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Review Article

Food Consumption Patterns and Demand Elasticities for South West Rural Ethiopia

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Abstract: Demand elasticities are powerful tools to quantify welfare effects of relative price changes concomitant to shocks in economic environment of consumers. This study examined food demand elasticities to demonstrate how rural households in South West Ethiopia react to income and price changes by drawing on 267 observations of Household Income and Consumption Expenditure Survey data collected by Central Statistical Authority. It estimated Quadratic Almost Ideal Demand Systems (QUAIDS) of six groups of food items controlled for censoring and expenditure endogeneity by applying Nonlinear Seemingly Unrelated Regression (NLSUR) technique after incorporating household characteristics into the systems as intercept shifters. The descriptive statistics results showed that households allocate about 55 percent of income to food consumption of which root crops, fruits and vegetables were the dominant. The inferential statistics revealed that household characteristics such as sex, family size, age, education and location significantly influence the consumption patterns, and changes in income and prices would induce adjustment in consumption patterns that manifest by change in the quantities and types of items consumed. The results implicate the need for emphasizing crop specific price policies over holistic approach and policies that target income over policies targeting prices.

Keywords: *QUAIDS*, *Expenditure elasticities*, Hicksian, Marshallian Price Elasticities

1. Introduction

In rural areas of Least Developing Countries (LDCs) such as Ethiopia most people are poor households who devote nearly 80 percent of budget to food [1], the largest component of gross domestic products, means intra household resource allocations are affected significantly in response to changes in prices and income. Demand elasticities provide information on how household adjust consumption bundles in response to exogenous shocks in economic environments. Subsequent changes in food consumption patterns pose considerable risks to welfare of poor who subsist on inadequate calories and are struggling daily to maintain healthy life. Hence, it is primary interest to policy analysts to study food demand which sheds light on some aspects of consumer behavior. In addition to deepening our understanding of consumer behavior, food demand elasticities are powerful tools to quantify welfare effects of relative price changes and to simulate the outcome for the purpose of policy analysis.

There are variant specifications of demand systems which are defined as set of equations describing consumers' problems of allocating budget to commodities subject to prices and income. However, to appeal to restrictions of consumer theory, the complete demand systems must satisfy the axioms of choices and preferences. One of the most flexible such framework is Quadratic Almost Ideal Demand System (QUAIDS) of Banks et al. [2]. Recent studies those employed this framework in include [1, 3-10] among others.

Given the importance of demand dynamics in policy analysis, it is surprising that not a single study examined it at regional level to the best of the author's knowledge. Therefore, this study tries to fill some of the gaps in our knowledge of how consumers in particular characteristics respond to changes in price, income and other determinants by following these literatures. It achieves this objective first by categorizing intra-household allocation of resources and food consumption patterns. Second, it provides estimates of food demand elasticities using the QUAIDS model that help to gain insights into magnitude of demand shifts due to price and income which help to quantify welfare effects of relative price changes and to simulate the outcome.

The next three sections present demand systems under second followed by procedures for estimating demand systems with QUAIDS framework and results under third and fourth sections respectively. Section five concludes the study.

2. Demand Systems

The empirical studies of demand have been initiated to measure elasticities in an effort to uncover how demand for particular good responds to change in price, income and other determinants. The earliest of the studies was a single equation methodology which used to estimate demand function without requirement for demand systems to satisfy theoretical restrictions and was replaced by the linear expenditure system (LES) of Stone [11]; the first utility –based demand models that satisfy theoretical restrictions of adding-up, homogeneity, and symmetry. However, the uneasiness with some strong restrictions like the proportionality between price and income elasticities, and necessity goods becoming luxury at higher incomes led to the development of new strand of models. This includes the Rotterdam model proposed by Theil [12]; the translog model of Christensen et al. [13] and the Almost Ideal Demand System (AIDS) model of Deaton and Muellbauer [14].

Deaton and Muellbauer's AIDS model has been used extensively in empirical works for its simplicity and it could have tested and validated the theoretical restrictions; it satisfies the axioms of choice exactly and can be interpreted in terms of aggregate consumer behavior by allowing consistent aggregation of individual demands to market demand. Few of studies those adopted this framework include [15-19].

Furthermore, the AIDS model has been extended into Quadratic Almost Ideal Demand System (QAIDS) by Banks et al. [2] who added a squared expenditure term with a constant, nonzero coefficient. This extension permits flexible fitting of Engle Curves and as a result, goods become luxuries at some expenditure levels and to be necessities at others.

Empirical analyses of demand system can be classified as aggregate studies: either based on time series or panel data and micro studies using household data. The latter offers advantages of studying not only the effect of household composition on expenditures and preferences but also the response of different consumer groups depending on the characteristics such as income, education, age, location, etc. Since the data contains detail information on consumption patterns, quantities of various goods and characteristics specific to particular households, the analysis offers better understanding of consumer behavior with greater precession and forecast ability.

There are two sets of determinants of household level demand analysis: One set consists of prices, quantities and expenditure on various items while the other contains household demographics such as sex, age, education, family size, location, time, etc. However, the selection of potential determinants of demand system should be based upon consideration of the variables that have a reasonable use in Ethiopia and elsewhere. Hence, literatures such as [1, 6- 8, 20] were consulted and as a result, demographic variables such as household size, sex, age and education were found relevant for the study.

Since food is not shared by all family members and its consumption is rival, food expenditure share and consumption pattern are expected to increase and vary respectively with family size. Household unit is composed of individuals in different age ranges which causes varying consumption preferences across families and change in preferences with change in age within family. Hence, age is important variable that affect consumption decision making process. Consumption behavior is also influenced by education. Highly educated people prefer leisure; communication and transport than less literate ones [6]. They are also likely to prefer more nutritious food and high value foods such as, animal products, fruits and vegetables.

