Ghanaian Journal of Economics, Vol. 2, December 2014

Analysis of households' demand for cereal and cereal products in Ghana

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Abstract

This paper analyses Ghanaian households' demand for cereals and cereal products with the objective of determining consumption patterns across expenditure (income) groups and estimating price and expenditure elasticities. The Linear Approximate Almost Ideal Demand System (LA/AIDS) is employed and applied to two nationwide household surveys which involved 4,523 and 5,998 households. Missing commodity prices and household expenditure in the datasets were imputed using single and multiple imputation techniques respectively. Overall, the findings indicate that the various expenditure items – rice, maize, guinea corn, sorghum and bread – are price and expenditure (income) inelastic, with significant cross price effects. This shows the possibilities of substitutability and complementarity among cereals in Ghana. Furthermore, the elasticities for households in lower expenditure quintiles are generally higher than the estimates for households in higher expenditure quintiles, an indication that income and price stabilization policies on cereals in Ghana could have far-reaching impact on lower-income households.

Keywords: *Imputation methods, AIDS model, demand analysis, expenditure shares, elasticity*

1. Introduction

Since time immemorial, cereal grains such as rice, maize and wheat have been part of human diet and are believed to have contributed significantly to shaping human civilization (Awika, 2011). According to the Food and Agricultural Organization

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(FAO, 2002), the majority of the world's population depend on cereals as the most important source of food and energy. In Ghana, household expenditure on cereals alone accounts for more than 23% of household total spending on food (Ghana Living Standards Survey Report, 2008). Among the variety of cereal grains, rice is the single most important source of calories followed by wheat and maize. In terms of production, these three grains – rice, wheat and maize - account for more than 50% of the world's production of cereals (Awika, 2011). Given the significance of cereals in human nutrition, it is rather surprising that little research attention has been paid specifically to the analysis of demand for cereals and cereal products (Deaton, 1990; Huang and David, 1993; Kumar et al., 2011). The majority of earlier studies on demand analysis for cereals have either examined a single type of cereal (most commonly rice) or aggregated individual cereal items into one commodity group and examined them as one group (Chesher and Rees, 1987; Deaton, 1987; Abdulai et al., 1999; Abdulai, 2002; Mittal, 2006; Gali and Rao, 2012). However, it can be observed that aggregation of all cereals into one commodity group can potentially result in an overestimation of the elasticities, especially when there are cross price effects among the aggregated individual items. Besides, the aggregation of individual cereal items can also lead to loss of vital information on commodity-specific demand estimates that can be used by policy-makers to assess the likely impact of changes in food policy on household demand and welfare (Teklu, 1996).

In Ghana, the evidence of disaggregated cereal demand analysis is relatively scarce even though there are comprehensive household data available to carry out this analysis (Ghana Living Standards Survey Report, 2008). Ackah and Appleton (2007) as well as Osei-Asare and Eghan (2013) are the few exceptions. But, even with these two studies, there are notable drawbacks beyond the common aggregation problem which warrant research attention. The first of these drawbacks is that the studies do not offer in-depth analysis of demand elasticities differentiated according to income groups. Meanwhile, there is abundant evidence in the literature to suggest that substantial differences may exist in the magnitudes of demand elasticities depending on households' level of expenditure (Pinstrup-Andersen and Caicedo, 1978; Abdulai, 2002). The other major drawback is that, typical of household survey data in general, there are missing values in the Ghana Living Standards Survey data which are not appropriately dealt with by the researchers, thereby creating the possibility of sample selection bias.

To fill the gaps identified in previous research, this study utilizes the data from the Ghana Living Standard Surveys three and four (GLSS 3 & 4) conducted in 1991/1992 and 1998/1999 respectively to estimate the price and expenditure (income) elasticities for cereals and cereal products by applying the Linear Approximate Almost Ideal Demand System (LA/AIDS) model. In the course of the estimation,

missing cluster prices and expenditure are appropriately dealt with using proven methods for imputations (i.e. single and multiple imputation techniques). Sadly, the more recent data in the fifth round of the Ghana Living Standards Survey (i.e. GLSS 5) could not be included in the analysis due to the unavailability of price data in that survey. Nonetheless, we assume that the two earlier surveys reflect the consumption patterns of cereals and cereal products in Ghana which should serve as the starting base for future research. To define what constitutes cereals and cereal products in this study, five major expenditure items - rice, maize, guinea corn, bread and "other cereals" (sorghum, millet and corn dough) - are used to construct the demand system. These five cereals are chosen because of their significance in household total food expenditure (Ghana Living Standards Survey Report, 2008). For each of the cereal items, the demand elasticities (i.e. price and expenditure elasticities) are calculated for five household expenditure groups (i.e. quintiles) which are generated by quintiles of household total expenditure per adult equivalent.

The results of this study show that rice, maize, guinea corn, sorghum and bread are price and expenditure (income) inelastic with significant cross price effects indicating cases of both substitutability and complementarity. Demand elasticities for households in lower expenditure quintiles are generally found to be higher than households in higher expenditure quintiles, suggesting that expenditure (income) and price stabilization policies could have far-reaching impacts on households in lower expenditure (income) group. With these findings, the contributions of this study are mainly in three respects. First, the study provides empirical evidence to support the view that data aggregation, as is the case in some prior studies (e.g. Ackah and Appleton, 2007), can lead to an overestimation of elasticities. Second, the study explicitly addresses the issue of missing data which is largely ignored by most past studies. Finally, the empirical estimates of price and expenditure (income) responses, as segmented by expenditure strata or quintiles, support the arguments of Pinstrup-Andersen and Caicedo, (1978) on the relationship between price elasticity of demand and expenditure (income).

The rest of the paper is organized as follows. Section 2 presents a literature review which summarizes the pertinent empirical studies that have been conducted using the strategies and analytical framework of the Almost Ideal Demand System. Section 3 describes the methodology in detail and how it is applied, including the econometric specification and estimation, data description and sources as well as the imputation methods that are used to impute missing prices and household expenditure from the survey data. Section 4 presents the findings in two main sections: the descriptive statistics highlighting household consumption patterns of cereals and cereal products in Ghana, and demand elasticities, indicating the responsiveness of the commodities to changes in prices and expenditure (income). The results are further discussed in

relation to existing knowledge, noting their implications for policy and government interventions. The last section presents the major conclusion and suggestions for future research.

2. Literature review

From the literature on food demand elasticities, the numerical estimates of demand elasticities for some food expenditure items are far from conclusive. This has been attributed to a number of factors, among them are differences in data types (cross sectional, time-series and panel) and countries' level of development (Zhang et al., 2001; Huang and David, 1993). Comparing the elasticity estimates for rice in Bangladesh, China, India, Indonesia, Japan, South Korea, Pakistan, Philippines and Thailand obtained by different authors, Huang and David (1993) noted that the estimates from cross-sectional household data tended to be higher than those based on aggregated time-series data. Similarly, Zhang et al. (2001) observed that even within the same country (i.e. China) there was a disagreement between time-series studies and cross sectional outcomes over the magnitude of expenditure elasticity for grains. They noted that demand systems estimated based on cross-sectional data yielded larger positive expenditure (income) elasticities for grains compared to estimates from time-series. To resolve the controversy over the magnitudes of these elasticities, Zhang et al. (2001) used panel data at the county level to estimate demand elasticities and the results show that grains have a relatively small positive income elasticity, when compared to other food groups, such as meat and fish. Furthermore, the findings of their study showed that food grains were a complement to vegetables, but a substitute for meat and fish.

