Food Consumption and Technology in Developing Countries: in Case of Ghana's Urban Households*

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Paper 1: Processed Peanut Products and Consumer Profiles: The Case of Ghana Urban Households

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Introduction

Ghana is the second-fastest growing economy in African country and reported a 13.5% GDP growth in 2011 (Tycholiz, 2012). From 2003 to 2012, the average GNI per capita (in current $) increased 20% annually (calculation based on World Bank, 2013). As a result, Ghana had been reclassified from the group of low-income countries to the low-middle-income countries in 2012 (Kopinski, 2012).

Both the good economic performance and the increasing income stimulate Ghana's food consumption. For example, between 2003 and 2009, fruit production (excluding fruit used in wine making) increased 53% with an average annual rate of 7.4%, while the fruit annual supply in kg per capita has increased 35%. The production of an important protein and energy food - peanuts - increased 11% between 2003 and 2009 with an average annual rate of 6.3 %. In terms of per capita supply, peanuts increased 20% during the 2003-2009 period. Additionally, the volume of peanuts utilized in processing increased 52% with an average annual rate of 8% between 2003 and 2009 (FAOSTAT, 2013).

In Ghana, peanuts are processed into a variety of forms (Atuahene-Amankwah et al., 1998; Awuah, 2000) including raw, roasted, cookies, flakes, and candies (McWatters and Cherry, 1982; Anim-Somuha et al., 2013). The majority of peanut products are made by cottage industry operators, but there is an emerging commercial peanut processing industry (Florkowski and Kollavali, 2013).

Peanuts are a legume but their composition is similar to tree nuts. Peanut varieties grown in Ghana contain from 22 to 30% protein on a dry basis (Yaw et al., 2008). A large number of studies demonstrate the health benefits of peanuts and peanut products. Peanuts are high in easily digestible fatty acids and vitamin E (Griel et al., 2004), which protects the nervous system and acts as an antioxidant (Orzechy ziemne prazone, 2013). Also, both the fatty acids and the vitamin E influence, among others, liver functions. Moreover, peanuts augment nutrients associated with reducing risk of cardiovascular disease (Alper & Mattes, 2003) and increasing serum magnesium concentration (Kris-Etherton, 1999). In addition, peanuts and peanut butter (or peanut paste as it is known in Ghana) contain monounsaturated fats and B-sitosterol, which provide protection against certain human cancers (Awed et al., 2000).

Although peanut processing products are of great importance to the diet of West African countries such as Ghana, very few studies investigate consumer preference of these various processed peanut products. Based on the survey data collected in urban Ghana in 2011, the objective of our study is to answer the following questions: a) What are the main peanut products in the diets of urban households in Ghana? b) What are the important attributes of the main peanut products? c) What is the target consumer group for each of the main peanut products?

The results of the study provide comprehensive insights regarding consumer preference for various peanut products as well as identifying the consumer profile for the major peanut products. The study helps private agents facilitate manufacturing and distribution decisions about their peanut products, and also provides useful information to public sectors concerned about enhancing food quality and food security.

Peanut product processing procedures

In Ghana, various food processing technologies and procedures are applied to process raw peanuts into a variety of peanut products. Some products are similar to those found in Europe or North America, such as roasted peanuts, while others fall into a general category, for example, snacks, but are a distinctly local concoction like nkati cake.

Peanut paste. Shelled peanuts are cleaned and graded to select good quality sound kernels. Nuts are then roasted to a desired level to develop appropriate flavor. The roasted peanuts are then ground with the skins included to make peanut paste, though sometimes the skins are removed.

Sugar-coated nuts. Sugar coating may be achieved by several means: 1) A thick sugar solution is prepared and the nuts (with the skins) are immersed in the solution to make a coating and then baked. 2) Nuts are first roasted, dipped in a sugar solution (with or without skins), and then dried in an oven. 3) Raw, high-quality nuts are coated with a sugar solution (or honey) in a pan-coater (a rotary drum), then dry roasted in an oven or fried in a deep-fat fryer.

Peanut in chocolate. There are a number of different formulations and processes. Our study only gives one type. Dry roasted, salted peanuts, almond bark white

chocolate, and sweet German chocolate are cooked slowly in a crock pot then allowed to sit for 20 minutes off the heat. This mixture is then dropped by the spoon onto a flat surface and allowed to harden into candies.

Nkati cake. This is a peanut-based candy popular in Ghana. The recipe requires only three ingredients: salted roasted nuts, sugar, and water. Sugar is added to water and heated to make a lightly caramelized, thick solution. Roasted nuts are coarsely ground, added to the sugar solution (while hot), spread on a parchment sheet, and allowed to cool.

