Analysis of household food demand and its implications on food security in Kenya: an application of QUAIDS model

Abstract

This paper evaluates household food security situation in Kenya in terms of access to food, using cross sectional data from the Kenya Integrated Household Budget Surveys (KIHBS). By estimating price and income elasticities, which provides an indication of the sensitivity of households to market shocks and thus the degree of household's constraint to access food. The empirical approach involve estimation of demand system analysis the QUAIDS model. Existing research focuses on disaggregate food items and other developing countries, but none has specifically used the QUAIDS model for the aggregated food groups to analyse food consumption patterns nationally for the Kenyan context. The empirical results show positive expenditure elasticities while all compensated and uncompensated price elasticities show negative results. While their magnitudes vary; expenditure elasticities for meat and fish, and essential condiments are elastic (sensitive to changes) and are considered as luxuries as their elasticities are greater than one. Whereas cereal and bread, dairy products, fruit and vegetables and other condiments, have both inelastic price and expenditure elasticities; they are considered to be normal goods with values less than one. With respect to low income households, rural households and those highly dependent on the consumption of own produced food ("auto-consumption"), a reverse relationship is exhibited where meat and fish expenditure are inelastic hence perceived as normal foods, which is somewhat unexpected. However, in Kenya this finding may be attributed to the fact that a majority of the households in the survey depend on their own domesticated animals for meat and fish consumption. Hence they are not largely involved in the formal market services and prices. Further analysis shows that household size, regional differences, the ratio of food expenditure to total income and the ratio of auto-consumption are statistically significant, and hence have a great impact on food consumption expenditure. The results are broadly consistent with microeconomic theory, however exceptions indicate an unusual pattern (less sensitivity to income changes) for the rural and low income households' meat and fish consumption. Interestingly, the low income households in our sample show that the food income elasticity for meat and fish to be less than one. These results should inform the design of policies aimed at improving the nutritional status of the poor, children and other vulnerable individuals.

JEL classification: D12, C31, Q18, O55
Key words: food security, food demand, QUAIDS, elasticity, Kenya

1. Introduction

Food and nutritional security remains a major global challenge especially with the increasing human population, food price volatility, adverse climatic changes and increase in diet related diseases (Abbott & de Battisti, 2011). It is estimated that 795 million people globally have no access to food in the right quality and quantity (Elver, 2015; WFP, 2015) and one in every three people suffer from severe malnutrition (FAO, 2014; WFP, 2015). While in some other extreme cases households experience both food shortages as well as insufficient micronutrients consumed in their diets (Manda, et al., 2016). Nonetheless, there seems to be a growing consensus on the need to rethink food security policy, particularly the need to take a holistic approach to the problem recognising that food security is a multifaceted and multidimensional concept. For instance, having a stable supply and access to food is an essential element of food security (Upton et al., 2016: Sibhatu, et al., 2015). This therefore suggests

that an integrated strategy aimed at boosting production and tackling food demand oriented challenges will in the long run help to achieve the dual goals of improving food security and reducing poverty levels (Andersen, 2014; Regmi & Meade, 2013).

Food demand is mainly determined by three strongly interlinked factors: population growth, urbanization, and changes in consumption patterns and lifestyles (Pieters, et al., 2013). Unlike the other four factors, food consumption patterns are often overlooked in research and policy areas of food security (Jones et al., 2013; Rizov et al., 2015). This is due to the fact that, food availability has for a long time been the major issue as opposed to utilisation, stability and access. Food demand is also closely linked to food prices and income variability. This has been another major concern affecting food availability and access. FAO, (2012) highlights that higher food prices lead to higher levels of undernourishment. Further, Kearney, (2010) reports that uncertainty of food prices has implications on individual household incomes and their food consumption patterns. Moreover, the majority of households in developing countries spend a much higher share of their income on food than those in developed countries (Rizov et. al., 2015), and FAO estimates, this share amounts to 60-80 per cent in developing countries, compared to 10-20 per cent in developed countries (Rizov et al., 2015; FAO, 2011; Park et al., 1996).

On the other hand, an increase in income normally leads to consumption of a varied diet and individuals tend to consume more high-value products such as meat, fish, milk, fresh fruit and vegetables (Rizov et al., 2015). Additionally, higher incomes and changing lifestyles increase the demand for energy, which in turn affects the production costs of agricultural commodities (Pieters, et al., 2013). This suggest that changes in food prices and income changes will have large welfare effect on both farmers and consumers (FAO, 2011). Therefore, in the event of high food prices and a decrease in income or lack of enough income, poor consumers find themselves unable to purchase the required food for their bodies to stay active and healthy (D'Souza & Jolliffe, 2012). This is based on the assumption that most of the poor, including a large share of smallholder farmers, are net buyers of food (Andersen, 2014; FA0, 2011). Therefore, higher food prices will have two main effects on the net buyers of food: an income effect through decreases in purchasing power of poor households and a substitution effect through shifts to less preferred food items (Andersen, 2014; D'Souza & Jolliffe, 2012; Ecker & Qaim, 2008).