Taking into account that methodological differences could also account for the variations in demand estimates, Huang and David (1993) conducted a cross-country study of nine Asian countries (namely; Bangladesh, China, India, Indonesia, Japan, South Korea, Pakistan, Philippines, and Thailand) to estimate demand elasticities (income and price) using the same methodology (i.e. the LA/AIDS model). The analysis focused on three cereal grains (i.e. rice, wheat and coarse grains) with nearly three decades of time series data from 1960 to 1988. For the main part, the results indicated that rice was a normal good and a necessity in most of the countries. The exception however, was that, in Japan and Thailand, income elasticity for total cereals were negative, indicating that rice was an inferior commodity. The authors concluded that although significant differences were still apparent in the estimates, those differences were related to urbanization. High-income countries had a lower demand for cereal grains than lower income countries. Adding urbanization to the econometric specification, the authors found that the income elasticities from the time series turned out to be consistent with those from cross section data.

In another review which focused on empirical studies on food demand in Sub-Saharan Africa, Teklu (1996) reported that the overwhelming majority of the studies used the AIDS model. However, the findings in respect of numerical estimates of demand elasticities were less generalizable for the various food items that were covered (including maize, rice (imported and local), wheat, sorghum, millet, and tubers) and for the different countries (including Burkina Faso, Gambia, Ghana, Niger, Rwanda, Kenya, and Zambia). In most of the country-specific studies, it was observed that food demand in general was responsive to changes in income and prices and the relationships were influenced by other factors such as income characteristics (level, source and form), demographic structure and location. Further, Teklu's (1996) study revealed that most of the studies were conducted at an aggregated level and therefore the priority of future research should be to generate detailed demand estimates that will have a higher utility for disaggregated policy analysis.

In several other studies, the benefits of disaggregated analysis have been reiterated, but the lack of sufficient detailed data has often prohibited such an analysis. Luckily for Ghana, there are comprehensive nationwide household surveys that should allow commodity-specific analysis. To proceed with such analysis, we outline in the next section the methodological approach that is adopted for this study and a description of the data together with how missing values and zero consumption are treated.

3. Methodology

3.1. Econometric specification and estimation

Since the results of this study are not intended to be used for simulation and/or forecasting, the LA/AIDS model is used to characterize consumer behaviour. This model is well-suited for this study due to its many desirable properties underscored in the literature (Deaton and Muellbauer, 1980; Ray, 1982; Buse, 1994; Ackah and Appleton, 2007). Taking into account household demographic characteristics, the LA/AIDS model can be specified at the cluster level for an M-good system as follows:

$$w_{ihc} = \alpha_i + \beta_i \ln\left(\frac{x_{hc}}{a(p)}\right) + \sum_{j=1}^{m} \gamma_{ij} \ln p_{jc} + \phi_1 Z_{hc} + \varepsilon_{ihc} \qquad (1)$$

$$i = 1, \ldots\ldots\ldots\ldots n \quad \ln a(p) = \alpha_0 + \sum_{i=1}^{m} \alpha_i \ln p_i + \frac{1}{2}\sum_{i=1}^{m}\sum_{i=1}^{m} \gamma_{ij} \ln p_i \ln p_j \qquad (2)$$

where w_{ihc} is the expenditure share of the i^{th} commodity of household h in cluster c, x_{hc} is the per capita total expenditure for household h in cluster c, Z is a vector of household characteristics, p_{jc} is the j^{th} commodity price in cluster c, $a(p)$ is the trans-

log price index defined by equation (2), α_i, β_i ,γ_{ij} and ϕ are parameters to be estimated and ε_{ihc} is the random error term with the standard properties. The per capita total expenditure (x_{hc}) is obtained by dividing total household expenditure on cereal and cereal products by household size. Variation in commodity price (p_j) is considered at the cluster level because the price data are at the cluster level.

In most empirical analyses involving the AIDS model (e.g. Ackah and Appleton, 2007), the Stone Price Index (SPI) is often used in place of the trans-log price index stated in equation (2). The benefit of using the SPI is that it permits the linearization of the AIDS model without compromising on efficiency. Hence, this study adopts a similar strategy by replacing equation (2) with the SPI expressed in mathematical form as:

$$\ln p^*_c = \sum_{i=1}^{m} w_{ic} \ln p_{ic} \tag{3}$$

where w_{ic} is the cluster expenditure share for commodity i in cluster c and p_{ic} is the price of commodity i in cluster c. It is important to note that the use of the SPI can potentially create simultaneity problems due to the budget shares appearing on both sides of the equation. An alternative index that could be used is the Fisher Price Index (FPI) but this was not feasible in this study due to data limitations.

For the AIDS model to be consistent with theory, the restrictions of adding-up ($\Sigma_i \alpha_i = 1; \Sigma_i \beta_i = 0; \Sigma_i \gamma_{ij} = 0$), homogeneity ($\Sigma_i \gamma_{ij} = 0$) and symmetry ($\gamma_{ij} = \gamma_{ij}$) must always hold. Consequently, we imposed these restrictions as a matter of necessity and logical thing to do. In order to obtain the elasticities for the expenditure items, the empirical strategy of Chalfant (1987) is used to derive the formulae. For each cereals and cereal product, the expenditure elasticity, uncompensated own-price and cross-price elasticities and compensated own-price and cross-price elasticities are expressed as follows:

$$e_i = \frac{\partial \ln q_i}{\partial \ln x} = 1 + \frac{1}{w_i}\frac{\partial w_i}{\partial \ln x} = 1 + \frac{\beta_i}{w_i} \tag{4}$$

$$\varepsilon_{ii} = -1 + \frac{1}{w_i}\frac{\partial w_i}{\partial \ln p_i} = -(1+\beta_i) + \frac{\gamma_{ii}}{w_i} \tag{5}$$

$$\varepsilon_{ij} = \frac{\partial \ln q_i}{\partial \ln p_j} = \frac{1}{w_i}\frac{\partial w_i}{\partial \ln p_j} = \frac{\gamma_{ij}}{w_i} - \beta_i\left(\frac{w_j}{w_i}\right) \tag{6}$$

$$e^*_{ij} = \varepsilon_{ij} + w_j e_i \tag{7}$$

where q_i is quantity demanded of the i^{th} commodity and all other variables are the same as previously defined. Given the theoretical restrictions imposed on the model, the Seemingly Unrelated Regression (SUR) procedure relying on maximum likelihood technique is employed to estimate the system of demand equations simultaneously. However, because budget shares are used in the system of equations, one of the equations has to be dropped to avoid a singular matrix. According to Pollak and Wales (1969), the SUR procedure is invariant to which equation is dropped. Therefore, the demand equations for "other cereals" is conveniently dropped and recovered from the $M-1$ equations after estimation. By a similar argument, the price of "other cereals" is treated as a numeraire and set to unity.

In demand models such as the AIDS, the Rotterdam and the Trans-log, where total expenditure is used to approximate household's income, it is usually the case that total expenditure is endogenous. This problem occurs because household expenditure can be correlated with unobserved characteristics affecting demand or influenced by common shocks (Fulponi, 1989; Blundell and Robin, 1999; Robin and Lecoeq, 2006; Barslund, 2011). In the presence of endogeneity, parameter estimates become inconsistent and biased and therefore to correct for endogeneity, the augmented regression approach by Hausman (1978) and Blundell and Robin (1999) was adopted. This approach involves two steps. In the first step, total expenditure on cereals is regressed on all the variables in the system including an instrument (i.e. household total income) for total expenditure on cereals. The second step involves predicting the residual of the regression in the first step and then including the residual as an additional explanatory variable in the AIDS demand system. As suggested by Blundell and Robin (1999), a straightforward test for endogeneity for each demand equation in the system is the significance of the included residual (Barslund, 2011). Blundell and Robin (1999) argue that, if total expenditure is exogenous in a particular demand equation, the coefficient of the residual variable should be insignificant for that equation. The results of the first step regression and the second step regression confirming endogeneity are reported in Tables A5-A7 in the appendix.