However, demand functions with aggregate time series data or household level data with highly aggregated commodity groupings are easily estimated by standard econometric techniques that assume the dependent variables in the system of demand equations follow a joint normal distribution. In contrast, when micro data are used, it becomes increasingly likely to observe non-consumption of some commodities by a large number of households leading to problem known as censoring. Factors such as non-preference, non-affordability, purchase infrequency, non-availability, and self-consumption during the recall period of the survey may render the expenditure zero for certain goods [1, 5, 7, 9].

One of the strategies for controlling zero consumption problems was deleting non-consuming households. However, it becomes increasingly likely to observe non-consumption of some commodities by a large number of households and the exclusion of a large number of observations in this nonrandom manner may cause selection bias. As a result, statistical techniques that can capture demand system with positive and zero quantities are used. One of such frameworks is a two-step estimation procedure proposed by [21]. The method is used in the paper and is discussed in the next section.

3. Methodology

3.1. Model and Estimation Techniques

3.1.1. Quadratic Almost Ideal Demand System (QAIDS)

The budget shares form QUAIDS model augmented for household-demographic variables $(D_i,\ldots,D_k)$[1] is given by

[1] household demographic characteristics are incorporated into demand system using demographic translation method see [1, 7, 10].

$$w_i = \alpha_i + \sum_{j=1}^{k} \delta_{ij} D_j + \sum_{i=1}^{n} \gamma_{ij} lnP_j + \beta_i \, ln\left(\frac{m}{a(P)}\right) + \frac{\lambda_i}{b(p)} ln\left(\frac{m}{a(p)}\right)^2 + \varepsilon_i \quad (1)$$

Where w_i is the expenditure share for the i[th] commodity, α_i, δ_{ij}, γ_{ij}, β_i and λ_i are the parameters to be estimated; α_i is the constant coefficient in the i[th] share equation; δ_{ij} and γ_{ij} are the slope coefficients associated with the j^{th} good in the i^{th} share equation; D_j is household-demographic variables; P_j is the price of the j^{th} good, and m is the total expenditure on the system of goods; and ε_i is error term. And $a(p)$, is tranlog and $b(p)$ and $\lambda(p)$ are Cob-Douglass functions of homogeneous degree in prices [1-10] with the following specifications:

$$lna(p) = \alpha_0 + \sum_{i=1}^{n} \alpha_i lnP_i \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \gamma_{ij} lnP_i lnP_j \quad (2)$$

$$b(p) = \prod_{i=1}^{n} P_i^{\beta_i} \quad (3)$$

$$\lambda(p) = \sum_i^n \lambda_i lnP_i \quad (4)$$

The parameters of the demand system should satisfy the following set of restrictions in order to comply with consumer theory: namely adding up, homogeneity and Slutusky symmetry.

Adding up of budget shares requires ($\sum_{i=1}^{n} w_i$=1):

$$\sum_{i=1}^{n} \alpha_i = 1; \sum_{j=1}^{k} \delta_{ij} = 0 \;\; \sum_{i=1}^{n} \gamma_{ij} = \sum_{i=1}^{n} \beta_i = \sum_{i=1}^{n} \lambda_i = 0 \quad (5)$$

Homogeneity of zero degree in price:

$$\sum_{i=1}^{n} \gamma_{ij} = 0 \quad (6)$$

And

$$\text{Slutsky symmetry:} \gamma_{ij} = \gamma_{ji} \quad (7)$$

3.1.2. Censored Demand System

Among econometric techniques developed for estimating demand systems with censored data, that of [21] was the prominent one. The two stage [2] consumption decision household problem in the presence of zero consumption involves estimating systems of equations in a model below:

$$d_i^* = \mathcal{Z}_i' \alpha_i + \upsilon_i d_i = \begin{cases} \text{if } d_i^* > 1 \\ ootherwise \end{cases} \quad (8)$$

$$w_i^* = x_i{}^i \beta_i + \mu_i w_i = d_i w_i^* \quad (9)$$

Where, w_i is the budget share of the good i and d_i is a dichotomous variable that takes 1 if the household did consume the good i and 0 otherwise; w_i^* and d_i^* are their unobserved, latent counterparts. x_is and $\mathcal{Z}_i$s are exogenous variables respectively representing household expenditures (and consumer prices) and demographics; α_i and β_i are unknown parameters to be estimated; υ_i and μ_i are error terms. The first step involves estimating a standard probit model of equation (8), i.e., the probability that a household will consume i[th] good as expressed in [9]. This is specified as

$$d_i = \alpha_i + \sum_{j=1}^{k} \delta_{ij} D_j + \sum_{i=1}^{n} \gamma_{ij} lnP_j + \beta_i \, ln\left(\frac{m}{a(P)}\right) + \frac{\lambda_i}{b(p)} ln\left(\frac{m}{a(p)}\right)^2 + \varepsilon_i \quad (10)$$

In the second step, the cumulative distribution $\Phi(\mathcal{Z}_i'\alpha_i)$ and probability density functions $\phi(\mathcal{Z}_i'\alpha_i)$ from the previous step are incorporated in the budget share equations [7-8] as,

$$w_i^* = \Phi(\mathcal{Z}_i'\alpha_i) w_i + \varphi\phi(\mathcal{Z}_i'\alpha_i) + \xi_i \quad (11)$$

As a result, the QUAIDS model takes the below form:

$$w_i^* = \Phi(\mathcal{Z}_i'\alpha_i)\left\{\alpha_i + \sum_{j=1}^{k} \delta_{ij} D_j + \sum_{i=1}^{n} \gamma_{ij} lnP_j + \beta_i \, ln\left(\frac{m}{a(P)}\right) + \frac{\lambda_i}{b(p)} ln\left(\frac{m}{a(p)}\right)^2\right\} + \delta_i \varphi\phi(\mathcal{Z}_i'\alpha_i) + \zeta_i \quad (12)$$