FAO, (2012) estimates that nearly 870 million people were undernourished in the period 2010–12, a figure that represents 12.5 percent of the global population, or one in eight people. A majority of the undernourished (or 852 million people) live in developing countries and more so a majority are found in the rural areas of developing countries, where the prevalence of undernourishment is estimated at 14.9 percent of the population (FSIN, 2017; FAO, 2012). Kenya like most developing countries in Africa still faces these challenges of food insecurity, with the recent years experiencing severe food shortages and associated diet related diseases (Moomaw et al., 2012; Elver, 2015). For instance,

according to the Kenyan Food Security Steering Group report of (2017), Kenya (as at January 2017), was experiencing acute food insecurity outcomes of high food assistance needs following the poor short rainy season of October-December 2016 (FEWS NET, 2017). These problems have been intensified by climate change, population growth, changing habits, food price volatility, and internal conflicts (FSIN, 2017). Nonetheless, the main issues in Kenya come from uncertain food sources, inconsistent food supply, affordability and the low purchasing power of a large proportion of the population (FEWS NET, 2017). Similarly, the economic review of agriculture 2007 indicates that 51% of the Kenyan population lack access to adequate food. This inaccessibility to food is closely linked to poverty which stands at 46% (GOK, 2012). Furthermore, nearly 20 million Kenyans still live in extreme poverty defined as income of less than $1.25 per day (Ministry of Agriculture, 2009).

The food security debate fundamentally centres on the right of everyone to have access to safe, sufficient, culturally acceptable and nutritious food, rather than sufficiency in food supply (Andersen, 2009; United Nations, 1948). As an example, maize is the staple crop in Kenya and the lack of it in households may be seen as an illustration of food insecurity in terms of the lack of access and availability of maize grain when required by the consumers (Mohajan, 2014). Cereals are the most popular food consumed and maize is the staple diet alongside fruits, vegetables, milk, eggs and starchy food items. Sweeteners, pulses, nuts, oil crops and meats products are consumed less (Chauvin 2012; Ministry of Agriculture, 2009). Despite the trend of lower levels of meat consumption nationally, its consumption has been gradually increasing in Sub-Saharan countries including Kenya, especially among mid-income households (Ministry of Agriculture, 2009). According to the latest figures from the Global report of food crises (FSIN, 2017), the number of food -insecure people in Kenya increased from 1.3 million to 2.2 million in February 2017 with about 10 million people still depending on food aid. Furthermore, since the agriculture sector is dominated by small scale farmers in developing countries, farmers would gain more in terms of income and nutritious diets if they produced various food commodities, driven by their preference and knowledge of the importance of consuming a varied diet (Sibhatu, et al., 2015). Therefore policies can be tailor-made to motivate farmers into improving their farming systems (Alexandria et al., 2015b).

Extensive studies have focused on the supply capacity of food systems, in particular, substantial efforts and resources are being spent on improving agricultural productivity and stimulating market access for smallholder producers (SDSN, 2013; Khush, et al., 2012; Andersen, 2014). However, less effort has been put to investigating and attempting to remedy the demand side challenges, in particular for the most food insecure population; the poor, rural, small-scale and subsistence farmers. This is due to the fact that they are often particularly vulnerable when faced with shocks and price and income variabilities. Cockx, et al., (2015) noted that there is chronic calorie deficiency around the world; with over 30% of the population in developing countries being nutrient deficient and one third of these being children (Manda, et al., 2016). This figure is consistent with the 870 million undernourished people

reported by the FAO, (2012) and explains why food supply side challenges have been of such great global concern and the evident less focus on demand side challenges.

This paper contributes to the growing literature focusing on how food security relate to households' consumption decision processes the related questions on how prices, incomes and demographics affect spending patterns. Food consumption pattern analysis enables one to establish a populations' food needs, with changes in incomes and prices. However increased household income does not necessary mean that more of that income is spent on food items, rather on other items due to lifestyle changes (Regmi & Meade, 2013). A key aim to improving food security status, and in some cases, to promote a shift to consumption of more beneficial goods (such as nutritious foods). Several studies including those by Bett et al., (2012) and (Abdulai & Aubert, (2004) have analysed household food demand in particular for developing countries and the potential role of demographic factors. Similarly, Rischke et al., (2015) analysed the role of supermarkets in enhancing food security (i.e. by expanding availability of particular food items and a source of highly processed, energy dense food items) as they tend to influence consumer behaviour especially in an urban Kenyan household. However most studies have overlooked the role played by demographic factors (Sibhatu, et al., 2015; Alexandria, et al., 2015a). The effect of demographic factors and. auto-consumption particularly in rural areas has not been adequately incorporated in food demand analysis (Alexandria, et al., 2015a).

In this paper we investigate the food security situation in Kenya and its measurements. Using food expenditure data from the Kenyan national Bureau of statistics (KNBS), the Kenyan Integrated Household survey of 2005/06, this paper makes an estimation of food demand systems (Ecker & Qaim, 2008; Carletto, et al., 2013). To analyse food consumption in Kenyan households in both rural and urban areas we use the Quadratic Almost Ideal Demand System approach (QUAIDS model) of Banks, Blundell & Lewbel, (1997). The QUAIDS model is favoured here over other demand system analyses, since it has been widely used, it is flexible and incorporates demographic variables which are important for this paper. Price and income elasticity estimates for six food groups, were obtained to estimate household food demand behaviour. In contrast to existing research which focuses on disaggregate food items, we use the QUAIDS model and aggregated food groups to analyse food consumption patterns nationally for the Kenyan context.

The remainder of the paper is organized as follows. Section two is focused on a description of the survey data. Section three gives the estimation procedure and empirical framework used. Empirical results are presented in section four. Conclusions are drawn in last section with the overall goal of contributing to the food security theme.

2. Data

This paper uses data from the Kenya Integrated Household Budget Survey (KIHBS), a Kenya government funded household survey implemented by the Kenya National Bureau of Statistics (KNBS). KIHBS (conducted every 10 years) is the most comprehensive household survey ever implemented in Kenya, covering all districts with a representative sample of 13,430 households in the country. The key objectives of KIHBS are update measures of living standards, the Consumer Price Index (CPI), and the System of National Accounts (SNA).