3.2. Data description

The data sources for this paper are the Ghana Living Standard Survey rounds three and four (GLSS 3 and GLSS 4), conducted in 1991/1992 and 1998/1999 respectively. These datasets are multidimensional household-level nationwide surveys conducted by the Ghana Statistical Service (GSS) to obtain a variety of information on living standards including incomes and expenditure. By definition, a household in both surveys refers to a group of people who usually have slept in the same dwelling and took their meals together for a minimum of 9 months out of the 12 months preceding the interview. Besides the household-level data, the surveys also included cluster

price data for 123 expenditure items (both food and non-food expenditure items). A cluster or enumeration area was demarcated as a geographic area consisting of a locality or group of localities that could be managed by one enumerator. In each cluster, three different prices were collected in a local market (the biggest market in the cluster) for all expenditure items (over 200 food and non-food) at different points in the market. For most of the items the three prices turned out to be the same. However, to capture all seasonal variations, the mean price was used. Robustness checks with median price were also performed. In total, the GLSS 3 data set has a random sample of 4,523 households, comprising 1,578 urban households and 2,945 rural households within 365 clusters while the GLSS 4 has a random sample of 5,998 comprising 2,199 urban households and 3,799 rural households in 300 clusters. In terms of duration, each survey was conducted over a period of one year.

3.3. Treatment of zero consumption and imputation of missing values

In dealing with household survey data it is not uncommon to observe that several commodities may have consumption values of zero (Dey, 2000). Such zero consumption may be due to the following reasons: imperfect recall by households; non-consumption during the survey period; permanent non-consumption, or simply missing (Tafere et al., 2010). Examining the GLSS 3 and 4 data, zero expenditure was evident (see Table A1 in the Appendix for the results). Not accounting for zero consumption could lead to inconsistent and biased estimates (Pudney, 1989; Heien and Wessells, 1990; Yen and Lin, 2006; Tafere et al., 2010; Barslund, 2011). In order to deal with this problem, the two-stage approach proposed by Heien and Wessells (1990) was adopted. In the first stage, a household's decision to consume a particular commodity is modelled as a dichotomous choice problem expressed in equation 8 and estimated by a probit model for each individual expenditure item.

$$w_{ihc} = f(p_{ic}, p_{jc}, \ldots\ldots, p_{nc}, x_{hc}, Z_{hc}) \tag{8}$$

where w_{ihc} is 1 if the h^{th} household in cluster c consumes the i^{th} expenditure item, (i.e. if $w_{ihc} > 0$) and 0 if the household does not consume the item in question. p, x and Z are commodity prices, household total expenditure on cereals and demographic and household characteristics that influence the household's decision to consume or not consume the commodity in question. From the results of the probit regression, an inverse Mills ratio is then determined for all households (both the consuming and non-consuming households) and included in the AIDS model as an additional explanatory variable in the second stage to obtain the censored demand system:

$$w_{ihc} = \alpha_i + \beta_i \ln\left(\frac{x_{hc}}{a(p)}\right) + \sum_{j=1}^{m} \gamma_{ij} \ln p_{jc} + \phi_i Z_{hc} + \delta_i \lambda_{ihc} + \varepsilon_{ihc} \tag{9}$$

where δ_i is the coefficient of the inverse Mills ratio and λ_{ihc} is the inverse Mills ratio,

which is determined as, $\lambda_{ihc} = \frac{\phi(p,z,x)}{\Phi(p,z,x)}$ for households that consume the expenditure item and for households that do not consume the expenditure item. The numerator, $\phi(p,z,x)$ is the probability density function and $\Phi(p,z,x)$ is the cumulative density function and all other variables remain same as defined in equation (1).

Apart from the zero expenditures, the GLSS 3 and 4 datasets required some adjustment for outliers and imputations of missing cluster price and expenditure shares (see Table A1 and A2 in the appendix for the incidence of missing cluster price and expenditure shares respectively). With regards to outliers, the Cox and Wohlgenant's (1986) rule of removing commodity prices that are not within five standard deviations of their respective means was applied. With price variation at the cluster level, all households in the same cluster were assumed to face the same price. This assumption is based on the law of one price. For the clusters where prices were not reported, the method of single imputation as outlined by Niimi (2005), and Ackah and Appleton (2007) was employed. That is, in clusters where the prices were missing or not reported, the mean price for Accra, other urban, rural coastal, rural forest and rural savannah for each region sampled in the same quarter was assigned to households in that cluster. After this correction, there were instances where cluster prices were still missing due to the lack of reported data for Accra, other urban, rural coastal, rural forest or rural savannah. In such cases, we replaced them with the mean price for urban/rural for the region in which they were found. After this process, if there were still missing cluster prices, they were replaced with the mean regional price.

Regarding missing expenditure shares, the technique of multiple imputation proposed by Rubin (1977) and widely used because of its many attractive properties, was adopted to impute the values of missing expenditure data for each expenditure item. The many attractive properties of Rubin's (1977) technique include its ability to introduce appropriate random error into the imputation process which makes it possible to get approximately unbiased estimates of all parameters and good estimates of the standard errors (Little, 1992; Little and Rubin 2002; Haziza, 2009). Other merits of the technique are that it can be used with any kind of data and any kind of analysis without specialized software (Rubin, 1987). Knowing that the quality of a multiple imputation model influences the quality of results, the selection of the variables to be included in the imputation model was carefully considered and based on the statistical significance of an empirical regression results. The results of these regressions are not included in this paper, but are available upon request. Only significant variables were used to constitute the imputation models. In applying imputation models, a decision to either use a multivariate normal model or imputation by chained equations (ICE) has to be made. The latter, ICE, is used because it is known to generate imputed values that tend to resemble the observed values. As a confirmation of its superiority, the imputed values generated through

the ICE are graphed with the observed values in Figures A1 and A2 in the appendix. Clearly, the imputed values do not fall outside reasonable limits, providing assurance that the imputed values are reliable.

4. Results and discussion

The results of the data analysis are organized into two main parts. The first part presents the descriptive statistics, which highlight the patterns of consumption between the two sample periods and the average expenditure shares for the various individual items by income groups. The second part is devoted to the demand elasticities which are segmented by income groups and disaggregated into compensated and uncompensated elasticities.

4.1. Descriptive statistics

Table 1 presents the average household expenditure on the various cereals and cereal products – maize, rice, guinea corn, bread and other cereals. From the summary statistics it can be observed that, in both GLSS 3 and 4, the average household expenditure on rice is the highest among the cereals and cereal products, followed by bread and guinea corn. The item with the lowest average expenditure is maize. These findings may be suggestive that Ghanaian households spend more on rice which could be explained by the price differential among the commodities as shown in Table 2.

Table 1: Average Expenditure shares of Commodities

Commodity	GLSS 3		GLSS 4	
	Mean	Std Dev	Mean	Std Dev
Maize	0.114	0.203	0.124	0.188
Rice	0.319	0.242	0.329	0.215
Guinea corn	0.155	0.211	0.167	0.197
Bread	0.245	0.206	0.219	0.174
Other Cereals	0.167	0.220	0.160	0.175

Source: Author's calculation from Ghana Living Standards Survey (GLSS) Rounds three and four

Notes:

- Ghana Living Standards Survey (GLSS) Round three and four has 4,523 and 5,998 households respectively.
- The household's expenditure on a particular item is obtained by summing the cash expenditure and the imputed value of the own-produced of that particular item.
- The expenditure share is the proportion of household expenditure on a particular commodity in total household expenditure on cereal and cereal products. It is obtained by dividing the household expenditure on a commodity by the total household expenditure on cereal and cereal products.

