinott and Haddad, 1995; Kirkpatrick and Tarasuk, 2003), income is not the exclusive factor. In fact, besides income, food expenditure is simultaniously determined by a number of socioeconomic and demographic factors, including education, age, and marital status (Sexauer, 1979; Kinsey, 1994; Cai, 1998). Because the tendency of the dispersion of food expenditure is often closely associated with multiple factors, thus grouping households only by their income level may not lead to accurate

results. In addition, under multi-dimensional heteroscedasticity, dividing the sample into several homogeneous subgroups, “each with a sufficient large number of observations” becomes increasingly difficult (Koenker and Hallock, 2001).

The quantile regression is particularly effective in this situation, because it can examine conditional quantiles along the entire distribution of dependent variable (Variyam et al., 2002). Quantile regression approach was first introduced by Koenker and Bassett (1978) to model quantiles of the conditional distribution of the response variable as functions of observed covariates. Classical least-squares regression such as the OLS focuses on the conditional mean, while quantile regression examines how covariates influence the entire response distribution (Koenker, 2005). Because of its particular feature, the quantile regression has been widely used to model food consumption patterns, allowing different relationship between dependent and independent variables across quantiles of the dependent variable (Masakure et al., 2008). Variyam et al. (2002) use the quantile regression to characterize the distribution of macronutrient intake among U.S. adults. Stewart et al. (2003) analyze income effect on vegetable and fruit spending among low-income households also by quantile regression approach.

The goal of the current study is to identify determinants of the entire food expenditure distribution, especially the lower and upper tails, namely, households with relative low and high food expenditure. The use of quantile regression approach allows us to examine the different effects of socio-demographic factors across the quantiles of household food expenditure distribution. The study uses a survey data set collected in 2011 in the three large cities of Ghana – Accra and Takoradi located in the Southern Region, and Tamale from the Northern Region.

Ghana, a West African country, has experienced and sustained a considerable economic improvement in the past several years. Specifically, Ghana achieved about eight percent average

annual growth rate of GDP from 2007 to 2011 (World Bank, 2012), and a ten percent annual growth rate in gross national income per capita (GNI per capita in current $) in 2011 (World Bank, 2012). The good economic performace stimulates Ghana's food consumption, and further attracts foreign investment including several international food retailers (Meng et al., 2014). In order to implement their market and product strategies effectively, studies on food consumption, especially in relation to those households with high food expenditure, are increasingly demanded by food marketers in recent decades. However, in spite of the remarkable economic growth, food inadequacy is still a big challenge faced by a number of households in Ghana. About 1.2 million people in Ghana, accounting for five percent of the total population, suffer from hunger at least during some periods of the year (World Food Programme, 2014). In addition, the economic growth is uneven across the country's regions, and the development of urban areas in southern and Coastal Region is considerably more advanced than that of northern Ghana. About 60 percent of population in northern Ghana are poor, compared to 20 percent in southern section (World Food Programme, 2014). Low per capita income level is more prevalant in northern Ghana, with more than 60 percent of households in that area living below the national poverty line (Cudjoe et al., 2010). Currently, a large number of Ghanian households still face a high risk of food inadequacy. Therefore, from the policy standpoint, research examining low food expenditure households in urban areas of Ghana is timely and relevant.

Past studies commonly explore the link between socio-demographic factors and food expenditure of an average household in the sample, using least square estimation. Beyond the mean level of food expenditure, the current study examines the entire food expenditure distribution, especially its two extreme tails, namely, households with relative low and high food expenditure. Results provide a comprehensive picture of food consumption distribution in urban

households of Ghana, because the quantile regression allows the different relationship between household food expenditure and its determinants across the quantiles of food expenditure level. The ability to measure potentially different marginal effects of determinants on household expenditure distribution generates detailed knowledge and, presumably, more effective policy from either national, regional or sector perspective.

The following section discusses, key concepts of the economic structure and the quantile regression approach. The detailed descriptive analysis of the data set is found in the next section. Then, Section 1.4 presents the empirical model and variable selection process. Estimation results at the selected quantiles are discussed in Section 1.5, with the comparison of the classic OLS results. Concluding remarks and implications are in final section of the chapter.

1.2 CONCEPTUAL FRAMEWORK AND QUANTILE REGRESSION METHOD

1.2.1 Conceptual framework

According to classical consumer demand theory, a household chooses the optimal food consumption to maximize its utility, constrained by the budget. To solve the first order condition of this optimization problem, the marginal rate of substitution equals the price ratio. The optimal household consumption is a function of factors including the price level, household income, and household preferences. The use of cross-sectional data in the present study allows to reasonably assume a stable price level, after controlling for regional price difference. Income is expected to positively relate to household consumption as implied by Engel Law in case of a normal good. In addition, household preferences, seizing the specific form of utility function and the shape of indifference curve, also affect household food consumption. However, capturing the household preferences is not necessarily easy. A large number of studies indicate that household

preferences can be shaped by a variety of socioeconomic factors such as occupation and education, as well as demographic factors such as age, marital status, and household composition (see for example McDowell et al. 1997; Han and Wahl 1998; Bittencourt et al. 2007; Ricciuto et al. 2006; Quaye et al. 2008; Jolly et al. 2008). Therefore, given the stable price assumption, household food expenditure, that is the amount of money spent on household food purchase, is influenced by income and other selected socioeconomic and demographic characteristics.

1.2.2 Quantile regression approach

The present study applies the quantile regression (QR) to examine how socioeconomic and demographic factors affect the entire food expenditure distribution, especially households with relative low or high food expenditure. Introduced by Koenker and Bassett Jr. (1978), quantile regression approach seeks to model quantiles of the conditional distribution of the response variable as functions of observed covariates. Later, numerous studies explored the advantages of quantile regression approach over the commonly used Least Square regression method.

A direct comparison between the Ordinary Least Squares regression (OLS) and quantile regression helps to understand why and when to apply quantile regression instead of the OLS. The key property is that the Ordinary Least Squares regression models the relationship between the set of explanatory variables and the conditional mean of the response variable, while the quantile regression extends the regression model to conditional quantiles of the response variable, such as the 10^{th}, or 90^{th} quantiles. OLS minimizes the squared error loss in Equation 1.1, while quantile regression minimizes weighted absolute error loss (Equation 1.2):

$$B_{ols} = \arg\min_B \sum (Exp - XB)^2 \tag{1.1}$$

$$B_q = \arg\min_B \left(\sum_{Exp > XB} q * | Exp - XB | + \sum_{Exp < XB} (1 - q) * | Exp - XB | \right) \tag{1.2}$$

where B_{ols} is the coefficients estimated by OLS, B_q is the coefficients estimated by quantile regression, and X is the covariate variables. In the applied notation, q is between 0 and 1 denoting the quantiles, and it can be any quantile of the dependent variable distribution. For example, if q equals 0.5, $B_{0.5}$ is the coefficient for the 50th quantile regression, indicating how the median of dependent variable responses when the explanatory variable increases one unit. Similarly, $B_{0.25}$ captures how the 25th quantile of dependent variable responses to the change of covariate variable.

Furthermore, the quantile regression approach does not divide the whole sample into subsets by quantiles of the dependent variable and estimate each subset separately. In contrast, the quantile regression uses the entire sample in the estimation procedure. Unlike OLS, which attaches exactly the same weight to each observation, the weights of observations in quantile regression are different for a subset of observations. For example, if q equals to 0.5, in Equation 1.2, the absolute value of both positive and negative errors are given an equal weight of 0.5. Therefore, the 50^{th} quantile regression is able to model the median of dependent variable. While if q equals 0.25, the absolute value of positive errors has the weight of 0.25, and the absolute value of negative errors has the weight of 0.75. Thus, in the estimation of the 25^{th} quantile coefficients, the sampled households with high food expenditure (shaped by positive errors) are given low weight, while households with the low food expenditure (shaped by negative errors) are given high weight. In contrast, the 90^{th} quantile regression assigns high food expenditure households with relatively high weight, while low food expenditure households with relatively low weight. Therefore, by endowing each subset of observations with different weights, the quantile regression permits the analysis of the entire distribution of the dependent variable.

Moreover, the OLS assumes that the variance of dependent variable is the constant and does not depend on any of the explanatory variables. This property is known as homoscedasticity. In addition, under this assumption, the explanatory variables are assumed to have the same effect for the response variable in each household. When the homoscedasticity assumption holds, the OLS curve, upper quantile curve, and lower quantile curve are parallel to each other (Figure 1.1). That is, results from OLS estimation and any quantile regression are exactly the same. However, if the data is affected by heteroscedasticity, and the variance of dependent variable changes in response to changes in explanatory variables, results of OLS estimation are not efficient any more. Alternative estimation methods such as Robust OLS or Weighted OLS, can be used to correct the heteroscedasticity and yield efficient estimation (Meng et al., 2013). But the fixed OLS curve, upper quantile curve, and lower quantile curve are not parallel to each other (Figure 1.2). Therefore, results from the least square methods can only model the mean level, and are not a good representative of the entire dependent variable distribution. Just as the mean gives an incomplete picture of a single distribution, the regression curve of the least square methods gives a corresponding incomplete picture for a distribution. Therefore, several different regression curves, corresponding to the various percentage points of the distributions, are estimated to obtain its comprehensive information of the entire distribution (Koener and Hallock, 2001).

Furthermore, if the heteroscedasticity is only associated with household income, dividing the entire sample by the household income may be a reasonable method. For example, McDowell et al. (1997) examine what factors influence food expenditure by grouping the sampled households into low-, middle-, and high-income groups; Kirkpatrick and Tarasuk (2003) compare the food expenditure patterns between low- and high-income households;

Jacobson et al. (2010) use the poorest income category households as a comparison to the rest of households examining the crucial role of household size and income in affecting food expenditure. However, in the current data set pertaining to urban households in Ghana, the dispersion of food expenditure changes with income, age, and the number of adults in a household. That is, the data set presents multi-dimension heteroscedastisity. Koenker and Hallock (2011) state that under multi-dimensional heteroscedasticity, dividing the sample into several homogeneous subgroups becomes increasingly difficult. Therefore, segmenting the entire sample into several homogenous subsets is of limited practical value.

Quantile regression is regarded to be particularly useful to address the multi-dimensional heteroscedasticity. The main advantage of quantile regression is its flexibility to model with data afflicted with heterogeneous conditional distributions (SAS, 2011). The quantile repression does not enforce the assumption that socio-demographic factors have exactly the same effects at every point of the food expenditure distribution. Therefore, the approach is presumed useful when a decision-maker requires knowledge about a change in food expenditure in a specific quantile in response to a change in consumer characteristic, her household features, or location. Koenker and Hallock (2001) suggest quantile regression can be applied to a number of fields including economics, and provide an example how to use quantile regression to explore the Engel's curve, which graphically shows that the dispersion of food expenditure increases as household income increases. Koenker and Hallock (2001)'s study may have influenced several studies. Variyam et al. (2002) use the quantile regression to characterize the distribution of macronutrient intake among U.S. adults. Spending among low-income households is the focus of Stewart et al. (2003) study, which analyzes the income effect on vegetable and fruit purchases using the quantile regression approach.

The current study employs the simultaneous-quantile regression at the 25th, 50th, 75th, and 90th quantiles generating insights about the food expenditure pattern of household along the entire food expenditure distribution. Application of the paired bootstrap procedure (500 replications) obtains standard errors for the estimators. Also, the F test verifies whether the explanatory variables have statistically significant differential effects at various quantiles.

1.3 DATA

The study applies survey data collected between February and June in Ghana in 2011. The survey was conducted among residents of three big cities in Ghana (i.e., Accra, Tamale, and Takoradi). Accra, the capital and largest city of Ghana, serves as the nation economic and administrative center. Takoradi, together with another the twin city Sekondi, is the capital city of the Western Region of Ghana. It is the fourth largest town and the industrial and commercial center of the country. Tamale, the capital city of the Northern Region, is mostly inhabited by the Mole-Dagomba linguistic group. The town serves as the commercial capital of the three northern regions (Ghana Web, 2013).

Following the preparation of the survey instrument, the initial day of survey implementation was treated as a pre-test. The survey was first implemented in Tamale. Dagmoba-fluent enumerators were recruited from the workers participating in the surveys organized by the Ghana National Statistical Service (GNSS) in the area. After translating the questionnaire into Dagmoba and assuring a single, consistent with the English version, interpretation of each question, the enumerators spent one half day interviewing households selected from the sample of households used by the GNSS. After the first day of data collection, the de-briefing of enumerators and scrutinized responses did not reveal problems in respondent

understanding of any posed questions. A total of 216 questionnaires were collected from Tamale households.

Similar implementation procedures were followed in Takoradi and Accra, although the interviews were most often held in English, because English is commonly spoken in urban coastal areas. In Takoradi, 230 households completed questionnaires, while 630 households were interviewed in Accra. The data were entered concurrently during the data collection by two assistants recruited from among the students at the University of Ghana at Legon. In the process of data entry, each questionnaire was examined for recording mistakes such as marking two responses where a single answer was required, and consulted with the enumerator performing the interview. Enumerator mistakes were rare and those noticed were cleared before the survey was completed in each area. Before the data has been used in the current study, each questionnaire was further verified for potential data entry errors.

The survey instrument included questions that asked about respondent food shopping and preparation habits, and total food spending. A respondent was also asked to share the income information. In addition, the enumerators recorded the household demographic characteristics, including the number and age of children, and gender and age of the respondent. On occasion, a respondent did not provide an answer about a specific question. Therefore, after deleting the missing observations, there is a total of 1008 households included in the present chapter.

Table 1.1 displays the summary of descriptive statistics, including variable mean and standard deviation. In the sample, 60.7 percent of the surveyed households are from Accra, 20.8 percent from Takoradi, and the remaining 18.5 percent from Tamale. The age of respondents ranged from 17 to 80 years old, where 25.3 percent are 30 years old or younger, 35.5 percent are between 31 and 40 years old, 23.9 percent are between 41 and 50 years old, and remaining 15.2

percent are above 50 years of age. Among the surveyed households, 75.3 percent are married households, and about 51.6 percent of respondents have secondary or higher education. In addition, a typical household is reported to have 0.94 children (4-12 years old), 0.98 teenagers (13-18 years old) and 2.2 adults (older than 18 years old).

In order to consider the regional difference of price level associated with regional variations in the inflation rate, the food expenditure and income were adjusted using the Regional Consumer Price Index calculated for May of 2011 (Ghana Statistics Services, 2011). Specifically, the regional Consumer Price Index (CPI) for food and nonalcoholic beverages was used to deflate the reported food expenditure, while household income was adjusted by the regional CPI for combined food and non-food items. According to the report from Ghana Statistics Services (2011), CPI for food and non-alcoholic beverages for the Northern Region was 272.95, Western Region was 351.47, while in Greater Accra the CPI was 334.03, respectively, using the year 2002 as the base. Similarly, the CPI for combined food and non-food items was 349.71, 383.90, and 387.73 for the Northern Region, Western Region, and Greater Accra, respectively. The calculated food price deflator for Tamale-based households is 0.817 and for households in Takoradi it is 1.052. The income deflator applied in Tamale and in Takoradi are 0.902 and 0.990, respectively.

The adjustment using the regional CPI allows to compare food expenditure and income in Tamale and Takoradi to figures reported from Accra households. In the month preceding the survey, the recorded income, after regional adjustments, ranges from 5.1 Ghanaian cedi ($1= 1.49989 Ghanaian cedi on January 1st, 2011 (Ghana web, 2013)) to 8,500 Ghanaian cedi with the mean of 652.7 Ghanaian cedi. While, the average weekly household food expenditure is 59.0 Ghanaian cedi, or 36.2% of the average household income, the weekly food expenditure of 25th

quantile is 30 Ghanaian cedi, the median is 50 Ghanaian cedi, the 75th quantile is 71.3 Ghanaian cedi, and the 90th quantile is 100 Ghanaian cedi.