Dzowe. Preparation of dzowe involves separately roasting peanuts and maize. The roasted maize is then milled several times in a disc attrition mill after which the roasted peanuts, sugar, and spices are added and the mixture put through a final milling process. The mixture is then lightly pounded with a mortar to help bind the mixture, which is then molded into small balls.

Data and method

The study is based on survey data collected in the three large 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 the Northern Region of Ghana. In response to questions included in the survey, the respondents reported their preference of various peanut products (i.e., boiled peanuts, roasted peanuts, peanuts in chocolate, dzowe/dakwa, kuli-kuli, peanut paste, sugar coated peanuts, and nkati cake), and their answers were recorded on a scale ranging from 1 to 6 (1=dislike very much, 2=dislike, 3=neither like or dislike, 4=like, 5=like very much, 6=do not eat). Additionally, respondents were asked about the important attributes of certain peanut products including color, aroma, taste, and health value. Moreover, information about certain socio-demographic characteristics such as age, gender, and household income and composition were collected during the survey.

A total of 1,076 households were surveyed. Among them, 60.6 percent were from Accra, 20.8 percent from Takoradi, and the remaining 18.6 percent from Tamale. Respondents varied in age from 17 to 80 years old and the mean age was 39.2 years. More than 98.3 percent of respondents were females who were in charge of food shopping and preparation, and 75.3 percent were married. In the month preceding the

survey, the recorded income ranged 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).

In the empirical model, the dependent variable is the preference for certain processed peanut products, while the explanatory variables are the socioeconomic and demographic factors, as well as the household location. Because the dependent variable is an ordinal variable, the data set is suited for the application of an ordered probit model (Gujarati, 2003). In order to increase the precision of the results and consider across-equation correlation, a multivariate ordered probit regression is employed (Greene and Hensher, 2010).

Results

1. Main peanut products

The results indicate that roasted peanuts, boiled peanuts, and peanut paste are the top three peanut products widely consumed in urban Ghana. As Figure 1 shows, only 0.56 percent of the households reported that they do not eat roasted peanuts, 0.84 percent do not eat boiled peanuts, and 1.22 percent do not eat peanut paste. In contrast, the proportion of not eating other peanut products such as nkati cake, dzomwe/dakwa, peanuts in chocolate, sugar-coated peanuts, and kuli-kuli all exceeds 4 percent.

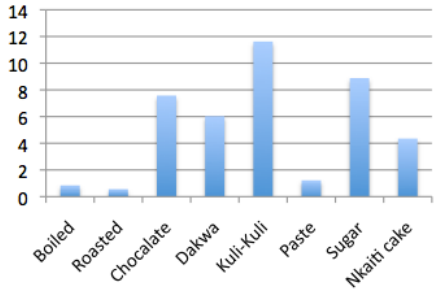

Figure 1: Proportion of households reporting they do not eat eight processed peanut items.

In addition, Figure 2 displays household preference for various peanut products. According to the results, 41.33 percent of households reported that they like roasted peanuts very much; corresponding proportions were 39.96 percent for peanut paste and 24.11 percent for boiled peanuts. Therefore, compared with other peanut products,

roasted peanuts and peanut paste are the most popular forms in which peanuts are consumed in urban Ghana. The following section focuses on these two peanut products.

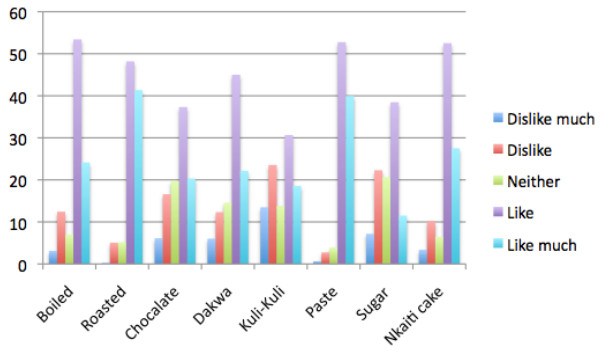

Figure 2: Preference for peanut products.

2. Important attributes

According to the rating score on important attributes, aroma, flavor, and protein value are essential to peanut paste, while for roasted peanuts the key attributes are taste, protein, and health value/benefit.

3. Consumer profiles

According to the estimation results of the bivariate ordered probit model, the correlation coefficient between the preference for peanut paste and roasted peanuts is 0.42. This significant positive correlation indicates that the households which like peanut paste are also likely to prefer roasted peanuts. Table 1 and table 2 display the statistically significant variables for each equation and their marginal effects in percentage terms.

