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Analysis of household demand patterns using household data

Re-thinking the use of unit values or community prices

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Abstract: Analysis of household food consumption patterns and welfare requires knowledge of household demand responses to changes in price and income. Estimation of the price and expenditure elasticities requires detailed data on household purchases and prices, which are often not available in many developing countries. To overcome constraints on the availability of price data, two approaches are mostly used: community prices and unit value (obtained by dividing household expenditure by quantity purchased). However, prices from these approaches are most likely measured with error. Also, they fail to account for quality variation in consumer demand. If these limitations persist, then price and expenditure elasticities estimated using these data are most likely to be biased, with negative implications for policy-making. In this paper, I assess the differences in price and expenditure elasticities for food between the unit value and community price approaches using household data from Tanzania. Estimations are done using the Quadratic Almost Ideal Demand System augmented to deal with issues of censored expenditure shares. My analysis also offers evidence on the food demand patterns in the country. Findings from the paper reveal no significant differences in the expenditure elasticities obtained from using unit value and community prices. The estimates from both approaches, however, indicate substantial discrepancies of price elasticities. These deviations mostly might have resulted from community prices if enumerators did not consider the probability of consumers to bargain. I suggest that before using household data, researchers should carefully account for quality variations and measurement errors when they derive price elasticities.

Key words: community prices, unit values, quality effect, household demand, income and price elasticities

JEL classification: D12, E64, O55

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1 Introduction

Policy analysis related to food consumption and household welfare requires knowledge of household demand responses to changes in price and income. For instance, a policy aimed to provide food subsidies either directly to (vulnerable) consumers or indirectly via agricultural input subsidies may require knowledge of the price elasticities of the food in order to assess the impact of the subsidies on the welfare of households.

Analysis of the price and income elasticities, however, requires extensive data on consumer purchases and income flow. While these data may be forthcoming in developed countries via regular household expenditure surveys, they are not readily available in developing countries. Available studies on developing country context(s) rely on general household surveys, which often lack detailed information on household purchases, particularly prices (Deaton 1988, 1997, 2000). This therefore limits the extent and quality of analysis required to influence policy in the respective countries.

To overcome the challenge, two approaches are often used to obtain proxy values for commodity prices. First, the unit value approach as proposed by Timmer and Alderman (1979), where commodity prices are estimated by dividing total expenditure on each commodity by the quantity purchased. The alternative approach is the use of community prices at the time of the survey as a proxy for the prices at which households purchased the items in their respective communities. The community price approach implicitly assumes the 'law of one price'; that is, all households in the community face the same commodity prices. The choice between these approaches, however, is an empirical question, as each of them are beset with limitations, notably, measurement error. The unit value approach does not account for quality differences in the commodities purchased. For instance, even though a consumer may purchase two varieties of milk at different prices, prices computed from the unit value approach will be unable to account for the price differences induced by product quality or branding effect. Such errors in measurement could have implications on estimated price elasticities. Similarly, in the case of community prices, measurement errors are likely to arise in cases where a large number of households make their purchases in markets *outside* the community, hence making them less-responsive to variations in prices *in* the community. Also, in many developing countries where price 'bargaining' is common practice, average market prices may not reflect the real prices paid by consumers. The limitations associated with these measures of obtaining proxy prices for commodities imply that care must be taken in using them to compute demand elasticities as the measurement errors may induce an upward or downward bias in the elasticities. In spite of these limitations, there is no consensus on the most appropriate method of deriving commodity prices from household surveys for demand analysis (Gibson and Rozelle 2011).

The main aim of this paper, therefore, is to contribute to the debate on these approaches, by evaluating the differences in price and expenditure elasticities associated with the use of community and unit value prices. Specifically, this paper addresses the following main question: to what extent does price and expenditure elasticities estimated from community prices differ from corresponding elasticities estimated using unit value prices? The extent of convergence or divergence in the elasticities from the two approaches is, partly, a measure of the reliability of these methods in predicting the true household responses to price and income changes. Additionally, the paper seeks to provide new evidence on food demand patterns and consumer response to price and income changes in a developing country context.

To this end, I use detailed household data from Tanzania to analyse the household food demand in the country, and consequently, estimate the price and expenditure elasticities by relying on commodity prices obtained from the unit value and community prices. I chose Tanzania for the empirical analysis not only because it is a developing economy but also because of data availability. The empirical strategy is summarized as follows. First, I assembled detailed data on expenditure and prices (unit value and community prices) of nine food groups to jointly estimate household demand for these food groups using a Quadratic Almost Ideal Demand System (QUAIDS) by Banks et al. (1997). Second, I estimated and compared price and expenditure elasticities to determine the differences in the two approaches and the implications for policy analysis.

Findings from the paper suggest that, while there are minor differences in expenditure elasticities estimated using price data from the unit value and community price approaches, there are large discrepancies between price elasticities from the two approaches. The findings suggest that both approaches are subject to measurement errors and if not carefully considered, they may lead to biased estimates. Further, findings reveal 'elastic' expenditure elasticities in Tanzanian households. More specifically, elastic food groups include cereals, starches, vegetables, and milk products, where the average income elasticities range between 1.1 and 1.2. The results further indicate that additional household income is spent more proportionally on fibre-dense food staples than on fat and milk protein products.

The rest of the paper is organized as follows. Section 2 describes the model of demand systems and the empirical strategy used in the paper. Section 3 provides a description of the data used in the analysis. Results are presented and discussed in Section 4. Concluding remarks are presented in Section 5.