The KIHBS questionnaire collects recall information on the quantities consumed for each of the food components over a one week period. The food quantities consumed were valued using reported unit prices from purchases along with locally representative prices obtained from the daily purchase diaries completed by each household over a two-week period. Two concerns arise while using reported unit prices, endogeneity and measurement errors, this has been tackled by calculating an aggregate price by; adjusting for measurement units (Capeau & Deron (1998) and adjusting price variations due to quality differences (Cox & Wohlgenant, 1986). Overall the KIHBS collected over 276,000 observations of over 140 distinct food items that were reported consumed by 13,158 households. This represents the most comprehensive and detailed data set on food consumption ever collected in Kenya.

The food groups were then aggregated to 7 distinct groups to justify the dynamic consumption behaviours; 1.cereals 2.dairy products 3.meat and fish 4.fruit and veg 5.bananas and tubers 6.fats and oils 7.other foods (including those consumed in the restaurant or away from home). Further for the current analysis, the food items were grouped into six food groups for purposes of the demand estimation and avoid zero consumption mainly due to infrequency of purchase during the short period of the survey; 1.cereal, bread and pulses 2.dairy products 3.meat and fish 4.fruit and vegetables, banana and tuber 5.essential condiments and 6.other condiments (excluding those consumed in the restaurant or away from home). A summary of consumption of individual food groups by households involved in the survey were as follows: 27.46% consumed cereals, bread and pulses, 6.94% consumed dairy products, 6.60% consumed meat and fish, 34.89% consumed fruit and vegetables, 11.83% consumed essential condiments and 12.27% consumed other condiments. This constructed food consumption aggregates includes four components: (a) food consumption derived from purchases, and consumption from (b) own production, (c) stocks and (d) gifts.

For about 37,000 of the reported cases of food item purchases over the past week, not all of the purchased quantities were consumed during that period. This is evidence that many households in Kenya purchase certain food items “in bulk” and then consume these over a period that exceeds 7 days. The items on which consumption information was collected in the KIHBS 2005/06 were classified into two broad categories: food and non-food. The food component consisted of the following sub-groups: cereals, bread, roots and tubers, poultry (chicken), meat, fish and sea foods, dairy products and eggs,

vegetable oil and animal fats, fruits, vegetables, pulses, sugar, non-alcoholic beverages, alcoholic beverages, food eaten in restaurants and canteens, and spices and condiments. The demographic variables used in the estimation procedure includes household size, ratio of food expenditure, ratio of own consumption from production for each food group and dummy variables for rural and urban differences, to capture factors that are not explained by both changes in price and or income and other factors that may contribute to heterogeneity of food demand elasticities. Household expenditure is commonly used as a proxy of income because household-reported income is generally regarded as unreliable, particularly in poorer countries where self-employment is prevalent (Deaton, 1997; Jones et al., 2013). Table 1 below, show the mean and standard deviation for the key variables used in the analysis of food demand. The households had an average of five family members. About, 35 percent of the households were in the urban and 65 percent in the rural areas.

Table 1: Descriptive statistics of variables used in the analysis

Variable	**Definition**	**Mean**	**Std. Dev.**
m	Total weekly household expenditure(KSH)	30392.78	66924.83
w1	Expenditure share on cereal & bread	0.2910	0.2657
w2	Expenditure share on dairy products	0.0919	0.1481
w3	Expenditure share on meat &fish	0.1034	0.1824
w4	Expenditure share on fruit & vegetables	0.1552	0.1846
w5	Expenditure share on essential condiments	0.2474	0.2940
w6	Expenditure share on other condiments	0.1111	0.2259
p1	Price of cereal & bread	32.3309	27.6839
p2	Price of dairy products	24.1351	19.4905
p3	Price of meat &fish	79.0560	58.3164
p4	Price of fruit & vegetables	13.1897	21.0882
p5	Price of essential condiments	50.6131	32.4841
p6	Price of other condiments	20.0567	74.1177
hhsize	Household size	5.0609	2.8020
rfexp	Ratio of food expenditure	0.2797	0.2923
rural	Dummy:1 if rural household & 0 otherwise	0.6460	0.4782
rautocn	Ratio of auto-consumption	0.4873	0.1122

Expenditure is in Kenyan shillings; 1 US Dollar equals 102.69 Kenyan Shilling.

3. Estimation procedure

The study conducts a food demand analysis using a 2005/2006 household expenditure survey data from the Kenya National Bureau of statistics to estimate the price and income elasticities at household level which characterise the sensitivity of households to market shocks and thus the degree of household's constraint to access food. In this paper we start by estimating Engel curves for the six food groups using non-parametric Kernel regression following Fan, (1992) and Banks et al., (1997). The shapes of the Engel curves are consistent with theory. They are non-linear and depict a positive relationship and hence suggesting that they are normal goods. However essential and other condiments show a reverse pattern therefore suggesting that these food groups are perceived as luxury. This preliminary analysis suggests that our choice of QUAIDS for estimating food demand behaviour in Kenya is justified as it is important

first to examine the expenditure share equations before imposing functional forms in the empirical analysis (Abdulai & Aubert, (2004); Rizov et al., 2015).