1.4 EMPIRICAL MODEL AND VARIABLE SELECTION

Recall the conceptual framework in Section 1.2, food expenditure is a function of income and socioeconomic and demographic characteristics. Therefore, in the present empirical model, weekly household food expenditure is the dependent variable, while socioeconomic and demographic characteristics (i.e., household income, education, occupation, age, age squared, marital status, household composition etc.) as well as location serve as explanatory variables. Equation 1.3 shows the general specification of the empirical model.

$$Exp = X_s B_s + X_d B_d + X_l B_l + e \tag{1.3}$$

where *Exp* is weekly household food expenditure in Ghanaian cedi, X_s is the vector of socioeconomic factor, X_d is the vector of demographic characteristics vector, X_l denotes location variables, *B's* are the corresponding coefficients to be estimated, and *e* is the stochastic error term.

Income is found to be one of the most prominent measures of food consumption behavior (Muhammad et al., 2011). The strong link between income and food expenditure is well established in traditional consumer demand theory. Food expenditure is expected to increase with household income because higher income indicates bigger purchase power. Jacobson et al. (2010) illustrate the increase in expenditure on food associated with an increase in income. Hopper (2011) illustrates the positive relationship between the household income and the quantities of food they purchased. With the income growth, not only the quantity of food consumption increases, but household food consumption patterns shift, especially in developing

countries. Regmi (2001) states that in developing countries, higher income results in bigger demand for meat products. As income increases, consumer's diet becomes more diversified and their staple foods are partly displaced by more appealing sources of nutrition such as animal and dairy products, fruit and vegetables, fats and oils (Delisle, 1990).

Besides income, many other socioeconomic and demographic characteristics of the consumers (i.e., education, age, marital status, and household composition) also found to affect food consumption patterns. Davis (1982) pointed out that the traditional theory assumes income is the major determinant of food expenditure patterns and it fails to include socio-demographic variable as important determinants of expenditure behavior explicitly. Socioeconomic factors affect consumers' food preference such as eating habits, indigenous knowledge about the method of preparation, cooking time or convenience, food nutritional or medicinal value, and taste (Quaye et al., 2009). A number of studies suggest that food expenditure is affected by the education levels of household head or household members (Frazao, 1992; Ricciuto et al., 2006). The demographic factors such as age, family size, and marital status are found to be significant factors for food expenditure (Bittencourt et al., 2007). Taste changes with age and so do preferences for specific foods (Vasdekis et al., 2001). Age affects food consumption frequency and food product selection (Jolly et al., 2008). Household size was found to have a significantly positive impact on aggregate household food expenditure (Neenan and Davis, 1977; Smallwood and Blaylock, 1981). Household composition is a significant factor of food consumption and expenditure, for example, the consumption of certain food items such as milk tends to be high, even on per capita or adult-equivalent basis, in households with a large number of young children (Delisle, 1990). The presence of children in households is expected to have a positive relationship with the expenditure on fresh vegetables, supported by Han and Wahl (1998).

1.5 RESULTS

Table 1.2 displays the estimation results of the quantile regression (QR) at 25th, 50th, 75th, and 90th quantiles, and as well as the results of ordinary least square (OLS). The first four columns show the QR results, and, for comparison, the last column of Table 1.2 shows the OLS results. The results of Breusch-Pagan test for heteroscedasticity after OLS regression are also included at the bottom of OLS result column.

1.5.1 Quantile regression vs. OLS

Recall the discussion of OLS and QR in previous section, OLS is used to model the conditional mean of food expenditure, while QR provides the coefficients of determinants for food expenditure at various quantiles, allowing the effects of the regressors to vary across the different points of the food expenditure distribution. Because the dependent variable (i.e., weekly household food expenditure) roughly follows the normal distribution, the mean and median values of the dependent variable are close. Therefore, it is not surprising that OLS results (modeling the mean) and the 50^{th} QR results (modeling the median) are consistent in terms of variable significance and the sign of coefficients. They both indicate that income, education, marital status, age, the number of children, the number of adult members and its square, Tamale dummy variable, and Takoradi dummy variable are significant in the weekly household expenditure equation.

However, the OLS results and QR results at tails are quite different. For example, OLS result suggests that education and marital status are significantly important in determining food expenditure, but neither the 25^{th} or 90^{th} quantile confirm it. In addition, even though the OLS and QR at tails suggest the same significant factors, the magnitude of the coefficients are very different. For instance, the coefficient of adult member number is 6.606 in the OLS results, while

in the QR results the coefficients of the same regressor are 3.196 and 8.045 at 25^{th} and 90^{th} quantile, respectively. Therefore, Table 1.2 confirms that under heteroscedasticity, the OLS results contrast in terms of the significance and magnitude of coefficients from QR results, especially at lower and upper tails of the food expenditure distribution. The remaining of this section discusses QR results at all quantiles in detail.

1.5.2 Quatile regression

Income has a positive effect on weekly household food expenditure across all quantiles. A hundred cedi increase in monthly income adds 1.4 cedi, 2.4 cedi, 3.8 cedi and 4.4 cedi, respectively, to the weekly food expenditure at the 25th, 50th, 75th and 90th quantiles. Results of the F test indicate that coefficients of income significantly vary across quantiles. The finding reaffirms the crucial role of income in affecting food expenditure, namely, food expenditure increases significantly as household income increases (Delisle, 1990; Jacobson, 2010; Hopper, 2011). However, the income effects on food expenditure vary along the food expenditure distribution. According to the estimation results, income has a smaller effect on households with low food expenditure, while larger effects on households with higher food expenditure. In other words, households with low food expenditure tend to be less sensitive to the income increase. Because low food expenditure households likely allocate the additional income to other purposes such as purchase of non-food goods or services. Therefore, the increase in income has smaller effect on food consumption among households at the lower tail of food expenditure distribution. In addition, the income elasticity of household food expenditure computed at the 25^{th}, 50^{th}, 75^{th}, and 90^{th} quantile of food expenditure distribution (Table 1.3) are 0.12, 0.21, 0.43, and 0.54, respectively. Results suggest that food is considered as a necessary good, and food expenditure increases as income increases but at a slow pace.

Among the socio-economic variables, the respondents attained education is found to be a significant factor in determining food expenditure. At the 50th quantile, respondents with a secondary or higher education level spend 4.7 cedi more on weekly food purchase than respondents with lower education level. The result is consistent with the argument that education closely correlates with the awareness of the importance of healthy diets (Stewart et al., 2003). Particularly at median food expenditure level, knowledge about nutrition and diet enable educated households to pursue more healthy food choices, reflected in higher food expenditure. However, education is not significant in households with relatively low or high food expenditure. Perhaps, for the low food expenditure households, the tight budget rather than the lack of knowledge about healthy food is the major constraint of food expenditure. While in high food expenditure households, they may already tend to consume food products of good quality and wide variety, thus, education would not increase their food expenditure significantly.

Apart from the socioeconomic characteristics discussed above, demographic factors including marital status, age, and household composition are also significantly associated with changes in the weekly food expenditure. Demographic measures are important because they differentiate households to a larger degree, especially in developing countries.

Marital status has a significantly positive effect on weekly household food expenditure at the 50th and 75th quantile. It may be that the married respondents are inclined to eat a different diet than the households of single consumers. The different diet results simply from caring for a spouse. A married household is more likely to host guests, celebrate holidays or have parties for immediate and extended family than households or respondents that are not married. At median food expenditure level, the expenditure gap between the married and not married households is 5.7 cedi per week, while at the upper quartile of food expenditure, the additional expenditure is

6.3 cedi per week, i.e. ten percent more than sample average. But based on F statistic test, the food expenditure gap between the married and unmarried households at the 50^{th} quantile is not significantly different from the gap at 75^{th} quantile.

Both age and its square are included in the empirical model specification. Although it is plausible to expect food expenditure to increase with age, this increase may occur at a decreasing rate. Age is positively correlated with weekly food expenditure in any quantile. The squared terms of age are significantly negative at the 25th and 50th quantile (i.e., two lowest quantiles). Basically, the effects of age on food consumption are associated with changes in nutritional requirements, tastes, and preference due to aging (Bittencourt, 2007). The finding stresses the decreasing rate at which weekly food spending increases as the respondent advances in age, for households with the median or from the bottom quantile. Although results of F test suggest that the coefficients of age significantly vary across quantiles, the square term of age does not. Therefore, the combined effects of age on food expenditure are different for median and low quantiles than for higher quantiles.

Household composition is another significantly influential factor in determining food expenditure distribution. At the 50th, 75th and 90th quantile, a household with a large number of children (between 4 and 12 years old) has a significantly higher weekly food expenditure. Children usually have special food needs for their growth, therefore, household spend more on food as the number of children increases. Results indicate that households with median and higher food expenditure are able to exercise possible choices about the child's specific nutrition needs. But, households in the lowest quantile appear unable to afford the additional food expenditure as a result of children presence. Also, results of F test suggest that the effects of the number of children do not vary across the 50^{th}, 75^{th}, and 90^{th} quantile. That is, the effects of

children on household food expenditure are roughly the same among households with the median and higher food expenditure.

Furthermore, the number of adult household members has a significant and positive influence on food expenditure, but at a decreasing rate at all quantiles. Results of the F test indicate that the effects of the number of adults and its square term are not significantly different for households from various quantiles. It indicates that one additional adult has the same effect on weekly food expenditure along food expenditure distribution. The number of adults is usually used to represent the household size, and, in general, a large household spends more on weekly food purchase than a small household. There are economies of scale even in case of large households, which suggests that the expenditure on food increases as the number of adults increases, but less than proportionately. Hence, food expenditure tends to increase with the household size, but at a decreasing rate.

In this study, the surveyed households are from three big cities-Accra, Takoradi, and Tamale; and the location is considered a factor that influences food expenditure. Results clearly indicate that households in Tamale spend less on food than in Accra in any quantile. Tamale is in less developed area in Ghana, therefore, it is not a surprise that Tamale households have significantly lower food expenditure than the capital's households. Moreover, the F test result indicates that the gap in weekly food expenditure between Accra and Tamale households is bigger in the upper quantiles and smaller in the lower quantiles. Households with substantial food expenditure likely purchase food products with high quality or in a wide variety. These premium foods are easier to find in the capital Accra than in Tamale, therefore, the gap in expenditure is larger between households spending relatively more on food in two cities. Similarly, compared to Accra households, Takoradi based households spend less on food at all

quantiles. However, the expenditure gap between Takoradi and Accra households is much smaller than between households from Tamale and Accra. It is plausible that Takoradi located in the coastal area experiences a relatively fast economic growth. Thus, the similarities between Takoradi's and Accra economies appear to be captured by the smaller gap in food expenditure between households there, than between Tamale and Accra. Results of F test do not imply the gap between Takoradi and Accra households in food expenditure varying significantly across the quantiles.

1.5.3 The diagnosis of heteroscedasticity

In Table 1.2, results of Breusch-Pagan test for heteroscedasticity are included in the OLS result column. Here, the null hypothesis of the test is that the dependent variable (i.e., weekly household food expenditure) has a constant variance for all observations. As shown in Table 1.2, Chi-square statistics is 656.73 (the degree of freedom is one) and, obviously, the corresponding p-value is much less than one percent. The null hypothesis is rejected, thus results of Breusch-Pagan test indicate that the heteroscedasticity is present in the data set.

As discussed in the Section 1.2, under the homoscedasticity assumption, each explanatory variable has the same effect on every single point of the dependent variable distribution. In case of the current study, if homoscedasticity holds, each independent variable would have the same effect in the 25^{th}, 50^{th}, 75^{th}, and 90^{th} quantiles of weekly food expenditure distribution. But based on the obtained QR results, the coefficients of several explanatory variables are significantly different across quantiles. For example, the variable income has a smaller effect on food expenditure at the lower tails of expenditure distribution, while has a larger effect at the higher tails. Similar effect is associated with the location dummy variable Tamale, that is, the food expenditure gap between Tamale and Accra households increases significantly across the

quantiles. Additionally, QR results show that several variables have a significant effect on food expenditure only at certain quantiles instead of the entire food expenditure distribution. For example, the variable education has a significant effect on food expenditure at the 50^{th} quantile, marital status is significant at the 50^{th} and 75^{th} quantile, and the effect of square term of age is significant at the 25^{th} and 50^{th} quantile. In fact, those different effects across the quantiles (i.e., income and Tamale) as well as the "partially" significant variables (i.e., education, marital status, and square term of age) reconfirm the violation of homoscedasticity assumption. This is consistent with the results of Breusch-Pagan test. More importantly, QR results not only confirm the presence of heteroscedasticity, but also provide useful insights about variables that could be suspect as the cause of heteroscedasticity in an estimated relationship. Empirical economists are well aware that detecting heteroscedasticity is not straightforward, especially when working with a multidimensional data set. Therefore, QR results definitely contribute to the selection of methods remedying heteroscedasticity.

The main purpose of this chapter is to investigate the entire distribution of food expenditure, particularly targeting households with relative low and high food expenditure rather than the mean expenditure level. Therefore, details about how variables suspect of contributing to heteroscedasticity in food expenditure modeling will not be discussed in this study. However, it is absolutely worth to recognize the important role of QR and related F test of coefficients across quantiles in diagnosing the presence of heteroscedasticity and identifying the suspect variables.

1.6 CONCLUSIONS AND IMPLICATIONS

Because of the recent substantial economic growth, Ghana has been re-classified to the category of lower-middle income countries in July of 2011 (The World Bank, 2011). Due to the good economic performance and increasing disposal income, food consumption patterns in Ghana are currently under a huge transition. Private organizations, such as domestic and international food producers/marketers, have paid increasing attention to the food consumption patterns among Ghanaian households, especially households at the upper tail of food expenditure distribution. However, in spite of the expanding economy, there are a large number of Ghanaian households with high risk of food inadequacy, especially in the northern part of Ghana. To formulate effective policies and efficient food assistance programs, the public sector needs robust knowledge from studies focusing especially on lower tail of food expenditure distribution to design solutions and reduce the risk of food inadequacy. It is the low food expenditure households that face a relatively high risk of food and energy inadequacy than the average households. Therefore, from the viewpoint of policy makers and private organizations, the two tails of food expenditure distribution rather than the mean are of particular relevance and importance. However, regular least square estimation methods such as the OLS are of limited value in examining the entire food expenditure distribution, and may even provide misleading results about low- and high-food expenditure households. Therefore, the study applies a particular estimation method called the Quantile Regression to investigate food expenditure distribution in urban households of Ghana, using a random sample from three large cities of Ghana. The study identified the underlying determinants of the entire food expenditure, especially focusing on two tails, and examined the different effects of determinants on food expenditure across subgroup of urban households.

1.6.1 Variation in socio-demographic effects on food expenditure across quantiles

The current study stratifies the sample into several quantiles and avoids the pitfall of interpreting household behavior limited solely to a focus on the average level of food expenditure in the sample. Results of the current study confirm the critical link between income and food expenditure, implying as income increases households spend more on food. More importantly, the study deepens the knowledge about the income-expenditure relationship by examining the effect of income along the entire food expenditure distribution, especially focusing households with relative low- and high-food expenditure. QR results indicate that increasing income has the smallest effect on food expenditure in the lowest quantile of researched households and the effect increases as food expenditure increases. In other words, high food expenditure households are more sensitive to the increase of income than low food expenditure households. The effect of income is more than threefold larger in the 90^{th} quantile compared to the 25^{th} quantile, suggesting that for lower food expenditure households, additional income is more likely spend on non-food rather than food items. The high effect of income in the top quantile likely reflects a shift to high quality or prepared foods, due to the emerging demand for convenience.

The difference in effects of education on food expenditure is of particular interest because it has contrasting influence when the OLS and QR results are compared. Limiting the analysis to the average effect would suggest a strong positive association between education and expenditures. However, the QR results confirm the statistically significant effect only for households in the median group. Education has an uneven effect on food expenditure across quantiles, its influence is not confirmed in the lowest quantile or those above the median. If nutrition and health are the purpose of public policies, individuals with at least high school

education from households with median incomes may be receptive to messages guiding their food choices and, consequently, expenditure. The absence of statistically confirmed education effect in other quantiles does not imply that education is not important or that a single message could be effective in linking education to food expenditure, presumably, on healthy foods. It is reasonable to expect that the messages to either tail of food expenditure distribution, when taking education of consumer into account, have to be different because the education may modulate the expenditure towards nutrient-dense foods among low-income households. Since there typically are more low-income households than rich households, education has the potential to affect a relatively larger portion of the population.

