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Food demand characteristics in Ghana: An application of the quadratic almost ideal demand systems

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ABSTRACT

In typical developing countries, a *one-size-fits-all* policies often tend to hurt the poor and vulnerable. Specifically, in food demand studies different social groupings have characteristically heterogeneous demand functions which may require unique attention in terms of food policies. In this paper, we examine the food demand characteristics of three categories of consumers in Ghana based on fourteen selected food commodity groups. We use the sixth round of the Ghana Living Standard Survey in 2012/2013 data collected by the Ghana Statistical Service in collaboration with the World Bank. We apply the Quadratic Almost Ideal Demand System (QUAIDS) to estimate price and expenditure elasticities of demand for food in both rural and urban areas in Ghana. Empirically, we find that fish and cereal products take close to half (about 46%) of the food budget of the average Ghanaian household. We also report heterogeneous food expenditure patterns across the six regions considered in the study. Surprisingly, we find that female-headed households disburse a higher proportion on food budget than their male counterparts. Also, in conformity to theory, we find that the very poor households allocate the highest proportion to food budget than the non-poor. These findings suggest that food policies in Ghana should be discriminately on social and geographical lines to protect the very poor from escalating food prices. Food aid and assistance programmes should target the aged, larger and very poor households and rural dwellers.

Introduction

Ghanaian consumers rely on a variety of food commodities to meet their dietary and nutritional requirements. Major food commodities include vegetables, legumes, fruits, cereals, meat and poultry, fish, eggs and milk. For a normal, healthy growth and bodily development, nutrition practitioners recommend certain levels of these food groups that provide balanced food and nutrition security. Oftentimes, many consumers fail to meet these dietary requirements due to limited purchasing power. Due to this, demand for the various food groups varies across regions and by income groups [14]. In 2013, the mean annual household income in urban centres was estimated at GH¢20,930.00, or per capita equivalence of GH¢7019.72. For the

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rural areas, the estimate averages around GH¢11,408.01 or per capita equivalence of GH¢3302.83. Per these estimates, the urban people are wealthier than rural dwellers; the irony is that food prices tend to be higher in the rural areas. Transaction costs are often cited as principally driving the relatively high food prices in the rural settings. However, Ansah and Tetteh [6] also remark that high postharvest losses in many of the foods that form the staple of the rural folks may create shortages that generate high food prices in these localities. Consequently, heterogeneity in food expenditure as a share of disposable income among rural and urban households is nontrivial [13,24,25]. This means that variation in food prices could affect the various social and geographical groupings differently, and also with varying implications for poverty and food insecurity.

Both income and food poverty retard economic growth and lead to malnutrition. Possible consequences of malnutrition are mortality and morbidity, which signify direct loss in human capital and productivity in the economy. From a microeconomic standpoint, a percentage loss in adult height due to childhood stunting is equivalent to a 1.4% loss in productivity of the individual [28]. Other indirect losses for a country's economy are caused by poor cognitive function and reduced school attainment that come from early childhood undernutrition [28]. In fact, the education gap and resulting lower skill-level of workforce largely slow the development of countries affected by malnutrition [28]. Undernutrition in early childhood also makes an individual more prone to diseases in later stages of life, such as diabetes and heart diseases.

According to the UN's Global Nutrition Report (2016), malnutrition in children has increased Ghana's healthcare cost and put burden on the country's educational system, where losses of up to $ 2.6 billion occur annually due to problems associated with poor nutrition in children. The report also revealed that 37% of the adult population suffered from stunted growth, and 24% from child mortality; this invariably reduces Ghana's workforce by 7.3%. These negative reports and statistics are the consequences of limited purchasing power of the poor and vulnerable in society. In Ghana, both the poor and rich are faced with the same policy settings. This means that higher food prices affect both the poor and rich, and sometimes the poor are the most affected due to structural rigidities and their confinement to rural areas.

As population rises, urbanization changes and so is food demand. Therefore, periodically there is need to update food consumption characteristics to guide policy decisions and implementation strategies [19,20,29]. We also need to understand how various socioeconomic groups within rural and urban areas differ in their expenditure patterns concerning luxuries, necessities, normal goods or giffen goods [10,11]. People certainly differ in food purchasing behaviour based on socioeconomic characteristics. Therefore, in this paper, we seek a better understanding of (i) the regional distribution of expenditure shares on various food groups (ii) the direction and extent to which sociodemographic factors such as age and household size influence household food expenditure patterns and (iii) the distributions of expenditure (budget) and price elasticities of the various food commodity groups by poverty status, location and across regions. Such knowledge is essential for food policy decisions, since estimated elasticities could help inform and design targeted food and tax policies for the various socioeconomic groups, so that the poor are not hurt by extreme events, such as price hikes.

The rest of the paper is organized as follows. The next section discusses the methods applied for the demand analysis in this paper based on the Quadratic Almost Ideal Demand System (QUAIDS). After the methods section follows a brief overview of the study data. The penultimate section summarizes the empirical results before the paper concludes in the last section, with some policy implications in relation to food demand in Ghana.

Methodology

Analytical framework

We adopt Banks et al. [7] Quadratic Almost Ideal Demand System (hereafter QUAIDS) to estimate expenditure share equations based on 14 food commodity groups from which various elasticity parameters are derived. The starting point of the QUAIDS model is the specification of the indirect utility function [22], given in Eq. (1).

$$\ln V(p,m) = \left[\left\{ \frac{\ln m - \ln a(p)}{b(p)} \right\}^{-1} + \lambda(p) \right] \tag{1}$$

where $[\ln m - \ln a(p)]/b(p)$ is the indirect utility function of a "Price Invariant Generalized Logarithmic" (PIGLOG) demand system, which is a system with budget shares linear in log total expenditure; λ is a differentiable, homogeneous function of degree zero in prices p; ln a(p) is the translog function given in Eq. (2) below.

$$\ln a(p) = \alpha_0 + \sum_{i=1}^{k} \alpha_i \ln p_i + \frac{1}{2} \sum_{i=1}^{k} \sum_{j=1}^{k} \gamma_{ij} \ln p_i \ln p_k \tag{2}$$

In the translog function, p_i is the price of good i for $i = 1, \ldots, k$. Again, in the indirect utility function, $b(p)$is the Cobb–Douglas price aggregator, taking the form specified in Eq. (3) below.

$$b(p) = \prod_{i=1}^{k} p_i^{\beta i} \tag{3}$$

while

$$\lambda(p) = \sum_{i=1}^{k} \lambda_i \ln p_i \tag{4}$$

In the QUAIDS specification, Eqs. (2)–(4) are substituted into the indirect utility function and differentiated with respect to p and m, and applying Roy's identity, which yields the budget share Eq. (5) as follows:

$$w_i = \alpha_i + \sum_{j=1}^{k} \gamma_{ij} \ln p_j + \beta_i \ln \left\{ \frac{m}{a(p)} \right\} + \frac{\lambda_i}{b(p)} \left[\ln \left\{ \frac{m}{a(p)} \right\} \right]^2, \quad i = 1, \ldots\ldots\ldots k \tag{5}$$

To incorporate demographic variables (z) in (5), Poi [22] extends Ray (1983)'s work and specifies the full QUAIDS model as in Eq. (6) below.

$$w_i = \alpha_i + \sum_{j=1}^{k} \gamma_{ij} \ln p_j + (\beta + \eta_i^{/}) \ln \left\{ \frac{m}{\overline{m_0}(z) a(p)} \right\} + \frac{\lambda_i}{b(p) c(p,z)} \left[\ln \left\{ \frac{m}{\overline{m_0}(z) a(p)} \right\} \right]^2 \tag{6}$$

where $c(p,z) = \prod_{j=1}^{k} p_j^{\eta_j' z}$

To satisfy the requirements of utility maximization, the adding up, homogeneity and Slutsky symmetry restrictions are observed as follows:

$$\sum_{i=1}^{k} \alpha_i = 1, \ \sum_{i=1}^{k} \beta_i = 0, \ \sum_{j=1}^{k} \gamma_{ij} = 0, \sum_{i=1}^{k} \lambda_i = 0, \gamma_{ij} = \gamma_{ji}, \ \sum_{j=1}^{k} \eta_{rj} = 0$$

In estimation, these conditional restrictions are automatically imposed by the 'quaids' command in Stata, and by default the last expenditure share equation is excluded to avoid a singular error-covariance matrix being produced [22]. Note also that the specific expenditure share equation omitted has no consequence on the resulting parameters.

From model (6), Poi [22] derives expression for computing the uncompensated price elasticity for the ith good when the price of good j changes as;

$$e_{ij} = -\delta_{ij} + \frac{1}{w_i} \left(\gamma_{ij} - \left[\beta_i + \eta_i^{/} + \frac{2\lambda_i}{b(p) c(p,z)} \ln \left\{ \frac{m}{\overline{m_0}(z) a(p)} \right\} \right] \times \left(\alpha_j + \sum_l \gamma_{jl} \ln p_l \right) - \frac{(\beta_j + \eta_j^{/} z) \lambda_i}{b(p) c(p,z)} \left[\ln \left\{ \frac{m}{\overline{m_0}(z) a(p)} \right\} \right]^2 \right) \tag{7}$$

Also, the expenditure or income elasticity equation for good i is

$$\mu_i = 1 + \frac{1}{w_i} \left[\beta_i + \eta_i^{/} z + \frac{2\lambda_i}{b(p) c(p,z)} \ln \left\{ \frac{m}{\overline{m_0}(z) a(p)} \right\} \right] \tag{8}$$

And the compensated price elasticities are obtained from the Slutsky equation as follows:

$$e_{ij}^{c} = e_{ij} + \mu_i w_j \tag{9}$$

The above formulation of the QUAIDS model renders it more preferred to the Almost Ideal Demand System (AIDS) counterpart because according to Abdulai [1], the QUAIDS permits a given commodity to be a necessity at one expenditure level and a luxury at another expenditure level.