Then we adjusted prices for local units and quality variations. To be precise, one that may reflect variations in quality rather than only in prices. For instance, one household could have bought a kilogram of rice while the other household a kilogram of a much cheaper rice variety, and yet in the expenditure survey both purchases would be reported as a kilo for the same item (rice) but at quite different cluster prices. For instance, Deaton, (1997) and Crawford, et al., (2003) have tried different approaches to explain the variation in quality on price however, their estimation procedures are not quite straight forward. Therefore for this current estimation, a conversion factor approach is adopted, where reported unit prices were not used for the demand analysis. Rather, they were further calculated to avoid issues of endogeneity, and appropriateness to value own production (Singh et al., 1986; Low, 1986; Deaton, 1987). Also an adjustment was made to tackle the issues brought about by variations in quality by cross sectional prices. Both estimations capture both temporal and spatial price variations (Cox & Wohlgenant, 1986). Moreover, to avoid having zero consumption on various food groups, food items were aggregated into six food groups. The choice of the food grouping were classified reflecting consumers preference tied to knowledge of the consumption culture (Abdulai & Aubert, 2004). A major advantage to this particular food-grouping scheme is that it reduces the total number of parameters in the model, thus making demand system estimation more manageable. Each food group price is computed as a weighted average of prices and also adjusted price for quality variations on food items reported by households. Then finally, QUAIDS model is estimated using Stata software using and code developed by Poi (2008; 2012).

3.1. ***Adjusted prices for local measurement units***

To generate the price for the food group the study first calculated conversion factors then used it alongside the reported quantities to calculate the expenditure on consumption as well as the composite price of the six food groups used in the estimation. It is important to find the appropriate pricing as the prices were not provided. Also the quantities reported from both purchases and auto-consumption were in local units hence price was calculated following Capeau & Deron (1998) as will be explained below. The quantities purchased in the market, were expressed in a local unit and the monetary value of the expenditure on the commodity as well. The data are clustered and market prices are assumed to be constant per cluster. We then start from a simple calculus procedure: price per unit times the purchased quantity equals to expenditures on purchases. Basically, the possibility of quality differences is initially ignored. The commodities under consideration is therefore assumed to be homogenous for all households. Local units are also assumed to be fixed per cluster, although they may vary across the clusters. The study allows for the possibility that a local unit has a different weight in kilograms/ litres depending on the actual commodity.

A simple notation is used: *q(i)*k* to represent the quantity purchased by household *i*, measured in unit k; *pj* is the price per kilogram/litre of that good in cluster j; $V^*(i)$ equals the amount spent on the good by household i and the $a_{jk}$is the conversion rate or factor of local unit k into kilograms for commodity *i* in cluster j. If values and quantities were measured without error, then they would be related according to following identity:

$$V^*(i) = p_J\, a_{jk}.\, q^*(i)k. \tag{1}$$

If the unit is measured in kilograms, then a_{jk} equals one. In that case the price p_j can be identified and used for all other observations to obtain the correct conversion factor. We do not observe the true expenditures and quantities but only the (random) guesses of the respondents of these true values. Other procedures then need to be used. We define $p(i)_{jk}$ as the commodity's price paid by household i in cluster j, if the quantity purchased is measured in unit k, so that for all k and j, equation (1) can be written as:

$$p(i)_{jk} = a_{jk}.p_j \;\; = \frac{V^*(i)}{q^*(i)k} \tag{2}$$

One can then replace $V^*(i)$and q*(i)*k* their observed counterparts $V\ (i)$and q(i)k, in order to obtain an estimate of p(i)jk. This procedure forms the first step in the estimations proposed by Lambert and Magnac (1997). Next outliers are corrected using medians over the cluster level *jk* for estimates $p(i)_{jk}$ denoted by p^*_{jk}. and p_j denoted by p^*_j for the *numéraire of price* .This calculation will produce conversion rates, denoted as a^*_{jk} as shown in equation 3:

$$a^*_{jk} = \frac{p^*_{jk}}{p^*_j} \tag{3}$$

While easy to implement, such two-step procedure involves inefficiency (Capeau & Deron, 1998), since only median of distributions are used for estimations. Nevertheless, for this study it is more appropriate than most practices, since it explicitly considers the problems of conversion rate. In most studies it appears to be assumed away. After obtaining the unit price from the conversion factor, total spending for each household on each of the *n* food items were calculated. Then, computed the weighting factor for each food group as follows; spending on food item i / total spending on food group. Then using these weights and the unit prices of each items to calculate the price of each food groups.

3.2. Quality adjusted prices

Once prices are adjusted for local measurements to avoid endogeneity and measurement errors, the cross-sectional prices obtained are further adjusted for quality variation effects which would otherwise increase heterogeneity of the aggregated food items. The sources of variation of cross-sectional prices are: differences in the regions and price discrimination; services acquired with the commodities; seasonal effects and differences in the quality due to the aggregate of non-homogeneous goods (Cox &

Wohlgenant, 1986). The study used the traditional procedure to generate quality-adjusted prices (Cox & Wohlgenant, 1986; Park et al., 1996) to adjust for price variations. The prices are regressed on selected social and demographic characteristics (Park et al., 1996).

$$reg_{tp_i} = \beta_\theta + \beta_1\, income + \beta_2 rural + \beta_3 rautocon + \beta_4\, hhsize + \beta_5 rfexp + \ \varepsilon_i \quad (4)$$

The variables include; reg_{tp_i} the imputed price of the 'i'th food group; *income,* indicates household food expenditure; *rural,* a binary variable representing a household located in the rural areas; *rautocon,* variables representing households' ratio of auto-consumption; *hhsize,* represents household size; *rfexp* variable representing household ratio on food expenditure. Quality-adjusted prices for each food group were generated by adding the constant β_θ value to the residuals (reg_{tp_i}) derived from each commodity regression (Cox & Wohlgenant, 1986; Park et al,. 1996). When either expenditure or quantity was zero, the adjusted price was equal to the intercept. The generation of these prices admits the possibility that some of them may be negative. This situation suggests that, after accounting for quality differences, one would have to pay a particular household to consume the good in question.