Roasted peanuts are preferred by Tamale and Takoradi households compared to the households in Accra. The probability premiums of both Tamale and Takoradi are about 12 percent in “like very much” and 10 percent in “like” categories. Moreover, households of respondents with college degrees prefer peanut paste less than their counterparts. It is plausible that having more education helps consumers to identify and choose from a wider variety of foods causing them to like peanut paste less than those with less education. Households with a large number of children (between ages 4 and 12 years) prefer roasted peanuts. An additional child leads to a 1.5 percent increase in probability that a household falls into the “like very much” category. It appears that the taste of roasted peanuts is attractive to children.

Table 1. Marginal effects with regard to the preference for roasted peanuts.

Variable/ dy/dx	Dislike much	Dislike	Neutral	Like	Like much
Tamale*	-.05035624	-.13666322	-.03600913	.10184351	.12118508
Takoradi*	-.05264056	-.14286273	-.03764262	.10646348	.12668244
College Edu*	.01906763	.05174818	.01363503	-.03856353	-.0458873
Children (4-12)	-.00614836	-.01668621	-.00439662	.01243482	.01479637

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.

In the case of peanut paste, the preference among Tamale and Takoradi households is also confirmed by statistical significance test as compared to Accra households, which is consistent to earlier reported preferences for roasted peanuts. To be specific, compared to Accra households, Tamale households have a 14% higher probability of choosing the answer “like roasted peanuts very much", while the probability premium for the same answer option is 6 percent between Takoradi and Accra households. The marginal effects with regard to peanut paste are closer between Takoradi and Accra, but in the case of preference for roasted peanuts, Takoradi and Tamale respondents were characterized by nearly identical probability of choosing the "like very much" response option. Also, large households prefer peanut paste more than smaller households. An additional adult member increases the probability of a respondent choosing the “like very much” option by 0.8 percent. Because there exists various ways to eat peanut paste (e.g., with bread or as a soup ingredient) it can satisfy the diverse needs of a big family.

Table 2. Marginal effects in peanut paste preference.

Variable / dy/dx	Dislike much	Dislike	Neutral	Like	Like much
Tamale*	-.09679769	-.11206708	-.06013922	.12081851	.14818548
Takoradi*	-.04472813	-.05178378	-.02778904	.05582763.	.06847332
Number of Adults	-.00560095	-.00648447	-.0034798	.00699085	.00857437

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

Conclusions

Peanuts are an essential component to the diets of residents in sub-Sahara African countries such as Ghana. By certain food processing technologies and procedures, peanuts are processed into various peanut-containing products. These products are vital sources of vitamin E, niacin, foliate, magnesium, and protein, although they are also associated with the high risk of aflatoxin contamination. Therefore, it is essential to determine the most popular peanut products and identify their target consumer groups to focus commercial manufacturing on supplying safe products.

Among the peanut products, roasted peanuts and peanut paste are found to be the major forms of processed peanuts consumed in urban Ghana. According to the summary of survey data, respondents expressed the opinion that aroma, flavor, and protein value were the key attributes for peanut paste, while attributes such as taste, protein content, and health value were especially important for roasted peanuts. Food producers and markets may expand their peanut product sales by selecting the most popular forms, and increase the quality by enhancing or assuring attributes important to consumers.

Consumer profiles are also identified in the study for both peanut paste and roasted peanuts. Regional factors are significant determinants of household preference in both roasted peanuts and peanut paste. Private sector agents such as food retailers may focus their promotion in Tamale and Takoradi. Moreover, results indicate that peanut paste is preferred by large households. Therefore, large package and various flavors of paste to meet large household needs may be a merchandising tool appropriate for the targeted group. In addition, roasted peanuts attract households with children; thus, satisfying children's taste expectations is of great importance. An important and relevant result is that households of respondents with a college degree prefer roasted peanuts less than respondents with less education. It indicates high quality peanut products are demanded to meet the well-educated household's needs.

Peanut products can be contaminated by aflatoxin. Frequent consumption of contaminated products for a long time period could lead to a number of health problems. Therefore, results of the study also respond to the public sector's concern about food safety to identify the area and consumer groups with a potentially substantial food contamination risk exposure.

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Paper 2: Modeling the Cooking Fuel Usage in Urban Households: the Case of Ghana

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Introduction

A wide range of benefits is strongly associated with modern fuel services, including a significant improvement in labor productivity, human health, or environmental protection. Modern energy sources are declared as clean, safe, and high-productivity fuels. Cooking with modern fuels allows labor and natural resources to be reallocated from fuel collection and production towards income-generating purposes (Heltberg, 2004). Also, modern fuels significantly reduce time spent on cooking.