3.1.3. Demand Elasticities

By differentiating (14) with respect to lnm and lnp_j, for using afterwards to determine respectively income and price elasticities, we get the following:

$$\epsilon_i = \frac{\partial w_i^*}{\partial lnm} = \Phi(\mathcal{Z}_i'\alpha_i)\left(\beta_i + \frac{2\lambda_i}{b(p)}\left\{ln\left[\frac{m}{a(P)}\right]\right\}\right) \quad (13)$$

$$\epsilon_{ij} = \frac{\partial w_i^*}{\partial lnp_j} = \Phi(\mathcal{Z}_i'\alpha_i)\left\{\gamma_{ij} - \epsilon_i\left(\alpha_j + \sum_{i=1}^{n} \gamma_{jk} lnP_k\right) - \frac{\lambda_i}{b(p)}\left\{ln\left[\frac{m}{a(P)}\right]\right\}^2\right\} \quad (14)$$

Where P_k, *a price index is* calculated as the arithmetic mean of prices for all *k* food groups. Then, conditional expenditure elasticities are written as,

$E_i = \frac{\epsilon_i}{w_i^*} + 1$ and the conditional Marshallian (or uncompensated) price elasticities are derived as,

$E_{ij}{}^u = \frac{\epsilon_{ij}}{w_i^*} - \vartheta_{ij}$, where, ϑ_{ij}, Kronecker delta defined as $\vartheta_{ij} = \begin{cases} 1 \; for \; i = j \\ 0 \; otherwise \end{cases}$

Using the Slutsky equation allows us to derive, the conditional Hicksian (or compensated) price elasticities as, $E_{ij}{}^c = \frac{\epsilon_{ij}}{w_i^*} + E_i w_i^*$

Hicksian price elasticities measure response of a particular quantity of a commodity as price changes for a constant level of utility while the Marshallian price elasticities do the same for a constant level of income.

3.1.4. Estimation Techniques and Procedures

Demand system specification such as (12) contains potential problem called expenditure endogeneity in the budget share equations that is likely to induce biased and inconsistent parameter estimates if not contained. Expenditure endogeneity arises because expenditure may be correlated with unobserved variables in budget share equations or it is jointly determined with the budget shares [19-20]. To deal with the endogeneity problem, this study applies two step augmented regression

2 In the first stage, households decide how much to consume of food and non-food items; and in the second stage, decide how much to consume of different foods groups.

technique known as control function approach. The procedure is an extension of the limited information augmented regression technique suggested by [22] and involves using instrumental variables to correct for endogeneity.

Following [2] income is used as relevant instrumental variable (IV) for food expenditure provide that income be sufficiently correlated with expenditure. This is tested by determining whether income and its square are statistically significant in the reduced form regression of expenditure equation. Their joint significance provides justification to use them as instrumental variables in the budget share equations. The specification for reduced form of real log expenditures follows [4,10,23] as a function of log prices, demographic variables, interaction terms between demographic characteristics and log income and quadratic terms of log income. The two-step augmented regression technique applied to the censored demand system case proceeds as follows: The first stage involves estimating reduced form models of real expenditures.

$$lnm_i = \alpha_i + \sum_{j=1}^{k} \delta_{ij} D_j + \sum_{i=1}^{n} \gamma_{ij} lnP_j + \beta_i lny_i + \sigma_i (lny_i)^2 + e_i \quad (15)$$

Where m_{i_i} is the total expenditure on the system of goods, α_i, γ_{ij}, β_i and σ_i are the parameters to be estimated $D_j s$ are household-demographic variables, $P_j s$ are prices and y_i is *income* of the household e_i is error term.

The second stage involves augmenting each budget share equation by the residuals from stage 1 (e_i), then equation (12) will be restated as,

$$w_i^* = \Phi(Z_i' \alpha_i)\left\{\alpha_i + \sum_{j=1}^{k} \delta_{ij} D_j + \sum_{i=1}^{n} \gamma_{ij} lnP_j + \beta_i ln\left(\frac{m}{a(P)}\right) + \frac{\lambda_i}{b(p)} ln\left(\frac{m}{a(p)}\right)^2 + \tau \acute{v}_\iota \right\} + \delta_i \varphi \phi(Z_i' \alpha_i) + \zeta_i \quad (16)$$

A test of expenditure exogeneity for each consumption share is then tested by checking statistical significance of the coefficients $\tau s(\text{of} \acute{e}_\iota s)$, which under the null hypothesis of expenditure exogeneity should equal zero [19].

After correcting for endogeneity, estimation of (16) is done by applying a modified version of the Nonlinear Seemingly Unrelated Regression (NLSUR) proposed by [24] to include censoring due to zero expenditures and endogeneity of expenditure.

3.2. Data Description

The analysis in this paper is drawn on Household Income and Consumption Expenditure Survey (HICES). The HICES2010/1 survey data contain national representative rural 9,494 household, however, for the South West rural region only 267 households have consistent data who reported information on various quantities of household consumables; consumption expenditures and household demographics. When the data are decomposed into zone, Bench Maji zone consists of 89 households; that of Kaffa and Sheka Zones consist of 122 and 56 households respectively.

By consulting previous studies such as [1,9] food commodities were classified into such six groups: cereals, pulses and oils, root crops, fruits and vegetables, animal products and others (table 1). However, aggregating food items into groups make it difficult to compute prices of aggregated bundles. As a result, unit values calculated by dividing the purchase value to quantity were used despite the limitations that they might contain measurement errors, reflect both quality and price differences (for details, see [1]). For each food commodity group, the prices indices are computed as weighted means of commodities in that group, the weights being the mean budget shares of each item.