Comparing the prices of the items in Table 2, especially the GLSS 4 data, it can be observed that the expenditure amounts are more or less a mirror reflection of the real prices. Rice and bread which are the most expensive items in real terms in the GLSS 4 data (GH¢ 0.214 and GH¢ 0.234) are also the commodities with the highest expenditure shares (0.329 and 0.219) respectively. Conversely, the expenditure items with the lowest average expenditure i.e. maize and guinea corn, are also the least expensive commodities. Another plausible explanation why the average expenditure on maize and guinea corn could be lagging behind rice is that relatively more households in Ghana do cultivate maize than rice and therefore could be spending less on maize because it is self-produced.

Table 2: Average Nominal and Real commodity prices (GH¢ per kg)

	GLSS 3		GLSS 4	
Commodity	Nominal Price	Real Price	Nominal Price	Real Price
Maize	0.011	0.070	0.055	0.064
Rice	0.023	0.150	0.181	0.214
Guinea Corn	0.010	0.067	0.070	0.083
Bread	0.013	0.085	0.195	0.234
Other Cereals:				
Sorghum	0.040	0.267	-	-
Millet	0.025	0.162	0.111	0.130
Corn Dough	0.023	0.151	0.109	0.127

Source: Author's calculation from Ghana Living Standards Survey (GLSS) round three and four in 1991/1992 and 1998/1999 respectively.

Notes:

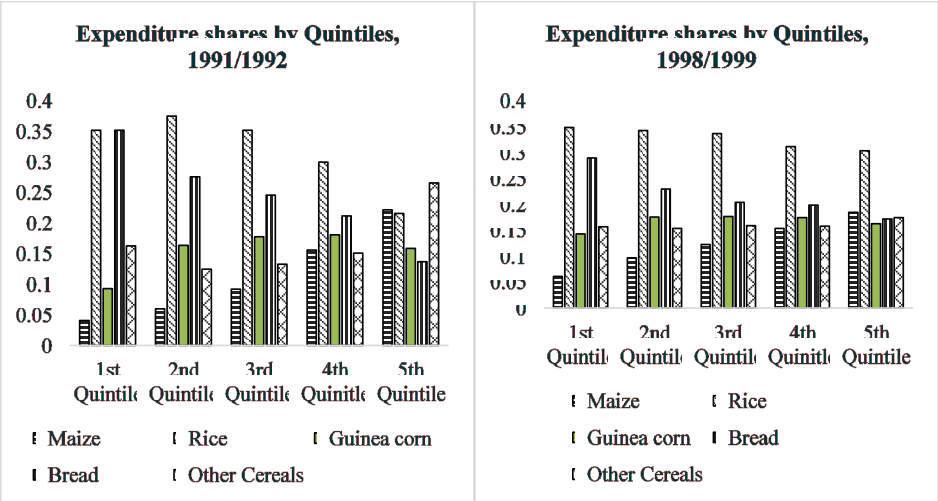
- Ghana Living Standards Survey (GLSS) Round three and four has 4,523 and 5,998 households respectively.
- Real price was obtained by deflating nominal price using the food price index with 1999 Accra price as base as reported in the GLSS data. Prices have been converted for old cedi to Ghana cedi by dividing the old cedi by 10,000. All prices are in per kilo terms

For the purpose of demand elasticities, it is also interesting to note the relationship between the prices. These results are shown in the correlation matrix reported in Table A3. Suffice to say that even though correlation does not suggest causation, the results generally suggest some relationship between the prices, albeit weak.

To illustrate the variation in consumption across households, the average expenditure shares are disaggregated into five expenditure groups known as quintiles, where the 1st quintile represents the 20% of the sample with the lowest expenditure share and the 5th quintile represents the 20% of the sample with the highest expenditure share. The results of this analysis are depicted in Figure 1.

Consistent with a priori expectation, households in the bottom quintile (i.e. 1st Quintile) spend more on almost all items (except maize) than their counterparts in the top quintile (i.e. 5th Quintile). The justification for this is that, because we are

Figure 1: Expenditure shares by Quintiles of total expenditure on Cereals



dealing with food items, low-income households tend to spend more on these items than their counterpart high-income households.

Additional summary statistics regarding the demographic characteristics (e.g. gender and household size) and location variables of household used in the modelling are all reported in Table A4 in the appendix. Overall, the samples in both surveys are not balanced among the ten regions of Ghana and between localities (rural and urban). The three Northern regions, namely Upper East, Upper West and Northern, have fewer households in the samples. Also, more than half of the households (65% in GLSS 3 and 63% in GLSS 4) are located in rural areas. Markedly, households headed by males dominate the samples, 68% in GLSS3 and 66% in GLSS 4. The average age of a household head, is 44 years in GLSS 3 and 46 in GLSS 4. In terms of household sizes, the average is around 4 individuals for both surveys. Furthermore, the results in Table A4 show the summary statistics for the instrument (i.e. total household income). In the GLSS 3 data, the average nominal household income is Gh₵ 37.32 while in GLSS 4 it is Gh₵ 216.90. Even though this result is corroborated by GLSS 3 & 4 reports (see Table A9 for an extract) released by the Ghana statistical Service (GSS), this represents a phenomenal increase in nominal income between the two sample periods. Corresponding to this growth, the real income only increased marginally by 2.5% from 237.45 to 243.39, suggesting that the astronomical increase in nominal income was palpable. Not too surprisingly, a further analysis of the income components of total nominal income reveals that income from agricultural activities and non-farm self-employment, which are largely unregulated by employment contracts exerting rigidities, are the highest (see Table A8 in the appendix).

Last but not least, the results in the appendix also include the various regression outputs. Worthy of note is the results relating to the parameter estimates of the LA/AIDS model. These results, reported in Tables A6 and A7 in the appendix, indicate that, at the 1 % level of significance, all the expenditure share of the various commodities are inversely related to total household expenditure on cereals. Precisely, the regression coefficients for total household expenditure on cereals are very small, ranging from -0.041 to -0.167 in GLSS 3 and -0.031 to -0.067 in GLSS 4. These findings give indications that the various commodity groups are necessities and not luxuries. Demographic characteristics such as age of household head, sex of household head and size of the household also have significant influence on the expenditure shares of most of the items.

4.3. Demand elasticities

4.3.1 Expenditure and price elasticities for cereals and cereal products

Table 3 presents the estimates for expenditure, own and cross price elasticities for the two sample periods evaluated at the sample means. Except for guinea corn, which has a negative expenditure elasticity in 1991/1992 and a positive expenditure elasticity in 1998/1999, all the other cereals and cereal products (rice, maize, guinea corn and bread) have positive expenditure elasticities and are all less than one. This confirms that most of the cereals and cereal product consumed by Ghanaian household can be regarded as necessities. In other words, a proportionate increase in expenditure (income) will lead to a less-than proportionate increase in the consumption of cereals, all else remaining the same. With reference to the guinea corn, the inconsistent findings are suggestive that some food items may change from inferior to normal (or perhaps even vice versa) depending on the prevailing economic conditions. Further, a closer inspection of the results also reveals that, in 1998/1999 where the mean expenditure on rice (0.402) is the highest, and followed by bread (see Table 1), the corresponding expenditure elasticities for rice (0.858) is also higher than bread (0.834). Intuitively, this can be given the interpretation that Ghanaian households who spend proportionately higher on food tend to be more expenditure responsive than their counterpart with lower average expenditure shares.