However, sub-Saharan Africa has the lowest access level to modern cooking fuels comparing to other developing countries. In sub-Saharan Africa, 80% of the population cooks with solid fuels (wood, charcoal, or coal) as compared to 58% in China and 71% in India, respectively (Prasad, 2011). Until recently, only 25% of population in that part of Africa has had access to electricity (Brew-Hammond, 2010). Among them, only one out of four (about 6% of total population) uses electricity for cooking purposes. Similarly, kerosene and gas, two common fuels are used by only 7% and 4% of the sub-Saharan population, respectively (Prasad, 2011). In contrast, the traditional cooking fuels still dominate the energy usage in many households of the sub-Saharan Africa. Wood, the oldest among traditional cooking fuels, is used by 69% of the population (Prasad, 2011). It is because a vast majority of sub-Saharan Africans have no access to modern energy types, or cannot afford any of them.

The lack of access to modern energy has constituted a major obstacle for achieving human wellbeing and social development (Brew-Hammond, 2010). Household members, especially women, spend a large amount of time on fuel collection and cooking using traditional fuels. Additionally, the traditional biomass fuel may also lead to a number of health and environmental problems. For example, high level of indoor air pollution from burning biomass for cooking or heating has been listed among the top 10 health risks damaging human health, especially children health. Indoor air pollution from biomass burning is responsible for 4.2 child deaths per 1000 population due to pneumonia (Jetter & Kariher, 2009; Prasad, 2011). Biomass use in cooking appears to result in environmental problems as well. Soil and land degradation may be related to the usage of biomass, particularly around densely populated areas. Moreover, biomass burning contributes to greenhouse gas (GHG) emissions (Prasad, 2011).

The multiple negative effects of the traditional biomass fuel use, suggest that it is desirable to accelerate the shifting from various types of biomass energy to modern cooking fuels. Moreover, access to affordable and appropriate energy must improve the living standard of the growing population, and make a significant difference in the fight against poverty (Brew-Hammond, 2010). Efforts have been underway in a number of countries in sub-Sahara Africa with the aim of promoting the fuel transition. The Economic Community for West African States (ECOWAS) intends to distribute modern fuels to all by 2015, while the Economic and Monetary Community of Central Africa (CEMAC) sets a target of 80% access to modern cooking fuels and appliances by 2015 (Prasad, 2011). Mauritius, South Africa, and Ghana were cited among the leading countries achieving considerable progress in increasing access to modern energy services for their citizens (Brew-Hammond & Kemausuor, 2009).

Currently, much is known about household decisions in choosing their cooking fuels. For example, determinants of household fuel choice and switching were discussed using comparable across-county household survey data from Brazil, Ghana, Guatemala, India, Nepal, Nicaragua, Republic of South Africa, and Vietnam (Heltberg, 2004). The effect of factors determining energy choice decisions was quantified by other studies conducted in the Republic of South Arica and in Burkina Faso (Louw et al., 2008; Ouedraogo, 2006). However, promotion of modern types of cooking energy may not induce the complete abandonment of the traditional fuel usage. In fact, a growing body of evidence indicates that using multiple cooking fuels simultaneously is quite a common phenomenon among households in developing countries. A predominant cooking fuel combination in Guatemala is firewood and liquid petroleum gas used by 26% urban households, while 52% of rural households in Vietnam often use wood complemented by straw, and 34% of households in rural South Africa use both firewood and kerosene for cooking (Heltberg, 2004). Thus, given the widespread use of multiple fuel types in developing world, previous studies sole focused on the household's major cooking fuel choice is insufficient to analyze the fuel usage situation. More specifically, many previous studies were limited to examine responses to the survey question such as "What is the major cooking fuel in your household?". Obviously, answers to this kind of question do not provide a comprehensive picture of the cooking fuel usage if a number of

households cook with multiple fuels. Therefore, many previous results may overrate the major fuel type, while underrating the use of other fuels.

The current study fills the gap and examines the cooking fuel usage by modeling the frequency of five alternative energy sources rather than investigating the choice decision. The study uses survey data obtained from a survey conducted in urban areas of Ghana in 2011. During the survey, households shared details about frequency of the most common fuels used for cooking in Ghana (i.e., wood, charcoal, liquid gas, electricity, and kerosene).

The study contribution is twofold. First, instead of solely exploring household decisions of cooking fuel choice, our study examines the fuel usage frequency. Knowledge of frequency supplies detailed and generally missing information about household behavior in cooking energy use. Second, by allowing the multiple fuel use in cooking in various areas of the country, results of the study must be more precise and meaningful in terms of the regional differences in cooking fuel use and possible implications for both human and environment's health. It can be used by local government or policy-makers to assess different cooking fuels usage in West Africa. Furthermore, insights gained about the household constraints in adopting modern cooking fuels helps to develop efficient energy strategies.