The empirical model

To implement the QUAIDS model in this study, we present the general empirical model of expenditure share Eq. (6) for the 14 food groups in our dataset in Eq. (10) below. The symbols w1 to w14 are the expenditure shares for cereals, meat products, chicken, fish, milk, egg, fats/oils, fruits, vegetables, sugar, condiments, starchy staples, pulses/nuts and beverages; the symbols p1 to p14 are the corresponding prices; $\alpha, b, \gamma, \lambda$ *and* η are all parameters to be estimated. Note that we have demographic variables captured in z, which are age, household size and location (1 if urban, 0 if rural).

$$w_i = \alpha_i + \sum_{i=1}^{14} \gamma_i \ln p_i + \beta \ln \left\{ \frac{m}{a(\mathbf{p})} \right\} + \frac{\lambda_i}{b(\mathbf{p})} \ln \left\{ \frac{m}{a(\mathbf{p})} \right\}^2 + \eta_i z + e \tag{10}$$

where e is the random error term.

Table 1
Summary statistics of the Categorical variables.

Variable	Category	Frequency	Percentage
Sex	Male	3144	66.82
	Female	1561	33.18
Educational Level	BECE	849	18.04
	MSLC	1007	21.40
	SHS/SSS	524	11.14
	Voc./Tech.	278	5.91
	Tertiary	369	7.84
	None	1678	35.66
Location	Rural	1793	38.11
	Urban	2912	61.89
Region	Ashanti	799	16.98
	Central	803	17.07
	Eastern	581	12.35
	Greater Accra	1126	23.93
	Volta	317	6.74
	Western	1079	22.93
Poverty Status	Non-poor	4207	89.42
	Poor	363	7.72
	Very poor	135	2.87

Table 2
Distribution of educational status of respondents across their location.

Location	Educational Status						
	None	BECE	MSLC	SHS/SSS	Voc/Tech.	Tertiary	Total
Rural	883	334	373	110	55	38	1793
Urban	795	515	634	414	223	331	2912
Total	1678	849	1007	524	278	369	4705

Data description and source

We used the sixth round of the Ghana Living Standards Survey 2012–13 (GLSS6), conducted by the Ghana Statistical Service in collaboration with the World Bank [14]. Related to previous rounds, the GLSS6 chose the household as the key socio-economic unit and provided information on living conditions and wellbeing of households. The survey is a nationally representative sample of 18,000 households in 1200 enumeration areas. Out of these, 16,772 households were successfully counted with a response rate of 93.2%.

The survey consisted of a household questionnaire and a community questionnaire. In the community questionnaire, prices from various community markets were reported. We therefore matched the prices of food commodities from the various markets to the corresponding households in those communities, using the many-to-one data (i.e., many households to one community) merge function in Stata. The survey gathered detailed information on demographic characteristics of households such as age of household head and education, as well as household expenditure on food and non-food commodities and prices of consumed goods from various community markets (Table 1).

The data used for the analysis covered only 6 out of the 10 regions in Ghana. From these regions, a total of 4705 households were valid for model estimation. Table 2 provides summary statistics of the variables used in the QUAIDS model.

Results and discussion

Socioeconomic and demographic characteristics

Majority of the respondents (66.08%) were male, with most being household heads compared to females. Household heads aged between 16 and 99 years, with the modal age group between 20 and 39 years. The mean age of the respondents was 44.40 years which depicts a youthful age distribution across rural and urban areas. The average household size was approximately 4 people, which corresponds to the national average and figures reported by Donkoh et al. [13]. Rural households are generally larger than urban households. According to the 2008 report of Ghana Statistical Service, a mixture of factors determines household size in Ghana, notably a desire to have large families, especially traditional families. In the case of urban families, the extended family system compels them to take care of dependants other than their immediate family members.

Among the six regions contained in the study, Greater Accra had the largest number of households (23.93%), followed by Western region (22.93%), Central region (17.07%), Ashanti (16.98%) and so on. From Table 2, about 7% of the respondents in the urban areas attained tertiary educcation, while only about 0.8% in the rural areas had attained tertiary education. This

Table 3
Poverty status across rural and urban areas.

Location	Poverty Status			
	Non poor	Poor	Very poor	Total
Rural	1445	237	111	1793
Urban	2762	126	24	2912
Total	4207	363	135	4705

Table 4
Summary statistics of prices of food groups and demographic variables.

Price Variable (average for commodity group)	Mean (Gh¢)	Std. Dev.	Minimum (Gh¢)	Maximum (Gh¢)
Total household food expenditure per month	301.44	393.97	0	20,348.7
Cereal	4.31	9.67	1.45	164.31
Meat	15.22	12.26	7.59	218.97
Chicken	11.56	13.96	0.02	138.46
Fish product	14.76	19.02	5.86	325.07
Milk product	17.60	56.25	2.61	1002.25
Egg products	23.23	309.95	0.20	5500
Fat/oils	8.32	39.02	0.51	694.48
Fruits	2.53	2.94	0.29	48.76
Vegetable	6.48	12.43	0.97	204.96
Sugar/Confectionary	6.48	3.50	0.82	31.38
Condiments	15.31	31.29	0.51	406.51
Starchy staples	6.82	6.82	1.05	42.95
Pulses/Nut	4.51	7.15	0.52	103.02
Beverages	3.75	4.36	1.02	70.39
Household size	3.69	2.37	1	22
Age (in years)	44.39	15.16	16	99

distribution is not surprising, since most of the educated people tend to be located in urban areas where white collar jobs are often located in Ghana.

About 64% of household heads had some formal education whereas approximately 36% had none. Of the educated group, 18.04% had been to at least primary and the junior high school and 21.40% had Middle School Leaving Certificate (MSLC). About 11% attended senior high school, 5.91% attended vocational/technical institution and the remaining 7.84% had a tertiary education.

As evidenced in Table 3, the number of non-poor people in urban areas was greater than those in the rural areas, while the rural areas recorded larger number of poor and very poor respondents as would be expected.

Overall, 89.42% of the households were non-poor while 10.58% were either poor or very poor. This low percentage of the poor can be attributed to the fact that the regions that are usually classified as the most deprived (Northern, Upper East, Upper West, and the Brong Ahafo regions) were excluded due to invalid data. Donkoh et al., [13] reported that poor households spend larger percentages of their income on food but less absolute food expenditure compared with their rich counterparts.

Expenditure shares and prices of food groups

The average total household expenditure on the various food groups was Gh¢301.44 per month. Given an average household size of four, the per capita consumption of the food commodities is Gh¢75.36. However there was much variation in the distribution, ranging from as low as Gh¢301.44 to as high as Gh¢20,348.70 in a year. Table 4 reports the average prices of the various food groups used in the analysis. On average, the price of egg products was the highest (Gh¢23.23), followed by that of milk product (Gh¢17.60), condiments (Gh¢15.31) and meat products (Gh¢15.22). The lowest or cheapest food group was fruits (Gh¢2.53).

Summary of regional distribution of expenditure shares on food groups

Table 5 provides the summaries of mean expenditure shares on food groups by regions. The results show that the expenditure share of cereals and bread, fish products, milk products, fruits, starchy staples and beverages in the food budget were very high, but the share of cereals and bread were the highest. Fish products (23.47%) take the highest proportion of the food budget of an average household in Ghana. Fish is the most important source of animal protein in Ghana [30]. On an average, the per capita fish consumption in Ghana is estimated at 20–25 kg higher than the World average of 13 kg. Ghana is only 60% fish self-sufficient [31]. Fish availability from local sources is also seasonal, hence imported fish fills the seasonal and annual deficits [31]. It is not surprising therefore, that fish products take the highest share of the Ghanaian food budget. For fish products, households in Eastern region spend the largest share (32.7%) of their food budget, while the

Table 5
Regional distribution of mean expenditure shares on food groups.

Food group	Ashanti	Central	Eastern	Greater Accra	Volta	Western	Pooled
Cereals	21.7	24.7	18.5	22.9	20.9	23.7	22.5
Meats	6.8	2.6	3.1	4.1	2.8	4.1	4.1
Chicken	3.7	1.5	2.0	2.8	3.8	3.4	2.8
Fish	21.3	23.0	32.7	19.5	24.7	24.1	23.4
Milk	2.8	2.1	1.4	3.1	2.4	2.1	2.4
Egg	1.7	1.4	1.3	2.0	1.6	1.7	1.7
Fats/oils	3.4	4.5	3.4	2.6	3.8	3.6	3.5
Fruits	5.5	3.1	3.1	10.2	4.3	3.0	5.3
Vegetables	12.1	14.6	16.6	12.7	13.7	13.1	13.6
Sugar	1.7	1.5	1.1	1.5	2.0	1.4	1.5
Condiments	1.4	1.8	1.5	1.0	1.9	1.8	1.5
Starchy staples	10.4	12.0	9.6	8.5	10.4	10.0	10.0
Pulses/nuts	1.5	1.8	1.3	1.3	2.9	1.7	1.6
Beverages /drinks	5.3	4.6	13.5	7.1	4.0	5.6	5.4

Table 6
Distribution of mean expenditure shares of food groups by sex, poverty status and location.