Table 1. *Food groups.*

Food category	Food items
Cereals	Teff whole grain, flour; wheat; whole grain, flour; maize; whole grain, flour; sorghum; whole grain, flour; barley; whole grain, flour; Africa (Finger) millet, durrah, oats/aja, pop corn, dagussa, rice and others; Bread, wheat - bakery; injera, spaghetti, maccoroni, cakes, beso, beyeyanetu, burger/sandwich porridge, biscuits
Pulses and Oilseeds	Horse beans, haricot beans, field peas, chick peas, soya beans, cow peas, linseed, lentils, shifera, adenguare, vetch; niger seed, linseed, groundnuts, sesame, sunflower, rape seed, castor beans; shiro/kollo; edible oils (cooking oil) and others
Root crops	Qocho, raw, Taro (Godere), raw; Enset (kocho, bulla and kocho pancake), potatoes, sweet potatoes, cassava, yam (boye), anchote, others
Fruit and vegetable	Ethiopian Kale, Onions, Garlic, Pepper (karia), green, Banana, Avacado, Sugar cane; bananas, pineapple, avocado, spinach, garlic, mango, orange, tomato, cabbage, beet root, carrot, lettuce, tikilgomen, pumpkin, Peach, Sacard basil, mushroom, pumpkin, leek, guava, citron, dates
Animal products	Beef, mutton, pork meat, butter, cheese, Cottage cheese; milk /yogurt, chicken, eggs, fish, wild animals, honey, offar and others
Other foods	Spices (pepper flour, fenugreek, Birds eye chil whole, ginger, cardmon, chillies, basil, cumin, turmeric; rue, etc); Stimulants (coffee boiled, coffee leaves or quiti, tea, chat); local drinks (tella, tej, araqi, Bukri', 'Karibo''Mewded' (home made), alcoholic (birra), soft drinks (pepsi, cokacola, mirinda, fanta,) other foods (sugar, salt, etc)

4. Results and Discussions

4.1. Food Consumption Patterns and Proportion of Zero Expenditure

The food expenditure share in the region is 55 percent, lower than national average[3]. The region experiences high consumption prevalence of root crops, fruits and vegetables of 14 percent each, which are light in values but bulky in volumes and can be contrasted against [1, 25]. It is implicated

3 Household consumables are categorized into eight groups: food, clothing, housing utensils, education, health, transport &communication, recreation & culture and other consumables.

that changes in price of the items relative to that of others will have significant impact on household welfare.

Cereals namely teff, barley, wheat, maize and sorghum are the major staples for households in rural south west Ethiopia as they are nationally. Root crops combined with fruits and vegetables account for the lion's share of household food budget (about 29 percent) in the region. Unlike the others in terms of volume of consumption, root plants such as qocho, taro (godere), raw, potatoes, sweet potatoes, cassava, yam (boye), anchote, and cabbage are heavily consumed as the main stay foodstuffs. Pluses, fruits & vegetables as well as animal products mostly complement cereals in serving of the main dish. Pulses provide cheap source of proteins as substitute for meat in terms of nutritional values. Other foods category includes items such as spices, stimulants, local alcoholic and non-alcoholic drinks, sugar, salt, and pepper, among others ranked second of significance in terms of household food consumption budget.

Table 2. *Food budget shares and proportion of zero expenditure by commodity groups.*

Food	**Bench Maji**		**Kaffa**		**Sheka**		**Total**	
	No. 122		**No. 122**		**No. 56**		**No. 296**	
	Mean	**Zeroes**	**Mean**	**Zeroes**	**Mean**	**Zeroes**	**Mean**	**Zeroes**
Cereals	0.35 (0.14)	0.00	0.17 (0.14)	0.04	0.18 (0.18)	0.09	0.23 (0.17)	0.04
Pulses and Oilseeds	0.11 (0.11)	0.13	0.19 (0.10)	0.02	0.17 (0.12)	0.09	0.16 (0.11)	0.07
Root crops	0.11 (0.13)	0.30	0.17 (0.12)	0.12	0.16 (0.16)	0.30	0.15 (0.13)	0.22
Fruit and vegetable	0.17 (0.09)	0.03	0.12 (0.06)	0.02	0.15 (0.10)	0.05	0.14 (0.09)	0.03
Animal products	0.10 (0.15)	0.49	0.10 (0.16)	0.57	0.16 (0.15)	0.29	0.11 (0.15)	0.49
Other foods	0.15 (0.11)	0.01	0.26 (0.09)	0.01	0.18 (0.10)	0.02	0.21 (0.11)	0.01
Overall	1.00	1.00	1.00	1.00	1.00	1.00	1.00	

Source: Author computation from HICES data, *standard deviations are into parentheses.

Zero expenditure is serious problem for animal food and root crops[4] about 49 and 22 percents respectively. The non-consuming number of households is negligible such that less than 5 percent for the rest groups except pulses and oils with zero of 7 percent. Appropriate econometric technique, i.e., [12] two-step procedure for controlling censoring is applied to estimate budget share equations of the groups where it is deemed significant.[5]

4.2. Tests for Relevance of Instruments

A second major problem that should be addressed before demand system estimation is endogeneity of the expenditure. To control for endogeneity of expenditure in the budget share equations, income and its square are often used as instrumental variables. Unfortunately, income variable is missing in the data sets at hand. Therefore, it is assumed that household spends all its income on purchase of non-durables[6]. Total household expenditure is used as proxy variable for income provide that it fulfils conditions for good instruments as does income for endogenous variable in the demand systems[7]. Test for instrumental variables relevance involves testing for significance of coefficients of total expenditure and its square and joint test in reduced form expenditure equation. Table 3 reports parameter estimates of the reduced form regression for food expenditure (lnm). By simple t-tests, the individual coefficients on lny and $(\text{lny})^2$ are significantly different from zero at 1 and 10 percent significance levels respectively. Also, the instruments are shown to be relevant with good explanatory power and a joint F-test for significance of 502.01 with a p-value of 0.00.