The results in Table 3 also show the own price elasticities (marked in grey colour on the principal diagonal) and the cross price elasticities (shown off the principal diagonal) reported in terms of both uncompensated and compensated demand. The significance of reporting both the compensated and uncompensated price elasticities is that the former is deemed to provide a more accurate measure of cross-price substitution between commodity groups (Abdulai, 2002). As a basic distinction, compensated price elasticities capture the substitution effect of a price change holding income constant. Stated differently, the uncompensated price elasticity captures both the substitution and the income effect of a price change while the

compensated price elasticity only represents the substitution effect. Focussing on the own price elasticities of demand for both compensated and uncompensated, it can be noticed in Table 3 that, consistent with a priori expectation and demand theory, all the individual expenditure items have negative elasticities ranging from -0.425 to -1.369. However, a comparison of the individual figures for each expenditure item indicates higher values for uncompensated price elasticities than compensated price elasticity, signifying that the commodities are normal goods. The exception, however, is guinea corn, which has higher absolute value for compensated price elasticity (-0.502) than uncompensated (-0.485) in 1991/1992. This is due to the commodity being an inferior good.

Table 3: Expenditure and price elasticity matrix -1991/1992 and 1998/1999

Prices	Expenditure elasticity	Commodity				
		Maize	Rice	Guinea Corn	Bread	Other Cereals
Uncompensated demand – 1991/1992						
Maize	0.278*	-0.457***	0.037**	0.132**	-0.115***	-0.968***
	(0.163)	(0.136)	(0.044)	(0.056)	(0.028)	(0.314)
Rice	0.762***	0.047	-0.958***	0.294***	0.214***	0.397
	(0.069)	(0.096)	(0.035)	(0.044)	(0.027)	(0.465)
Guinea Corn	-0.110	0.121	0.009	-0.485***	-0.160***	-0.613**
	(0.101)	(0.076)	(0.024)	(0.067)	(0.030)	(0.308)
Bread	0.836***	-0.113*	0.184***	-0.021	-0.804***	-0.605*
	(0.074)	(0.061)	(0.023)	(0.041)	(0.041)	(0.334)
Other Cereals		-0.981*	0.624**	-0.116	-0.026	-1.369***
		(0.513)	(0.245)	(0.339)	(0.246)	(0.016)
Compensated demand – 1991/1992						
Maize		-0.425**	0.049	0.119*	-0.021	-0.611*
		(0.122)	(0.042)	(0.054)	(0.026)	(0.325)
Rice		0.135	-0.717***	0.259***	0.479***	1.397**
		(0.116)	(0.035)	(0.041)	(0.033)	(0.455)
Guinea corn		0.164*	0.127***	-0.502***	-0.030	-0.124
		(0.075)	(0.021)	(0.061)	(0.025)	(0.304)
Bread		-0.045	0.371***	-0.048	-0.599***	0.276
		(0.056)	(0.026)	(0.040)	(0.034)	(0.338)
Other Cereals		-0.934	0.754**	-0.135	0.117	-0.829***
		(0.524)	(0.246)	(0.334)	(0.239)	(0.004)

Uncompensated demand – 1998/1999						
Maize	0.750***	-0.553***	0.028***	0.226***	-0.065**	-1.423***
	(0.057)	(0.060)	(0.025)	(0.036)	(0.023)	(0.308)
Rice	0.858***	0.038	-0.968**	0.378***	-0.046	0.628**
	(0.034)	(0.063)	(0.036)	(0.046)	(0.046)	(0.326)
Guinea corn	0.605**	0.332**	0.151	-0.948***	0.060*	0.179
	(0.083)	(0.051)	(0.020)	(0.038)	(0.029)	(0.391)
Bread	0.834***	-0.133**	-0.035	0.128**	-0.939***	-0.341
	(0.049)	(0.039)	(0.028)	(0.045)	(0.039)	(0.281)
Other Cereals		-1.605***	0.506**	0.412	-0.040	-1.181**
		(0.409)	(0.156)	(0.347)	(0.201)	(0.035)
Compensated demand – 1998/1999						
Maize		-0.460***	0.079**	-0.151***	0.168***	-1.158**
		(0.060)	(0.023)	(0.033)	(0.021)	(0.320)
Rice		0.209**	-0.685***	0.578***	0.229***	1.333***
		(0.061)	(0.039)	(0.038)	(0.036)	(0.322)
Guinea corn		-0.205**	0.295***	-0.846***	0.200***	0.539
		(0.047)	(0.021)	(0.041)	(0.026)	(0.373)
Bread		0.297***	0.153***	0.260***	-0.756***	0.192
		(0.038)	(0.025)	(0.034)	(0.043)	(0.278)
Other Cereals		-1.486**	0.642**	0.508	0.092	-0.841**
		(0.408)	(0.156)	(0.352)	(0.201)	(0.002)

Source: Author's calculation from GLSS 3

Notes: Standard errors in parentheses. They are obtained by bootstrapping cluster of observations (1000 replications)
***, **,* denote significance at 1, 5 and 10 percent respectively

Figures marked in grey colour are own price elasticities of demand

Furthermore, the results in Table 3 reveal that, in both samples, maize is the least price elastic commodity, followed by guinea corn, bread, rice and "other cereals". This suggests that for any uniform price stabilization policy on these commodities, the welfare impact on maize relative to the other cereals and product could be lower holding all other things equal. On a fiscal side, it can also be suggested that the imposition of tax on maize could potentially yield more revenue to the government than the other products because it is less elastic. Given the absolute values of the own-

price elasticities of demand, it can be concluded that all the individual expenditure items exhibit price inelastic demand.

Additional results worth noting from Table 3 are the cross price elasticities of demand depicted off the principal diagonal. Among other interpretations, these results indicate that the expenditure item, bread is complementary to both maize and guinea corn (i.e. negative cross price elasticity) but substitute to rice (i.e. positive cross price elasticity). A possible explanation for this finding is that because maize and guinea corn are commonly used to prepare food such as porridge in Ghana which tends to be consumed with bread, these two cereals are perceived as substitutes but complement to bread. However, in the case of rice, guinea corn and maize, which appear to be substitutes, the findings may be suggesting that these cereals are alternative ingredients that are probably used to prepare many common dishes within the Ghanaian context.

4.3.2. Expenditure and price elasticities by expenditure groups

To capture the differences in elasticities according to expenditure (income) groups, households' spending on the various expenditure items were grouped into quintiles, where 1 represents households with the lowest expenditure (income) bracket on any given cereals or cereal product and 5 represents households with the highest expenditure (income) bracket. The results of the analysis are reported in Table 4. As expected, the expenditure elasticities of households in the bottom quintile are higher than those in the top quintile. This implies that lower- expenditure (income) households are more expenditure (income) sensitive than higher-expenditure (income) households. The possible explanation for this is that because households in lower quintiles tend to have a more stringent budget constraint and a level of income that can barely support their basic necessities, they are likely to react more to changes in expenditure than their counterparts in the upper quintiles.