Food group	Male	Female	Very Poor	Poor	Non-Poor	Urban	Rural
Cereals	23.1	21.4	25.8	24.2	22.3	22.5	22.5
Meats	4.3	3.7	0.9	2.5	4.3	4.5	3.4
Chicken	2.9	2.7	1.0	2.1	3.0	2.6	3.1
Fish	22.9	24.4	31.8	28.9	22.7	20.1	28.8
Milk	2.6	2.0	1.0	0.9	2.6	3.0	1.4
Egg	1.7	1.6	0.7	1.1	1.8	1.9	1.2
Fats/oils	3.3	3.9	3.8	3.6	3.5	3.3	3.9
Fruits	5.8	4.1	1.0	2.4	5.6	7.2	2.1
Vegetables	12.8	15.1	19.5	16.1	13.2	13.1	14.4
Sugar	1.6	1.3	1.0	1.2	1.5	1.5	1.5
Condiments	1.5	1.6	1.3	1.7	1.5	1.2	2.0
Starchy staples	9.3	11.6	9.1	10.9	10.0	10.4	9.4
Pulses/nuts	1.6	1.7	1.2	1.5	1.6	1.5	1.9
Beverages /drinks	5.9	4.3	1.2	2.2	5.8	6.4	3.7

least is Greater Accra (19.5%). In Ghana, the coastal areas like Greater Accra, Central and Western regions engage in fishing activities due to their proximity to the Sea, which could explain why they spend relatively low shares on fish products.

Households also spend about 22.55% of their food budget on cereals and bread, and this is followed by the vegetables (13.62%). The food group which takes the least share of the food budget is sugar and confectionary (1.55%). It is not surprising that cereals and bread came second because maize and rice are the major food staples consumed by households in Ghana. A household in Central region, for instance, spends 24.7% food budget share on cereals. This is followed by Western (23.7%), Greater Accra (22.9%), Ashanti (21.7%), Volta (20.9%) and then Eastern region (18.5%).

On meat expenditure across the six regions, a household in the Ashanti region spends the highest of 6.89% share of its food budget followed by households in the Western (4.16%), Greater Accra (4.15%), Eastern (3.12%), Volta (2.86%) and Central (2.67%) regions. Looking at Ashanti, Western and Greater Accra regions, a lot of mining, manufacturing and industrialization, crude oil exploitation activities, among other services go on there. Consumers in these areas therefore have higher incomes, which could explain the high expenditure on meat products for the three regions. It is important to note that, higher expenditure does not necessarily mean consumption. Higher expenditure could arise from higher prices of meat in those regions [26,27].

Besides fish and cereals, the third food group which takes more of the household food budget is vegetables, where a household in the Eastern region spends about 16.1% share of the food budget, followed by Central region (14.6%), Volta (13.7%), and so on. Again, households in the Ashanti region spend the least amount on vegetables.

Summary of expenditure shares on food groups by sex, poverty status and location

We observe important heterogeneities in the expenditure shares across various demograhicups groups. From Table 6, female-headed households spend a higher proportion of their food budget (24.4%) on fish relative to male-headed households (22.9%). With cereals, male-headed households spend a higher proportion of their food budget (23.1%) than female-headed households (21.4%). Also, female-headed households spend more on vegetables (15.1%) than their male counterparts (12.8%). Generally, female-headed households disburse a higher proportion of the food budget than the males who allocate relatively small proportion.

Also, Table 6 shows the relationship between income level (poverty status) and food budget allocation across the various food groups. The results show that the very poor households allocate the highest proportion of their food budget, the poor

follows next while the non-poor spend the least on food. On fish products, the very poor households allocate 31.8% share of their food budget while the poor allocates 28.9%, but the non-poor allocate only 22.7% share of the food budget to fish. On cereals and vegetables, similar allocations were observed at varying proportions.

Thus, household food budget depends on the income of the household, where high income households tend to allocate a smaller proportion of their household budget on food. Survival is a more important concern for the poor and very poor households than the non-poor; hence the poor and very poor households tend to allocate more of their budget on food. It should be noted that this does not mean that lower income households spend more on food than high income households in absolute monetary terms.

With respect to the location of households and food expenditure, Table 7 further shows that rural households, who are mostly poor, spend a larger proportion on the various food groups compared to the urbanites, who are averagely non-poor. On fish products, rural households allocate 22.59% of their budget while urban households allocate 22.53% of their food budget. On cereals and vegetables similar trends are observed at varying proportions. This implies that household food budget is affected by the location of the household. These findings agree with existing evidence in many areas [4,8,20,21,23].

Estimation results of the quadratic almost ideal demand system

The estimation results of the QUAIDS is reported in Table 7 above. We infer from the table that all parameters are statistically and significantly different from zero, except in few isolated cases. For instance, the alpha coefficients (intercepts) are statistically significant and positive for all the food groups, except the chicken food category, which is negative and insignificant. For the parameters of the linear and quadratic expenditures, all food groups report statistically significant coefficients expect for meat (expenditure), chicken, fats and pulses (quadratic expenditure for all). The quadratic expenditure values are consistently smaller in magnitudes than the linear expenditure estimates, as would be expected. The statistical significance of both the linear and quadratic expenditure values indicate that the total food budget is an important determinant for the expenditure shares of most food groups, and that apart from pulses, the consumption of all other food groups are very sensitive to food expenditures.

For the demographic variables, age has a statistically significant influence on the demand for all food commodity groups except for condiment and pulses. For household size, the effect is statistically significant for all food products except meat, chicken, fats, sugar and starchy staples. On the other hand, location affects demand for all food commodities except chicken, fats and sugar. The values reported for age and household size are less strong operationally (actually quite close to zero) compared to the effects of location on the expenditure shares. These results are quite expected, since demand for various food commodities would depend on the location besides the conventional price and quantity factors. Our findings on the effect of demographic factors on food expenditure ignal with results from most demand studies [9,12,15–18].

We observe from the results generally that households in the urban areas (location = 1) tend to allocate larger proportion of their food budget on meat, milk, egg, fruits and starchy staples than households in rural areas. This is also quite expected because the urban areas are naturally characterized by the relatively affluent households who are able to afford protein foods such as meat, milk and eggs. Also, households with more members tend to change their feeding patterns to comply with household total food budget. At any given level of prices and expenditure, as household size increases, members of the household are forced to adjust their patterns of demand towards cheap food items such as cereals, starchy staples among others, and away from expensive food commodities like meat and chicken.

Demand elasticities of food groups

From the estimated QUAIDS coefficients, we calculate and report the price and expenditure elasticities: (i) over the entire sample (ii) by the locations of the respondents (i.e. the rural and urban areas) and (iii) by respondents' poverty profiles (i.e. very poor, poor and non-poor). Note that we generated the elasticity parameters using postestimation commands after the quaids regression. The expenditure shares of the various food groups are also examined across regions, by sex, income status and location.

Expenditure elasticities of food demand

The estimated average expenditure elasticities of the fourteen (14) food groups for the entire sample across households in the six selected regions are presented in Table 8. The positive signs of the expenditure elasticities indicate that all the food categories are normal goods across all the regions. The positive sign also implies that an increase in household food budget (income) will cause an increase in the expenses on all the food groups, ceteris paribus.

In all the regions, the expenditure elasticities of cereals and bread are less than one but positive, indicating that they are normal goods. Thus, an increase in household income will increase quantity demanded and consumed of these food commodities. Therefore, across all the six regions cereals and bread are necessities with an average elasticity of 0.89. The results accord with other Ghanaian studies like Aidoo [5], who found that the expenditure elasticities for cereals and other carbohydrate foods were positive, making them normal goods and constituted the diet of poorer households, and thus expenditure (income) inelastic.

The pooled results show that household cereal budget share increases at an increasing rate of 5.35% for every 10% increase in the total food budget, other things equal. For every 1% increase in the household food budget, expenditure on

Table 7
Estimation results of the Quadratic Almost Ideal Demand System.