Demographic characteristics are very important and their effects vary across all quantiles. Being married positively influences food expenditure in the two middle quantiles. The effect would be considered significant if the analysis is limited to the average effect, but the QR results are insignificant in the lowest and highest quantiles. Marital status has been explained by hosting more guests or celebrating a larger number of family events leading to food expenditure increase. Low income households of the married respondents may not be able to afford celebrations, while the highest income households may celebrate in a different fashion, for example, by visiting restaurants. Again, the absence of statistically confirmed influence of marital status at two ends of the expenditure distribution does not imply that identical reasons are responsible for the observed outcome.

Age induces higher food expenditure across all quantiles, and the effect tends to be larger among high food expenditure households. More important from policy or food distributor perspective is that as individuals advance in age, those from households in the two lowest quantiles, their food expenditure increase with age, but at a decreasing rate, and after reaching

certain age, food expenditure even decrease as age increases. Although food needs decline with age, the decreasing expenditure may lead to malnourishment in lower income households causing increased disease incidence or even premature death. Monitoring households of low income, older individuals could prevent negative social phenomenon from occurring. Also, food distributors may have to be informed and encouraged to carry products favored by elderly nutritional needs.

If children are present in a household, food expenditure tends to increase, except for the lowest quantile. The increasing expenditure at median or upper quantiles is a positive sign implying that the risk of inadequate food consumption among children may not exist. The lack of confirmed effect of children presence in the lowest quantile contrasts with the uniformly positive effect if the evaluation is made only at the mean. Poverty is not uncommon in households with children and low-income households require monitoring and, if needed, assistance to assure children eat a balanced and adequate diet. As noted earlier, income supplementation may not be an effective approach to increase food intake because additional income is likely to be spent on other items.

The number of adults in the household has the uniformly positive effect on food expenditure across all households, but the effect significantly declines if the number of adults continues to increase. Both effects increase across households and are notably smaller and larger at two tails of the distribution. Overall, households behave in a similar fashion with regard to this measure. It has to be noticed that the effects in the three lower qunatiles are considerably lower than at the mean and suggest the effect is weaker, while the opposite is true for households in the upper quantiles.

Location has a clearly significant influence on food expenditure across all quantiles in the studied urban households in Ghana. The comparison of Tamale- and Takoradi-based households against Accra households shows that the difference was considerably larger between Tamale and Accra households than Takoradi and Accra households. The negative effects of location are relatively less in the lowest quantile and increase progressively to the highest quantile. It appears that the differences in expenditure among lowest income households are smaller between Tamale or, especially, Takoradi and Accra than among the top quantile. The difference is present after adjusting for possible differences in regional changes in price level. Consequently, national policies must recognize large differences in food expenditure and, if Engle's law holds, a highly variable risk of inadequate food consumption between the capital city and other towns included in the study, especially Tamale. There have been earlier studies that suggested a different speed of economic growth between the southern and northern parts of the country (Cudjoe et al., 2010; World Food Programme, 2014). Industry and commerce are concentrated in southern Ghana, while Accra is also the nation's administrative center. Area around Tamale is predominantly rural and offers a different earning opportunities or lifestyle. The differences allow food distributors to make instant adjustments, but the public policies may require additional information about possible influence of cultural, historical, or religious factors to address the possible variation in risk of low food expenditure and inadequate food consumption. For public sectors and nongovernment organizations concerned about food inadequacy, related food interventions such as food assistant need to focus on noncapital cities especially in less developed areas such the Northern Region of Ghana. The difference in food expenditure is also important from the standpoint of household size. The average household in Tamale is considerably larger than in Takoradi or Accra and, as estimation results show, the expenditure

tend to increase with every additional adults in the household, but at a decreasing rate. Consequently, the amount of food available for each household member may be smaller in very large households leading to malnutrition. With the increasing life expectancy in Ghana, the needs of older consumers will become an increasingly pressing issue. Results suggest that not married (including divorced or widowed persons) have relatively low food expenditure and may be at risk of inadequate food consumption more often than the households of married consumers.

1.6.2 Implications for public sector

The useful insights of the entire food expenditure distribution, especially the lower tail, help to refine public policies. Results indicate that despite the significant role of income in increasing household food expenditure for all quantiles, the income effect is relatively low in households with low food expenditure. Because in those households, additional income is more likely to be allocated to non-food needs such as clothes and children's education. Therefore, from the public policy standpoint, to reduce food insecurity risk and improve nutrition, it is essentially necessary to provide food assistance together with the complementary programs such as school feeding program. Moreover, results also suggest that unlike household with median or higher food expenditure, households at the lower quartile of food expenditure distribution were not able to increase their food spending to meet the nutrition needs of children's growth. Thus, among low-food-expenditure households, besides targeting the improvement of the total household consumption, food assistance programs may also need to consider the special food needs of individual household members such as children. Furthermore, the food expenditure gap between Tamale- and Accra-based households increased along the food expenditure distribution. In other words, the gap of household food expenditure between Accra- and Tamale-based households was smaller at lower tail and larger at upper tail of food expenditure distribution. It

indirectly shows that the food supply system in Northern Ghana in terms of food availability, quality, and variety is still in need of improvement, which demands attention from local government.

1.6.3 Implications for private organizations

This chapter provides a comprehensive picture of food expenditure in urban households in Ghana, including the upper tail of food expenditure distribution. Such information is remarkably useful for private sector in formulating their food distribution and marketing strategies. Resulting consumer profiles suggest that food marketers need to focus promotion on the high-income and well-educated households in relatively developed areas and recognize nutrient needs of children and food preference of large households. For example, food retailers need to recognize the increasing demand of high food expenditure households for food products with better quality and wider variety. Moreover, because of the significant role of educational attainment level in determining food expenditure, providing information about nutrition and healthy diet through on site promotion or proper advertisements might encourage additional household food expenditure, and further enhance food retailer's market sale. In contrast to similarities in food expenditure among households spending relatively less on food, among households with high food expenditure, the regional difference is still significant. Therefore, food producers and marketers are suggested to selectively target their food marketing and promotion at relatively developed areas like Southern and Coastal Region with a different type of promotions and use that experience in designing promotions in areas in the North, like Tamale.

Table 1.1: Descriptive statistics of variables in the sample.

Variable name/type	Variable description / units of measurement	Mean	Std dev
Dependent variable:			
Food_Exp	Weekly food spending (including fish and meat) in Ghanaian cedis	59.0000	40.7800
Independent variables:			
	Socioeconomic factors		
Income	Household income in the month preceding the survey in Ghanaian cedis	652.6981	784.2063
Employ_self	=1 if a respondent is self employed	0.6419	0.4797
Employ_gov	=1 if a respondent is gov/civil employee	0.2421	0.4285
Educ	=1 if a respondent has a secondary or higher education (including Senior high/GCE O-A level, Vocational school, Technical school, Teacher training, University, Postgraduate)	0.5159	0.5000
	Demographic factors		
Married	=1 if a respondent is married	0.7530	0.4315
Age	Actual age in years	39.2361	10.6610
Children	Number of household members between 4-12 years old	0.9425	1.0634
Teenager	Number of household members between 13-18 years old	0.9772	1.1910
Adult	Number of household members older than 18 years old	2.2341	1.8714
	Location		
Tamale	=1 if a household is in Tamale	0.1845	0.3881
Takoradi	=1if a household is in Takoradi	0.2083	0.4063

Table 1.2: Quantile and OLS regression estimation results for the expenditure on food in urban households in Ghana, 2011.

Methods	Quantile Regression				OLS
Variable name/Coef (std err.)	25th	50th	75th	90th	
Intercept	-5.555	-14.008	2.539	4.542	-10.078
	(8.696)	(13.795)	(15.907)	(19.654)	(13.197)
			Socioeconomic factors		
Income	0.014***	0.024***	0.038***	0.044***	0.023***
	(0.004)	(0.004)	(0.004)	(0.010)	(0.001)
Employ_self	-0.923	4.298	1.965	8.429	4.711
	(2.849)	(3.572)	(4.415)	(5.360)	(3.504)
Employ-gov	-1.856	1.318	-5.132	-8.919	-2.575
	(3.299)	(3.977)	(5.314)	(5.867)	(4.086)
Educ	3.338	4.738*	3.689	3.948	6.049***
	(2.380)	(2.696)	(3.250)	(4.777)	(2.399)
			Demographic factors		
Married	3.658	5.733**	6.344**	4.407	5.438**
	(2.267)	(2.399)	(2.859)	(4.633)	(2.523)
Age	1.143***	1.653**	1.382*	1.763*	1.448**
	(0.437)	(0.672)	(.792)	(1.042)	(0.672)
Agesq	-.011**	-0.015*	-0.010	-0.013	-0.012
	(0.005)	(0.008)	(0.009)	(0.012)	(0.008)
Children	0.787	2.321*	3.451**	4.980**	2.678***
	(0.910)	(1.319)	(1.550)	(1.998)	(1.023)
Teenager	0.477	0.797	1.349	0.007	.452
	(0.902)	(1.243)	(1.423)	(1.802)	(0.937)
Adult	3.196**	3.965***	3.794**	8.045***	6.606***
	(1.438)	(1.473)	(1.715)	(2.901)	(1.469)
Adultsq	-0.261*	-0.352**	-.344**	-.758***	-.595***
	(0.153)	(0.170)	(0.170)	(0.282)	(0.171)
			Location		
Tamale	-10.276***	-17.450***	-23.339***	-25.151***	-18.397***
	(2.380)	(2.629)	(3.554)	(6.322)	(3.020)
Takoradi	-3.164	-9.773***	-11.316***	-15.719***	-9.123***
	(2.924)	(2.882)	(3.203)	(5.616)	(2.767)
Chi2 stat.					656.730
P-value					0.0001

Note: *, ** and *** denote significance at 10%, 5%, and 1% levels, respectively. Standard errors (in parentheses) are bootstrap estimates based on 500 replications of the design matrix.

Table 1.3: Income elasticity of food expenditure across quantiles of food expenditure distribution in urban households in Ghana, 2011.

Quantiles of food expenditure	25th	50th	75th	90th
Income elasticity	0.12	0.21	0.43	0.54

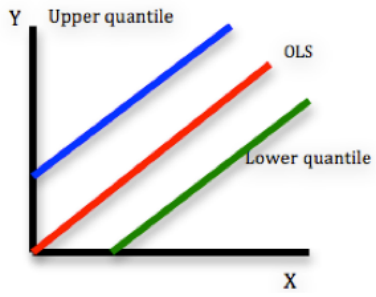

Figure 1.1: OLS and quantile regression under homoscedasticity.

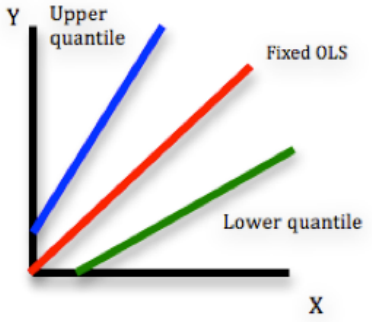

Figure 1.2: OLS and quantile regression under heteroscedasticity.

CHAPTER 2

CONSUMER'S FOOD SHOPPING CHOICE IN GHANA: SUPERMAREKT OR TRADITIONAL OUTLETS?[1]

[1] Meng, T., Florkowski, W. J., Sarpong, D. B., Chinnan, M. S., and Resurreccion, A.V.A. 2014. *International Food and Agribusiness Management Review*, 17(A): 107-129.
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ABSTRACT

This chapter assessed the relative importance of different food retail outlets (i.e., supermarkets, open-air markets, and hawkers) in food supply system of Ghana, and identified the socio-demographic profiles of consumers associated with shopping in each retail format. Results of the study indicate open-air markets still dominate the food supply system in Ghana, while supermarkets and hawkers play an active role as alternative food shopping outlets. Well-educated, high-income households prefer to frequent supermarkets for food shopping, while hawkers attract households with small children, likely because of convenient access.

2.1 INTRODUCTION

A tremendous dietary change and nutrition transition is occurring in developing countries. For the most part, this change is due to the substantial economic growth and rapid disposable income increase during the last decades. Consumers have become more concerned about the diversity, nutrition, and quality of food products they eat. Between 1963 and 2003, there was a decline in root and tuber consumption in developing countries, but a large increase in calorie-dense food products including meat (119%), sugar (127%), and vegetable oils (199%) (Kearney 2010). In the Eastern Asia/Pacific Rim region, including China and Thailand, pesticide free is considered as key food attribute (Moser et al. 2011). Similarly, demand for organic food products has increased, in addition to demand for quality assurance measures such as product labeling and traceability (Mashinini 2006). Now consumers are able to exercise these preferences due to increasing access to the expanded retail sector.

In addition to this large shift in food preferences, the food supply system in these developing countries, especially food retail formats, is also undergoing a dramatic change.

Driven by the new food demand and liberalization of retail foreign direct investment (FDI), the "supermarket revolution" wave began in developing countries in the early 1990s and then spread to Latin America, followed by East/Southeast Asia and East/South Africa, then finally West Africa (Reardon et al. 2003; Reardon et al. 2004; Reardon and Hopkins 2006). In China, many international retailers, such as Walmart, are present and expanding quickly (McLoughlin et al. 2012) and their share amounts to 5-20% of national food retail sales (Hawkes 2008).

Numerous previous studies comprehensively explored the effect of supermarkets. The reports include the competition between supermarkets and existing actors in the food system (Reardon et al. 2009; Neven et al. 2006), the challenges faced by small farms and small processing/distribution firms (Louw et al. 2007 and 2008), as well as the macro impacts on domestic market development, local employment, and economic growth (Shepherd 2005; Emongor and Kirsten 2009). However, as the final link in the food supply chain, the consumer's role has often been neglected or underestimated. Among the previous studies, very few investigate supermarket expansion in developing countries and how it relates to the consumer food outlet choice. Consumers' selective adoption of supermarkets was first identified by Goldman (2000), who noted "consumers who regularly shop in supermarkets continue to purchase fresh food in traditional outlets". Okello et al. (2011) used interview information to access consumer choice of retail outlets when purchasing fresh vegetables in Kenya. Gorton et al. (2011) applied a consumer-centered model to investigate the extent to which supermarkets can capture food retailing in Thailand. Unfortunately, many developing countries do not have resources to conduct consumer surveys about food consumption and diet (Kearney 2010). Our study expands this literature by explicitly considering consumer decisions. We examine

consumer food retail format choice of both modern and traditional food outlets in terms of consumer's socio-demographic characteristics in West Africa.

Growing incomes, expanding retail outlets, and changing consumer preferences in developing countries call for an examination of determinants of consumer retail food outlet choice. This study investigates consumers' food retail shopping choices and explores how the choices could affect their diet, nutrition, and health. The present study contributes to the empirical literature addressing consumer outlet choice, and specifically fills the gap in such studies in sub-Saharan Africa by analyzing consumer choice of retail outlets for food purchasing, using the survey data collected from Ghana's urban households in 2011. The objectives of the study are to: a) explore the food retail system structure in urban Ghana; b) identify what factors, including socio-demographic characteristics, affect consumer food shopping frequency in supermarkets and traditional outlets, i.e., open-air markets and hawkers; c) illustrate the potential association between food retail outlet choice and consumer diets.

In recent decades, diet-related chronic health conditions such as obesity, diabetes, and heart disease have attracted a lot of attention. Dietary patterns can be influenced by the availability and accessibility of different types of foods (Farley et al. 2009). The increased consumption of energy-dense foods rather than foods such as fresh vegetables and fruits may be the reason for an increased prevalence of poor nutrition, obesity, and chronic diseases (Donkin et al. 2000).