4. Empirical framework

Quadratic almost Ideal demand system (QUAIDS)

The investigation of food demand and the estimation of elasticity coefficients provide useful information on the consumption behaviour of different population categories in relation to incomes, expenditures and household characteristics (Alexandria et al., 2015a). Access to food is determined by cost of food, willingness to pay and household income (Westengen & Banik, 2016). For instance, how much of the income/ budget does the household spend on food or particular food items? This study used the Quadratic Almost Ideal Demand System (QUAIDS) of Banks, Blundell & Lewbel (1997) at household level to assess food access dimension of food security. This study first employed a smooth local regression technique whose superiority over kernel and other methods has been demonstrated by Fan, (1992). An estimation technique employed to examine the shape of the Engel curves before moving on to consider the demand systems with other covariates (Abdulai & Aubert, 2004). Where, *y- axis* is food group share and *x*-axis is logarithm of household food expenditure.

Three demand systems have received considerable attention because of their relative empirical expediency. The Linear Expenditure System (LES) developed by Stone, (1984), the almost Ideal demand system (AIDS) developed by Deaton and Muellbauer, (1980) and the combination of these two systems in to a generalised Almost Ideal Demand System (GAIDS) proposed by Bollino, (1987). Other complete demand systems found in the literature but not as widely used are the Rotterdam model of Theil (1976) and Barten (1969) and the translog model of Christensen, et al., (1975). Quadratic almost Ideal demand system is another popular demand-system estimation because of its flexibility and is relatively simple and comprehensive demand system due to Banks, Blundell and Lewbel (1997). It is

an extension of the Almost Ideal Demand System (1980) proposed by Deaton and Muellbauer, (1980) that allows demand curves to be nonlinear in the logarithmic of expenditure, hence exhibit nonlinear Engel curve Poi (2012). The QUAIDS model allows you to fit either the standard AIDS model of Deaton and Muellbauer (1980) or the quadratic AIDS model of Banks, Blundell, and Lewbel, (1997). Moreover, adding demographic variables was difficult with AIDS model, and QUAIDS model solved those shortcomings. Demographic variables can be specified and are incorporated using Ray's, (1983) method. Post estimation commands allow you to compute expenditure elasticities as well as compensated and uncompensated price elasticities. Moreover, QUAIDS model is consistent with consumer theory and matches well with the observed pattern of consumer purchasing behaviour (Banks et al., 1997).

The paper is following the indirect utility function of (Banks et al., 1997)

$$lnV(p,m) = \left[\left(\frac{lnm - lna(p)}{b(p)}\right)^{-1} + \lambda(p)\right]^{-1} \tag{4}$$

Where In *a (p)* is in the form of

$$lna(p) = \alpha_o + \sum_{i=1}^{k} \alpha_i ln\, p_i + \frac{1}{2}\sum_{i=1}^{k}\sum_{j=1}^{k} y_{ij}\, lnp_i lnp_j \tag{5}$$

Where the price of good i=1……k and is represented by p_i; b(p)and λ (p) represented as follows

$$b(p) = \prod_{i=1}^{k} p_i^{b_i} \tag{5}$$

$$\lambda\,(p) = \sum_{i=1}^{k} \lambda_i lnp_i\,, \qquad where \sum_{i=1}^{k} \lambda_i = 0 \tag{6}$$

Then apply Roy's identity to the indirect function above, the expenditure shares for good *i* are obtained, normally given by.

$$w_i = \frac{p_i q_i}{m}$$

Where, aside from the price i and the quantity q*i* of good *i* *m* stands for the household's total expenditure on all goods in the demand system. Thus, if the number of goods in the system is *N*, then

$$\sum_{i=1}^{N} w_i = 1$$

$$wi = \alpha_i + \sum_{j=1}^{n} \alpha_{ij} ln\, p_j + \beta_i ln\left(\frac{m}{a(p)}\right) + \frac{\lambda}{a(p)}\left(ln\left(\frac{m}{a(p)}\right)\right)^2 \quad i = 1 \ldots., k \tag{7}$$

$$i = 1 \ldots., k (8)$$

Where *wi, pi, pj* and *m* are expenditure shares, price of good 'i' and household j and total expenditure respectively.

To comply with economic theory the QUAIDS command automatically impose restrictions of adding up, homogeneity and Slutsky symmetry as shown below;

$$\sum_i \alpha_i = 1; \sum_i \beta_i = 0 \sum_i \lambda_i = 0 \sum_i y_{ij} = 0 \; and \; y_{ij} = y_{ji}$$

For all group *i*

Also in line with Banks, Blundell and Lewbel (1997), the paper applies the demographic effect on the demand system through the intercept equation……8

Once parameters are estimated, the system estimates the corresponding elasticities as follows

$$\mu_i \equiv \frac{\partial w_i}{\partial lnm} = \beta_i + \frac{2\lambda_i}{b(p)}\left[ln\left(\frac{m}{a(p)}\right)\right] \tag{9}$$

$$\mu_{ij} \equiv \frac{\partial w_i}{\partial lnp_j} = \gamma_{ij} - \mu_i\left(\alpha_j + \sum_k \gamma_{jk} lnP_K\right) - \frac{\lambda_i \beta_j}{b(p)}\left[ln\left(\frac{m}{a(p)}\right)\right]^2 \tag{10}$$

Using the first expression above, expenditure elasticity can then be found as:

$$e_i = \frac{\mu_i}{w_i} + 1$$

While price elasticities are given by

$$e_{ij} = \frac{\mu_{ij}}{w_i} - \delta_{ij}$$

Where δ_{ij} is Kronecker's delta (that is, it equals one when the two subscripts coincide, and zero otherwise. Using the Slutsky equation $e_{ij}^c = e_{ij}^u + e_i w_j$ the compensated price elasticities can be calculated and used to assess the symmetry and negativity conditions by examining the matrix with elements wi $[e_{ij}^c]$, which should be symmetric and negative semi-definite in the usual way.