Variable	Symbol	Cereals	Meat	chicken	Fish	Milk	Egg	Fats	Fruits	Vegs	Sugar	Cond	starchy	pulses	beverages
Constants	α_i	0.314***	0.017***	−0.001	0.147***	0.037***	0.026***	0.012***	0.147***	0.084***	0.026***	0.005***	0.078***	0.011***	0.096***
		(0.009)	(0.005)	(0.003)	(0.011)	(0.003)	(0.002)	(0.003)	(0.008)	(0.006)	(0.002)	(0.002)	(0.005)	(0.002)	(0.006)
Expenditures	β_i		0.001	0.010***	0.087***			0.009***		0.044***		0.007***	−0.005	0.002	−0.018***
		−0.044***	(0.002)	(0.002)	(0.006)	−0.012***	−0.003***	(0.001)	−0.072***	(0.003)	−0.008***	(0.001)	(0.003)	(0.001)	(0.003)
		(0.005)				(0.002)	(0.001)		(0.004)		(0.008)				
Quadratic expenditure	λ_i	0.006***	.003***	0.000		0.003***	0.001***	0.000	0.012***		0.002***		0.002**	0.000	0.005***
		(0.001)	(0.001)	(0.000)	−0.022***	(0.000)	(0.000)	(0.000)	(0.001)	−0.010***	(0.000)	−0.001***	(0.001)	(0.000)	(0.001)
					(0.001)					(0.001)		(0.000)			
Cereal price	γ_{i1}	0.012***	0.001	−0.001	−0.008**	−0.000	−0.000	0.005***		−0.001	0.001	0.001	0.003*	−0.002**	0.002
		(0.004)	(0.002)	(0.001)	(0.004)	(0.001)	(0.001)	(0.000)	−0.013***	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)
									(0.002)						
Meat price	γ_{i2}		0.016***	0.006***		−0.001	−0.000	0.003*	0.001	0.002	0.001	0.001	−0.002**	−0.000	−0.006***
			(0.003)	(0.001)	−0.021***	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
					(0.003)										
Chicken price	γ_{i3}			0.004***	−0.004**	0.003***	0.000	−0.001	0.003***		0.000		−0.000	−0.001**	−0.005***
				(0.001)	(0.002)	(0.001)	(0.000)	(0.001)	(0.001)	−0.003***	(0.001)	−0.001***	(0.000)	(0.001)	(0.001)
										(0.001)		(0.000)			
Fish price	γ_{i4}				0.027***	0.000	0.000		0.019***	−0.006**	−0.001			0.001	0.005*
					(0.006)	(0.002)	(0.001)	−0.004***	(0.003)	(0.003)	(0.001)	−0.002***	−0.006***	(0.001)	(0.003)
								(0.002)				(0.001)	(0.002)		
Milk price	γ_{i5}					−0.003*	0.000	−0.001	−0.003**	0.001	0.001	0.002***	0.001*	0.001	−0.001
						(0.002)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Egg price	γ_{i6}						0.000	0.001*	−0.000	−0.001*	−0.001	0.000	0.000	0.001**	−0.000
							(0.000)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Fats/oil price	γ_{i7}							−0.002		0.000	0.001	0.001*	−0.001	−0.001*	0.003**
								(0.002)	−0.005***	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
									(0.001)						
Fruits price	γ_{i8}									0.009***	−0.001	−0.001		0.000	0.001
									−0.008***	(0.002)	(0.001)	(0.001)	−0.004***	(0.001)	(0.002)
									(0.003)				(0.001)		
Vegs price	γ_{i9}									−0.004*	0.001	0.000	−0.002**	0.002***	0.002
										(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Sugar price	γ_{i10}										−0.001	0.000	−0.000	−0.001	0.001
											(0.001)	(0.000)	(0.000)	(0.001)	(0.001)
Cond price	γ_{i11}												−0.000	−0.001**	0.001
												−0.001***	(0.000)	(0.000)	(0.001)
												(0.000)			
Starchy price	γ_{i12}												0.009***	0.000	0.003***
													(0.001)	(0.000)	(0.001)

(*continued on next page*)

Table 7 (*continued*)

Variable	Symbol	Cereals	Meat	chicken	Fish	Milk	Egg	Fats	Fruits	Vegs	Sugar	Cond	starchy	pulses	beverages
Pulses price	γ_{i13}													−0.000	0.000
														(0.001)	(0.001)
Beverage price	γ_{i14}														−0.001**
															(0.003)
Age	η_{1i}				0.000***					0.000***		−0.000	0.000***	−0.000	−0.000***
		−0.000***	−0.000***	−0.000***	(0.000)	−0.000***	−0.000***	−0.000***	−0.000***	(0.000)	−0.000***	(0.000)	(0.000)	(0.000)	(0.000)
		(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)		(0.000)				
Household size	η_{2i}	0.001***	−0.000	−0.000	0.001**	−0.000**		−0.000		0.000*	−0.000	0.000***	0.000	0.000***	−0.001***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	−0.000***	(0.000)	−0.001***	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
							(0.000)		(0.001)						
Location	η_{3i}		0.007***	0.001		0.005***	0.002***	0.000	0.007***		0.000		0.008***	−0.001**	0.006***
		−0.004***	(0.001)	(0.001)	−0.027***	(0.000)	(0.000)	(0.000)	(0.001)	−0.003***	(0.000)	−0.002***	(0.001)	(0.000)	(0.001)
		(0.001)			(0.002)					(0.001)		(0.000)			
Rho (demographic effects on expenditures)															
Rho_age	−0.009***														
	(0.004)														
Rho_household size	0.009**														
	(0.000)														
Rho_location	0.892***														
	(0.141)														

NB: ***, ** and * indicates significance at 1%, 5% and 10% respectively; standard errors in parenthesis.

Table 8
Regional distribution of mean expenditure elasticities on food groups.

Food group	Ashanti	Central	Eastern	Greater Accra	Volta	Western	Mean	Pooled
Cereals	0.89	0.92	0.85	0.89	0.92	0.89	0.89	5.35
Meats	1.33	1.84	1.51	1.54	1.61	1.57	1.55	9.39
Chicken	1.21	1.38	1.24	1.24	1.21	1.21	1.24	7.48
Fish	0.86	0.55	0.86	0.81	0.80	0.89	0.80	4.78
Milk	1.35	1.43	1.58	1.28	1.61	1.37	1.39	8.61
Egg	1.05	1.23	1.02	1.04	1.07	1.02	1.07	6.43
Fats/oils	1.30	1.32	1.32	1.37	1.33	1.29	1.32	7.93
Fruits	0.80	0.88	0.73	0.79	0.91	0.27	0.71	4.37
Vegetables	0.95	0.91	0.99	0.94	0.90	0.98	0.95	5.67
Sugar	1.15	1.38	1.15	1.14	1.13	1.05	1.17	7.02
Condiments	0.99	0.95	1.02	0.96	0.95	1.05	0.99	5.91
Starchy staples	1.29	1.28	1.30	1.26	1.24	1.32	1.29	8.98
Pulses/nuts	1.16	1.11	1.14	1.12	1.11	1.13	1.13	6.78
Beverages /drinks	1.17	1.24	1.24	1.13	1.26	1.07	1.16	7.10

cereals increases by 0.89% in the Ashanti region, 0.92% in Central, 0.85% in Eastern, 0.89% in Greater Accra, 0.92% in Volta and 0.89% in the Western regions. These trends are also true for condiments, vegetables, fruits and fish. All these are necessary goods with inelastic expenditure elasticities ranging from 0.55% to 0.98%.

Meat products in all regions had expenditure elasticities larger than one and positive, indicating that they are normal goods, where an increase in household income increases the quantities demanded. Across all the six regions therefore, meat is a luxury with an average elasticity of 1.55. These results conform to other studies [1–3] and also confirms the Bennets' law, that as the income of people increase they tend to shift away from starchy staples and towards protein related foods (e.g. meat). The expenditure elasticities for meat and other meat products is positive making them normal goods and constitute the diet of richer households and thus expenditure (income) elastic. For the pooled data, a 10% increase in household food budget share guarantees 9.39% share increase in the household meat budget in Ghana, ceteris paribus. For every 1% increase in the household food budget, there will be an increase in the expenditure on meat by 1.33% in Ashanti, 1.84% in Central, 1.51% in Eastern, 1.54% in Greater Accra, 1.61% in Volta and 1.57% in the Western regions.

Price elasticities of food groups

Based on the QUAIDS estimates, the price and expenditure elasticities were evaluated at the mean values of the data over the food groups, income status and location. Table 9 presents the Marshallian (Uncompensated) and Hicksian (Compensated) price elasticities with respect to food groups' budget shares for the entire sample. In terms of the cross-price effects, the results show a mixture of gross and/or net complements and substitutes.

The results show that almost all own-price elasticities are significantly less than zero exhibiting inelastic relationship with only few being elastic. Consistent with theory, the own-price elasticities bear negative signs. Compensated price elasticities describe a type of demand that compensates the consumer for the loss in purchasing power from the price increase such that their utility remains constant. Unlike the uncompensated, compensated elasticity allows for utility levels to be controlled leading to more significant net substitutes. Uncompensated price elasticities on the other hand describe a type of demand function that maximises utility given prices and wealth. In other words, it deals with how demand changes when price changes, holding money income constant. The estimates for the own-price uncompensated elasticities are smaller in magnitude compared to compensated own-price elasticity estimates.

The estimated elasticities suggest that the quantities demanded of most food groups are not very sensitive to price changes. In other words, when the prices of the food commodities increase, either the quantity demanded by household decreases slightly or not at all. What this means is that majority (97%) of the food groups are necessities of life and refuse to respond to price changes, as found in many other studies that food commodities are usually necessities while non-food commodities are luxuries [1]. Since food is something man cannot live without, these results are not surprising.

It must be noted that all cross-price elasticities with positive signs are substitutes (implying that as the price of one good increases, the demand for the other good increases); those with negative signs are complements (demand for the good is increased when the price of another good falls). A special condition can also exist in the case of independent goods that have zero cross price elasticity, such that as the price of one good increases, demand for the second good remains unchanged. For the uncompensated price elasticities, substitution effect occurs between cereals and milk products, cereals and fats or oils, cereals and sugar or confectionary, among others. Among these, the most inelastic substitution effect occurs between sugar/confectionary and chicken.