Conceptual framework

Numerous studies, analyses, and policy formulations including the present study are based on the "energy ladder model," which conceptualizes fuel usage in cooking by three distinct phases (Heltberg, 2004). In the first phase, universal biomass reliance dominates the household fuel usage. The second phase is captured by households switching away from biomass to fuels such as kerosene, coal, and charcoal in response to higher incomes, urbanization, and biomass resource scarcity. In the third phase, households are hypothesized to move to liquid petroleum gas or electricity for cooking.

The current study assumes that the fuel usage frequency is proportional to the quantity of fuel demand. The demand depends on income, price, and household preferences. It is reasonable to assume stable prices in a cross-sectional data. Although the preferences are unobserved, they are shaped by socio-demographic characteristics.

Thus, the explanatory variable selection in the current study is guided by both consumer theory and previous studies about cooking fuel choices. Evidence shows that selected socioeconomic and demographic factors significantly affect household cooking fuel usage. Several studies closely link income growth with changing household fuels (Barnes & Qian, 1992; Leach, 1992; Ouedraogo, 2006). Other studies indicate that households of respondents with high educational attainment level tend to use modern fuels because modern energy types offer significant time savings, especially for women (Heltberg, 2004). Demographic characteristics are also relevant because the household energy selection can be captured by its size and composition (Heltberg, 2004; Ouedraogo, 2006).

Data

The study uses survey data collected in three large 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, while Tamale is the capital city of the Northern Region. During the face-to-face interviews, the respondents were asked to report their usage frequency of the most common cooking fuels (i.e., wood, charcoal, liquid gas, electricity, and kerosene). Respondents also shared some personal information and household characteristics such as age, gender, occupation, income, and household composition.

Table 1 shows the definition and measurement units of variables included in the empirical analysis. It displays descriptive statistics such as the mean and standard deviation of each variable. In the sample, 60.6 percent of survey participants are from Accra, 20.8 percent from Takoradi, and the remaining 18.6 percent from Tamale, respectively. Among the surveyed households, three out of four are households of married respondents. The average respondent is 39.2 years old. In addition, the typical household has one teenage household member (between 13 to 18 years old), two adult members (between 19 to 60 years old), and 0.15 elder members (more than 61 years old). Moreover, the mean household income in the month preceding the survey is 646.1 cedi. In terms of employment status among respondents, 64.2 percent report being self-employed, 24.3 percent are government or civil employees, and 11.5 percent are either not employed, students, or the retired. In terms of their educational attainment level, 38.2

percent of respondents have a secondary education and 13.4 percent have a college education.

The usage frequencies regarding each cooking fuel type are displayed in Table 2. Charcoal and liquid gas appear to be the most widespread cooking fuels used in Ghana. About 86.6 percent of the surveyed households use charcoal seldom, often, or very often. About two thirds, 68.5 percent, use liquid gas. Additionally, about one third of households report cooking with charcoal very often, and more than half of households report to cook with liquid gas very often, respectively. Regarding the traditional biomass fuel, only about 20.9 percent of households still use wood, and among the users of wood for fuel, one half of them use wood only seldom. According to the survey results, only a small number of households cook with such fuels as kerosene and electricity. Electricity is used by about 11.2 percent, and kerosene by 17.3 percent of the respondents, respectively. Among the users of either of the two fuel types, only 1.7 percent and 2.6 percent report using kerosene or electricity very often, respectively.

Empirical model

The empirical model consists of an equation system. The system is applied to examine the determinants of household cooking fuel usage with regard to five different fuel types (i.e., wood, charcoal, liquid gas, electricity, and kerosene). A separate equation is specified for each fuel type. The usage frequency of each fuel type is the dependent variable and is measured on a scale from one to four with the increasing number indicating more frequent use of a certain fuel type (i.e., 1=not at all, 2=seldom, 3=often, 4=very often). The explanatory variables include selected socio-demographic characteristics, income, and location indicator (i.e., household income, education, occupation, age, marital status, household composition, and regional location).

The study applies the ordered probit regression model to investigate how the socio-demographic factors affect an urban household's cooking fuel usage frequency. Social science research commonly uses ordinal numbers to measure and quantify phenomena transformed into variables. The ordered probit model is among the most common tool to deal with the ordered categorical variable. The basic framework of the regression model is in Equation 1, where Y^* is the latent variable behind the fuel use

frequency, X denotes the selected explanatory variable vector, B is the coefficient vector, and e is the error term, which is assumed to follow normal distribution:

$$Y^* = XB + e \tag{1}$$

The relation between the latent variable Y^* and the dependent variable Y is defined in Equation 2. 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 the model expression, Cut_0 and Cut_4 are used to denote negative infinite and infinite) (Sajaia, 2008). The probability of fuel usage frequency being equal a certain number i can be expressed as the difference between two Cumulative Distribution Functions (CDFs) of normal distribution (Equation 3). In each equation, the likelihood function of the empirical model (Equation 4) is the product of all possible probabilities with the indicator variable d as corresponding power, and N is the total sample size. The regression model is estimated by maximum likelihood method using STATA commands.