5. Empirical results

The principal goal of this paper was to analyse the effects of income on household food consumption behaviour. To accomplish this goal, the data was partitioned into a low-income group and a high-income group. The distribution of households was segmented into four quartiles, in terms of income level, household dependency on auto-consumption and a further two quartiles of rural- urban regional differences. Also an interaction of the quartiles was computed to observe how households would react to prices and income changes. Parameter estimates were obtained for the full sample and for subsamples of rural and urban households and of low-income and high-income households.

Table 2 below, reports compensated and uncompensated price elasticities and expenditure elasticities estimated from the QUAIDS parameters estimated for the 2005/06 KIBHS data. The own price elasticities of the analysed food groups, found on the elasticity diagonal matrix, measure the percentage of demand changes as a result of the 1% changes of the respective group price (the values are negative because the price effect on quantity demanded is inversely related). Both compensated and uncompensated own-price elasticities are negative and thus consistent with demand theory. Own-PE estimates ranged from -0.4179 to -0.8156. Cross-PE estimates were generally larger; with values between -0.5057 to -0.9206 of absolute values. The compensated price elasticities provide a more accurate picture of cross-price substitution between commodity groups, since they are a measure of substitution effects net of income. The fact that the signs of some compensated elasticities are different from those of the uncompensated elasticities suggests that expenditure effects are significant in affecting consumer demand decisions. Most of the cross-price elasticities are positive, indicating that the relevant food groups are substitutes, as would be expected. The differences in the expenditure elasticities are reflected in the variation of the uncompensated own-price elasticities. A comparison of the own-price elasticities again shows differences between the four income classes, with generally greater responses to changes in prices for low income households than high income households.

On the other hand, the expenditure elasticities of all food groups are positive with magnitudes ranging between 0.8255- 1.2729. Thereby indicating that meat and fish, and essential condiments are elastic and are therefore considered as luxuries as their elasticities are greater than one, and is generally typical for a Kenyan household to be meat and fish elastic. However, cereal, dairy products, fruit and vegetables and other condiments are expenditure inelastic and are considered to be normal goods with positive elasticities less than one. To formally test the significance of the quadratic expenditure term and the set of demographic variables, a Wald tests on the estimated parameters was performed. The test showed that household size, regional difference, ratio of food expenditure on total income and ratio of subsistence farming; to be statistically significant, hence they have a great impact on food consumption. Result further indicate that auto consumption/ subsistence consumption has a significant effect on food demand in Kenyan household and more so the rural households but less in urban areas. All compensated

cross-price elasticities are positive albeit relatively small in magnitude suggesting that the respective food groups are substitutes, thus, confirming that our food group classification is appropriate. And also our grouping system avoids the problem of zero consumption and makes it easier to estimate the demand system.

Table 2: Elasticities for the whole sample

Expenditure Elasticity	Cereal & bread	Dairy products	Meat & fish	Fruit &Vegetables	Essential condiments	Other condiments
	0.9020	**0.8770**	**1.0160**	**0.8255**	**1.2729**	**0.9795**
Compensated						
Cereal & bread	**-0.5088**	0.0512	0.1162	0.1071	0.1697	0.0647
Dairy products	0.1611	**-0.4250**	0.1389	0.0895	0.0258	0.0097
Meat & fish	0.3339	0.1262	**-0.8156**	0.1479	0.1113	0.0961
Fruit &Vegetables	0.1999	0.0532	0.0942	**-0.5778**	0.1744	0.0561
Essential condiments	0.2060	0.0113	0.0530	0.1141	**-0.4179**	0.0335
Other condiments	0.1505	0.0007	0.0900	0.0606	0.1181	**-0.4199**
Uncompensated						
Cereal & bread	**-0.7713**	-0.0317	0.0229	-0.0328	-0.0535	-0.0356
Dairy products	-0.0940	**-0.5057**	0.0482	-0.0466	-0.1913	-0.0877
Meat & fish	0.0383	0.0328	**-0.9206**	-0.0097	-0.1400	-0.0168
Fruit &Vegetables	-0.0403	-0.0227	0.0089	**-0.7059**	-0.0299	-0.0356
Essential condiments	-0.1644	-0.1057	-0.0786	-0.0834	**-0.7329**	-0.1079
Other condiments	-0.1345	-0.0894	-0.0113	-0.0914	-0.1243	**-0.5287**