Many complementary relationships among commodities are noted from Table 9. For example, chicken and beverages, meat and chicken, meat and fats/oils, etc., with the most inelastic complementary effect existing between fruits and fats/oils. This can be associated with the affluent in society who have gone past price and are more conscious about food security or health. The more one consumes fats/oils, the higher the quantity of fruits consumed to decrease the risk of getting heart diseases. Not surprising, the most inelastic complementary effect exists between fruits and fats/oils. Substitutes and

Table 9
Compensated and uncompensated price elasticities of entire sample.

	P1		P2		P3		P4		P5		P6		P7		P8		P9		P10		P11		P12		P13		P14	
	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C
Q1	−0.91	−0.71	.01	.05	−0.00	.02	−0.04	.17	.00	.03	.00	.02	.02	.06	−0.03	.02	−0.01	.11	.01	.02	0.00	.02	.02	.11	−0.01	.01	.02	.07
Q2	−0.05	.23	−0.63	−0.56	.13	.17	−0.61	−0.31	−0.03	.01	−0.02	.00	.06	.09	.00	.10	.01	.21	.01	.03	.02	.04	−0.08	.06	−0.02	−0.00	−0.21	−0.09
Q3	−0.11	.18	.19	.25	−0.85	−0.82	−0.17	.11	.09	.13	−0.01	.03	−0.03	.02	.07	.15	−0.13	.03	−0.01	.02	−0.05	−0.03	−0.04	.10	−0.05	−0.03	−0.20	−0.13
Q4	−0.05	.17	−0.09	−0.05	−0.01	.01	−0.82	−0.59	−0.00	.02	.00	.02	−0.01	.03	.04	.08	.01	.13	−0.01	.01	−0.00	.01	−0.02	.08	.01	.02	.01	.06
Q5	0.01	.26	−0.03	.02	.11	.15	−0.08	.19	−1.11	−1.10	.01	−0.00	−0.05	−0.04	−0.06	.01	−0.03	.15	.03	.02	.06	.08	.04	.15	.04	.05	−0.02	.03
Q6	.02	.23	−0.02	.01	.00	.05	−0.02	.25	.01	−0.00	−0.98	−0.98	.06	.09	.01	.02	−0.08	.08	−0.02	−0.01	.02	.05	−0.00	.09	.06	.08	−0.00	.04
Q7	.08	.36	.08	.10	−0.02	.01	−0.14	.18	−0.04	−0.03	.02	.04	−1.05	−0.97	−0.17	−0.15	−0.00	.14	.02	.05	.03	.06	−0.04	.09	−0.04	.00	.05	.10
Q8	−0.07	.08	.03	.08	.05	.08	.27	.38	−0.02	.00	−0.01	.01	−0.10	−0.10	−0.98	−0.90	.12	.23	.00	.00	−0.02	−0.01	−0.06	.00	.01	.01	.09	.07
Q9	−0.03	.19	.02	.06	−0.02	.01	.00	.22	−0.00	.03	.01	.01	.00	.04	.03	.09	−1.0	−0.86	.00	.02	.01	.02	−0.02	.09	.02	.03	−0.00	.09
Q10	.08	.30	.05	.07	−0.00	.03	−0.12	.14	.05	.03	−0.03	−0.01	.04	.11	.00	.01	.05	.17	−1.08	−1.1	.01	.03	−0.03	.07	−0.04	−0.01	.06	.10
Q11	.01	.25	.07	.10	−0.08	−0.06	−0.10	.16	.09	.13	.02	.06	.06	.13	−0.09	−0.05	.05	.17	.00	.03	−1.1	−1.1	−0.01	.11	−0.05	−0.03	.02	.07
Q12	−0.01	.25	−0.03	.02	−0.01	.03	−0.09	.17	−0.06	.04	−0.00	.02	−0.01	.03	−0.06	.00	−0.04	.12	−0.01	.01	−0.00	.02	−0.92	−0.81	.00	.02	.02	.09
Q13	−0.15	.10	−0.03	−0.01	−0.08	−0.05	.05	.34	.06	.07	.06	.08	−0.08	.01	.01	.03	.14	.26	−0.04	−0.01	−0.05	−0.02	.02	.13	−1.02	−0.98	.01	.06
Q14	.08	.30	−0.11	−0.07	−0.10	−0.07	.04	.25	−0.01	.01	.00	.01	.04	.07	.08	.14	.01	.15	.01	.03	.01	.02	.06	.16	.00	.02	−1.07	−1.08

Legend: Q1-Q14 and P1-P14 are the respective quantities and prices of cereals, meat, chicken, fish products, milk products, egg product, fat/oils, fruits, vegetables, sugar/ confectionary, condiments, starchy staples, pulses/nuts, and beverages. U = uncompensated elasticity, C = compensated elasticity.

complements in an uncompensated demand system are referred to as gross substitutes and gross complements respectively [11]. Hence, all the examples mentioned earlier are gross substitutes and complements.

The compensated own-price elasticity for cereals (−0.71), meat (−0.56), chicken (−0.81), fish products (−0.58), egg products (−0.98), fats/oils (−0.96), fruits (−0.90), vegetables (−0.86), starchy staples (−0.80) and pulses/nuts are inelastic, while milk products (−1.08), sugar/confectionary (−1.04), condiment (−1.07) and beverages (−1.01) are price elastic. The compensated cross-price elasticity shows substitutability for all cereal categories. For meat categories, the exception arises for fish products, pulses/nuts and beverages, for fish products except meat, for milk products except egg products and fats/oils and continues for the others.

The sign shift from negative to positive in some of the compensated cross-price elasticity estimates further emphasizes the presence of greater income effects on consumers. Considering substitution among different food groups, compensated demand provides the best estimates due to a purely substitution effect, unlike the uncompensated elasticity which constitutes both substitution and income effects. The compensated cross-price elasticity also provides net substitution due to their plausibility in determining substitution effect.

From Table 10, all uncompensated own-price elasticities are far lager than the cross-price elasticities. Again, all substitute food products and most complement food products across rural and urban households had inelastic uncompensated cross price elasticities. Perhaps, for rural households one can think of them as been generally poor with low income, and at the same time often spending a larger percentage of their meagre income on food. For this reason, they cannot readilily shift from one food commodity to another following a price change, hence the observed inelastic food demand. Also, in rural areas due to large household sizes food demand is high but often there are limited options to choose from and with constrained food budget. The results for the urban households is quite surprising but not implausible, since they are often richer with higher income and can actually afford foods with higher prices. Urban areas are characterized by increasing populations due to rural-urban migration. Unlike rural areas, urban areas have many and diversified jobs and income sources, hence potential changes in feeding behaviour might result from increasing affluence. However, in most urban areas in Ghana, there are still high percentage of poor and very poor households. This finding is consistent with Engel's and Bennet's laws of food demand.

In rural areas, cereals and starchy staples act as substitutes sometimes; at other times, they are complements. A 100% increase in the price of meat leads to a 1% increase in the quantity demanded of cereals, 18% in chicken, and so on. Despite that these food commodities are price inelastic, rural households are mostly smallholder farmers with lower income hence cash constrained. They can barely afford protein foods by sacrificing or reducing the budget for other food commodities. These findings agree with the observation that luxurious food commodities like beverages are complements with meat, chicken, milk, egg products and pulses/nuts, and also that they are not constant components of the rural household's food budget, but substitute with food commodities that make up the food budget of rural households like cereals, starchy staples, vegetables, among others.

In the case of urban households, the findings are consistent with prior expectations, since the estimated elasticities reveal that most of the protein foods are complements to carbohydrate foods. This accords with many food demand studies on rice, maize, yam and cassava in Ghana. Another reason may be that urban dwellers are more concerned with food quality and safety and so would want to balance their diets or perhaps an indication that increasing affluence leads to a gradual shift from carbohydrate foods to meat, fish and protein foods. This becomes even clearer when cross-price elasticities of cereal and meat, chicken or fish products are compared. A 100% increase in the price of starchy staples will increase the quantity demanded of cereals by 1%, indicating that they are gross substitutes.

Compensated price elasticities for rural and urban dwellers

Table 11 provides a summary of the compensated elasticities for rural and urban dwellers. Compared to compensated own-price elasticities, uncompensated own-price elasticities are higher in absolute values for cereals, meat, chicken, fish products, milk products, egg products, fats/oils, fruits, vegetables and sugar/confectionary. For condiments, starchy staples, pulses/nut and beverages, the compensated own-price elasticities are higher. This means that in the latter five food groups, there can be some sort of compensation that will lead to net substitutability and complementarity.

The latter food groups, i.e., sugar/confectionary, condiments, and beverages are price elastic, though complements. Compensated cross-price elasticities describe most of the food commodities as substitutes indicating how people try to allocate their limited resources to achieve a satisfactory level of utility. The uncompensated cross-price elasticities describe the food commodities generally as complements.

The main difference in the urban food demand behaviour is that, apart from cereals and starchy staples being complements, all the others are substitutes which is contrary to the uncompensated own-price elasticities. Thus, urban households with high incomes tend to shift their tastes and preferences anytime. Finally, uncompensated price elasticities predict most of the cross-price elasticities as complements while compensated elasticities generally predicts them as substitutes.

Uncompensated price elasticities for very poor, poor and non-poor households

Tables 12–14 report the compensated and uncompensated price elasticities for the very poor, poor and non-poor households across the six study regions. Just like the price elasticities for rural dwellers, that of very poor households also have positive and negative price elasticities, suggesting that there are both substitute and complement commodities. Also, all the food groups that had positive signs making them substitutes in very poor households had inelastic price elasticities. This

Table 10
Uncompensated elasticities for rural and urban dwellers.