Table 4: Expenditure elasticities by quintiles of total household expenditure

ITEM	Quintiles				
	1	**2**	**3**	**4**	**5**
GLSS 3 – 1991/1992					
Maize	1.15*	1.25**	1.47***	1.36*	0.22
	(0.65)	(0.50)	(0.33)	(0.39)	(0.22)
Rice	1.08**	0.98***	0.85**	0.92**	0.81***
	(0.22)	(0.13)	(0.15)	(0.22)	(0.17)

GUC	0.71*	0.89**	0.75**	0.95**	-0.02
	(0.42)	(0.24)	(0.36)	(0.33)	(0.29)
Bread	0.89***	1.10**	1.11***	0.73***	0.56**
	(0.16)	(0.14)	(0.18)	(0.17)	(0.19)
GLSS4 – 1998/1999					
Maize	0.92**	1.40**	0.81***	0.40	0.82***
	(0.44)	(0.29)	(0.17)	(0.25)	(0.17)
Rice	0.93***	1.11**	1.04***	1.06**	0.58***
	(0.15)	(0.08)	(0.07)	(0.14)	(0.10)
GUC	1.19**	0.60*	1.29***	1.29***	0.71***
	(0.31)	(0.14)	(0.10)	(0.15)	(0.18)
Bread	1.08***	1.04*	1.04***	1.10**	0.56***
	(0.16)	(0.09)	(0.08)	(0.12)	(0.13)

Source: Author's calculation from GLSS 3 & 4

Standard errors in parentheses

Standard errors are obtained by bootstrapping cluster of observations (1000 replications)

***, **,* denote significance at 1, 5 and 10 percent respectively

GUC = Guinea Corn; OTC= Other Cereal

Similar to the quintile analysis of expenditure elasticities, Table 5 presents the results of the own-price elasticities by quintiles. In the GLSS 3 data, except bread and guinea corn, the own- price elasticities for all other commodities are higher for households in the lower quintile compared to households in the highest quintile. However, in the GLSS 4, there are no exceptional cases; the own-price elasticities for all items are higher for households in the lower bottom than households in the top quintile. Analogous to the interpretation of expenditure elasticities, these results signify that lower-income households are more price sensitive than households in the higher expenditure (income) group.

Table 5: Own-price elasticities by quintiles of total household expenditure

Item	Quintiles				
	1	2	3	4	5
GLSS 3 – 1991/1992					
Maize	-1.40**	-0.28	-0.40	-0.38	-0.46**
	(0.71)	(0.70)	(0.38)	(0.30)	(0.23)
Rice	-1.13**	-1.03***	-0.78***	-0.95***	-0.82***
	(0.21)	(0.17)	(0.13)	(0.15)	(0.26)
GUC	-0.41	-1.07	-0.42*	-0.78**	-1.14**
	(0.37)	(0.24)	(0.25)	(0.34)	(0.34)
Bread	-0.86**	-0.67**	-1.11***	-0.51**	-1.44***
	(0.20)	(0.22)	(0.22)	(0.24)	(0.43)
OTC	-1.04*	-0.98*	-0.99**	-1.03*	-1.42*
	(0.04)	(0.02)	(0.03)	(0.04)	(0.04)
GLSS 4 – 1998/1999					
Maize	-0.83**	-0.01	-0.65**	-0.60**	-0.62**
	(0.30)	(0.31)	(0.24)	(0.20)	(0.21)
Rice	-1.18***	-0.73**	-1.06**	-0.99***	-0.86***
	(0.16)	(0.16)	(0.13)	(0.13)	(0.14)
GUC	-1.11**	-1.13**	-1.02**	-0.46**	-0.87***
	(0.20)	(0.18)	(0.13)	(0.16)	(0.20)
Bread	-1.13***	-0.73**	-1.13***	-0.81***	-1.04***
	(0.15)	(0.13)	(0.12)	(0.14)	(0.16)
OTC	-0.98**	-1.00	-0.94***	-1.01*	-1.28*
	(0.05)	(0.02)	(0.02)	(0.03)	(0.03)

Source: Author's calculation from GLSS 3 & 4

Standard errors in parentheses

Standard errors are obtained by bootstrapping cluster of observations (1000 replications)

***, **,* denote significance at 1, 5 and 10 percent respectively

GUC = Guinea Corn; OTC= Other Cereal

To highlight the contributions of this study, the findings are discussed in relation to some prior studies in the literature. Particularly, the studies conducted by Senauer (1990), Jones et al. (1994), and Raunikar et al. (1985) are worth mentioning. These studies have also analysed price and income responsiveness by income groups and found similar results to those in this study. That is, lower expenditure (income) households are more price and income/expenditure sensitive than households in higher expenditure (income) groups. A number of other studies have also been conducted in different countries using similar strategies as the ones adopted in this

study but focussing on various commodities. For example, Tafere et al.'s (2010) study was on food demand in Ethiopia, Garcia et al. (2005) estimated price and income elasticities for fish in the Philippines, Timmer (1981) computed elasticities for rice and cassava in Indonesia, and Dey (2000) also analysed demand for fish types in Bangladesh.

Using time series data, Huang and David (1993) have analysed demand for cereal grains in nine Asia countries, including Bangladesh, China, India, Indonesia, Japan, South Korea, Pakistan, Philippines, and Thailand. Although Huang and David's (1993) study used time series data as opposed to the cross sectional survey adopted in this study, the findings are still comparable qualitatively. Consistent with the findings of this study, the total expenditure elasticities of demand for rice in the less developed countries were positive and ranged from 0.25 (in the Philippines) to 0.53 (in India). By contrast, the most developed countries in Huang and David's (1993) study such as Japan had a negative total expenditure elasticity of demand for rice as will be expected for a country with one of the world's highest per capita income.

In the context of Ghana, this study is the first to be conducted focusing on only cereals and cereal products. As noted in the introduction, the prior studies of Ackah and Appleton (2007) as well as Osei-Asare and Eghan (2013) have also estimated price elasticities for cereals but not at a disaggregated level. Nevertheless, by comparing the findings of their studies to the current one, it can be noted that the elasticity estimates obtained by combining all cereals into one commodity group are more than the respective elasticities when cereals are disaggregated. This suggests that, indeed, data aggregation may result in overestimation of price elasticity, especially when cross price effects are evident as is the case in this study. For this reason, the disaggregated approach adopted in this study has shed some more light not only on the elasticities of the various cereals but also on the benefit of data disaggregation. Different from the other studies, this study is also the first of its kind to explicitly deal with missing cluster prices and expenditure values in a nationwide household survey in Ghana. In this respect, our findings are not subject to the possible biases and inconsistencies introduced by the complete case analysis method of dealing with missing values. Therefore, it is possible for future researchers to follow the example of this study.

5. Conclusion, implications and directions for future research

For many government policies, especially price stabilization policies and tax/subsidy reforms, it is valuable to analyse consumers' responsiveness to changes in price and income. It is even more important, if the analysis is done at a disaggregated level which avoids the tendency to provide misleading estimates due to cross price effects. Taking cognizance of this need and the existence of missing values in Ghanaian

household surveys, this paper empirically analysed two household survey data in Ghana in order to derive demand elasticities for cereals and cereal products which could be used for policy advice. The linear approximate version of the AIDS was adopted as the main analytical technique due to its many desirable properties. In all, five-commodity groups involving rice, maize, guinea corn, bread and other cereals were constructed and estimated using the seemingly unrelated regression techniques. The major findings are that: a) households' consumption patterns of cereals and cereal products did not vary significantly between the two survey periods (1991/92 and 1998/99); b) expenditure and price elasticities for cereals and cereal products are relatively small in Ghana ranging from -0.425 to -1.369 for expenditure elasticities and -0.457 to -1.369 for own price elasticity; c) there are significant cross price effects among cereals and cereal products; and d) expenditure (income) elasticities and price elasticities are higher for lower-income households than higher-income households.