The retail food outlets including supermarkets, hawkers, and open-air markets connect consumers to their food choices. These food retail outlets play a significant role in affecting consumers' diet-related health and nutrition, by the foods they sell and prices they charge. Both the promotional strategies used by some retail outlet types, and the implemented nutrition-related

activities (Hawkes 2008; Tessier et al. 2010) may lead to disparities in diet and health (Moore and Diez Roux 2006). However, there is a lack of consensus on which food retail format is the best for promoting optimal nutrition for consumers. For example, in Chile, the traditional markets still compete strongly in the fruit and vegetable sector (Faiguenbaum et al. 2002). This ability to compete is a result of consumer perceptions that traditional markets offer both good prices and freshness (Goldman et al. 2002). In several large Chinese cities, about 49% of consumers reported buying the bulk of their fresh vegetables from supermarkets (Hu et al. 2004). For those participants in the US food stamp program, supermarket access was a positive predictor of fruit consumption (Rose and Richards 2004). Some studies find that limited access to supermarkets may result in poor nutrition by reducing consumption of healthy fresh foods (Morland et al. 2006; Tessier et al. 2008; Farley et al. 2009).

Additionally, supermarkets play a crucial role in introducing new processed foods or nutritious products, such as exotic out-of-season fruits or conveniently packaged vegetable snacks (Hawkes 2008). However, there are also some critics of different food outlets (i.e., supermarket, open-air market, and hawkers). For instance, supermarket expansion may be related to modern health problems such as obesity (Michimi and Wimberly 2010). Also, it has been shown that low food quality is often closely related to food products offered by hawkers (Mensah et al. 2002; Hanashiro et al. 2005; Toh and Birchenough 2000; Rane 2011). Similarly, practicing appropriate sanitation guidelines and periodic bacteriological control is necessary in open-air markets to reduce food contamination (Angelidis and Koutsoumanis 2006; Filiousis et al. 2009).

Results of an econometric model using the ordered logit regression indicate that supermarkets are accepted by urban households, especially those with high incomes or the higher

education. Such households are more likely to have been exposed to exotic or out-of-season vegetables and fruits, processed food products, and new, highly nutritious food products. However, consistent with a previous study (Field et al. 2010), the traditional retail food outlets continue to be a significant part of the agri-food system in Ghana. Results of the current study suggest that open-air markets still dominate the food retail system in Ghana, and are preferred by non-college educated households. Open-air markets especially provide large households with locally produced foods including fresh meat, vegetables, and fruits. The significant role of hawkers (the oldest food retail format) has been confirmed in Ghana's food retail system. They are favored by the low-income and less-educated households with small children, competing in terms of convenience. Thus, individuals frequently buying from hawkers are more likely to consume ready-to-eat foods, convenience foods, or beverages.

For decades, researchers focused solely on supermarkets as retail outlets (Mai and Zhao 2004; Min 2006; Theodoridis and Chatzipanagiotou 2009). Several studies explored the product attributes in supermarkets and traditional markets such as price, quality, and variety (Goldman and Hino 2005; Minten and Reardon 2008). However, there is a lack of adequate studies assessing and comparing both modern and traditional food retail outlets in terms of consumer food shopping frequency, especially in West Africa, and the corresponding development of consumer profiles. Therefore, the present study fills the gap with a unique and comprehensive, as permitted by gathered data, illustration of consumer's food shopping choice issue in Ghana. The identified consumer profiles in each food retail outlet type provide insights to private organizations. Food manufacturers, distributors/marketers, or potential food retailers gain knowledge essential for marketing strategy, including entry or expansion decisions. Furthermore, knowledge of food retail choices shows how various food retail formats are associated with

consumer food selection, which affects consumer diet, nutrition, and eventually, health. This valuable information can be used by public agencies concerned about improving local diet, nutrition, and health by promoting certain healthy foods through different food retail outlets.

2.2 FOOD RETAILING IN GHANA

In the 1990s, the supermarket expansion spread to developing countries. Supermarket format appealed to consumers with adequate buying power. In East Africa, supermarkets developed from a tiny niche to an active food retail outlet in Kenya taking a fifth of food retail, while more than a third of their sales were from better off consumers (Neven et al. 2006). In South Africa, the number of supermarkets has been steadily growing, and has become a strong competitor for local stores (D'Haese and Huylenbroeck 2005). Regarding traditional food outlets, urbanites in Nigeria tend to buy their food from street vendors and hawkers (Nigeria 2013). Similarly, evidence suggests that expansion of the modern supermarket sector continues in Ghana, even though traditional food retail outlets such as open-air markets and street hawking remain important in food shopping. The latter two represent a significant part of the agri-food system that meets the needs of low-income and rural households (Reardon et al. 2004; Field et al. 2010).

McClelland's (1962) definition states, "Supermarkets are large self-service food shops." In our study, "supermarket" typically implies a larger grocery store owned by an independent proprietor. It also includes some large chain stores located in shopping centers. Supermarkets sell a wide variety of products such as dry goods, meats, bakery items, beverages, frozen foods, dairy products, and non-food goods, and provide food-processing services.

In Ghana, supermarkets sell high-quality organic and natural foods including freshly prepared meats, baked bread, and garden fresh produce, while a large number of products are imported. Also exotic, out-of-season fresh fruits and vegetables and processed fruits and vegetables are sold in supermarkets, consumption of which benefits consumers' health. Ready-to-eat food items such as pizza, burgers, fried rice, potato chips, and grilled/roasted/fried chicken are also provided in Ghana's supermarkets. Additionally, although the car ownership remains quite low-one vehicle for every 22 Ghanaians, the sale of cars experienced a substantial increase, 40 % in 2011, which likely contributed to the supermarket expansion (Ghana 2013). Currently, the domestically owned supermarkets dominate the supermarket sector. For example, Max Mart Limited, a subsidiary company of Kwatsons Ghana Limited, opened their first business operation on August 8, 2001; by the end of 2011, it had four branches in the greater Accra region (Kwatson Ltd. 2013). However, the country's economic growth is also encouraging international supermarket chain expansion. For instance, at the end of May 2013, Carrefour, the world's second-largest retailer, stated it would enter eight West and Central African countries including Ghana in the near future (Carrefour Group 2013).

The open-air market is a public marketplace selling food and merchandise. In Ghana, it is an integral part of the food retailing system (Field et al. 2010). Ghana is famous for its open-air markets. For example, Techiman's food market claims to be the largest food and agricultural market in West Africa, and Market Circle in Takoradi is also well known for their open-air markets. Some open-air markets operate every day, while others on a regular cycle. Most goods sold there are of domestic origin or locally produced foods, including fresh vegetables, fruits, and meat. Some markets, such as Makola Market located outside Accra, even offers live crab, chicken, and fish, which would not normally be sold in open-air markets. Although open-air

markets lack cold storage facilities and proper protection of product freshness, they appeal to buyers with competitive prices and travel convenience.

Hawkers are persons traveling through towns and neighborhoods to sell goods. In large cities, they usually occupy major street intersections. Items sold by hawkers range "from plantain chips to chewing gum to book bags to live puppies" (Davis 2008). Most foods sold by hawkers are ready-to-eat or prepared food products for on-site consumption. Spicy foods and beverages are also sold by hawkers at reasonable and affordable prices (Johnson and Yawson 2000). In Ghana and most West African countries, hawkers are still a necessary part of the food retail system. Street hawking is both time and cost effective for consumers, since transactions can occur through buyer car windows, avoiding the potential troublesome travel to markets. Hawkers often sell food at competitive prices because the products are usually sold by item instead of bulk (Davis 2008). People lacking marketable skills, or employment, turn to hawking to earn income. Occasionally, even school children hawk to supplement their family earnings. Because of a lack of knowledge, education, and regulation, food sold by hawkers is potentially a source of public health problems due to microbial contamination (Toh and Birchenough 2000).

Food selection in each retail outlet does not vary greatly with locations; however, various locations add to the offered foods a few local items. For example, open-air markets in the city of Tamale tend to serve more local dishes such as boiled or stewed rice. In addition, due to the uneven economic development, local supermarkets are more concentrated in the southern Ghana in Accra and Takoradi than in the Northern Region e.g., in Tamale.

2.3 CONCEPTUAL FRAMEWORK

Our study employs a utility-maximization model with the following assumptions: a) each household's utility depends on the quantity of both food products and non-food products they consume; b) the food shopping frequency in each food retail outlet is proportional to the corresponding quantity of purchased food products; c) in cross sectional data applications, after controlling for regional differences, prices of both food and non-food products are reasonably assumed to be stable.

Individual household wants to maximize the utility level by choosing the optimal quantity of both food and non-food products within the budget constraint (Equation 2.1 and 2.2):

$$Max\ U = U(F_{super}, F_{open}, F_{hawker}, NF) \tag{2.1}$$

$$s.t.\ \mathrm{I} = \mathrm{P}_{\mathrm{F}_{super}} \bullet F_{super} + \mathrm{P}_{\mathrm{F}_{open}} \bullet F_{open} + \mathrm{P}_{\mathrm{F}_{hawker}} \bullet F_{hawker} + NF \tag{2.2}$$

where F's are food quantities purchased in each food outlet, NF is the non-food consumption quantity, and P's are the corresponding price indexes (the price of non-food goods are normalized). By solving the above constrained maximization model, the optimal consumption quantity is a function of price index, income, and the household preference parameter w (Equation 2.3). Here, k denotes different food retail outlet formats. It is worth noting that w captures the particular utility function form.

$$F_k^* = f(P_{F_{super}}, P_{F_{open}}, P_{F_{hawker}}, \mathrm{I}, \omega) \tag{2.3}$$

Given the price stability assumption, the optimal food shopping frequency Fre_k^*, which is positive and proportional to the corresponding food product quantity, is a function of both income and household preference parameter.

$$Fre_k^* = f(\mathrm{I}, \omega \mid \mathrm{P}_{\mathrm{F}_{super}}, \mathrm{P}_{\mathrm{F}_{open}}, \mathrm{P}_{\mathrm{F}_{hawker}}) \tag{2.4}$$

Although household preferences are often unobservable, they can be shaped by socio-economic factors, such as education and occupation (McDowell et al. 1997; Bittencourt et al. 2007; Jolly et al. 2008), and demographic factors including age, gender, and household composition (Han and Wahl 1998; Ricciuto et al. 2006; Bittencourt et al. 2007; Quaye et al. 2009).

2.4 DATA

This study uses data generated by a project focusing on the urban population in Ghana. For the purpose of learning about urban population food purchase and consumption habits, three cities were selected: Tamale, Takoradi, and Accra. The cities are located in two distinct ecological zones. Tamale is in the northern part of the country in the dry savannah zone, while Takoradi and Accra are in the coastal zone. Tamale and Takoradi are two centers of regional economic and cultural activity, while the inclusion of the greater Accra area was dictated by its sheer size and leading commercial role in the country. This selection also captures differences in regional economic development and possible differences in household structure and behavior resulting from varying ethnicities in the local populations. Ethnic differences posed a challenge in data collection, since it required training a different set of enumerators fluent in the local languages (besides English) in the northern and coastal areas.

The data was collected using a survey instrument specifically developed from a larger project in Ghana. The survey instrument included several sections, and each was devoted to a different issue. One section was on general shopping habits, including questions about food expenditure, while other sections probed for the type of foods consumed and food attributes as well as consumption frequency of selected foods. Respondents were also asked about household characteristics such as income, education, and household size.

After the preparation of the questionnaire, data collection in the three cities took place between February and June, 2011. Households surveyed in Tamale were part of the sample surveyed by the National Statistical Service and the enumerators had previously participated in data collection through personal interviews there. Pilot testing of the questionnaire took place on the first day of data collection and did not reveal any potential problems in communicating issues or respondent difficulty in providing answers. During the following days, completed questionnaires were immediately reviewed for potential response errors and data were entered concurrently into a spreadsheet. Similar procedures were applied to data collection in Takoradi and Accra. Households in the two cities were selected based on the previous experience of the surveying team from earlier surveys. A total of 1,010 completed questionnaires were collected including 188 households in Tamale, 210 in Takoradi, and 612 in Accra.

Table 2.1 shows the summary of the important descriptive statistics of the variables included in this study, and provides variable description and units of measurement. The respondents' ages range from 17 to 80 years old and the mean age is 39.2 years. More than 98 % of respondents are females, who are commonly in charge of food shopping and preparation in Ghana, and 75.3 % of respondents are married. Also, 64.2 % of respondents are self-employed, 24.2 % work in the government sector or civil departments, while the remaining 11.6 % are retired, students, or unemployed. In the month preceding the survey, the recorded income ranges from 5 Ghanaian cedis to 8,500 Ghanaian cedis with the mean of 646.6 Ghanaian cedis ($1 = 1.4965 Ghanaian cedi on May 1, 2011).

2.5 EMPIRICAL MODEL

Choice of food retail outlets and the patronage frequency related to each store format is assumed to reflect consumer purchasing behavior, which is further determined by certain key factors such as socio-economic and demographic characteristics. To explore the determinant of food retail outlet choice, three parallel equations are applied to examine the determinants of household food purchase frequency at each food outlet type (supermarkets, open-air markets, and hawkers). The shopping frequency at each food outlet is measured on a scale from one to five with the increasing number indicating more frequent shopping in a certain outlet type (i.e., 1=almost never, 2=once a month, 3=every other week, 4=once a week, 5=more than once a week), which is the dependent variable. The explanatory variables include socio-demographic characteristics and location (i.e., household income, education, occupation, age, marital status, household composition, and regional location).

First, the ordinal logit regression model is applied in this study to investigate the socio-demographic factors effect on an urban household's food shopping frequency at each food outlet. Social science research commonly uses ordinal numbers to measure and quantify phenomena transformed into variables. The ordinal logit model, also known as the proportional-odds model, has been broadly applied to analysis of categorical data and has a simple interpretation of the odds ratio (Fullerton 2009). The basic framework of the ordinal logit regression is in Equation 2.5, where Y* is the latent variable behind the food shopping frequency, X denotes the selective explanatory variable vector, B is the coefficient vector, and e is the error term which is assumed to follow logit distribution.

$$Y^* = X\beta + \varepsilon \tag{2.5}$$

The relation between the latent variable Y* and the dependent variable Y is defined in Equation 2.6. When the latent variable is between particular cut points, the dependent variable is equal to a certain ordinal level, where Cut's are parameters needing to be estimated assuming $Cut_{i-1} < Cut_i$ (because of convenience in model expression, Cut_0 and Cut_5 are used to denote negative infinite and infinite) (Sajaia, 2008). In addition, in the present study, Cut_1 - Cut_4 are unknown parameters to be estimated with B using STATA build-in program. Because there are four unknown cut off points, the current model does not estimate the intercept term. This is a departure from the version proposed by Greene (2003), where one of the cut off points is set to zero. Consequently, three cut off points as well as an intercept are being estimated (Greene, 2003). However, the resulting differences are minor whether four or three unknown cut off points and the intercept are chosen, because the current model can be converted to Greene's proposed parameterization form (STATA, 2009). The probability of food shopping frequency equaling a certain number i can be expressed as the difference between two Cumulative Distribution Functions (CDFs) of logit distribution (Equation 2.7). For each food retail outlet format equation, the likelihood function of the empirical model (Equation 2.8) is the product of all possible probabilities with the indicator variable d as corresponding power, and N is the total sample size.

$$Y = i, \text{ if } Cut_{i-1} < Y^* < Cut_i, \text{ where i} = 1, 2, 3, 4, 5 \tag{2.6}$$

$$\begin{aligned} Prob(Y = i) &= \text{Prob}(Cut_{i-1} < Y^* < Cut_i) \\ &= \text{Prob}(Cut_{i-1} - X\beta < e < Cut_i - X\beta) \\ &= F(Cut_i - X\beta) - F(Cut_{i-1} - X\beta) \end{aligned} \tag{2.7}$$

$$Likelihood = \prod_j \prod_i Prob(Y = i)^{d(Y=i)}, \text{ where j} = 1,2, \ldots N,$$
$$\text{d} = 1 \text{ if Y} = \text{i; d} = 0 \text{ otherwise.} \tag{2.8}$$

Second, the marginal effects are further computed to quantify each significant socio-demographic factor's effect on the probability of each food shopping frequency level. For

example, the marginal effects of income measure the change in the probability of shopping for food in each frequency category (i.e., almost never, once a month, every other week, once a week, and more than once a week) caused by a one-unit increase in income. The calculation equation can be seen in Equation 2.9 (Greene 2003).

$$\frac{d\,\mathrm{Prob}(Y=i)}{dX_l} = -\beta_l[\mathrm{f}(Cut_i - \mathbf{X}\beta) - \mathrm{f}(Cut_{i-1} - \mathbf{X}\beta)] \tag{2.9}$$

2.6 RESULTS

2.6.1 Food Retail System Structure

The survey provides information about the shopping frequency in each retail outlet type. Among responding households, 7.3 % report shopping for food at supermarkets “more than once a week,” 9.8 % “once a week,” 8.4 % “every other week,” 25.0 % “once a month,” and the remaining 48.5 % “almost never.” In terms of outlet type, given the above mentioned frequency categories, the proportions of households that report buying food in open-air markets are 36.3, 32.8, 16.3, 11.4, and 3.3 %, respectively; for “shop food from hawkers,” the percentages are 16.5, 9.9, 11.9, 10.8, and 51 %, respectively. Based on the shopping frequencies for each food retail outlet type listed above, it is clear that the open-air market dominates the food retail system in Ghana. Nearly 70 % of responding urban households report shopping for food at least once a week in open-air markets.