Table 3. *Reduced form expenditure model.*

Independent variables	**Dependent Variable: food expenditure (lnm)**
Constant	-4.846 (2.837)*
Price of Cereals	0.012 (.016)
Price of pulses	0.0005 (.017)
Prices of root crops	-0.055 (.018)**
Prices of fruits and vegetables	0.008 (.017)
Prices of animal products	-0.033 (.019)*
Prices of other products	0.003 (.018)
Lny	1.876 (.5641)***
(lny)^2	-0.047 (.028)*
Household size	-0.002 (.008)
Household head sex	0.077 (.047)*
Age of household head	0.003 (.001)
Literacy	0.064 (.058)
Years of schooling	0.003 (.019)
Zonal dummy	-0.026 (.019)
Survey dummy	-0.073 (.057)
R-squared	0.8043
Adj R-squared	0.7931
F (p-value) -502.01	0.000

***; **; * denote significance at 1:5 and 1 percent respectively. Standard errors are in parentheses.

To contain endogeneity linear, square and cubic terms of the residuals from regression in reduced form model of expenditure in demand system equations.

4.3. Marginal Effects

Factors other than price and income such as family size, age, sex, education, time, and location among others affect preferences and should be incorporated into estimation of the

4 High proportion of zero for root crops attributes to summer survey recall period whereas the roots are heavily consumed in dry seasons.

5 The presence of zeros is tolerated if it is less than five percent.

6 Household expenditure according to CSA Consumption Expenditure Survey constitutes two outlay categories: money cost of food and non-food nonfood items (such as housing and utensils; clothing; education, healthcare, transport and communications; culture and recreations, and other consumables).

7 The relevance condition requires income be sufficiently correlated with expenditure, and the exogeneity condition requires income must not be correlated with the error term in the demand model.

demand system. The last two were included as seasonal and zonal dummies indicating differences in the time and the place where the foods were consumed.

Table 4. *Marginal effects of demographic and dummy variables.*

Equation	Household size	Head sex	head age	Head Years of schooling	Zonal dummy	Seasonal dummy
Cereals	0.01 (.004)*	.03 (0.025)**	-0.01 (.005)*	0.07 (005)*	0.067 (.01)***	0.070 (.03)**
Pulses	0. 01 (0.003)*	0.09 (0.016)*	0.1 (0.48)	0.12 (0.3)*	-3. (0.8)***	-0.08 (0.2)*
root crops	3.4 (0.37)*	0.38 (0.18)**	0.12 (0.05)*	0.21 (0.47)*	-0.16 (0.1)*	-0.15 (0.3)*
fruits and vegetables	0.171 (0.27)*	-0.23 (0.13)	0.8 (0.04)**	0.327 (0.34)	3.3 (0.67)**	7.3 (1.9)***
animal products	-0.21 (0.045)*	-0.01 (0.049)	0.13 (0.4)	-0.49 (0.6)	-0.01 (0.1)	0.03 (0.03)
other food	-0.2 (0.03)*	0.17 (0.16)	-0.23 (0.49)	-7.92 (4.0)	-54 (0.8)***	-12 (0.03)***

***,**,* denote significance at 1, 5 and 10 percent, respectively. Standard errors in brackets.

Table 5. *Quantity responses to movement in price and expenditure (marginal effects).*

Equation	Price of Cereals	Price of pulses	Prices of root crops	Prices of fruits and vegetable
Cereals	-0.03 (0.01)***	0.02 (0.004)*	0.04 (0.005)***	0.08 (0.055)*
Pulses	0.02 (.004)*	-0.03 (0.01)***	-0.008 (0.005)*	0.01 (0.004)**
root crops	0.04 (.005)***	-0.01 (0.005)*	-0.014 (0.003)***	-0.04 (0.001)***
fruits and vegetables	0.08 (0.055)*	0.01 (0.004)**	-0.035 (0.005)***	0.027 (0.008)**
animal products	0.003 (0.005)	0.0024 (0.003)	0.003 (0.005)	-002 (0.004)
other food	0.002 (0.004)	0.02 (.005)***	-0.005 (.004)	-0.01 (0.004)***

Table 5. *Continued.*

Equation	Prices of animal products	Prices of other products	Lny	(lny)^2
Cereals	0.003 (0.005)	0.002 (0.004)	0.15 (.07)**	0.8 (0.28)**
Pulses	0.002 (0.003)	0.02 (0.005)***	-0.04 (0.04)	0.6 (0.3)*
root crops	0.003 (0.005)	-0.005 (.004)	0.002 (0.003)	-.06 (0.2)**
fruits and vegetables	-0.002 (0.004)	-0.01 (.004)***	0.04 (0.02)**	-0.6 (0.53)*
animal products	-0.002 (.005)	-0.003 (0.004)	-0.02 (0.01)*	-2.3 (1.05)*
other food	-0.003 (.004)	0.0042 (0.006)	0.04 (0.012)**	-1.2 (2.43)

***,**,* denote significance at 1, 5 and 10 percent, respectively. Standard errors in brackets.

The QUAIDS model is estimated by applying nonlinear seemingly unrelated regression to the system of five share equations (other food is dropped to avoid covariance matrix singularity). The estimator is a feasible nonlinear generalized least squares estimator that is implemented with the Stata 13 command nlsur. The demand system consists of 90 parameters that measure marginal effects.[8] For the purpose of elaboration, the results are split into two parts. The vectors belonging to demographic and dummy variables are illustrated in table 4. Others are presented in table 5.