	P1		P2		P3		P4		P5		P6		P7		P8		P9		P10		P11		P12		P13		P14	
	R	U	R	U	R	U	R	U	R	U	R	U	R	U	R	U	R	U	R	U	R	U	R	U	R	U	R	U
Q1	−0.91	−0.91	.01	.01	−0.00	−0.00	−0.04	−0.04	.01	.00	.00	.00	.02	.02	−0.03	−0.03	−0.01	−0.01	.01	.01	.00	.00	.02	.02	−0.01	−0.01	.02	.02
Q2	−0.06	−0.05	−0.54	−0.66	.16	−0.12	−0.75	−0.57	−0.02	−0.02	−0.02	−0.02	.05	.03	.03	.02	.02	.02	.01	.01	.02	.01	−0.10	−0.08	−0.03	−0.02	−0.19	−0.15
Q3	−0.09	−0.11	.18	.21	.87	−0.85	−0.17	−0.20	−0.09	.11	.01	.01	−0.02	−0.03	.08	.09	−0.13	−0.15	−0.00	−0.00	−0.05	−0.06	−0.03	−0.03	−0.05	−0.05	−0.18	−0.22
Q4	−0.03	−0.05	−0.08	−0.11	.01	−0.01	−0.84	−0.77	−0.00	−0.00	.00	.00	−0.00	−0.00	.03	.04	.00	.01	−0.00	−0.01	−0.00	−0.00	−0.01	−0.02	.01	.01	.01	.01
Q5	.01	.00	−0.04	−0.02	.20	.10	−0.14	−0.07	−1.2	−1.1	−0.03	−0.02	−0.14	−0.07	−0.08	−0.04	−0.00	−0.00	.01	.00	.11	.05	.05	.02	.05	.02	−0.05	−0.03
Q6	.02	.01	−0.05	−0.03	.03	.02	−0.03	.01	−0.04	−0.03	−1.0	−1.0	.07	.05	−0.05	−0.03	−0.08	−0.05	−0.03	−0.02	.05	.03	−0.01	−0.01	.09	.06	−0.01	−0.01
Q7	.08	.09	.05	.05	−0.02	−0.02	−0.09	−0.11	−0.05	−0.06	.02	.02	−1.0	−1.0	−0.19	−0.23	−0.03	−0.03	.03	.03	.04	.04	−0.03	−0.04	−0.02	−0.02	.03	.04
Q8	−0.20	−0.07	.11	.03	.15	.04	−0.51	.15	−0.03	−0.01	−0.02	−0.01	−0.30	−0.09	−0.86	−0.10	.32	.09	−0.02	−0.01	−0.06	−0.02	−0.18	−0.05	−0.01	−0.00	.26	.07
Q9	−0.04	−0.04	.02	.02	−0.02	−0.02	−0.01	−0.01	.00	.00	−0.01	−0.01	.00	.00	.03	.04	−1.0	−0.10	.00	.00	.00	.00	−0.01	−0.01	.01	.02	.00	.01
Q10	.08	.08	.03	.03	.00	.00	−0.09	−0.09	.01	.01	−0.03	−0.03	.08	.08	−0.05	−0.04	.03	.03	−1.1	−1.1	.01	0.12	−0.03	−0.03	−0.03	−0.03	.05	.05
Q11	.01	.02	.04	.07	.07	−0.11	−0.06	−0.10	.08	.13	.03	.05	.07	.12	−0.08	−0.12	.02	.03	.01	.01	−1.1	−1.1	.00	.00	−0.03	−0.05	.01	.02
Q12	−0.01	−0.01	−0.03	−0.02	−0.01	−0.01	−0.10	−0.09	.01	.01	−0.00	−0.00	−0.01	−0.01	−0.06	−0.06	−0.04	−0.04	−0.01	−0.01	−0.00	−0.00	−0.92	−0.93	.00	.00	.03	.02
Q13	−0.13	−0.16	−0.05	−0.06	−0.07	−0.09	.07	.09	.04	.15	.06	.07	−0.03	−0.01	−0.03	−0.03	.10	.12	−0.02	−0.03	−0.04	−0.05	.02	.02	−1.0	−0.10	−0.00	.00
Q14	.10	.05	−0.16	−0.09	−0.15	−0.04	.01	.00	−0.01	−0.01	−0.00	−0.00	−0.04	.02	.13	.07	.01	.01	.02	.01	.01	.00	.08	.05	.00	.00	−1.1	−1.1

Legend: Q1 - Q14 and P1 - P14 are the respective quantities and prices of cereals, meat, chicken, fish products, milk products, egg product, fat/oils, fruits, vegetables, sugar/ confectionary, condiments, starchy staples, pulses/nuts, and beverages. U = urban, R = rural.

Table 11
Compensated price elasticities for rural and urban dwellers.

	P1		P2		P3		P4		P5		P6		P7		P8		P9		P10		P11		P12		P13		P14	
	R	U	R	U	R	U	R	U	R	U	R	U	R	U	R	U	R	U	R	U	R	U	R	U	R	U	R	U
Q1	−0.71	−0.71	.04	.05	.03	.02	.22	.14	.02	.03	.01	.02	.06	.05	−0.01	.04	.12	.11	.02	.02	.02	.01	.10	.11	.01	.01	.06	.08
Q2	.27	.26	−0.50	−0.60	.20	.16	−0.34	−0.30	−0.00	.02	−0.01	.01	.10	.08	.07	.12	.23	.19	.03	.03	.05	.03	.04	.07	−0.01	−0.00	−0.14	−0.06
Q3	.19	.18	.22	.27	−0.83	−0.81	.19	.06	.11	.15	.02	.03	.02	.01	.10	.18	.05	.03	.02	.02	−0.02	−0.04	.09	.10	−0.02	−0.04	−0.14	−0.13
Q4	.18	.16	−0.04	−0.07	.02	.01	−0.57	−0.59	.01	.02	.01	.02	.03	.03	.05	.11	.14	.13	.01	.01	.02	.01	.07	.07	.03	.02	.04	.07
Q5	.29	.26	.00	.03	.24	.13	.22	.16	−1.16	−1.05	−0.02	.01	−0.09	−0.03	−0.05	.04	.17	.15	.02	.02	.13	.07	.16	.14	.07	.04	−0.00	.05
Q6	.24	.23	−0.01	.02	.06	.04	.31	.22	−0.02	.01	−0.99	−0.98	.11	.08	−0.02	.04	.06	.08	−0.02	−0.01	.07	.04	.08	.10	.11	.07	.03	.06
Q7	.35	.37	.09	.11	.02	.01	.25	.14	−0.04	−0.03	.04	.05	−0.96	−0.97	−0.16	−0.14	.15	.13	.05	.05	.06	.06	.08	.09	.01	.00	.08	.12
Q8	−0.13	.12	.12	.07	.16	.07	.61	.32	−0.03	.02	−0.01	.01	−0.29	−0.06	−0.85	−0.90	.37	.20	−0.02	.01	−0.05	−0.01	−0.14	.03	−0.00	.01	.27	.13
Q9	.19	.19	.06	.07	.01	.00	.28	.19	.02	.03	.01	.01	.04	.03	.06	.11	−0.85	−0.87	.02	.02	.02	.02	.08	.09	.03	.03	.04	.07
Q10	.30	.30	.07	.08	.04	.03	.19	.11	.02	.04	−0.02	−0.01	.12	.11	−0.02	.03	.18	.16	−1.05	−1.04	.03	.03	.06	.07	−0.01	−0.01	.09	.11
Q11	.24	.25	.08	.12	−0.04	−0.09	.24	.11	.09	.16	.04	.07	.11	.15	−0.06	−0.05	.17	.17	.02	.03	−1.05	−1.09	.10	.11	−0.01	−0.04	.05	.09
Q12	.25	.25	.01	.03	.03	.03	.23	.14	.02	.04	.01	.02	.04	.03	−0.04	.03	.12	.11	.01	.01	.02	.01	−0.81	−0.81	.03	.02	.07	.10
Q13	.12	.09	−0.01	−0.01	−0.04	−0.06	.38	.31	.05	.08	.07	.09	.01	.00	−0.01	.05	.25	.26	−0.01	−0.01	−0.01	−0.03	.12	.14	−0.98	−0.98	.04	.07
Q14	.33	.28	−0.12	−0.04	−0.11	−0.06	.31	.21	.00	.02	.01	.02	.08	.06	.15	.15	.16	.14	.04	.03	.03	.02	.18	.16	.02	.02	−1.1	−1.0

Legend: Q1 - Q14 and P1 - P14 are the respective quantities and prices of cereals, meat, chicken, fish products, milk products, egg product, fat/oils, fruits, vegetables, sugar/ confectionary, condiments, starchy staples, pulses/nuts, and beverages. R is rural, U is urban.

Table 12
Compensated and uncompensated price elasticities for the very poor households.