$$Y = i, \text{ if } \text{cut}_{i-1} < Y^* < cut_i, \text{ where i} = 1, 2, 3, 4. \tag{2}$$

$$\begin{aligned} \Pr ob(Y = i) &= \text{Prob}(Cut_{i-1} < Y^* < Cut_i) \\ &= \text{Prob}(Cut_{i-1} - XB < e < Cut_i - XB) \\ &= \text{F}(Cut_i - XB) - \text{F}(Cut_{i-1} - XB) \end{aligned} \tag{3}$$

$$Likelihood = \prod_j \prod_i \Pr ob(Y = i)^{d(Y=i)}, \text{ where j} = 1,2, \ldots N,$$

$$\text{d} = 1 \text{ if Y} = \text{i; d} = 0 \text{ otherwise.} \tag{4}$$

Results

According to the estimation results and significance tests, the usage frequency of five cooking fuels are associated with demographic factors such as marital status, age, and household composition, socioeconomics factors such as income, occupation, and education, as well as household location. Estimation results are displayed in Table 3.

Wood. As income increases, households are less likely to use wood very often for cooking., High income households are likely to abandon this traditional cooking fuel. The finding is consistent with the previous argument that the traditional biomass still dominates the low income households' energy needs (Prasad, 2008). Regarding the

occupation effects government or civil employees have a significantly lower probability of cooking very often with wood comparing to those not employed, students, and the retired. Because people working in govern/civil department earn relatively regular and stable wages, they depend less on less expensive biomass fuel to cook. Also, respondents with a secondary or collage education tend to not use wood as their cooking fuel. It is not surprise that education negatively affects the use of wood. Cooking with wood requires plenty of time spent on fuel collection and, later, requires constant attention while cooking, and highly educated households usually have higher opportunity cost of time. In contrast to Accra-based households, households in Tamale are more likely to apply wood very often for cooking. Moreover, a large household size significantly increases the probability that the household cooks very frequently with wood.

Charcoal. Income has a significantly negative effect on cooking with charcoal very often. High income households can afford cleaner and more efficient fuel types and are less dependent on charcoal. Government or civil employees are less likely to use charcoal very often for their cooking in comparison to the unemployed, students, and the retired. As the education level increases, the likelihood of relying on charcoal for cooking significantly decreases. Specifically, households with the secondary or higher education tend to use the traditional fuel, charcoal, less often. Comparing with households in the capital, Tamale residents are more likely to cook with charcoal very often. Recalling the finding in relation to wood usage frequency above, it seems the traditional fuels such as wood and charcoal continue to play a predominant role in less developed areas of Ghana. The finding also indicates that households with a large number of adult members are more likely to cook with charcoal very often due to their high energy demand.

Liquid gas. Households with high income have a larger probability of cooking with liquid gas very often than households with less income. High income households can afford the access fee and monthly payment in relation to liquid gas usage. The finding confirms the positive association between income growth and access to modern fuel (Sokona et al., 2012). Unlike the unemployed, students, and the retired without or with irregular income, respondents working in the government or civil department tend to cook with liquid gas very often. The higher the education level, the more likely the household cooks with liquid gas very often. Clearly, having the secondary or college

education increases the liquid gas usage frequency. Compared to households located in Tamale, those located in the Capital tend to cook with liquid gas very often. However, there is no difference in that frequency category between Accra and Takoradi residents. Moreover, households of married respondents are more likely to use liquid gas to cook very often. It is plausible that they are attracted by the convenience of this modern cooking fuels.

Electricity. Increasing incomes are found to be positively associated with the probability of cooking very often with electricity. The low income households have a large chance they never use electricity for cooking, likely due to the relatively high electricity cost. Electricity is used mainly for lighting, radio and TV, and it is widely unaffordable for cooking, especially among low-income households (Prasad, 2008). Both government or civil employees and the self-employed have a significant lower probability of very often using electricity for cooking. It appears that even for those with good and relatively stable jobs electricity is too expensive, especially when there are alternative energy sources such as the liquid gas as discussed above. Households with a secondary or college education tend to use electricity very often for cooking purpose. It is quite possible they know the essential benefits in relation to this clean energy source on human health when used in home surroundings. Accra based households are more likely to cook very often with electricity than Tamale households, but not with regard to households located in Takoradi. There still is a limited access to electricity in northern Ghana including Tamale. Furthermore, married households cook with electricity very often as compared to their counterparts. Age has a significant positive effect on the probability of using electricity for cooking very often. As people advance in age they tend to pursue a more healthy lifestyle including the use of clean modern energy for cooking. Households with a large number of children are less likely to cook very often with electricity. Similarly, the number of elders also has a negative effect on cooking very often with electricity, and it might result from the elder residents old cooking habits.