The inclusion of the demographic variables is justified that each one is significant at in least three demand equations (table 4). The marginal effects are evaluated at sample mean of household size, household head age, and household years of schooling with all dummy variables equal to zero. The reference household size is inhabited by five members; headed by head with average age years of 40; literate with two average years of schooling. Large sized households consume more cereals, pulses, root crops, fruits and vegetables and other food groups while small sized ones consume more animal products and dairy products. Dissimilarity among households' head with regards to sex, age and literacy significantly affect how much consumed of almost all food groups. The seasonal dummies capture significantly differences in time of consumption patterns for sample households in five of the demand equations. Likewise, the marginal effects for zonal dummies control for sizeable dissimilarity in consumption patterns of the foods in Bench Maji, Kaffa and Sheka zones. This is an indication that consumption patterns are not stable all year round and vary across residence locations of household and hence, the needs for accounting them in budget share equations.

Table 5 presents the marginal effects of the QUAIDS estimates vis –a- vis prices and expenditure terms. The null hypothesis of zero marginal effect is rejected for about 52% and 75% of price and expenditure vectors respectively (table 5). Five out of six own-price responses are significantly different from zeroes with reasonable sign. All except the category of other food group[9] are sensitive to change in prices as expected; negative own marginal price effect means that an increase in the prices results in decrease in demand for that food category. The one exception is the positive sign for fruits and vegetables implicating that it is Giffen good. At conventional significance levels, the marginal cross price responses are sizeable between: cereals, pulses, root crops and fruits and vegetables; between: pulses, root crops, fruits and vegetables and other food; between: root crops, fruits and

8Of these vectors 42 are for household demographic variable and dummies; 36 are for prices and 12 are for real expenditure and its square.

9Aggregation of less related food items in other food group blurs possible relation between quantity demand and price.

vegetables; between: fruits and vegetables and other food group. The negative (positive) coefficient denotes substitutes (compliments) goods and small coefficient value shows weak quantity responses to movement in relative prices possibly due to level of aggregation in the commodity groups. The last two columns of table 6 relate to the coefficients for real expenditure $\left(\frac{m}{a(P)}\right)$ and quadratic expenditure $\left(\frac{m}{a(p)}\right)^2$ terms respectively denoting AIDS and QUAIDS demand system specifications. The test for appropriate model specification involves simply testing for the statistical significance of lambda (λ_i) for each budget share equation or the system as whole. The null hypothesis that lambda (λ_i) is zero is rejected in budget share equations of five groups, thus providing evidence in support of QUAIDS specification. Budget share equation for other food groups needs to be modeled in linear expenditure term. Positive (negative) coefficient for marginal budget share effects means if income increases in the future the amount spent on the food group of that income increases (decreases) by the amount of the figures.

4.4. Demand Elasticities

The marginal effects of the QUAIDS estimates of price and income coefficients in table 5 reveal the uncertainty surrounding demand analysis rendering difficult to interpret them directly. For this reason, price and income effects are best evaluated in terms of elasticities evaluated at means of sample.

4.4.1. Expenditure Elasticities

All expenditure elasticities are statistically significant at 1% level (table 6). The estimates are all positive and hence, all are normal foods. An increase in rural households' income increase the demand for commodities considered, as would be expected. Moreover, cereals, fruits and vegetables, and animal products are luxuries with expenditure elasticities in excess of unity, while pulses, root crops and other food group are necessities with their coefficients in short of unity. This implies that other things remain constant a change in demand due to change in income is higher in the former groups than in the latter groups. It can also be interpreted that increasing income will increase the demand for expensive items than does it increase the demand for necessities.

Table 6. *Expenditure Elasticity Endogeniety adjusted.*

Equation	Coefficient	Standard errors
Cereals	1.058	(0.031)***
Pulses	0.895	(0.028)***
root crops	0.97195	(0.028)***
fruits and vegetables	1.0195	(0.0232)***
animal products	1.24	(0.120)***
f other products	0.858	(0.057)***

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

4.4.2. Own and Cross Price Elasticities

Tables 7 and 8 present respectively conditional Marshallian and Hicksian own and cross price elasticities. The uncompensated elasticity of demand represents changes in the quantity demanded as a result of changes in prices, capturing both substitution and income effect, whereas, compensated elasticity of demand describes only the substitution effect as a result of price change, keeping the level of utility constant. Own and cross price elasticities represent consumers' response to price change. The on diagonals cells are own price elasticites and the off diagonals cells are cross price elasticities.

All own price elasticies are statistically significant at 1%. Negative coefficients denote inverse relationships between price and quantity demanded of each commodity group. The degree of consumer response is measured by the amount absolute values of elasticities coefficients exceed the unity. Based on uncompensated price elasticities calculation, all except animal products and other food group all are price elastic. A change in the price of any of them will result in more than proportionate change in quantity demanded of that food commodity group. Nevertheless, when income effect is removed (Hicksian price elasticities), all became price inelastic with pulses and cereals near unity which means proportionate change in quantity demanded of the will be equal to the same proportionate change in own price that trigger them. When the overall effect is considered the own price elasticity is ranked in descending order as; cereals, pulses and oils followed by fruits and vegetables, then by animal products. Consumption of root crops appeared least responsive to price change, implying that income effect overwhelms the substitution effect by reducing the degree of response. This is evident from table 8 that when income effect is removed, the response to own prices gets higher indicating substitution with the commodities that constitute the group. In contrast, by pure substitution effect comparison the order of responses changes as highest for pulses and oils, followed by cereals, root crops and animal products.