	P1		P2		P3		P4		P5		P6		P7		P8		P9		P10		P11		P12		P13		P14	
	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C
Q1	−0.93	−0.69	0.01	0.02	−0.00	0.01	−0.03	0.26	0.00	0.01	0.00	0.01	0.02	0.06	−0.03	−0.02	−0.01	0.18	0.01	0.01	0.00	0.02	0.02	0.10	−0.01	0.00	0.02	0.03
Q2	−0.08	0.42	0.58	0.60	0.55	0.57	−2.44	−1.84	−0.09	−0.07	−0.06	−0.05	0.28	0.36	0.08	0.10	0.10	0.47	0.07	0.09	0.10	0.12	−0.30	−0.13	−0.06	−0.04	−0.63	−0.61
Q3	−0.28	0.16	0.52	0.54	−0.59	−0.57	−0.46	0.09	0.24	0.25	−0.01	−0.00	−0.07	−0.01	0.20	0.22	−0.34	−0.00	−0.02	0.00	−0.13	−0.11	−0.09	0.07	−0.13	−0.11	−0.56	−0.54
Q4	−0.06	0.22	−0.07	−0.06	−0.01	0.00	−0.89	−0.55	−0.01	0.00	−0.00	0.00	−0.01	0.03	0.02	0.03	−0.01	0.20	−0.01	0.00	−0.00	0.01	−0.02	0.07	0.00	0.02	−0.00	0.01
Q5	0.14	0.33	−0.06	−0.06	0.25	0.26	−0.08	0.15	−1.23	−1.22	0.02	0.03	−0.10	−0.07	−0.08	−0.08	−0.01	0.13	0.07	0.08	0.14	0.15	0.13	0.19	0.10	0.11	−0.01	−0.00
Q6	0.13	0.29	−0.05	−0.05	0.01	0.01	−0.01	0.19	0.04	0.04	−0.95	−0.94	0.15	0.17	0.05	0.06	−0.17	−0.05	−0.05	−0.05	0.05	0.06	0.03	0.08	0.14	0.15	0.03	0.04
Q7	0.07	0.38	0.08	0.09	−0.02	−0.01	−0.13	0.25	−0.03	−0.02	0.02	0.03	−1.05	−1.00	−0.16	−0.14	−0.00	0.23	0.01	0.03	0.02	0.04	−0.03	0.08	−0.04	−0.02	0.05	0.06
Q8	−0.06	−0.57	0.18	0.16	0.30	0.28	1.64	1.00	−0.05	−0.07	0.07	0.06	−0.45	−0.53	−0.81	−0.83	0.77	0.38	0.04	0.02	−0.08	−0.11	−0.19	−0.37	0.06	0.04	0.57	0.55
Q9	−0.03	0.24	0.01	0.02	−0.01	−0.00	−0.01	0.32	−0.00	0.01	−0.01	−0.00	0.00	0.04	0.02	0.03	−1.01	−0.81	0.00	0.01	0.00	0.02	−0.02	0.08	0.01	0.03	0.00	0.01
Q10	0.14	0.36	0.08	0.09	−0.00	0.01	−0.14	0.12	0.07	0.08	−0.04	−0.03	0.07	0.10	0.01	0.01	0.10	0.25	−1.11	−1.11	0.01	0.02	−0.03	0.05	−0.06	−0.05	0.09	0.10
Q11	−0.03	0.29	0.08	0.09	−0.10	−0.09	−0.15	0.25	0.11	0.12	0.02	0.03	0.07	0.12	−0.12	−0.10	0.04	0.28	0.00	0.02	−1.10	−1.08	−0.02	0.09	−0.07	−0.05	0.01	0.03
Q12	0.00	0.29	−0.03	−0.02	−0.01	0.01	−0.10	0.26	0.01	0.02	−0.00	0.01	−0.01	0.03	−0.06	−0.05	−0.04	0.18	−0.01	0.00	−0.00	0.01	−0.91	−0.81	0.00	0.02	0.03	0.04
Q13	−0.22	0.10	−0.04	−0.03	−0.10	−0.09	0.06	0.44	0.07	0.09	0.07	0.08	−0.11	−0.06	0.00	0.01	0.18	0.41	−0.05	−0.04	−0.07	−0.05	0.02	0.13	−1.03	−1.01	0.00	0.02
Q14	0.53	0.57	0.46	−0.45	−0.43	−0.43	0.30	0.35	−0.00	−0.00	0.02	0.02	0.20	0.20	0.41	0.41	0.10	0.12	0.08	0.08	0.04	0.04	0.32	0.33	0.03	0.03	−1.27	−1.27

Legend: Q1-Q14 and P1-P14 are the respective quantities and prices of cereals, meat, chicken, fish products, milk products, egg product, fat/oils, fruits, vegetables, sugar/ confectionary, condiments, starchy staples, pulses/nuts, and beverages. U = uncompensated elasticity, C = compensated elasticity.

Table 13
Compensated and uncompensated price elasticities for the poor households.

	P1		P2		P3		P4		P5		P6		P7		P8		P9		P10		P11		P12		P13		P14	
	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C
Q1	−0.92	−0.70	0.01	0.03	−0.00	0.02	−0.04	0.23	0.00	0.01	0.00	0.01	0.02	0.06	−0.03	−0.01	−0.01	0.14	0.01	0.02	0.00	0.02	0.02	0.12	−0.01	0.01	0.02	0.04
Q2	−0.05	0.30	−0.38	−0.34	0.21	0.25	−0.99	−0.57	−0.04	−0.02	−0.03	−0.01	0.11	0.16	0.02	0.06	0.03	0.26	0.03	0.04	0.04	0.06	−0.13	0.03	−0.03	0.00	−0.26	−0.22
Q3	−0.14	0.19	0.26	0.29	−0.80	−0.77	−0.23	0.17	0.12	0.13	−0.01	0.01	−0.04	0.01	0.10	0.13	−0.17	0.05	−0.01	0.01	−0.07	−0.04	−0.05	0.10	−0.07	−0.04	−0.28	−0.25
Q4	−0.05	0.19	−0.08	−0.05	−0.01	0.01	−0.87	−0.57	−0.01	0.00	−0.00	0.01	−0.01	0.03	0.03	0.05	−0.00	0.16	−0.01	0.01	−0.00	0.01	−0.02	0.09	0.00	0.02	0.00	0.02
Q5	0.11	0.32	−0.08	−0.05	0.29	0.31	−0.14	0.12	−1.27	−1.26	0.02	0.03	−0.12	−0.09	−0.12	−0.09	−0.04	0.10	0.08	0.09	0.16	0.18	0.13	0.22	0.11	0.13	−0.03	−0.01
Q6	0.07	0.26	−0.04	−0.02	0.00	0.02	−0.02	0.22	0.02	0.03	−0.97	−0.96	0.09	0.12	0.03	0.05	−0.12	0.02	−0.04	−0.03	0.03	0.04	0.01	0.10	0.09	0.10	0.02	0.03
Q7	0.08	0.37	0.08	0.11	−0.02	0.01	−0.14	0.21	−0.03	−0.02	0.02	0.04	−1.05	−1.00	−0.17	−0.14	−0.00	0.19	0.02	0.03	0.03	0.05	−0.03	0.10	−0.04	−0.02	0.05	0.08
Q8	−0.07	−0.09	0.07	0.07	0.12	0.12	0.64	0.62	−0.03	−0.03	0.03	0.02	−0.20	−0.20	−0.93	−0.93	0.30	0.29	0.01	0.01	−0.04	−0.04	−0.10	−0.11	0.02	0.02	0.22	0.23
Q9	−0.04	0.22	0.01	0.04	−0.02	0.01	−0.01	0.29	−0.00	0.01	−0.01	0.00	0.01	0.04	0.02	0.05	−1.01	−0.84	0.00	0.02	0.01	0.02	−0.02	0.11	0.02	0.03	−0.00	0.02
Q10	0.11	0.33	0.06	0.09	−0.00	0.02	−0.13	0.13	0.06	0.07	−0.03	−0.02	0.06	0.09	0.00	0.03	0.07	0.21	−1.09	−1.08	0.01	0.02	−0.03	0.07	−0.05	−0.03	0.07	0.09
Q11	−0.01	0.27	0.06	0.09	−0.07	−0.05	−0.10	0.23	0.08	0.09	0.01	0.03	0.06	0.10	−0.08	−0.05	0.03	0.22	0.00	0.02	−1.17	−1.05	−0.01	0.11	−0.05	−0.03	0.01	0.04
Q12	−0.00	0.27	−0.02	0.01	−0.00	0.02	−0.08	0.24	0.01	0.02	−0.00	0.01	−0.01	0.03	−0.05	−0.02	−0.04	0.14	−0.01	0.01	−0.00	0.02	−0.93	−0.81	0.00	0.02	0.02	0.05
Q13	−0.17	0.11	−0.03	−0.01	−0.08	−0.06	0.03	0.38	0.06	0.07	0.06	0.07	−0.08	−0.04	0.00	0.03	0.14	0.33	−0.04	−0.03	−0.05	−0.03	0.02	0.14	−1.02	−1.00	0.00	0.03
Q14	0.26	0.42	−0.25	−0.24	−0.24	−0.22	0.13	0.33	−0.01	−0.00	0.01	0.02	0.12	0.13	0.21	0.23	0.03	0.14	0.04	0.05	0.02	0.03	0.16	0.24	0.01	0.02	−1.16	−1.15

Legend: Q1-Q14 and P1-P14 are the respective quantities and prices of cereals, meat, chicken, fish products, milk products, egg product, fat/oils, fruits, vegetables, sugar/ confectionary, condiments, starchy staples, pulses/nuts, and beverages. U = uncompensated elasticity, C = compensated elasticity.