Table 3: Distribution of elasticities between rural and urban households

Expenditure Elasticity	Cereal & bread	Dairy products	Meat & fish	Fruit &Vegetables	Essential condiments	Other condiments
Rural	**0.8850**	**0.8804**	**1.0446**	**0.8259**	**1.2664**	**0.9990**
Urban	**0.9363**	**0.8708**	**0.9802**	**0.8248**	**1.2858**	**0.9427**
Compensated rural						
Cereal & bread	**-0.5092**	0.0526	0.1025	0.1018	0.1846	0.0677
Dairy products	0.1715	**-0.4280**	0.1258	0.0859	0.0341	0.0107
Meat & fish	0.3549	0.1339	**-0.8170**	0.1446	0.0901	0.0936
Fruit &Vegetables	0.2062	0.0534	0.0820	**-0.5721**	0.1770	0.0536
Essential condiments	0.2211	0.0140	0.0361	0.1090	**-0.4193**	0.0391
Other condiments	0.1646	0.0034	0.0759	0.0589	0.1221	**-0.4249**
Compensated urban						
Cereal & bread	**-0.5073**	0.0486	0.1426	0.1176	0.1401	0.0585
Dairy products	0.1421	**-0.4202**	0.1625	0.0959	0.0102	0.0095
Meat & fish	0.3028	0.1160	**-0.8067**	0.1545	0.1338	0.0995
Fruit &Vegetables	0.1879	0.0519	0.1164	**-0.5868**	0.1684	0.0622
Essential condiments	0.1783	0.0073	0.0841	0.1235	**-0.4129**	0.0197
Other condiments	0.1254	-0.0049	0.1141	0.0630	0.1114	**-0.4090**
Uncompensated rural						
Cereal & bread	**-0.7756**	-0.0295	0.0239	-0.0310	-0.0412	-0.0317
Dairy products	-0.0935	**-0.5096**	0.0476	-0.0462	-0.1906	-0.0882
Meat & fish	0.0405	0.0370	**-0.9098**	-0.0122	-0.1764	-0.0238
Fruit &Vegetables	-0.0424	-0.0232	0.0086	**-0.6961**	-0.0338	-0.0391
Essential condiments	-0.1600	-0.1034	-0.0764	-0.0811	**-0.7425**	-0.1031
Other condiments	-0.1361	-0.0892	-0.0128	-0.0910	-0.1328	**-0.5371**
Uncompensated urban						
Cereal & bread	**-0.7627**	-0.0362	0.0209	-0.0364	-0.0784	-0.0436
Dairy products	-0.0954	**-0.4990**	0.0494	-0.0473	-0.1930	-0.0854
Meat & fish	0.0355	0.0273	**-0.9340**	-0.0067	-0.0950	-0.0073

Fruit &Vegetables	-0.0371	-0.0227	0.0093	**-0.7224**	-0.0240	-0.0277
Essential condiments	-0.1724	-0.1090	-0.0830	-0.0879	**-0.7130**	-0.1204
Other condiments	-0.1317	-0.0902	-0.0084	-0.0921	-0.1086	**-0.5117**

Table 4: Distribution of elasticities between high and low income households

Expenditure Elasticity	Cereal & bread	Dairy products	Meat & fish	Fruit &Vegetables	Essential condiments	Other condiments
High income	**0.8904**	**0.8345**	**1.0771**	**0.6805**	**1.1618**	**0.7628**
Low income	**0.9072**	**0.9072**	**0.9978**	**0.8478**	**1.3246**	**1.1336**
Compensated						
High income						
Cereal & bread	**-0.5104**	0.0095	0.1477	0.0076	0.2967	0.0489
Dairy products	0.0340	**-0.1352**	0.1896	-0.0334	0.0078	-0.0628
Meat & fish	0.2742	0.0823	**-0.7991**	0.0496	0.3055	0.0876
Fruit &Vegetables	0.0172	-0.0350	0.1020	**-0.1352**	0.1070	-0.0560
Essential condiments	0.1775	0.0016	0.1104	0.0142	**-0.3588**	0.0551
Other condiments	0.0696	-0.0445	0.1097	-0.0490	0.2933	**-0.3791**
Low Income						
Cereal & bread	**-0.4921**	0.0761	0.0897	0.1535	0.1406	0.0322
Dairy products	0.2355	**-0.4940**	0.1082	0.1425	0.0203	-0.0126
Meat & fish	0.3999	0.1575	**-0.8144**	0.1874	0.0202	0.0494
Fruit &Vegetables	0.2647	0.0791	0.0732	**-0.6031**	0.1553	0.0308
Essential condiments	0.2528	0.0159	0.0050	0.1637	**-0.4001**	-0.0373
Other condiments	0.1455	-0.0257	0.0544	0.0736	-0.0669	**-0.1809**
Uncompensated						
High Income						
Cereal & bread	**-0.7208**	-0.0398	0.0272	-0.0411	-0.0716	-0.0442
Dairy products	-0.1632	**-0.1814**	0.0767	-0.0791	-0.3374	-0.1502
Meat & fish	0.0196	0.0226	**-0.9449**	-0.0093	-0.1401	-0.0251
Fruit &Vegetables	-0.1436	-0.0727	0.0099	**-0.1725**	-0.1745	-0.1272
Essential condiments	-0.0971	-0.0627	-0.0468	-0.0494	**-0.8394**	-0.0665
Other condiments	-0.1107	-0.0867	0.0065	-0.0908	-0.0222	**-0.4589**
Low Income						
Cereal & bread	**-0.8054**	-0.0259	0.0201	-0.0281	-0.0383	-0.0296
Dairy products	-0.0777	**-0.5961**	0.0386	-0.0391	-0.1586	-0.0744
Meat & fish	0.0553	0.0452	**-0.8910**	-0.0124	-0.1765	-0.0185
Fruit &Vegetables	-0.0281	-0.0163	0.0081	**-0.7728**	-0.0119	-0.0269
Essential condiments	-0.2046	-0.1332	-0.0966	-0.1014	**-0.6613**	-0.1275
Other condiments	-0.2459	-0.1533	-0.0326	-0.1534	-0.2904	**-0.2581**

1 US Dollar equals 102.69 Kenyan Shilling.
In **bold diagonally** are the expenditure, compensated and uncompensated price elasticities.