As the oldest and most common food retail format, hawkers still play an active role in Ghana’s food supply. About 16.5 % of households reported buying their food from hawkers more than once a week. Compared with the two traditional outlets, the supermarket has been accepted as one of the main food retail outlets by nearly twenty percent of the responding households, who buy their food from supermarkets "once a week" or "more than once a week".

2.6.2 Determinants of Food Shopping Frequency

According to the results from the ordinal logit estimation (Table 2.2), the demographic factors (i.e., marital status, age, household structure), socio-economic factors (i.e., income, occupation, and attained education level), and location are found to have a statistically significant effect in determining the food shopping frequency. Also, the values of Deviance statistics are displayed at the bottom of Table 2.2, and the degrees of freedom is the difference between the number of parameters in saturated model and the present model. It is used to test model-fitting by comparing the log likelihoods of the current model and the saturated model. Because the p-values of Deviance statistics are much larger than 10 percent, thus, Deviance goodness of fit test supports the selection of the present model. Tables 2.3, 2.4, and 2.5 show the marginal effects of key factors associated with the food purchase frequency for each of three outlet types, i.e., supermarket, open-air market, and hawkers.

Supermarkets. Income has a significant positive influence on food shopping frequency in supermarkets. The result is consistent with a previous finding in Kenya (Okello et al. 2011). However, in our study, a 25 % growth of the household monthly income decreases the probability of "almost never" buying food in a supermarket by only one percent. Although income is an essential factor, the magnitude of its effect is still quite small.

Moreover, respondents with a secondary or college education are more likely to buy food in supermarkets frequently. This finding is similar to the result obtained in the study conducted in greater Tunis (Tessier et al. 2010). In the present study, respondents admitting to have a college education have a 14.4 % higher probability to patronize supermarkets “more than weekly.” Well-educated households are more concerned about food quality and variety (Sanlier and Karakus 2010) and supermarkets can address their concerns. Supermarkets offer a wide

choice of food items and the high quality standards and nutrition of procured products (Rao and Qaim 2011).

Furthermore, respondents from married households are found to purchase food more frequently in supermarkets, and have a six percent lower probability in "almost never" patronizing supermarkets than households of the unmarried. The finding differs from an earlier study conducted in Turkey, which indicated that supermarkets appeal equally to married and unmarried shoppers (Kaynak and Borak 1981). The current study result is consistent with a study of Chinese consumer behavior, which suggests that the positive relation between married status and supermarket patronage is due to the required single shopping trip (Mai and Zhao 2004).

In addition, household size has a positive influence on food shopping frequency in supermarkets. One additional adult increases the probability of buying food in supermarkets "more than once a week" by 4.8 %. Large households, especially those consisting of two or three generations, may demand a wide range of foods (Florkowski et al. 2002). The wide diversity of products including both food and non-food items make a supermarket the most convenient one-stop store for large households. Furthermore, results indicate that the appeal of supermarkets varies by location. Comparing with Accra households, households in Takoradi are more likely to shop for food in a supermarket, plausibly because Takoradi is a large port and commercial center of Ghana.

Open-air markets. Occupation has a significant effect on food shopping frequency in open-air markets. Compared with the unemployed, students, the retired, or the self-employed buy foods less frequently in the open-air markets. Because of the possible flexible work time, the self-employed households may spend some time in cultivating back-yard gardens to supplement their food needs.

Moreover, college-educated households have an 18.5% lower probability of shopping "once a week" for food in open-air markets, because an open-air market may not meet their high expectations for food quality. In addition, married households are found to buy food less often at the open-air markets. Compared with unmarried households, married households have a 5.6% lower probability of patronizing open-air markets for food shopping more than weekly. It is plausible that married households demand more diverse foods and the open-air markets, providing only locally produced food products, cannot satisfy their needs.

Food needs decrease with advancing age. The likelihood of purchasing food in open-air markets "more than weekly" decreases significantly with the respondent's age. The result supports the finding of a significant relationship between age and frequency of visits to open-air markets in Hungary (Czakó and Sik 1999). In the case of the present study, 10 years added to a respondent's age decreases the probability of shopping for food "more than once a week" in open-air markets by 2.7%.

Larger households shop for foods in open-air markets more frequently. Because a large household demands a high volume of individual food products, the need for large quantities of food is easily satisfied in open-air markets because fewer foods are prepackaged or sold in uniform size packages. The presence of an additional adult in a household increases the likelihood of food shopping in an open-air market "more than weekly" by 2.2%. Location also influences the shopping frequency of open-air markets. A Takoradi household shops for food less often with a 6.5% lower probability than an Accra household in open-air markets. It appears that open-air markets appeal less to Takoradi residents.

Hawkers. Higher income households buy food items less often from hawkers than lower income households. A 25% increase in household monthly income would decrease the

probability of buying food from hawkers by 1.6%. The finding of this study confirms that income significantly influences where consumers shop (Goldman et al. 1999). Furthermore, the college-educated respondents buy less frequently from hawkers, and have a 15.2% higher probability of "almost never" buying food from hawkers than respondents with less education. Due to low quality and narrow selection, hawker-sold foods could be unattractive to well-educated households.

The number of very young children (younger than 3 years old) and the number of adult household members (19-60 years old) both have a positive effect on the food shopping frequency from hawkers. Most foods sold by hawkers are ready-to-eat or prepared foods such as bagged roasted peanuts, which may appeal to households with small children. Also, households with a large number of adults have a higher demand for ready-to-eat food, because adults are likely to work. When traveling to and from work they are likely to purchase snacks and beverages from hawkers as suggested by casual observations.

Both Tamale and Takoradi residents have a higher food shopping frequency from hawkers than Accra-located households. Hawkers seem to be quite numerous outside the capital. At present, the development of Ghana's urban areas is still uneven, and hawkers adapt to various environments; in the capital they are quite visible along major routes and main intersections, while in other cities they may be more mobile and travel through neighborhoods rather than limiting their presence to heavily traveled roads.

2.6.3 Consumer Profile, Food Retail Outlet Choice, and Diet and Health

Results of the study indicate that supermarkets are preferred by high-income and well-educated households especially in the city of Takoradi. Because a typical supermarket has a wide selection of food products, households that frequently shop in supermarkets are more likely to be exposed

to a number of healthy food products that might not be traditional to the Ghanaian diet. Offerings may include but are not limited to out-of-season vegetables and fruits or international products with high nutritional density. However, frequently, supermarket shoppers are also likely to purchase high-calorie food items including potato chips, burgers, and pizza, which have been linked to potential weight and obesity problems.

Open-air markets are found to continue to dominate the food retail system in Ghana, with 70 % of households reporting to patronize them “once a week” or “more than once a week”. Open-air markets are traditional food outlets particularly attractive to large households in Accra. Thus, it is the larger households that are more likely to consume domestic and local food products including in-season vegetables and fruits, and purchase live poultry and locally supplied fish.

The mobile hawkers offering convenient shopping are more likely to attract food purchases by low-income and less-educated large households especially those having small children. Therefore, convenience foods including mostly of ready-to-eat and some food snacks sold by hawkers are more likely to be purchased by households of a lower socio-economic status than households of the better educated or higher income.

2.7 CONCLUSIONS AND IMPLICATIONS

The expectations regarding food quality, selection, and service are growing among African consumers. The expansion of modern food retail outlet types, such as supermarkets, has begun in West Africa in recent years. Previous studies have investigated the influence of supermarket expansion from various perspectives. However, due to data limitations, very few researchers have explored the changing retail outlets from the consumer viewpoint. Modern food

retailers need comprehensive information about the food supply chain to make entry or expansion decisions, while traditional food retailers need suggestions to improve their products and service to keep their business economically viable. In addition, policy makers concerned about improving consumer diets need insights to guide their strategies by recognizing the consumer group profile of each food retail outlet. Local food formats vary substantially by neighborhood demographic and socio-economic composition (Moore and Diez Roux 2006).

Different food retail formats affect consumer diet and nutrition through the food products and services they provided (Hawkes 2008; Tessier et al. 2010). This study assessed the relative importance of different food retail outlets (i.e., supermarkets, open-air markets, and hawkers, identified the socio-demographic profiles of consumers associated with shopping in each retail format, and then illustrated how the food retail outlet choices might affect consumer diet and nutrition, using the surveyed data set collected in 2011 from three big cities in Ghana (Accra, Tamale, and Takoradi).

2.7.1 The Relative Importance of Different Food Retail Outlets

Results of food shopping frequencies indicate that the traditional open-air markets still dominate the food retail system in Ghana. Only 3.3% of households reported that they never shop for foods in open-air markets. A large number of basic and inexpensive food products are sold in open-air markets, and it remains an integral part of the food supply chain. Hawkers, as a traditional food retail format, fill a niche to meet consumers' specific demand for ready-to-eat foods, and attract buyers by offering shopping convenience. As a modern food outlet, supermarkets have been gradually accepted by urban households, and the results indicate that about 17% of households purchased food in supermarkets at least weekly. Currently,

supermarkets provide a wide variety of high-quality food item, and play a dynamic role in the food supply of Ghana.

2.7.2 Implication for Food Marketers

This study provides a broad understanding of consumer profiles and their food shopping frequency in three main food retail outlets. The gained insights facilitate the examination of an urban household's choice among food outlet types by revealing their food shopping habits and preferences, an essential prerequisite for food sales. Supermarkets have been adopted as a food retail outlet by high-income and well-educated households, especially large married households from developed urban areas. To attract additional buyers, modern food retailers may need to keep and enhance their advantage by providing quality, variety, and service. Modern retailers provide potential consumers with product or promotion information and encourage them to try the new shopping experience in supermarkets.

In spite of the expanding presence of supermarkets in West Africa, the open-air market remains a major outlet in the agri-food supply system. The open-air markets especially meet the needs of less-educated households by offering convenience and availability of inexpensive basic foods. Large households of retired or unemployed households also frequently shop in open-air markets. To retain their dominant market share, open-air market traders may need to employ strict guidelines and adopt necessary storage/protection technology to enhance food quality and the shopping environment.

Large-size, low-income, or less-educated households with small children, especially those in a non-capital area, tend to buy foods from hawkers because of the convenience and relative price. Street hawkers may retain their shopper base by providing additional ready-to-eat foods such as snack foods and beverages to attract on-site consumption.

2.7.3 Implications for Public Sector

Supermarkets play an increasingly substantial role affecting the diet of urban Ghana households through their mix of offerings. High-income and well-educated households, who shop regularly in supermarkets, are more likely to consume healthy food items including imported vegetables and fruits, as well as new highly nutritious food products. The wide food selection in a supermarket offers households who frequently shop there a balanced diet. Nevertheless, these frequent supermarket shoppers are also at a relatively high risk of unhealthy weight gain because calorie-dense food items such as potato chips and chicken are also offered in supermarkets. However, policy makers need to keep in mind that the effect of any nutrition or diet intervention in modern food outlets is still limited in terms of consumer population, and those interventions generally reach only those who shop in supermarkets regularly.

The traditional food retail outlets such as open-air markets and hawkers remain essential elements in the food supply system of Ghana. Specifically in open-air markets, households can access most locally produced foods including in-season fresh vegetables and fruits. Large households, especially those with small children, buy frequently from hawkers. Therefore, monitoring the traditional food outlets is crucial to gauge food access and advance consumer diet and health, especially among low-income households in Ghana's less-developed regions. There is a need for public agencies to continue efforts to reduce the threat of food-borne diseases, by encouraging proper handling and storage of food.

2.7.4 Limitations of the Study

The food format’s influence on consumer diet, nutrition, and health varies across countries and areas, and is affected by numerous factors including the local food retail system, the level of economic development, and consumer food purchases, perceptions, and culture.

Therefore, the implications that any food retail format has positive or negative effects on consumer diet and health are uncertain. The present study illustrates implications for diet in terms of available foods in each food outlet and the profile of consumers regularly patronizing any of the three food outlet types. Future studies are needed to fully address the correlation between food availability and actual consumer purchase in each food outlet.

Table 2.1: Descriptive statistics of variables included in the empirical model.

Variable name	Variable description / units of measurement	Mean	Std dev
Dependent variable:			
Freq_market	How often do you buy food products in the market? Almost never=1; once a month=2; every other week=3; once a week=4; more than once a week=5	3.870	1.100
Freq_super	How often do you buy food products in the supermarket? Almost never=1; Once a month=2; Every other week=3; Once a week=4; More than once a week=5	2.056	1.292
Freq_hawker	How often do you buy food products from the hawkers? Almost never=1; once a month=2; every other week=3; once a week=4; more than once a week=5	2.272	1.538
Independent variables:			
	Demographic factors		
Married	=1 if a respondent is married	0.753	0.431
Age	Actual age in years	39.222	10.656
Kid	Number of household members 3 years old or younger	0.363	0.645
Children	Number of household members between 4-12 years old	0.945	1.067
Teenager	Number of household members between 13-18 years old	0.983	1.205
Adult	Number of household members between 19-60 years old	2.087	1.751
Elder	The squared number of household members 61 years old or older	0.153	0.505
	Socio-economic factors		
Income	Household income in the month preceding the survey / in Ghanaian cedis	646.070	785.081
Employ_self	=1 if a respondent is self-employed	0.642	0.480
Employ_gov	=1 if a respondent is gov/civil employee	0.243	0.429
Educ_sec	=1 if a respondent has a secondary education (including Senior high/GCE O-A level, Vocational school, Technical school, or Teacher training)	0.382	0.486
Educ_col	=1 if a respondent has a college education (including university, or postgraduate)	0.134	0.340
	Location		
Tamale	=1 if a household is in Tamale	0.186	0.389
Takoradi	=1 if a household is in Takoradi	0.208	0.406

Table 2.2: Estimation results of the food purchase frequency by three outlet types in urban households of Ghana, 2011.