Kerosene. Results of the study indicate that high-income households are more likely to cook very often with kerosene. The finding is consistent with the existing statement that poorer households continue to use charcoal and wood for cooking, but use kerosene for lighting (Laan and Beaton, 2010). College education has a significant

negative effect on the kerosene use in cooking the main meal. Households in Tamale are less likely to cook very often with kerosene as compared to Accra-based households. In the less developed area of the country, like Tamale, households without access to electricity use kerosene for lighting, but not for cooking. Moreover, a respondent's increasing age is closely correlated with the high probability of cooking very often with kerosene. Large size households, in terms of adult members, are more likely to use very often kerosene for cooking, possibly due to their high energy demand.

Conclusions

Accessing to the modern energy services is gaining significant benefits in relation to human health, environmental protection, as well as sustainable development. However, a vast majority of households in sub-Saharan Africa are still excluded from access to modern fuels and heavily relay on the traditional biomass as a source of fuel for cooking. Many previous studies explored household decisions in relation to cooking fuel choice but without the consideration of multiple fuel usage. Rather than solely focusing on the choose-or-not decision, the present study investigated fuel usage frequency for several different cooking fuels, and identified the constraints impeding the shift from the traditional biomass to modern fuels as well as ascertained factors that encourage the use of each fuel type.

Results of the study indicate that charcoal and liquid gas are the most widespread cooking fuels among urban households in Ghana. To be specific, 86.6 percent of respondent urban households cook with charcoal, and 31.7 percent report to use it very often. The corresponding percentages in relation to the use of liquid gas are 68.5 percent and 52.4 percent, respectively. Based on the results, the use of wood, the most traditional cooking fuel, has declined among urban households in Ghana with only 20 percent of households still using it. Kerosene and electricity play a very limited role in cooking in Ghana. Because of the relative high costs of electricity, most of households continue to use it for lighting (similarly to kerosene) but not cooking. Only 11.2 percent and 17.3 percent of households report to cook with electricity or kerosene, respectively. Since a traditional fuel such as charcoal still plays a very prominent role in the energy balance of sub-Saharan Africa, enhancing the households' access to modern cooking fuels would

accelerate the transition to modern fuels. Households currently relying heavily on traditional biomass or biomass-based fuels would benefit from increased cooking efficiency and healthier environment. The specifics of policies formulating and implementing relevant energy use programs need to consider the current use of cooking fuels as identified in this study.

The study results permit establishing household profiles in relation to their cooking fuel usage. Still, income is the major constraint in using modern fuels for cooking. High-income households choose to cook with liquid gas or electricity, and are less likely to use traditional fuel such as wood or charcoal. Household income not only affects household cooking fuel choice, but also the corresponding usage frequency. Therefore, providing affordable modern fuels to the population, especially poor households, continues to be of great importance. Energy subsidies to the low-income households could enhance their use of efficient cooking fuels. In addition, household with regular and stable income, e.g., government or civil employees, are more likely to cook with liquid gas, while less likely to use either wood or charcoal frequently. It indicates that households lacking or having irregular income including the unemployed, students, or the retired are exposed to the effects of cooking fuels that are detrimental to human health and lower environmental quality. High-education of respondents has been found to promote the transition from biomass fuels to modern cooking fuels. Such households are more likely to use liquid gas or electricity and are less likely to use wood, charcoal, or kerosene.. Thus, creating training and education opportunity is essential to encourage that households move up 'the energy ladder'.

Furthermore, the cooking fuel usage frequency is significantly associated with demographic factors. Households of married respondents cook with liquid gas and electricity very often. Age has a significant positive effect on cooking with electricity and kerosene frequently. But, the number of adults significantly increases the usage frequency of less desirable, from the health and pollution standpoint, cooking fuels including wood, charcoal, and kerosene. Households with a large number of elders (61 years or older) are less likely to cook with electricity because of cooking habits. Comparing with residents of the capital city, respondents from households in less developed area, such as Tamale, still heavily rely on wood and charcoal, and are less

likely to often use modern fuels such as liquid gas or electricity.

These consumer cooking fuel usage profiles outlined above provide valuable information about households energy use for fundamental daily functions. The fuel use varies across households and those with more education or income tend to use fuels that generate less health or environmental hazards. Energy aid and promotion program need to consider more on those unmarried households with a number of elders from less developed area.