Based on the findings of this study certain conclusions and implications can be drawn. First, it can be concluded that household demands for cereals and cereal products in Ghana are expenditure and price inelastic and as such can be regarded as normal goods which are also necessities. With this finding in mind, it implies that government's imposition of taxes on these food items could be effective at raising revenue, but also creating a higher incidence on consumers relative to producers. Second, the presence of cross price effects indicates that there are opportunities for coordinating government policies on agricultural products. That is, government can use taxes and subsidies on one expenditure item to realign consumption to its productive capacity areas. Finally, with respect to the quintile analysis, it can be concluded that low income groups in Ghana may be the most affected by changes in prices and income. Hence, government price stabilization or food assistance programmes in the form of subsidies could be more beneficial to the poor, all things being equal.

Like all other studies, this study has its own limitations relating to the datedness of the survey data, the limited number of food items considered and the use of Stone Price Index to linearize the AIDS model. Much as these have been identified as limitations, they also represent opportunities for future research. As indicated previously, the most recent survey data could not be used because the price data are not available. However, given the hindsight from this study, lumping cereals into "other cereals" produced the highest elasticity, confirming the belief that data aggregation has the tendency to probably overstate elasticity measures. Thus, as a possible extension to this study, future research can further disaggregate the data. Also, because the results of this study were not intended for any simulation or forecasting purposes, the linear version of the almost ideal demand system was considered suitable for the objectives of the current study. In future studies, the quadratic almost ideal demand

system could be employed. But, where the linear version is still required then alternative price indices such as the Fisher Price Index or the Laspeyres Price Index could be substituted for the Stone's Price Index.

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Appendix

Table A1: Incidence of zero consumption and missing values

Commodity	GLSS 3		GLSS 4	
	Zero consumption (%)	Missing values (%)	Zero consumption (%)	Missing values (%)
Maize	37.03	37.74	32.82	30.78
Rice	6.01	35.20	5.75	18.42
Guinea corn	23.83	36.33	17.01	30.23
Bread	3.16	25.89	2.32	14.22
Other Cereals	4.89	61.77	5.65	33.88

Source: Author's calculation from Ghana Living Standards Survey (GLSS) round three and four in 1991/1992 and 1998/1999 respectively.

- Ghana Living Standards Survey (GLSS) Round three and four has 4,523 and 5,998 households respectively

Table A2: Incidence of missing cluster prices

Commodity		GLSS 3		GLSS 4	
		Number of missing cluster prices	% of total cluster	Number of missing cluster prices	% of total cluster
Maize		141	38.63	70	23.33
Rice		118	32.33	81	27
Guinea corn		113	30.96	133	44.33
Bread		214	58.63	70	23.33
Other Cereals:					
	Sorghum	123	33.70	274	91.33
	Guinea corn	253	69.32	187	62.33
	Corn Dough	263	72.05	200	66.67

Source: Author's calculation from Ghana Living Standards Survey (GLSS) round three and four in 1991/1992 and 1998/1999 respectively.

- Ghana Living Standards Survey (GLSS) Round three and four has 4,523 and 5,998 households respectively. Round three and four has 365 and 300 clusters respectively.

Table A3: Price correlation matrix for GLSS 3

	Maize	Rice	GCorn	Bread	Millet	CDou
GLSS3						
Maize	1.000					
Rice	0.132	1.000				
Guinea Corn	0.122	0.612	1.000			
Bread	0.298	0.005	-0.034	1.000		
Millet	0.067	0.246	0.662	0.116	1.000	
Corn Dough	0.281	0.330	0.200	0.098	0.102	1.000
GLSS4						
Maize	1.000					
Rice	-0.117	1.000				
Guinea Corn	0.078	-0.097	1.000			
Bread	-0.129	-0.110	-0.236	1.000		
Millet	-0.047	-0.096	0.396	-0.044	1.000	
Corn Dough	0.136	0.043	0.054	-0.003	0.026	1.000

Source: Author's calculation from GLSS 3

GCorn= Guinea Corn; Sor= Sorghum; CDou= Corn Dough

Table A4: Sample means of demographic and location variables

Variables	**Description**	**GLSS 3**	**GLSS 4**
Region		**%mean**	**%mean**
Western Region	Household Located in Western	0.11	0.11
Central Region	Household Located in Central	0.11	0.12
G. Accra Region	Household Located in G. Accra	0.14	0.14
Volta Region	Household Located in Volta	0.15	0.11
Eastern Region	Household Located in Eastern	0.09	0.14
Ashanti Region	Household Located in Ashanti	0.16	0.18
B. Ahafo Region	Household Located in B. Ahafo	0.10	0.09
Northern Region	Household Located in Northern	0.07	0.06
Upper East Region	Household Located in Upper East	0.02	0.02
Upper West Region	Household Located in Upper West	0.04	0.04
Locality			
Urban	Household Located in Urban	0.35	0.37
Rural	Household Located in Rural	0.65	0.63
Household Size	Household size	4.49	4.28

Gender (Head)			
Male	Male household head	0.68	0.66
Female	Female household head	0.32	0.34
Age (Head)	Age of household head	44.29	45.83
Interview Time			
Quarter 1	Interviewed first quarter of the year	0.27	
Quarter 2	Interviewed second quarter of the year	0.28	
Quarter 3	Interviewed third quarter of the year	0.20	
Quarter 4	Interviewed fourth quarter of the year	0.25	
Instrument			
Household Income		37.27	216.90

Source: Author's calculation from GLSS 3 & 4

- Household income is in Gh¢

Table A5: First stage regression

LnPcE	GLSS 3	GLSS 4
	LnPcE	LnPcE
HH Income	0.105***	0.131***
	(0.018)	(0.015)
Relative prices (in logs)		
Maize	0.494***	0.160**
	(0.102)	(0.073)
Rice	-0.030	0.043
	(0.060)	(0.148)
Guinea corn	0.163**	-0.168***
	(0.063)	(0.063)
Bread	-0.222*	0.102
	(0.129)	(0.095)
Other Cereals	-0.812**	-0.674
	(0.359)	(0.485)
Age	0.001	-0.001
	(0.001)	(0.001)
HH Size	-0.798***	-0.720***
	(0.023)	(0.021)
Female (1=male)	-0.098***	-0.138***
	(0.038)	(0.028)
Rural (1= urban) 2	-0.075	-0.318***
	(0.073)	(0.100)

Forest (1=coastal) 2	-0.423***	-0.143**
	(0.053)	(0.066)
Savannah (1=coastal) 3	0.209**	0.072
	(0.100)	(0.108)

Source: Author's calculation from GLSS 3 & 4

Notes: Standard errors in parentheses

Standard errors are obtained by bootstrapping cluster of observations (1000 replications)

***,**,* denote significance at 1, 5 and 10 percent respectively

All prices are in logs and real price. Real prices were obtained by deflating nominal price using the food price index with 1999 Accra price as base. Prices have been converted for old cedi to Ghana cedi by dividing the old cedi by 10,000. All prices are in per kilo terms

LnPcE= log of adult equivalent expenditure on Cereals

HH=Household

Table A6: Parameter estimates of AIDS model (GLSS 3)

Maize		Commodities			
		Rice	Guinea Corn	Bread	
Total Expenditure on Cereals		-0.085***	-0.076***	-0.167***	-0.041**
		(0.017)	(0.022)	(0.015)	(0.018)
Relative Prices (in logs)					
	Maize	0.054***	-0.017	-0.006	-0.031***
		(0.013)	(0.013)	(0.009)	(0.006)
	Rice	-0.017	-0.013	-0.004	0.034***
		(0.013)	(0.011)	(0.006)	(0.008)
	Guinea Corn	-0.006	-0.004	0.045***	-0.035***
		(0.009)	(0.006)	(0.009)	(0.006)
	Bread	-0.031***	0.034***	-0.035***	0.032***
		(0.006)	(0.008)	(0.006)	(0.008)
	Other Cereals	-0.163***	0.211***	-0.089*	0.041
		(0.056)	(0.076)	(0.051)	(0.059)
Demographic & Geographic					
Age		0.000**	0.000	-0.000	-0.000
		(0.000)	(0.000)	(0.000)	(0.000)
HH Size		0.005	0.026**	-0.035***	-0.008
		(0.006)	(0.012)	(0.008)	(0.012)
Sex of Head(1= male)		-0.016***	0.001	0.002	-0.030***
		(0.004)	(0.007)	(0.005)	(0.007)
Rural (1= urban) 2		0.001	0.000	0.012	0.010