Variable name	Supermarket	Open-air market	Hawker
		Demographic factors	
Married	0.25349*	-0.24350*	0.04522
	(0.151)	(0.142)	(0.149)
Age	-0.00431	-0.01200**	0.00704
	(0.006)	(0.006)	(0.006)
Kid	-0.02985	0.16904*	0.20744**
	(0.102)	(0.10348)	(0.104)
Children	-0.07427	0.09581	0.02942
	(0.063)	(0.06008)	(0.060)
Teenager	-0.05023	0.06092	-0.02516
	(0.055)	(0.053)	(0.054)
Adult	0.08472**	0.09567**	0.11536***
	(0.038)	(0.038)	(0.037)
Elder	-0.03926	0.02435	0.12588
	(0.122)	(0.119)	(0.126)
		Socio-economic factors	
Income	0.00022***	-0.00009	-0.00040***
	(0.000)	(0.000)	(0.000)
Employ_self	-0.08531	-0.38872**	-0.01709
	(0.198)	(0.193)	(0.200)
Employ_gov	0.20216	-0.32851	-0.13058
	(0.228)	(0.224)	(0.238)
Educ_sec	0.87222***	-0.15811	-0.17102
	(0.144)	(0.139)	(0.144)
Educ_col	1.52828***	-0.93490***	-0.627**
	(0.225)	(0.216)	(0.249)
		Location	
Tamale	0.07856	0.09129	1.10924***
	(0.183)	(0.175)	(0.175)
Takoradi	0.78090***	-0.39179**	0.61091***
	(0.159)	(0.155)	(0.161)
Cut_1	0.79496	-4.54563	0.60000
	(0.359)	(0.397)	(0.362)
Cut_2	2.04273	-2.78762	1.11436
	(0.365)	(0.359)	(0.364)
Cut_3	2.66764	-1.73911	1.75667
	(0.370)	(0.353)	(0.367)
Cut_4	3.66458	-0.25385	2.41600
	(0.382)	(0.347)	(0.370)
Deviance stat.	2570.068	2720.624	2593.018
P-value	1	1	1

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

Table 2.3: Marginal effects in food purchase frequency of supermarkets.

Variable name/ dy/dx	Almost never	Once a month	Every other week	Once a week	More than once a week
			Demographic factors		
Married*	-0.0632 (0.03756)	----------	0.0148 (0.00876)	0.0170 (0.00977)	0.01363 (0.00771)
Adult	-0.0211 (0.00939)	0.0054 (0.00252)	0.0050 (0.00228)	0.0059 (0.00267)	0.0047874 (0.00217)
			Socio-economic factors		
Income	-0.0016 (0.00002)	0.0001 (0.00001)	0.0001 (0.00001)	0.0002 (0.00001)	0.0001 (0.00000)
Educ_sec*	-0.2121 (0.03359)	0.0435 (0.00876)	0.0500 (0.00921)	0.0636 (0.0119)	0.05499 (0.01113)
Educ_col*	-0.3301 (0.038)	----------	0.0694 (0.0092)	0.1264 (0.02123)	0.1442641 (0.03269)
			Location		
Takoradi*	-0.1873 (0.03586)	0.0277 (0.00639)	0.0446 (0.00954)	0.0604 (0.01423)	0.0546 (0.01416)

Note**:** This table only reports the results at 10% significance level. Standard errors are in parentheses; (*) dy/dx is for discrete change of dummy variable.

Table 2.4: Marginal effects in food purchase frequency of open-air markets.

Variable name/ dy/dx	Almost never	Once a month	Every other week	Once a week	More than once a week
			Demographic factors		
Married*	0.0056	0.0205	0.0234	----------	-0.0563
	(0.00322)	(0.01152)	(0.0136)		(0.03327)
Age	0.0003	0.0011	0.0012	----------	-0.0027
	(0.00016)	(0.00054)	(0.00059)		(0.00138)
Adult	-0.0023	-0.0084	-0.0093	----------	0.0218
	(0.001)	(0.00338)	(0.00372)		(0.00864)
			Socio-economic factors		
Employ_self*	0.0090	0.0329	0.0372	----------	-0.0896
	(0.00454)	(0.01591)	(0.01837)		(0.04485)
Educ_col*	0.0322	0.1018	0.0814	----------	-0.1855
	(0.01141)	(0.02837)	(0.01619)		(0.03607)
			Location		
Takoradi*	0.0106	0.0372	0.0374	---------	-0.0856
	(0.00503)	(0.01592)	(0.01475)		(0.03248)

Note**:** This table only reports the results at 10% significance level. Standard errors are in parentheses; (*) dy/dx is for discrete change of dummy variable.

Table 2.5: Marginal effects in food purchase frequency of hawkers.

Variable name/ dy/dx	Almost never	Once a month	Every other week	Once a week	More than once a week
			Demographic factors		
Kid	-0.0518047 (0.02592)	0.0040733 (0.00221)	0.0113 (0.00576)	0.0127 (0.00645)	0.0238 (0.01198)
Adult	-0.0288084 (0.00931)	0.0022651 (0.00088)	0.0063 (0.006269)	0.0070 (0.00238)	0.0132 (0.00431)
			Socio-economic factors		
Income (10 cedi)	0.0010 (0.00003)	-0.0001 (0.00000)	-0.0002 (0.00001)	-0.0002 (0.00001)	-0.0005 (0.00001)
Educ_col*	0.1523 (0.05764)	-0.0192142 (0.01018)	-0.0365 (0.01522)	-0.0357 (0.0133)	-0.0609 (0.02046)
			Location		
Tamale*	-0.2654 (0.03819)	----------	0.0396 (0.0061)	0.0646 (0.01075)	0.1629 (0.03174)
Takoradi*	-0.1511 (0.03894)	0.0054 (0.00242)	0.0284 (0.00694)	0.0375 (0.01026)	0.0799 (0.02385)

Note**:** This table only reports the results at 10% significance level. Standard errors are in parentheses; (*) dy/dx is for discrete change of dummy variable.

CHAPTER 3

EXPENDITURE ON FRESH VEGETABLES, FRESH FRUITS, AND PEANUT PRODUCTS IN URBAN GHANA: DOES LOCATION MATTER?

3.1 INTRODUCTION

People require safe and nutritious food to meet their dietary needs and food preferences for a healthy and active life (FAO, 1996). Health benefits are closely associated with consumption of several specific foods such as fresh vegetables, fruits, and nuts. Increasing the consumption of vegetables and fruits is a practical and essential way to reduce disease risk and maximize good health (Steffen, 2006). Current scientific evidence emphasizes the crucial role of fruit and vegetable consumption in prevention of a wide variety of chronic diseases, including cardiovascular diseases, hypertension, diabetes, and obesity (Van Duyn et al., 2000; Van't Veer et al., 2000; Bazzano, 2006; Low et al., 2007; Uusiku et al., 2010). Additionally, low vegetable and fruit intake is among the five leading behavioral or dietary risks, being responsible for 24 percent of new cancer cases and 30 percent of cancer deaths (Ott et al., 2011). Conversely, greater vegetable and fruit intake has a protective effect in cancers of the stomach, esophagus, lung, oral cavity, pharynx, endometrium, pancreas, and colon (Steinmetz and Potter, 1996). Besides vegetables and fruits, nuts, an excellent source of multiple nutrients including vitamin E and magnesium, play a crucial role in health protection and promotion as well (King et al., 2008). Nuts (including peanuts, although it is a legume) have high contents of several healthy

food compounds such as antioxidants (Blomhoff et al., 2006) and unsaturated fatty acids (Ros and Mataix, 2006). Moreover, various agencies have consistently shown a close association between nut consumption and cardiovascular and coronary heart disease risk reduction (Blomhoff et al., 2006; Kris-Etherton, 2008; Mattes et al., 2008; Sabaté and Ang, 2009). The role of nuts in reducing the risk of diabetes, obesity, and cancer has recently been identified as well (King et al., 2008).

Sub-Saharan Africa has the highest prevalence of undernutrition in the world (FAO, 2008), with widespread nutrient deficiencies of Vitamin A, iron, and zinc (FAO/WHO, 2001). Moreover, chronic diseases, the leading cause of death in the world (Yach et al., 2004), are not limited to developed countries, and have become increasingly prevalent in developing countries as well (Ruel et al., 2005). In Africa, more than 90% of patients with hemorrhagic stroke and more than half with ischaemic stroke are found to have high blood pressure (Mensah, 2008). In spite of the remarkable and well-documented effects of fresh vegetables and fruits on health, their consumption is still far below the dietary recommendation level, especially in the developing world including many African countries (WHO, 2004; USDA, 2004). Africa has the lowest vegetable and fruit consumption in the world (Lock et al., 2005). The WHO recommended consumption level of vegetable and fruits is 146 kg per year, while in West African country such as Ghana, the vegetable and fruit consumption per capita was only 73.6 kg per year in 1998 (Ruel et al., 2005).

In contrast to the low fresh vegetable and fruit intake, peanut based products in Ghana are closely associated with relatively high consumption and eating frequency. National per capita peanut consumption was about 0.61 kg per week in Ghana (Awuah, 2000), and 80 percent of Ghanaians eat peanut products weekly or more often (Jolly et al., 2008). Peanut is an important

source of protein and fat in developing countries (Awuah et al., 2009), and it plays an essential role in the diet of most African countries, especially Ghana (Tsigbey et al., 2003; Jolly et al., 2008). In Ghana, as in most other West African countries, peanut is often processed into a wide variety of forms, including roasted peanuts, boiled peanuts, peanut paste, and peanut cake. Roasted or boiled peanuts are eaten as snacks, peanut paste is often used in preparation of soup, and peanut cake is added in some local delicacies (Tsigbey et al., 2003). Regular consumption of peanuts is found to lower the total cholesterol and triacylglycerol concentration among healthy Ghanaians (Lokko et al., 2007). However, peanuts are often contaminated with aflatoxin due to poor handling, storage, and process conditions (Awuah et al. 2009; Florkowski and Kolavalli, 2013). The presence of aflatoxin suppresses the immune system of humans and contributes to cancer and other health problems (Groopman et al., 1996; Florkowski and Kolavalli, 2013).

Consumption patterns and trends of these health-promoting food items have been remarkable interest to researchers, policy makers, and food retailers for decades (Hall et al., 2009). Ruel et al. (2005) investigate the pattern and determinant of vegetable and fruit consumption in sub-Saharan African by a multicountry comparison. Smith and Eyzaguirre (2007) explore the role of African leafy vegetables (ALV) in health promotion and protection, while Uusiku et al. 2010 review the literature about leafy vegetables consumed in sub-Saharan Africa. Determinants of fruit and vegetable consumption include sensory appeal, familiarity and habit, cost, availability, and media influence (Pollard et al., 2002). Among these factors, the familiarity and habit are of particular importance, and they can be captured by socioeconomic and demographic characteristics such as income, household size and composition, gender, and education (Ruel et al. 2005). Likewise, because of the crucial role of peanuts for health, several studies have investigated peanut products consumption from comprehensive perspectives. For

example, Jolly et al. (2008) investigated the consumption frequency of peanuts and evaluated factors influencing consumer-eating decisions. Awuah et al. (2009) focused on the factors affecting the peanut products sorting along the marketing chain, and Florkowski and Kolavalli (2013) examined the quality of peanut products in relation to aflatoxin contamination in Ghana.

By 2030, two-thirds of the world's population will live in cities, and nearly all of this urban population growth takes place in developing countries (World Bank, 2013). In Africa, many cities will double in size over the next 15 to 20 years due to the substantial urban sprawl (World Bank, 2013). Vegetable and fruit consumption has grown at a faster rate in most urban centers of the developing world than in rural area (Hertel, 1997). The increasing urbanization and rapidly expanding population create a big demand for vegetable in most West African countries (Affokpon et al., 2011). In previous studies, the effect of household location in food consumption is consistently confirmed (Wetherbee, 2004; Ruel et al., 2005) but mostly in terms of the urban-rural difference (Smith et al., 2005; Fotso, 2007; Van de Poel et al., 2007). However, due to the lack of data, the regional difference between urban areas has been largely ignored. There are few studies empirically measuring the location effect in food consumption of urban households in Africa, and even fewer researchers examine how the location interacts with other factors in determining the household food consumption.

In sub-Saharan Africa, regional disparities are serious (Konadu-Agyemang, 2000). In Ghana, the southern part of the country grows faster than the northern part (Grant and Nijman, 2004). Therefore, exploring how the food expenditure varies with the location is increasingly policy-relevant, especially among households in fast growing urban areas. In addition, although in traditional sub-Saharan African diet, peanuts and peanut-based products are often complementing vegetables and fruits in main dishes or snacks, few studies have explored peanut

product consumption in association with fresh vegetables and fruits in a single study. Therefore, the results are also applicable in guiding private sector decision regarding food distribution.

Our study fills this knowledge gap and examines how location affects food expenditure on fresh vegetables, fresh fruits, and peanut products using survey data collected from urban households in Ghana in 2011. The current study addresses two major issues: a) it investigates how the expenditure on fresh vegetables, fresh fruits, and peanut products varies by location; b) it provides insights about the determinants of expenditure on these food categories, considering the regional difference in household location.

The current study provides a comprehensive understanding of the determinants of the food expenditure (i.e., fresh vegetable, fresh fruit, and peanut products) in urban household of a West African country, Ghana. Results confirm that fresh vegetable and peanut product consumption varies significantly with location, and furthermore, the location factor interacts with income. Although the finding is confirmed in case of vegetable and peanut product expenditure, it is not significant in case of fresh fruit expenditure.

The study also provides valuable insights to private sector. Knowledge of factors driving or hampering expenditure on any of the three product category are indispensable in formulating national or regional marketing strategy in countries where market intelligence is poor. Food retailers are suggested to promote their fresh vegetables and fruits to the high-income, well-educated households of married consumers in southern areas of Ghana, while target their peanut products sale to large educated households in the noncapital cities. Increasing consumption of foods with highly desirable nutrients such as vegetables and fruits is a practical and sustainable way to reduce decease risk and promote nutrition diet. Understanding the effects of location and consumer profile helps policymakers to facilitate community and local programs to increase

fresh vegetables and fruits consumption, while results in relation to peanut product consumption shed light on peanut-based product contamination risk by identifying areas and households with high peanut product consumption.

3.2 CONCEPTUAL FRAMEWORK

The study applies concepts from the consumer demand theory and the Engel curve. Within the budget constraint, households decide the optimal levels of their food and nonfood consumption that maximize their utility level (Equation 3.1). Here, the food products include fresh vegetables, fresh fruits, peanut products, as well as other food items;

$$\text{Max } U=U(q_v, q_f, q_p, q) \tag{3.1}$$

$$\text{s.t. } PQ=I \tag{3.2}$$

In Equation 3.1, U is the household utility, q_v is fresh vegetable consumption, q_f is fresh fruit consumption, q_p is peanut product consumption, q is household consumption of other food items as well as all other non-food products. Equation 3.2 states the budget constraint, where P is a price index vector for fresh vegetables, fresh fruits, peanut products, and all other goods, Q is the corresponding consumption vector containing all the consumption variables mentioned as elements, and I is a scalar indicating household income. It is noted that the price index of all other goods is normalized and equals one for convenience of comparison. After solving for the Lagrange, the optimal food consumption of fresh vegetables, fresh fruits, and peanut products is found to be a function of price index, household income, and household preferences (Equation 3.3):

$$q^*=q(P, I; k) \tag{3.3}$$

where q* is the optimal food consumption vector, and k is the household preference parameter defining the particular utility functional form. Although household preferences are often not observed, it can be shaped and captured by socio-economic factors such as education and occupation, as well as demographic characteristics including household composition, gender, age, and location (Ruel et al., 2005). After controlling for the regional price difference, it is reasonable to assume stable price in cross-section data. Therefore, given the constant price assumption, the food expenditures, the product of food consumption and the corresponding price, depend on household income, socioeconomic factors, and demographic factors including location. Here, location factors may relate with other determinant variables in affecting food expenditures. The close relation between the consumption of specific goods and income has been well documented by Engel curve (Wetzstein, 2005). Food is a normal good, so its consumption is expected to increase with income. Studies are remarkably consistent in supporting fresh vegetables, fresh fruits, and peanut product consumption are influenced by socio-demographic factors (Ruel et al., 2005; Jolly et al., 2008; Hall et al. 2009).