Cross price elasticities measure the effect of a price change in one commodity on the demand for another. Of 30 estimated uncompensated (Marshallian) and compensated (Hicksian) cross price elasticities, 20 and 18 respectively are significantly different from zero at conventional significance levels. All coefficients are less than 1 in absolute value implying weak response of one commodity group to changes in price of the other. The negative (positive) coefficient denotes gross substitutes (compliments) goods and the smaller coefficient value shows the weaker quantity responses to movement in relative prices possibly due to level of aggregation in the commodity groups. For instance, appositive coefficients for pulses and oilseeds equation vis-a- vis price of cereals show that the demand for former decrease with surge in price of cereals all things remain constant. Also the smaller coefficient for compensated price elasticities dictates the complementarily relationship between the two groups becomes fragile if only substitution effect is considered. Moreover, when price increases are offset by equivalent income increases to maintain the original utility level, the responses tend to be weaker for most of the food groups. The low response is expected because there is less substitutability (complementary) between food groups i.e., substitutability (complementary) happens within food groups.

The estimated elasticities are powerful instruments in guiding policy makers choose from among alternatives and devise policies targeted at poor. Comparison of expenditure and price elasticities (tables 6 and 7) show that the magnitudes of the former are greater than that of the latter (except pulses). It can be inferred from these results that income has higher impacts than prices. It can be interpreted that policies that favor producers by increasing general food prices would not have a significant impact on consumption patterns as those that favor growth in income [5].

Policies that target income growth would lead to higher demand for animal products, cereals and fruits and vegetables while those rise the prices would shift the consumption away of the goods.

5. Conclusion

The study was motived to uncover how rural households in South West Ethiopia would react to changes in prices and income by estimating demand elasticities of six groups of food items by applying QUAIDS framework controlled for censoring and endogeneity. This task was achieved: first by identifying that household in the region spend more on foods than any other consumables mostly on root crops and fruits and vegetables. Second, it was confirmed that household demographic characteristics such as age, family size, literacy, location and season affect consumption patterns as do economic factors. Third, changes in prices would induce changes in consumption of food bundles as was theoretically expected and higher income would lead to more consumption of luxury foods such as fruits and vegetables, animal foods and cereals than other groups. Fourth, it was observed that income has far more impacts than do prices.

These findings provide important insights into understanding consumer behavior in general and food consumption patterns in the study area in particular. The largest share of household income is spent on food consumption which increases with household size as is expected in poor country such as Ethiopia. The estimated budget share equations provide evidences for specifying the food demand systems in QUAIDS form. The influences of demographic characteristics, time and location on preference signify their underlying importance in demand analysis. The estimated price elasticities corroborate the theoretical predictions that changes in income and prices will induce adjustment in consumption patterns that manifest by change in the quantities and types of items.

Two implications can be drawn from the findings which would be power full instruments in policy advices: The smaller cross price elasticities indicate limited substitutability (complementary) between commodities revealing to emphasize sector specific policies over holistic approach; and higher expenditure elasticities than price counterparts are evidence for effectiveness of policies that target income over policies targeting prices.

Table 7. *Marshallin (uncompensated) own and cross price elasticities.*

Equation	Price of Cereals	Price of pulses	Prices of root crops	Prices of fruits and vegetable	Prices of animal products	Prices of other products
Cereals	-1.8 (0.05)***	0.51 (0.16)***	-0.4 (0.03)***	0.4 (0.04)**	-0.05 (0.04)	-0.05 (0.04)
Pulses	0.4 (0.04)***	-1.2 (0.05)***	-0.19 (0.04)**	0.08 (0.04)*	0.04 (0.03)	0.12 (0.03)***
root crops	-0.5 (0.04)***	-0.07 (0.04)*	-1.1 (0.03)***	-0.2 (0.03)***	0.02 (0.05)	-0.04 (4.04)
fruits and vegetable	-0.211 (0.13)	0.2 (0.1)*	-0.46 (0.13)***	-1.0 (0.10)***	-0.25 (0.12)**	-0.35 (0.3)
animal products	0.2 (0.1)**	0.16 (0.07)**	0.2 (0.08)**	-0.1 (0.06)**	-0.9 (0.07)***	0.1 (0.06)*
other food	-0.17 (0.13)	0.23 (0.07)***	0.15 (0.1)	0.09 (0.06)	0.86 (0.06)***	-0.19 (0.067***

***,**,* denote significance at 1, 5 and 10 percent, respectively. Robust standard errors in brackets. Own-price elasticities are on the diagonal and cross-price elasticities off the diagonal.

Table 8. *Hicksian (compensated) own and cross price elasticities.*

Equation	Price of Cereals	Price of pulses	Prices of root crops	Prices of fruits and vegetable	Prices of animal products	Prices of other products
Cereals	-0.9 (0.05***	0.24 (0.02)***	-0.1 (0.04)***	251 (.023)***	0.24 (0.23)	0.2 (0.18)
Pulses	0.24 (4.025)**	-0.98 (0.04)***	0.18 (0.03)***	0.28 (0.03)***	0.24 (0.03)***	0.33 (0.027)
root crops	-0.2 (0.043)***	0.17 (0.032)**	-0.8 (0.024)***	0.013 (0.034)	0.27 (0.39)	0.21 (0.03)
fruits and vegetable	0.27 (0.036)***	0.3 (032)***	0.01 (0.036)	-0.5 (0.1)***	-0.25 (0.04)**	0.11 (0.036)***
animal products	0.24 (0.043)***	0.24 (0.03)***	0.28 (0.48)	-0.22 (0.05)**	-0.8 (0.05)***	0.209 (0.33)
other food	0.23 (0.22)	0.29 (0.2)	0.22 (0.25)	0.15 (0.023)***	0.199 (0.25)	-0.73 (0.03)***

The cells with parameters are complemented with asterisk in line with their significance: *** implies significance at the 1% level, ** implies significance at the 5% level and * implies significance at the 10% level. Robust standard errors in brackets. Own-price elasticities are on the diagonal and cross-price elasticities off the diagonal.