With respect to compensated elasticities, households living in extreme poverty conditions are the more responsive to income changes in essential condiments and other condiments, exhibiting the highest value, above unit (elastic), however, all price elasticities appear to be inelastic but vary magnitude. The compensated elasticity range from -0.1352 to -0.7991 for high income households and -0.1809 to -0.8144 for low income households, in both income levels, meat and fish tend to exhibit the highest elasticities while low elasticities vary, with high income households having dairy products and low income households having other condiments. Cereals and bread, and essential condiments tend to have almost similar elasticity values. This comes as no surprise since grains represent on average 41% percent of the households food expenditures and the group contains the most important staples in the Kenyan diet: maize, rice and pulses. And also the essential condiments group comprise of items that

most households cannot avoid to purchase, sugar, salt, oil and fats and tea bags, As compared to uncompensated price elasticities, their magnitudes are higher than those of compensated but still negative and less than one. Both still exhibit high values in meat and fish while very low in dairy products for high income households and other condiments for low income households.

As expected, expenditure elasticities for cereals and bread, dairy products, fruit and vegetables inelastic, meaning they are considered as normal goods and households consume even when income changes. Therefore, it is an important policy consideration especially due to the fact that they are considered as staples for the households. Contrary to expectation though, consumption of meat and fish is inelastic for low income and rural households. This is probably due to the fact that high income households tend to consume the high quality food products. This is also true for rural households as well who are highly dependent on a large proportion of their food quantities from own production/auto consumption. This may be attributed to: Meat and fish consumption on rural, low income, subsistence households having some limitations: 1.meat i.e. beef, and chicken are slaughtered and consumed over a long period of the consumption and this may be in within or without the period when this particular survey was done, this can therefore create some sort of bias. This would somehow bring another issue in quantifying the amount of the meat consumed during the week, for instance, if a household slaughter a whole cow, and depending on the number of household members, the meat will not be all consumed by the end of the week. 2. Majority of the household within the study were rural households who tend to consume meat and fish from the livestock they own, and rarely purchase from the market. 3. There are various meat products within the food group (aggregated food groups), and different meats can have varied elasticities, this agrees with some of the consumption patterns of rural households as they are not involved in the market. For instance, in Bett et al., (2012) and Shibia, et al., (2017), they show that different meats have different expenditure elasticities values in both low and medium-low income groups. For instance, both authors analysed using Linear Approximate Almost Ideal Demand System (LA-AIDS) model, and found varied values on expenditure elasticities. Shibia, et al., (2017), found similar results for boneless beef was -0.9894, and Goat/mutton- 0.8937 and pork 0.9594 to be inelastic, likewise, Bett et al., (2012), reported inelastic expenditure values for Indigenous chicken-0.8537, Beef-0.8455, mutton/goat- 0,2547. Therefore, it will be interesting to analyse which specific meats have more impact on the elasticities, hence a more specific study of separability between disaggregate meat products and aggregate categories. Meat demand is evolving as demand drivers emerge and change over time. Multiple factors work to collectively shape meat demand including traditional economic determinants such as relative prices and income as well as non-traditional determinants such as health, nutrition, and food safety information; changing product characteristics and new product developments; and shifts in consumer demographics and lifestyles.

6. Conclusion

In this paper we reviewed household food security situation in Kenya in terms of access to food, using cross sectional data from the Kenya Integrated Household Budget Surveys (KIHBS). The empirical approach illustrated the food consumption pattern for Kenyan households using the Quadratic almost ideal demand system (QUAIDS) with the inclusion of demographic factors into the model. We estimated price and income elasticities, which provides an indication of the sensitivity of households to market shocks and thus the degree of household's constraint to access food in Kenya. The empirical results show positive expenditure elasticities and all compensated and uncompensated price elasticities being negative. While their magnitudes vary, expenditure elasticities for meat and fish, and essential condiments are elastic (sensitive to changes) and are considered as luxuries as their elasticities are greater than one. Whereas cereal and bread, dairy products, fruit and vegetables and other condiments, have both inelastic price and expenditure elasticities. And are considered to be normal goods with values less than one. With respect to low income households, rural households and highly dependent on auto consumption a reverse relationship is exhibited where meat and fish expenditure are inelastic hence perceived as normal foods which is somewhat unexpected. However, in Kenya this finding may be attributed to the fact that a majority of the households in the survey depend on own domesticated animals for meat and fish consumption. Hence they are not largely involved in the formal market services and prices. The results are broadly consistent with the demand theory for the whole household consumption pattern of all food groups, however exceptions indicate unusual pattern of less sensitivity to income changes for the rural and low income households' for meat and fish consumption. The results should therefore inform the design of policies aimed at improving the nutritional status of the poor, children and other vulnerable individuals. Further analysis shows that household size, regional differences, the ratio of food expenditure to total income and the ratio of auto-consumption are statistically significant, and hence have a great impact on food consumption expenditure. The results are broadly consistent with microeconomic theory, however exceptions indicate an unusual pattern (less sensitivity to income changes) for the rural and low income households' meat and fish consumption.

Food security as a complex and multidimensional concept is threatened by global food price volatility and challenges of undernutrition and malnutrition in developing countries. This study contributes to increased understanding of the potential role of household socio-economic characteristics, food prices and income in explaining food demand in Kenya and its implications to food security. The general findings for the price and income elasticities show that households are sensitivity to price and income changes, policies should take into account the implications it has on food security situation. Kenya as a country with all its abundance of resources and agricultural potential can be able to provide sufficiently to its citizen as it is capable of supplying large quantities of agricultural raw materials to meet its supply and demand needs. Moreover, food pricing and income related policies have potential to improve

population access to diets in required quality and quantity, therefore, the price and income elasticities values are very important to inform related policies aimed at improving food security.

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