3.3 DATA

The present study uses the survey data collected in three big cities of Ghana (i.e., Accra, Takoradi, and Tamale) in 2011. Accra is the capital of Ghana, Takoradi is an important port and the fourth largest city, and Tamale is the capital city of Northern Region. Both Accra and Takoradi are located in the South, while Tamale is in the North of Ghana. Questions in the survey instrument are structured to probe respondents about their food shopping habits, food spending, and other information such as age, gender, occupation, household income, and household composition. The food spending questions ask respondents to share information about

weekly spending on fresh vegetables, fresh fruits, and peanut products. Here peanut products include peanut paste, dzowe, kuli-kuli, and other peanut-based products.

After deleting incomplete records, 1,010 observations were employed in the data analysis. Table 3.1 shows the definition and units of variables included in the empirical analysis, and some descriptive statistics such as mean and standard deviation. In the present sample, 60.6 percent of respondents are from Accra, 20.8 percent from Takoradi, and the remaining 18.6 percent from Tamale. Results indicate that a typical urban household in Ghana spent 13.0 cedi on fresh vegetables, 5.4 cedi on fresh fruits, and 3.3 cedi on peanut products per week, respectively. Among the surveyed households, three out of four respondents were married, and the average age was 39.2 years old. Additionally, on average, there are about one teenager household member (between 13 to 18 years old), two adult members (between 19 to 60 years old), as well as 0.15 elder members (above 61 years old). Moreover, the mean of household income in the month preceding the survey was 646.1 cedi. Among the respondents, 64.2 percent were reported as self-employed, 24.3 percent were government or civil employee, and 11.5 percent were not employed, students, or the retired. In terms of their education level, more than half of the respondents have a higher-than-high-school education.

The weekly household food expenditure on fresh vegetables, fresh fruits, and peanut products in the three cities are shown in Table 3.2. Weekly household expenditures on fresh vegetables are 14.4, 11.1, and 9.7 cedi, respectively, in Accra, Takoradi, and Tamale, expenditures on fresh fruits are 5.7, 5.2, and 4.2 cedi, respectively, and on peanut products the expenditures are 2.7, 3.5, and 4.9 cedi, respectively. Comparing with Tamale, households in Accra and Takoradi reported higher food expenditure on fresh vegetables and fruits, but lower peanut product expenditure.

3.4 EMPIRICAL MODEL

Within the present conceptual framework, both ANOVA analysis and SUR-Tobit model were employed in order to fully test and examine the effect of urban household location on fresh vegetable, fresh fruit, and peanut product consumption. The analysis of variance (ANOVA) was involved in the exploratory step in modeling the expenditure and involves the statistical test whether weekly household expenditure on each food category varies by location. ANOVA has been applied broadly in economics, statistics, business, public health, and medicine (Neter et al., 1996). This method is used to determine whether there are any significant differences between the means of three or more independent groups (Laerd, 2013). For example, ANOVA can be used to test if there is any income difference among young people, middle-age people, and senior people. Here, in the present study, the tested hypothesis is that the means of weekly specific food category expenditure are the same in Accra, Takoradi, and Tamale (Equation 3.4):

$$H_0^i:\ \mathrm{u}^i_{\mathrm{Accra}} = \mathrm{u}^i_{\mathrm{Takoradi}} = \mathrm{u}^i_{\mathrm{Tamale}} \tag{3.4}$$

where u is the mean of weekly food expenditure, and i denotes each food category. Therefore, the means of fresh vegetables, fresh fruits, and peanut product expenditure are tested separately.

Next, mutivariate Tobit model (MV-Tobit model) examines how the location affects the food expenditure after controlling the key socio-demographic variables. The household food expenditures are censored at zero, namely, 1.21% of surveyed households reported zero expenditure in fresh vegetables, 7.53% did not report any expenditure on fresh fruits, and 6.41% of the surveyed households did not have any expenditure on peanut products. In each equation for the particular food category, the Tobit model is suitable to address the censored food expenditure (Greene, 2003). Vegetables, fruits, and peanut products may be ingredients in the

same dish or complementary dishes in the same week. Also, because the household expenditure on the three food items may be related to each other, the potential cross-equation correlations need to be addressed by specifying an equation system to obtain efficient results (Barslund, 2009). In each equation, weekly household expenditure is the dependent variable, while explanatory variables include socio-demographic characteristics, location, and interaction terms between location and income. Equation 3.5 shows the empirical model:

$$\begin{aligned} EXP_v^* &= XB_v + e_v \\ EXP_f^* &= XB_f + e_f \\ EXP_p^* &= XB_p + e_p \\ EXP &= \max(EXP^*, 0) \end{aligned} \tag{3.5}$$

EXP*'s are the latent variables of weekly household food expenditure on fresh vegetables, fresh fruits, and peanut products, X is the explanatory variable vector, B's are the estimated coefficients, and e's are the stochastic error terms. The error term vector is assumed to follow multivariate normal distribution in Equation 3.6:

$$e=(e_v, e_f, e_p)' \sim N(0, V) \tag{3.6}$$

$$0 = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}, \quad V = \begin{bmatrix} r_v^2 & r_{vf} & r_{vp} \\ r_{vf} & r_f^2 & r_{fp} \\ r_{vp} & r_{fp} & r_p^2 \end{bmatrix}$$

where V is variance-covariance matrix of error terms, r_{ij}'s are the corresponding cross-equation correlations between equation i and j, and r_i's are the standard deviations of error terms. For example, r_{vf} is the correlation coefficients between the error terms in fresh vegetable expenditure equation and in fresh fruit expenditure equation. The model was estimated using maximum simulated likelihood by STATA mvtobit program (Barslund, 2009).

3.5 RESULTS

3.5.1 ANOVA Analysis

Recalling the average weekly household expenditures on fresh vegetables, fresh fruits, and peanut products in Section 3.3, households in Accra and Takoradi spend more on fresh vegetables and fruits, but less on peanut products than Tamale households. Results of ANOVA confirmed that the location effect was statistically significant. The values of F-statistics are 15.35 in fresh vegetable equation, 5.5 in fresh fruit equation, and 38.25 in the peanut products equation, respectively. The degrees of freedom all equal 2, and p-values of the three separate tests are all significant at less than one percent. Thus, based on ANOVA analysis, household expenditure on the three health-relevant food categories (i.e., fresh vegetables, fresh fruits, and peanut products) varies with location.

Despite results from ANOVA supporting that location differences exist in fresh vegetable, fruit, and peanut product expenditure, whether such disparity originates from the location factor itself or from the socio-demographic factors behind location is still not clear. Therefore, to further examine the location difference, the control of the socio-demographic factors becomes necessary. The following section discusses the estimation results of determinants of household expenditure, including socio-economic factors, demographic factors, location, and interaction terms between location and income.

3.5.2 Multivariate Tobit Model

A censored household survey data set often has a large number of zero responses. If the number of observed zero responses greatly excesses the number of predicted zero responses in the model, then instead of using regular censored model, zero-inflated model would be used to analyze the data. To check this zero-excess issue, the present study compares the probability of

observed zero responses with the probability of predict zero responses. Results indicate that the probabilities of observed zero responses in fresh vegetable, fresh fruit, and peanut product expenditure are 1.21%, 7.53%, and 6.41%, respectively, which are much less than the probability of predicted zero expenditures by the current multivariate Tobit Model (i.e., 14.6%, 20.2%, and 18.5%). Therefore, there is no need to consider zero-inflated model in the current study.

The estimation results from multivariate Tobit Model are stated in Table 3.3. It displays the coefficients of demographic factors, socio-economic factors, location, and selected parameters in the estimation equation system. Here, sigma is the estimate of the standard deviation of the error term in each equation, while R is the estimate of parameter in the variance-covariance matrix of cross-equation error terms. The Likelihood Ratio test is used to test the hypothesis that all of the three covariance parameters jointly equal to zero. If this hypothesis holds, then the multivariate Tobit model can be simplified to three single Tobit models.

Results of the Likelihood Ratio test suggest to reject the null hypothesis. Thus, the correlation parameters between three equations do not jointly equal zero. In other words, the error terms in this specific equation system are correlated. Therefore, by considering the across-equation correlations, the multivariate Tobit Model provides more efficient results than three separate Tobit models. Although the three correlations are all positively significant, their magnitudes are different. The value of the correlation of error terms is 0.60 between fresh vegetable and fresh fruit equations, 0.29 between fresh vegetable and peanut product equations, and 0.23 between fresh fruit and peanut product equations, respectively. There is a number of peanut based products in Ghana, e.g., kuli-kuli, nkati cake, roasted peanuts, boiled peanuts, or dzowe.

The finding confirms that in the diet of sub-Saharan Africa as illustrated by urban households in Ghana, peanut products are often consumed independently of fresh vegetables and fruits, but sometimes complement fresh vegetable and fresh fruit consumption as well. For example, a roasted banana and roasted peanuts can be combined for lunch, while peanut products and vegetables are often used as ingredients in the same dish.

Furthermore, marginal effects of explanatory variables on the observed food expenditure are derived by multiplying the estimated coefficients by the probability of being in the non-censored part of the distribution (Brown et al., 2012). The marginal values are displayed in Table 3.4. Recall that in the data summary in Section 3.3, the proportion of zero expenditure in fresh vegetables, fresh fruits, and peanut products are 1.21%, 7.53%, and 6.41%, respectively. Thus, the probabilities of being in the non-censored part of food expenditure are 98.79%, 92.47%, and 93.59%, respectively.

Fresh vegetables. Accra-based households have significantly higher weekly fresh vegetable expenditure than households in Tamale, and the premium is about 4.24 cedi. However, the difference is not confirmed between Accra and Takoradi households. Because of the relatively slow economic development in northern Ghana the established low fresh vegetable spending in Tamale is not surprising. Income has a significantly positive effect on fresh vegetable expenditures. The income elasticity of fresh vegetable expenditure is 0.19, indicating if income increases one percent the expenditure on fresh vegetable will increase 0.19 percent. Well-off households tend to purse a healthier diet and likely consume more vegetables than their court parts. The behavior is remarkably consistent with previous studies (Ruel et al., 2005; Hall et al. 2009). Among the interaction terms, the interaction between income and Tamale dummy is significant, indicating that income has a larger effect in encouraging higher fresh vegetable

consumption in Tamale than in Accra. Or in other words, Tamale households are more sensitive to the income growth in increasing their vegetable expenditure than households in other two cities. Furthermore, well-educated respondents spend 1.90 cedi more on fresh vegetables every week than those with lower than high school education. Education provides consumer more knowledge including that about the health benefits of fresh vegetable consumption, thus, respondents with more education are likely to attach more importance to eat fresh vegetables than those with low education level.

Beside socioeconomic factors, the demographic characteristics such as marital status and age also have a statistically significant influence. Married households have higher food expenditures on fresh vegetables than their counterparts, plausibly because they tend to pursue more balanced diets. Moreover, due to the increasing knowledge about the link between health maintenance and diet, age has a positive effect and leads to a fresh vegetable expenditure increase. A ten-year advancement in age brings about 1.3 cedi increase in weekly fresh vegetable spending. The finding confirms that fresh vegetable consumption vary by age (Lock et al., 2005).

Fresh fruits. After controlling for socio-demographic factors, the location factors do not have significant effects on the fresh fruit expenditure. It suggests that the regional differences in fresh fruit spending originate from the underlying socio-demographic characteristics rather than the location itself. Similarly to the fresh vegetable expenditure discussed above, high fresh fruit spending is closely associated with high social status in terms of income and education. The weekly fresh fruits expenditure is significantly increasing with income. And, the income elasticity of fresh fruit expenditure is 0.22, which is slightly higher than the income elasticity of fresh vegetables. The finding is consistent to the results in Ruel et al. (2005) study that the

estimated income elasticity for fruit is greater than the elasticity for vegetables in eight sub-Saharan countries, including Ghana. Moreover, the high educational attainment of respondents leads to a 2.1 cedi premium in weekly fresh fruits expenditure than that of households with lower than high school education level. Because fresh fruits are an excellent source of various essential nutrients, the households with high social status are likely to consume more fresh fruits and, therefore, spend more on fresh fruits.

In terms of demographic factors, the variables such as marital status, age, and household composition are found to have significant effect in determining fresh fruit spending. High fresh fruit expenditure is closely correlated with respondents from the married households. According to the results, the difference of weekly fresh fruit expenditure between the married and non-married households is about 0.77 cedi. Moreover, as age increases, food expenditure on fresh fruits grows substantially. A ten-year increase in respondent's age brings about a 0.5 cedi increase in weekly fresh fruit spending. Furthermore, households with more adult members are found to spend more on fresh fruits, and the corresponding marginal effect is 0.36 cedi per one additional adult member in a household. This finding is consistent with previous studies. For example, Ruel et al. (2005) find that adult share is positively associated with the budget allocated to fruit and vegetable in several sub-Saharan African countries.

Peanut products. Results of the study indicate that both Tamale and Takoradi households have higher peanut product expenditure than the households in Accra. The gap between Tamale and Accra households is about 1.4 cedi weekly, more than 50 percent of the average expenditure in peanut products in Accra. The difference between Takoradi and Accra households is even larger, Takoradi households spend 1.7 cedi more on peanut products than Accra households. The finding indicates that the traditional diet such as high peanut and peanut-based product

consumption is still popular in the non-capital cities. Tamale is located in the Northern region that is generally considered to be the high production and consumption zone of peanut products, while the Great Accra is considered as a low production and consumption zone (Awuah et al., 2001). Furthermore, households with higher income spend more on peanut products than households with lower income. The income elasticity for peanut products is 0.07, which is less than one. This finding suggests that peanut is a necessary good in an urban household, indicating as income increases, peanut product expenditure increase but at a slower pace. Comparing with households based in the capital, income has a larger effect in Tamale households, but a lower effect in Takoradi households. It suggests that similar income growth has different effects on peanut product expenditure in the three cities. In other words, Tamale households are more sensitive to income growth and increase their peanut product spending as compared to Accra households, conversely, Takoradi households are less sensitive. Moreover, the well-educated households spend 0.59 cedi more on peanut products weekly. The finding confirms the positive role of education in peanut consumption (Moon et al., 1999). Additionally, food expenditure on peanut products is positively related to the number of adult household members, probably because large households demand more peanut products.

3.5.3 Summary of location effects

Based on the results of multivariate Tobit model, the location effects on weekly household expenditure (i.e., fresh vegetable, fresh fruit, and peanut product expenditure) are summarized in Figures 3.1-3.3. After controlling for socioeconomic and demographic factors, household expenditure on fresh vegetables and peanut products vary by location, while the location effects in fresh fruit expenditure equation are not significant.

Households in Accra and Takoradi have significantly higher fresh vegetable expenditure than Tamale-based households (Figure 3.1). This is likely due to the fact that the economic development is still uneven in Ghana, and the southern part of the country, where Accra and Takoradi are located, has experienced a much faster economic growth than the northern part. Moreover, the curve indicating the relationship between income and vegetable expenditure for Tamale households has a significantly steeper slope, suggesting that Tamale households are more sensitive to income growth than residents in the other two cities, in terms of increasing their fresh vegetable expenditure. This finding suggests that increasing income is more efficient in Northern Ghana than in Southern Ghana with the aim of enhancing the fresh vegetable consumption.

In the case of fresh fruits (Figure 3.2), although results of ANOVA analysis indicate that the location effects on fresh fruit expenditure is significant when controlling for the selected socio-demographic factor effects, weekly household expenditure on fresh fruits does not significantly vary by location in urban households in Ghana. This finding indicates that the difference between urban centers in fresh fruit expenditure essentially originates from the corresponding socio-demographic characteristics associated with households in different cities, rather than the household location factor itself.

Regarding peanut product expenditure shown on Figure 3.3, households in noncapital cities (i.e., Tamale and Takoradi) have significantly higher expenditure from the Accra-based households. Specifically, noncapital households spend at least 1.4 cedi more on peanut product consumption weekly than households in Accra. Peanut and peanut based products are an integral part in the diet in West African countries including Ghana, and results indicate that noncapital cities adhere to the traditional diet more strongly than capital households.