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References

[1] Tefera, N., M. Demeke, & S. Rashid. (2012). "Welfare Impacts of Rising Food Prices in Rural Ethiopia: a Quadratic Almost Ideal Demand System Approach", Selected Paper prepared for presentation at the International Association of Agricultural Economists (IAAE) Triennial Conference, Foz do Iguaçu, Brazil, 18–24.

[2] Banks, J., R. Blundell, & A. Lewbel. (1997). "Quadratic Engel curves and consumer demand. Review of Economics and Statistics", 79 (4), 527-539.

[3] García-Enríquez, J., & Echevarría, C. A. (2016). Consistent Estimation of a Censored Demand System and Welfare Analysis: The 2012 VAT Reform in Spain. *Journal of Agricultural Economics*, *67* (2), 324–347. https://doi.org/10.1111/1477-9552.12144.

[4] Lakkakula, P., Ripplinger, D., & Schmitz, A. (2016)." U.S. sweetener demand analysis: A QUAIDS model application", Journal of Agricultural and Resource Economics, 41 (3): 533–548.

[5] Maganga, A. M., Alexander, M., Phiri, R., Mapemba, L. D., Gebremariam, G. G., & Dzanja, J. K. (2014)." A Food Demand System Estimation for Rural Malawi: Estimates Using Third Integrated Household Survey Data", Paper Presented at the Agricultural and Applied Economics Association Annual Meetings in Minneapolis, MN, July 28-30, 2014., 1–21.

[6] Dybczak, K., Tóth, P., & Voňka, D. (2014). "Effects of price shocks on consumer demand: Estimating the QUAIDS demand system on Czech household budget survey data", Finance a Uver - Czech Journal of Economics and Finance, 64 (6), 476–500.

[7] Boysen, O. (2012). "A Food Demand System Estimation for Uganda", IIIS Discussion Paper, 396.

[8] Ecker, O., & Qaim, M. (2011). "Analyzing Nutritional Impacts of Policies: An Empirical Study for Malawi. World Development", 39 (3), 412–428.

[9] Tafere, K., Taffesse, A. S., & Tamru, S. (2010)."Food Demand Elasticities in Ethiopia: Estimates Using Household Income Consumption Expenditure (HICE) Survey Data", ESSP2 Discussion Paper 011.

[10] Dhar, T. P., & Foltz, J. D. (2004). "Is Soy Milk? The Economics of The Soy Milk Market" Retrieved from http://ideas.repec.org/p/ags/aaea04/20337.html (excesion date 10/04/2018).

[11] Stone, R. N. (1954)." Linear expenditure systems and demand analysis: An application to the pattern of British demand", Economic Journal, (64), 511-527.

[12] Theil, H. (1965), "The information approach to demand analysis", *Econometrica*, 33 (1): 67-87.

[13] Christensen, L., Jorgenson, D. W., & Lau, L. J.(1975). "Transcendental logarithmic utility functions", American Economics Review, (65), 367-383.

[14] Deaton, A., & Muellbauer, J. (1980). "An almost ideal demand system", *The American Economic Review*, *70* (3), 312–326.

[15] Suriani, Diana Sapha, A., Rizki, C., & Majid, M. (2018)." Analysis of food demand elasticity of rice for the poor in Aceh, Indonesia: An almost ideal demand system approach", *DLSU Business and Economics Review*, 27 (2): 179-189.

[16] Guerrero-López C., Colchero, M., & Unar-Munguía, M. (2017)." Price elasticity of the demand for soft drinks, other sugar-sweetened beverages and energy dense food in Chile", *BMC Public Health*, 17 (1): 180. doi: 10.1186/s12889-017-4098-x. PMID: 28183287; PMCID: PMC5301435.

[17] Hayat, N. Hussain, A. & Yousaf, H. (2016)." Food Demand in Pakistan: Analysis and Projections", *South Asia Economic Journal*, 17 (1) 94–113.

[18] Shimeles, A., & Delelegn, A. (2013). "Rising Food Prices and Household Welfare in Ethiopia: Evidence from Micro Data", African Development Bank Group Working, (182), 1–40.

[19] Barslund, M. (2011)." Censored Demand System Estimation with Endogenous Expenditures in Clustered Samples: An Application to Food Demand in Mozambique", *LICOS Discussion Paper 280/2011 Censored*, (0), 0–36.

[20] Bopape, L., & Myers, R. (2007). "Analysis of household demand for food in South Africa: Model selection, expenditure endogeneity, and the influence of socio-demographic effects", *African Econometrics Society Annual Conference*, 22.

[21] Shonkwiler, J. S. & S. T. Yen. *1999).* Two-step estimation of a censored system of equation. *American Journal of Agricultural Economics,* 81 (4): 972-982.

[22] Hausman, J. A. (1978), "Specification Tests in Econometrics", Econometrica 46 (6): 1251- 1271.

[23] Blundell, R., & Robin, J. M. (1999). "Estimation in Large and Dissaggregated Demand Systems: An Estimator for Conditionally Linear Systems. *Journal of Applied Econometrics*," *14* (3), 209–232.

[24] Poi, B. P. Demand-system estimation: Update. The Stata Journal, 2008, 8 (4): 554-556.

[25] Klugman, J., & Loening, J. (2007). Welfare Impacts of Food Price Inflation in Ethiopia. Policy Note, Poverty Reduction and Economic Management Unit, Africa Region, (105653), 34-41.