	(0.013)	(0.013)	(0.010)	(0.011)
Forest (1 = coastal) 2	-0.085***	0.098***	-0.030***	0.019**
	(0.011)	(0.010)	(0.009)	(0.008)
Savannah (1=coastal) 3	0.042**	-0.071***	0.092***	-0.048**
	(0.020)	(0.017)	(0.015)	(0.020)
Residual	0.071***	-0.032***	0.051***	-0.082***
	(0.004)	(0.008)	(0.005)	(0.008)

Source: Author's calculation from GLSS 3

Standard errors in parentheses

Standard errors are obtained by bootstrapping cluster of observations (1000 replications)

***,**,* denote significance at 1, 5 and 10 percent respectively

All prices are in logs and real price. Real prices were obtained by deflating nominal price using the food price index with 1999 Accra price as base. Prices have been converted for old cedi to Ghana cedi by dividing the old cedi by 10,000. All prices are in per kilo terms

HH=Household

Table A7: Parameter estimates of AIDS model (GLSS 4)

Maize		Commodities			
		Rice	Guinea Corn	Bread	
Total Expenditure on Cereals		-0.031***	-0.047***	-0.067***	-0.036***
		(0.007)	(0.011)	(0.014)	(0.011)
Relative Prices(in logs)					
	Maize	0.052***	-0.015*	-0.046***	0.010**
		(0.008)	(0.008)	(0.006)	(0.005)
	Rice	-0.015*	-0.005	0.042***	-0.022***
		(0.008)	(0.013)	(0.007)	(0.008)
	Guinea Corn	-0.046***	0.042***	-0.002	0.007
		(0.006)	(0.007)	(0.007)	(0.006)
	Bread	0.010**	-0.022***	0.007	0.005
		(0.005)	(0.008)	(0.006)	(0.010)
	Other Cereals	-0.204***	0.159***	0.059	-0.015
		(0.051)	(0.051)	(0.059)	(0.044)
Demographic & Geographic					
Age		0.000**	-0.000	0.000	-0.000
		(0.000)	(0.000)	(0.000)	(0.000)
HH Size		-0.001	0.014**	-0.016***	-0.013***
		(0.005)	(0.007)	(0.006)	(0.004)
Sex of Headb(1=male)		0.007	-0.005	0.017***	-0.040***
		(0.004)	(0.005)	(0.004)	(0.004)

Locality(1=urban) 2	0.011	-0.032***	0.041***	-0.028***
	(0.009)	(0.010)	(0.009)	(0.009)
Ecological zone(1=coastal) 2	-0.048***	0.020***	0.050***	-0.006
	(0.009)	(0.007)	(0.006)	(0.006)
Ecological zone(1=coastal) 3	0.071***	-0.071***	0.041**	-0.049***
	(0.016)	(0.016)	(0.017)	(0.012)
Residual	0.057***	-0.032***	0.025***	-0.061***
	(0.004)	(0.006)	(0.008)	(0.004)

Source: Author's calculation from GLSS 4

Standard errors in parentheses

Standard errors are obtained by bootstrapping cluster of observations (1000 replications)

***,**,* denote significance at 1, 5 and 10 percent respectively

All prices are in logs and real price. Real prices were obtained by deflating nominal price using the food price index with 1999 Accra price as base. Prices have been converted for old cedi to Ghana cedi by dividing the old cedi by 10,000. All prices are in per kilo terms

HH=Household

Table A8: Distribution of total nominal and real household incomes across components

	GLSS 3 (1991/1992)		GLSS 4 (1998/1999)	
Income Component	**Nominal average (Gh¢)**	**Real average (Gh¢)**	**Nominal average (Gh¢)**	**Real average (Gh¢)**
Income from employment	8.14	52.17	45.62	50.08
Household agro income	12.95	81.28	87.51	100.91
Gross non-farm self-employment	13.19	85.02	64.57	71.29
Rental income (actual & imputed)	0.58	3.65	4.35	4.89
Remittances	2.23	14.01	21.88	24.08
Other income	1.24	7.94	4.59	5.12
Total income	37.92	237.45	216.90	243.39

Source: Authors' calculations from the Ghana living Standard Survey 3 & 4

Notes:

- Real income was obtained by deflating nominal income by an already provided price index in the GLSS 3 & 4. This index uses 1997 Accra prices as the base year.
- In the GLSS surveys, income from employment relates solely to employee compensation (either in cash or imputed in kind) for all household members who are active in the labour force while Household Agro income is income derived either explicitly from the sale of cash crops or livestock products, or implicitly from the consumption of homegrown agricultural produce. In addition, Gross non-form self-employment income constitutes all income from own account activities other than those that are agriculture based while rental income includes actual income received from leasing land, equipment, buildings or dwellings and imputed rent from owner occupied dwellings.

Furthermore, remittances income relates to current transfers received by households from other households, in addition to an imputation corresponding to the provision to a household of rent-free or subsidized accommodation by another household (including cases in which the dwelling is occupied by squatters).

Table A9: Growth in average expenditure and income in the GLS 3 and 4 data

Wave/Round	Average expenditure (Gh¢)	Average income (Gh¢)
GLSS 3 (1991/1992)	74.8	48.0
GLSS 4 (1998/1999)	424.4	226.7
Percentage change	467.37%	372.29%

Source: extract from GLSS 3 and 4 Reports

Figure A1: Distribution of imputed and observed expenditure values-GLSS 3

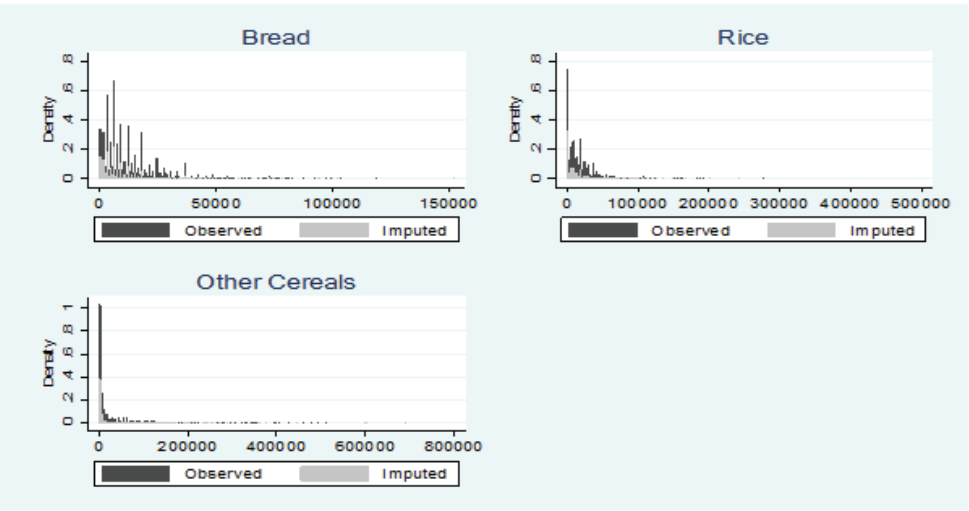

Figure A2: Distribution of imputed and observed expenditure values-GLSS 4