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Table 1. Descriptive statistics of variables included in the empirical model.

Variable name	Variable description / units of measurement	Mean	Std dev
Dependent variable:			
Fre_wood	How often do you use wood to cook your main meal of the day? 1=not at all; 2=seldom; 3=often; 4=very often	1.365	0.807
Fre_char	How often do you use charcoal to cook your main meal of the day? 1=not at all; 2=seldom; 3=often; 4=very often	2.779	1.037
Fre_lgas	How often do you use liquid gas to cook your main meal of the day? 1=not at all; 2=seldom; 3=often; 4=very often	2.848	1.345
Fre_elect	How often do you use electricity to cook your main meal of the day? 1=not at all; 2=seldom; 3=often; 4=very often	1.175	0.553
Fre_kero	How often do you use kerosene to cook your main meal of the day? 1=not at all; 2=seldom; 3=often; 4=very often	1.260	0.649
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 13-18 years old	0.983	1.205
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_sec	=1 if a respondent has a secondary education (including Se high/GCE O-A level, Vocational school, Technical sch Teacher training)	0.382	0.486
Educ_col	=1 if a respondent has a college education (including Se high/GCE O-A level, Vocational school, Technical sch Teacher training, 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. Frequency of fuel usage in cooking the main meal of the day

Frequency/Percentage	Not at all	Seldom	Often	Very often
Wood	79.12	10.69	4.80	5.39
Charcoal	13.38	27.03	27.88	31.71
Liquid gas	31.50	4.55	11.57	52.37
Electricity	88.84	6.47	2.99	1.69
Kerosene	82.73	11.08	3.59	2.59

Table 3. Ordered probit estimation results of the cooking fuel use frequency in urban households of Ghana, 2011.

Variable name/ Coef (std err.)	Wood N=956	Charcoal N=1003	Liquid gas N=989	Electricity N=941	Kerosene N=940
	Demographic factors				
Married	0.1895	-0.0260	0.2432**	0.3993***	-0.1523
	(0.1244)	(0.0831)	(0.0952)	(0.1470)	(0.1113)
Age	0.0042	0.0013	-0.0013	0.0117**	0.0094*
	(0.0050)	(0.0036)	(0.0041)	(0.0058)	(0.0048)
Children	0.1188***	0.0458	-0.0356	-0.1171**	0.0090
	(0.0396)	(0.0306)	(0.0351)	(0.0591)	(0.0410)
Adult	0.1782***	0.0434**	-0.0406	0.0609	0.0900***
	(0.0279)	(0.0218)	(0.0265)	(0.0384)	(0.0280)
Elder	0.3274***	-0.0312	-0.0876	-0.3248**	-0.0701
	(0.0900)	(0.0685)	(0.0811)	(0.1637)	(0.1039)
	Socio-economic factors				
Income(100 cedi)	-0.0179**	-0.01352***	0.07495***	0.0126*	0.01137*
	(0.0082)	(.0050)	(0.0111)	(0.0072)	(0.0066)
Employ_self	-0.1225	-0.1662	0.0022	-0.6144***	-0.2352
	(0.1414)	(0.1140)	(0.1288)	(0.1704)	(0.1441)
Employ_gov	-0.4879***	-0.4936***	0.5376***	-0.3169*	-0.0797
	(0.1999)	(0.1335)	(0.1571)	(0.1921)	(0.1749)
Educ_sec	-0.3897***	-0.2873***	0.5085***	0.4430***	-.1294
	(0.1196)	(0.0816)	(0.0927)	(0.1426)	(0.1127)
Educ_col	-0.9952***	-0.7488***	0.5666***	0.8895***	-0.4550**
	(0.2760)	(0.1306)	(0.1652)	(0.1897)	(0.1962)
	Location				

Tamale	0.7463***	0.3226***	-0.6749***	-0.9639***	-0.3922***
	(0.1292)	(0.1028)	(0.1229)	(0.2555)	(0.1522)
Takoradi	-0.1196	0.0343	0.0666	-0.1854	-0.0315
	(0.1435)	(0.0930)	(0.1081)	(0.1482)	(0.1262)
	Parameters				
Cut1	1.4452	-1.5130	0.1049	1.8263	1.1277
	(0.2704)	(0.2010)	(0.2250)	(0.3134)	(0.2644)
Cut2	2.0867	-0.5343	0.2783	2.3704	1.7650
	(0.2761)	(0.1983)	(0.2253)	(0.3187)	(0.2686)
Cut3	2.5563	0.2612	0.6420	2.8728	2.185371
	(0.2841)	(0.1970)	(0.2258)	(0.2873)	(0.2739)
Pseudo R-square	0.1963	0.0620	0.1476	0.1310	0.0378

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