Table 14
Compensated and uncompensated price elasticities for the non-poor households.

	P1		P2		P3		P4		P5		P6		P7		P8		P9		P10		P11		P12		P13		P14	
	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C
Q1	−0.91	−0.71	0.01	0.05	−0.00	0.02	−0.04	0.17	0.01	0.03	0.00	0.02	0.02	0.06	−0.03	0.02	−0.01	0.11	0.01	0.02	0.00	0.02	0.02	0.11	−0.01	0.01	0.02	0.08
Q2	−0.05	0.25	−0.65	−0.59	0.12	0.16	−0.58	−0.27	−0.02	0.01	−0.02	0.01	0.06	0.11	0.00	0.08	0.01	0.18	0.01	0.03	0.02	0.04	−0.08	0.06	−0.02	0.01	−0.15	−0.08
Q3	−0.11	0.18	0.18	0.24	−0.86	−0.82	−0.17	0.13	0.08	0.12	−0.01	0.02	−0.03	0.02	0.07	0.14	−0.12	0.05	−0.01	0.01	−0.05	−0.03	−0.03	0.09	−0.05	−0.03	−0.20	−0.12
Q4	−0.05	0.16	−0.09	−0.05	−0.01	0.02	−0.81	−0.60	−0.00	0.02	−0.00	0.02	−0.01	0.02	0.05	0.10	0.01	0.13	−0.01	0.01	−0.00	0.01	−0.02	0.07	0.01	0.02	0.01	0.07
Q5	0.00	0.25	−0.03	0.02	0.10	0.13	−0.07	0.18	−1.10	−1.07	0.00	0.02	−0.05	−0.01	−0.06	0.01	−0.03	0.11	0.03	0.04	0.06	0.07	0.03	0.14	0.04	0.06	−0.02	0.04
Q6	0.02	0.24	−0.02	0.02	0.00	0.03	−0.02	0.19	0.01	0.04	−0.98	−0.96	0.06	0.09	0.01	0.06	−0.08	0.05	−0.02	−0.01	0.02	0.03	0.00	0.10	0.05	0.07	0.00	0.06
Q7	0.08	0.35	0.08	0.14	−0.02	0.02	−0.14	0.14	−0.04	−0.00	0.02	0.05	−1.05	−1.01	−0.17	−0.10	−0.00	0.16	0.02	0.04	0.03	0.05	−0.04	0.09	−0.04	−0.02	0.05	0.12
Q8	−0.07	0.09	0.03	0.06	0.05	0.07	0.25	0.41	−0.02	0.00	0.01	0.02	−0.09	−0.07	−0.99	−0.95	0.11	0.20	0.00	0.02	−0.02	−0.01	−0.06	0.01	0.01	0.02	0.09	0.13
Q9	−0.03	0.19	0.02	0.06	−0.02	0.01	0.00	0.23	−0.00	0.02	−0.01	0.01	0.01	0.04	0.03	0.08	−1.00	−0.87	0.01	0.02	0.01	0.02	−0.02	0.08	0.02	0.04	−0.00	0.06
Q10	0.08	0.30	0.05	0.09	−0.00	0.02	−0.12	0.10	0.04	0.07	−0.03	−0.01	0.04	0.08	0.00	0.06	0.05	0.17	−1.08	−1.06	0.01	0.02	−0.03	0.07	−0.04	−0.02	0.05	0.11
Q11	0.01	0.25	0.07	0.12	−0.08	−0.05	−0.10	0.14	0.09	0.12	0.02	0.04	0.07	0.10	−0.09	−0.02	0.05	0.19	0.00	0.02	−1.08	−1.06	−0.01	0.10	−0.05	−0.04	0.02	0.08
Q12	−0.01	0.25	−0.03	0.02	−0.01	0.03	−0.09	0.17	0.01	0.04	−0.00	0.02	−0.01	0.03	−0.06	0.01	−0.04	0.11	−0.01	0.01	−0.00	0.02	−0.92	−0.81	0.00	0.02	0.02	0.09
Q13	−0.15	0.10	−0.03	0.02	−0.08	−0.04	0.05	0.30	0.06	0.09	0.05	0.07	−0.08	−0.04	0.01	0.07	0.14	0.28	−0.04	−0.02	−0.05	−0.03	0.02	0.13	−1.02	−1.00	0.01	0.07
Q14	0.07	0.29	−0.10	−0.06	−0.09	−0.06	0.03	0.26	−0.01	0.02	0.00	0.02	0.04	0.07	0.07	0.12	−0.00	0.13	0.01	0.03	0.01	0.02	0.05	0.15	0.00	0.02	−1.07	−1.01

Legend: Q1-Q14 and P1-P14 are the respective quantities and prices of cereals, meat, chicken, fish products, milk products, egg product, fat/oils, fruits, vegetables, sugar/ confectionary, condiments, starchy staples, pulses/nuts, and beverages. U = uncompensated elasticity, C = compensated elasticity.

could be due to the fact that very poor households are the lowest income groups and are often unable to meet their basic needs of life, including food.

A major difference observed between the poor and very poor households is that, the latter have higher elasticity values approaching unity. This means that gradually they are moving from a point where they have no or limited options to choose from due to limited budget to a point where they can have options to choose from and that any price change will significantly affect their feeding behaviour. The elasticity characteristics for the poor are similar to that for the very poor households.

The price elasticities for non-poor households exhibited similar features as the poor households. Major differences are that, as the price of a protein foods increases, the quantity demanded of other protein and non-protein foods and starchy staples decrease. For example, complementary relationships exist between the price of meat and the quantity demanded of fish, milk and egg; the price of chicken and the quantity demanded of fish; the price of fish and the quantity demanded of meat, chicken, fish and milk among others. These food commodities are gross complements. For example, a percentage decrease in the price of fish products increases the quantity demanded of cereals by 0.04%. Fish products are also substitutes to eggs (0.01%). These results confirm the general perception that urban dwellers are continually changing their food consumption behaviour, shifting from carbohydrate related foods to protein foods, as well as paying much attention to their health, which from this study, is a characteristic of non-poor households. In accordance with demand theory, the own-price elasticities bear negative signs.

Compensated price elasticities for very poor, poor and non-poor households

Generally, the results for the compensated price elasticities show that food demands of the very poor tend to be more responsive to price changes than the non-poor. These results compare quite well with the existing evidence elsewhere [23]. A notable observation from the own-price uncompensated elasticities is their negative and inelastic nature. For the cross-price uncompensated elasticities, we observe both complement and substitute food commodity groups across the very poor, poor and non-poor households. For the compensated elasticities, fruits and pulses/nuts are complementary with about half of other food groups. Majority of all other food groups have substitutionary relationships.

For poor households, the uncompensated and compensated price elasticities also show both positive and negative values, suggesting that the commodities are both substitutes and complements. However, these values are generally inelastic, suggesting that an increase in the price of one commodity hardly cause poor households to shift to the other commodities with lower prices. All the substitute products considered in poor households had inelastic cross-price elasticities but not own-price elasticity for some of the the food commodities.

The estimated price elasticities for non-poor households exhibited similar features as the urban households in the uncompensated demand system but not the same for compensated demand elasticities. The differences are evident in the net substitutability between many food groups. For the uncompensated demand elasticities, major differences are that as the price of a protein food increases, the quantity demanded of the other protein and non-protein foods increase. Such food commodities are thus gross complements. But for the compensated price elasticity results, as the prices of protein and carbohydrate foods increase, the quantity demanded of related protein and carbohydrate foods increases.

Conclusions and policy implications

In this paper, we examined food demand characteristics in selected regions of Ghana based on data from 4705 households. We estimated expenditure and price elasticities for 14 food commodity groups to examine how demographic factors like household size and age and socioeconomic status (i.e., poverty profile) affect food demand. The results suggest that fish and cereal products take close to half of the food budget (46%) of the average Ghanaian household. Thus, on an average a household spends almost half of her food budget on fish and cereal products. Households in the Eastern, Central and Ashanti regions spend large part of their food budget on fish and vegetables products, cereals and bread, and meat, respectively. Furthermore, female-headed households disburse a higher proportion of their food budget across majority of the food groups considered in this study compared to their male counterparts. Not surprisingly, the very poor households allocate the highest proportion of their food budget than the poor and non-poor.

The estimated elasticities of food items in relation to price, expenditure (income), age and household size are pertinent for investment and policy decisions. Investors in Eastern and Central regions could consider fish and cereal product businesses, especially by trading across regional or international borders. Policy makers can ensure that water bodies where fishes are reared and/or harvested are not polluted in the southern. Food aid and donor agencies should target the aged, larger households, the very poor households and the rural dwellers for food security interventions. Also, population control measures should be intensified in rural areas in order to control birth and improve their standards of living. This is backed by the fact that household size and food consumption are directly linked; larger household size generally increases food demand. Evidence from the findings of this research put responsibility on the agriculture sector to produce sufficient food commodities especially fish products, cereals and vegetables for domestic consumption especially as population grows rapidly.

While the results provided in this study are credible, a major limitation needs to be highlighted. The GLSS data set provides information on aggregate prices of food groups based on clusters, since prices faced by individual households were

not available. This made it impossible to estimate price elasticities for the ten regions of Ghana because some of the prices in four regions were not available in the data set.

Declaration of Competing Interest

The authors declare that they have no conflict of interest

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