3.6 CONCLUSIONS AND DISCUSSIONS

In recent years, despite the significant improvement in the diet in terms of both food variety and quality, a lack of nutrient-dense diet is still prevalent in many African countries. Sub-Saharan Africa has the highest prevalence of malnutrition in the world (FAO, 2008). Many African countries are confronted with the deficiency in essential vitamins and minerals owing to low consumption of fruit and vegetables (Afari-Sefa et al., 2012). Because the health benefits of fresh vegetables, fresh fruits, and peanuts are well established, integrating these nutrition-dense foods in the existing diet is of crucial importance. Both health-promoting organizations and food retailers need in-depth studies to identify the determinants of the consumption of these specific food items. Although numerous studies explore the consumption of these food items from various perspectives, due to a lack of data, the effects of location difference on food consumption in urban areas have been ignored in most of the previous research. Some studies may have addressed consumption differences in rural and urban areas, but neglected to note that the differences among urban areas can be substantial within the same country. Using a survey data set from urban Ghana households collected in 2011, the study established that besides socioeconomic and demographic factors (including income, education, marital status, age, and household composition), the food expenditure on fresh vegetables and peanut products varies with location, and location factors are found to interact with income in determining the household expenditure.

The current study extended the existing research of specific food consumption in two ways. First, it examines the location effect on food expenditure in urban households, considering the interaction effects between location and income in determining specific food expenditure.

Second, it contributes to the development of estimation methods of investigating a food expenditure system using multivariate Tobit model, by taking the across-equation correlation into consideration. It enhances the efficiency of the estimation results and provides more precise information to public and private sectors.

3.6.1 Location difference

This chapter provides information about regional patterns of food consumption related to fresh vegetables, fresh fruits, and peanut products in urban households of Ghana. According to the estimation results, household food expenditure on fresh vegetables, fresh fruits, and peanut products are positively correlated with each other. In other words, these three food items compliment each other, which confirms that peanut products are often consumed together with fresh vegetables and fruits in Ghana. In case of fresh vegetable expenditure, Northern urban households such as those in Tamale, had lower fresh vegetable expenditure than households from two southern cities (i.e., Accra and Takoradi). The expenditure gap between Tamale households and households in the other two cities was 4.2 cedi weekly, about 43.5% of the average fresh vegetable expenditure in Tamale households. In addition, income was found to have a larger effect in increasing fresh vegetable expenditure among Tamale-based households than households in the other two cities. Regarding household expenditure on fresh fruits, controlling for the effects of the key socio-demographic factors, the regional difference in fresh fruit expenditure was not significant. Moreover, for peanut product expenditure, households in non-capital cities, such as Tamale and Takoradi, have higher expenditure than capital-based households. Also, comparing with Accra households, Tamale households are more sensitive to income change in encouraging peanut product consumption, while Takoradi households are less sensitive than Accra households.

3.6.2 Socioeconomic and demographic characteristics

Besides location difference, the study provides a comprehensive picture of consumer profiles of these health-improving foods (i.e., fresh vegetables, fresh fruits, and peanut products) in urban households of Ghana. Well-educated and high-income households, especially the married households with a large number of adult members, have high fresh vegetable and fresh fruit expenditures. For example, households with participants having formal education spend 1.88 cedi more on fresh vegetable consumption weekly, i.e., about 14.5% more of the average expenditure on fresh vegetables. The difference between households of married and unmarried respondents was 2.18 cedi weekly, equaling 16.8% of the average expenditure. In addition, as the respondents' age increase, their weekly household expenditure on fresh vegetables and fresh fruits also increases significantly, with the expenditure premiums of 0.13 cedi and 0.05 cedi, respectively. Moreover, large households with higher income and education are also closely associated with high expenditure on peanut products. Specifically, households with respondents having formal education spent 0.59 cedi more on peanut products than their counterparts, which is about 18% of the average peanut product expenditure. Moreover, an additional adult member in a household brought 0.19 cedi increase in peanut products expenditure, about 6% of the average expenditure.

3.6.3 Implications for private organizations

The information about the location difference in specific food expenditures can help food retailers to craft their market strategies. Specifically, fresh vegetable sales should target more developed areas such as southern Ghana, while peanut product sale needs to focus on non-capital areas. Based on the consumer socio-demographic characteristics, food marketers are suggested to focus their promotion of fresh vegetables and fruits on households of prominent

social status by providing fresh vegetables in a wide variety and of good quality, because those households are more concerned about food quality and variety (Sanlier and Karakus, 2010). Meanwhile, food retailers and producers are suggested to enhance the quality of their peanut products to attract households with high income and education level, in order to increase their market sales.

3.6.4 Implications for public sector

The location effects need to be taken into consideration when the public sector formulates its health-promoting programs. Results indicate that besides urban-rural difference of food consumption explored in previous studies, the regional difference in urban areas is also significant. Food assistance program that involves fresh vegetables needs to be focusing on the less developed area such as Northern Ghana, and, moreover, increasing household income seems an efficient way in promoting fresh vegetable consumption in Ghana, especially in Tamale. Because Tamale households tend to be more sensitive to the growth of income in increasing their expenditure on fresh vegetables.

This chapter highlights the importance of socio-economic and demographic factors in shaping fresh vegetable and fruit consumption patterns in urban households of Ghana. Households with lower socio-economic status report low fresh vegetable and fruit expenditure. From the policy standpoint, the public sector needs to recognize the crucial role of income and education in determining fresh vegetable and fruit consumption, and possibly address specific food aid forms to these low-income and low-educated households. In addition, “education and behavior-change programs” (Ruel et al., 2005) promoting fresh vegetable and fruit consumption should focus on emphasizing the health benefits of high vegetable and fruit intake. Results indicate that income is still the major constraint of the health-promoting food items consumption.

Local development programs creating more job opportunities or enhancing the current wage level might be the key of increasing nutrition-dense food consumption in the long run. In the meantime, effects such as reducing post-harvest loss and improving the storage process (Ruel et al., 2005) of these health-promoting food items may increase the food availability and decrease the food price, and therefore, helps to encourage the healthy food consumption.

Fresh fruits and vegetables appear safe for now because the pesticide costs discourage their use, except for herbicides. Peanuts in Ghana are frequently contaminated by aflatoxin (Florkowski and Kolavalli, 2013), which has been confirmed to be closely associated with six of ten most important health risks in developing countries (Williams et al., 2004). Besides the health promoting effects of peanut, public sector needs to be concerned about food safety issues such as aflatoxin contamination associated with peanut products. Results show that consumption of peanut products is high and present in all areas, especially in the non-capital cities such as Tamale and Takoradi. Those households with relative higher peanut product expenditure are, at the same time, potentially exposed to higher risk of aflatoxin contamination. It is imperative to assure such households with high peanut product expenditure facing low risk of aflatoxin exposure from peanut product consumption. Therefore, public sector needs to strongly focus on noncapital households' consumption of peanut products, monitoring the process of peanut product production, storage, processing, and distribution to reduce the contamination risk. Also, it is crucially important to translate accurate and useful information to consumers about the detrimental health effects of aflatoxin contaminated food ingestion and ways to distinguish the contaminated products from the safe ones.

Aflatoxin contamination is often associated with the particular forms of peanut products (Florkowski and Kolavalli, 2013). For example, peanut paste is more likely to be associated with

contamination than roasted peanuts. Therefore, not only total peanut product consumption, but also the particular consumption forms should be investigated in the future study, in order to examine the corresponding food contamination effect on the population at a given expenditure level.

Table 3.1: Descriptive statistics of variables included in the empirical model.

Variable name	Variable description / units of measurement	Mean	Std dev
Dependent variable:			
Exp_Veg	Weekly household food expenditure on fresh vegetables/in Ghanaian cedi	12.962	12.220
Exp_Fruits	Weekly household food expenditure on fresh fruits/in Ghanaian cedi	5.408	5.836
Exp_Peanuts	Weekly household food expenditure on peanut products/in Ghanaian cedi	3.293	3.383
Independent variables:			
	Demographic factors		
Married	=1 if a respondent is married	0.753	0.431
Age	Actual age in years	39.222	10.656
Children	Number of household members between 4-12 years old	0.945	1.067
Adult	Number of household members between 19-60 years old	2.087	1.751
Elder	Number of household members 61 years old or older	0.153	0.505
	Socio-economic factors		
Income	Household income in the month preceding the survey / in Ghanaian cedis	646.070	785.081
Employ_self	=1 if a respondent is self-employed	0.642	0.480
Employ_gov	=1 if a respondent is gov/civil employee	0.243	0.429
Educ	=1 if a respondent has a formal education (including Senic high/GCE O-A level, Vocational school, Technical school Teacher training, University, or postgraduate)	0.516	0.500
	Location		
Tamale	=1 if a household is in Tamale	0.186	0.389
Takoradi	=1 if a household is in Takoradi	0.208	0.406

Table 3.2: Weekly household expenditure on fresh vegetables, fresh fruits, and peanut products by cities.

Weekly expenditure	Accra	Takoradi	Tamale	F-stat. of ANOVA	P-value
Fresh vegetables	14.385	11.088	9.731	15.350	0.000
Fresh fruits	5.686	5.179	4.207	5.500	0.004
Peanuts products	2.653	3.487	4.871	38.250	0.000

Table 3.3 Estimation results of food expenditure on fresh vegetables, fresh fruits, and peanut products in urban households of Ghana, 2011.

Variable name/Coef (std err.)	Vegetables	Fruits	Peanuts
Intercept	2.4670	-0.5218	0.7722
	(1.9754)	(0.9653)	(0.6078)
	Demographic factors		
Married	2.2077*	0.8332*	0.2892
	(0.8459)	(0.4158)	(0.2544)
Age	0.1313***	0.0492***	0.0134
	(0.0357)	(0.0175)	(0.0107)
Children	0.2877	0.0539	0.1329
	(0.3536)	(0.1742)	(0.1036)
Adult	0.2785	0.3919***	0.2022***
	(0.2108)	(0.1010)	(0.0665)
Elder	-0.0022	-0.5183	-0.1512
	(0.7196)	(0.3471)	(0.2167)
	Socio-economic factors		
Income	0.0040***	0.0019***	0.0004***
	(0.0005)	(0.0003)	(0.0002)
Employ_self	-0.1028	-0.0194	0.1769
	(1.1330)	(0.5556)	(0.3467)
Employ_gov	0.1759	-0.1916	-0.1977
	(1.3339)	(0.6447)	(0.4087)
Educ	1.8984**	2.2457***	0.6271***
	(0.8288)	(0.4060)	(0.2487)

Table 3.3 Estimation results of food expenditure on fresh vegetables, fresh fruits, and peanut products in urban households of Ghana, 2011. (cont'd)

Variable name/Coef (std err.)	Vegetables	Fruits	Peanuts
		Location	
Tamale	-4.2931***	-0.3494	1.5297***
	(1.6344)	(0.8011)	(0.4775)
Takoradi	-2.2213	-0.0858	1.8178**
	(1.5139)	(0.7461)	(0.4453)
Tamale*income	0.0094***	0.0013	0.0043***
	(0.0048)	(0.0023)	(0.0014)
Takoradi*income	0.0002	0.0006	-0.0020***
	(0.0028)	(0.0014)	(0.0008)
		Parameter	
Sigma of Vegetable equation	11.4067***		
	(0.2637)		
Sigma of Fruit equation	5.6309***		
	(0.1324)		
Sigma of peanut product equation	3.3305***		
	(0.0779)		
R between fresh vegetable and fruits equation	0.6017***		
	(0.0209)		
R between fresh vegetable and peanut product equation	0.2864***		
	(0.0302)		
R between fresh fruits and peanut product equation	0.2326***		
	(0.0313)		

Note: *, ** and *** denote coefficients are significant at 10%, 5%, and 1% levels, respectively. Standard errors are in parentheses.

Table 3.4 Marginal effects in food expenditure on fresh vegetables, fresh fruits, and peanut products in urban households of Ghana, 2011.

Variable name/Marginal effects (std err.)	Vegetables	Fruits	Peanuts
	Demographic factors		
Married	2.1810*	0.7705*	0.2707
	(0.8357)	(0.3845)	(0.2381)
Age	0.1297***	0.0455***	0.0125
	(0.0353)	(0.0162)	(0.0100)
Children	0.2842	0.0498	0.1244
	(0.3493)	(0.1611)	(0.0970)
Adults	0.2751	0.3624***	0.1892***
	(0.2082)	(0.0934)	(0.0622)
Elder	-0.0022	-0.4793	-0.1415
	(0.7109)	(0.3210)	(0.2028)
	Socio-economic factors		
Income	0.0040***	0.0018***	0.0004***
	(0.0005)	(0.0003)	(0.0002)
Employ_self	-0.1016	-0.0179	0.1656
	(1.1193)	(0.5138)	(0.3245)
Employ_gov	0.1738	-0.1772	-0.1850
	(1.3178)	(0.5962)	(0.3825)
Educ	1.8754**	2.0766***	0.5869***
	(0.8188)	(0.3754)	(0.2328)
	Location		
Tamale	-4.2412***	-0.3231	1.4316***
	(1.6146)	(0.7408)	(0.4469)
Takoradi	-2.1944	-0.0793	1.7013**
	(1.4956)	(0.6899)	(0.4168)
Tamale*income	0.0093***	0.0012	0.0040***
	(0.0047)	(0.0021)	(0.0013)
Takoradi*income	0.0002	0.0006	-0.0019***
	(0.0028)	(0.0013)	(0.0007)

Note: *, ** and *** denote marginal effects are significant at 10%, 5%, and 1% levels, respectively. Standard errors are in parentheses.

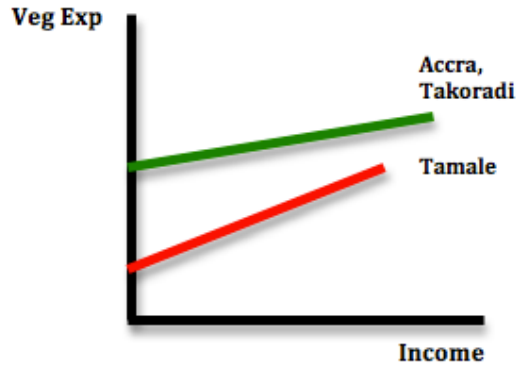

Figure 3.1: Difference in effects of location in fresh vegetable equation.

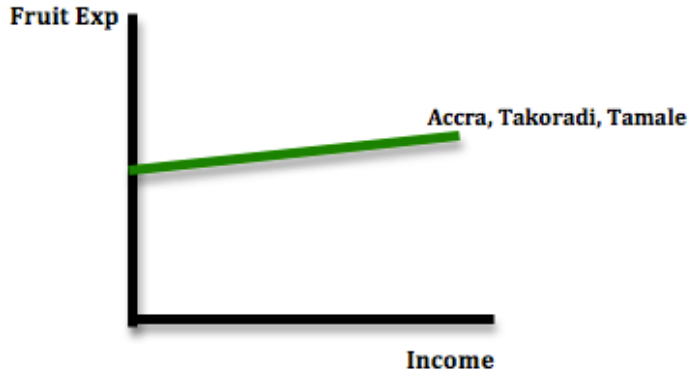

Figure 3.2: The absence of difference in effects of location in fresh fruit equation.

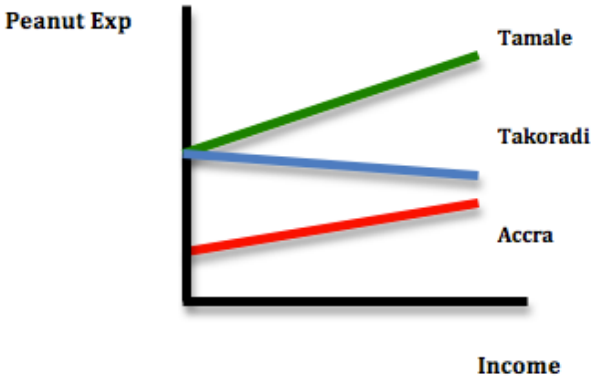

Figure 3.3: Difference in effects of location in peanut product equation.

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