2 Methodological framework

In this section, I construct the theoretical framework based on the standard consumer theory. To this effect, I assume a quasi-concave utility function of the sampled household and 'full-choice behaviour' of each household (i.e. the consumer makes purchase decisions rationally) to gain utility from any demand at a given limited household income. Furthermore, I assume that the amount of food consumed by each household and the quality choice are both functions of food market prices, household income, and other economic factors. It is also useful to mention that the prices of any of the nine food groups eventually affects the quantity and quality a household can decide to consume (Deaton 1990).

2.1 The Working–Leser model

To model the allocation decisions of household expenditures, I followed the Working–Leser model specifications (Leser 1963; Working 1943; see also Deaton and Muellbauer 1980b). Two-stage budgeting has been assumed, which means that initially households allocate their budgets between food and non-food items, and then within the food categories. We can define food expenditure share as

$$S_F = \alpha_F + \gamma_F \ln P_F + \sum_{k \in K} \eta_k Z_k + \beta_F \ln Y + \lambda_F (\ln Y)^2 \tag{1}$$

where S_F stands for the expenditure food share in relation to total household expenditures, $\boldsymbol{Z}$ is the vector of household demographic variables while $\boldsymbol{Y}$ represents household total expenditure.

The P_F is the Stone price index calculated based on the weighted sum of the individual food item prices expressed in logarithms, with the weight being the expenditure shares of each food item as follows:

$$\ln P_F = \sum_{g=1}^{9} \ln \left[\prod p_j^{S_F} \right] \tag{2}$$

2.2 QUAIDS

The concept of the QUAIDS model was applied for the first time by Banks et al. (1997) and viewed as an extension of the famous Almost Ideal Demand System (AIDS) model by Deaton and Muellbauer (1980a). Having a quadratic term in expenditures, this type of demand system is more flexible than usual AIDS, as it allows demand curves to be non-linear in the logarithm of income and Engel curves. When conceiving the model, Banks et al. (1997) argued that for many household expenditures, the usual empirical demand models, such as AIDS and indirect translog (ITL) by Christensen et al. (1975), do not provide an accurate general picture of the observed behaviour across group expenditure. In that sense, they show that most of the consumption data mark Engel curves that are more non-linear with rank 3, and this cannot be estimated adequately by the AIDS or ITL model. The QUAIDS model has gained international recognition since its inception and a number of economists have applied it most widely (among others, see Abdulai 2002; Boysen 2016; Khanal et al. 2015; Tan et al. 2016). The QUAIDS model is generally derived from the usual indirect utility function

$$\ln V(p, y) = \left(\left[\frac{\ln y - \ln a(p)}{b(p)} \right]^{-1} + \lambda(p) \right)^{-1} \tag{3}$$

where *y* is household expenditure, *p* is price, and *a*(*p*) is the translog price aggregator expressed as

$$a(p) = \alpha_0 + \sum_{j=1}^{n} \alpha_n \ln p_j + \frac{1}{2} \sum_{j=1}^{n} \sum_{i=1}^{n} \gamma_{ji} \ln p_j \ln p_i \tag{4}$$

where *j*=1, . . . 9 of food groups, namely, cereals, starches, sugar, nuts, vegetables, fruits, meat, milk and oil products.

$$b(p) = \beta_0 \prod_{j=1}^{n} p_j^{\beta_j} \tag{5}$$

where *b*(*p*) is a Cobb–Douglas aggregator and the term

$$\lambda(p) = \sum_{j=1}^{n} \lambda_i \ln p_j$$

is a differentiable, homogeneous function of degree zero of prices and where

$$\sum_{j=1}^{n} \lambda_j = 0.$$

By applying Roy's identity to Equation 3, the expenditure share of the QUAIDS model can be derived:

$$S_{jk} = \alpha_{jk} + \sum_{i=1}^{n} \gamma_{ij} \ln(p_{jk}) + \beta_j \ln\left[\frac{y_k}{a(p)}\right] + \frac{\lambda_j}{b(p)}\left[\ln\left\{\frac{y_k}{a(p)}\right\}\right]^2, \text{for } j=1,\ldots,k \tag{6}$$

where S_{jk} stands for the budget share for each food group of the kth household in its total food demand expenditures; k=1, . . . , N represents the sampled households; P_{jk} represents the food prices for the kth household consumer; y_k represents the total food expenditures of the kth household; $a(p)$ and $b(p)$ are described in Equations 4 and 5 , respectively, while γ_{ij}, β_j, and λ_j are the parameters to be estimated. If the quadratic term in Equation 6 is not incorporated, then the usual AIDS model can be estimated. Equation 6 defined above should theoretically satisfy the laws of demand. To achieve this, the adding-up condition, the homogeneity of degree-zero property in prices and income, and the symmetry conditions of the Slustky parameters need to be imposed, which results in the following restrictions of the QUAIDS model:

$$\sum_{j}^{n} \alpha_{jk} = 1, \sum_{j}^{n} \beta_j = 0, \sum_{j}^{n} \lambda_j = 0, \sum_{j}^{n} \gamma_{ji} = 1 \tag{7}$$

where γ_{ij}=γ_{ji} for all food groups j.

To account for heterogeneity among households, household demographic variables are included in the QUAIDS model. Specifically, the following demographic characteristics have been considered in the model in the current paper: age of household head, regional dummies, household population size, and marital status of the household. In the relevant literature (Khanal et al. 2015; Tan et al. 2016; Zheng and Henneberry 2009, these demographics and household characteristics have been considered to have significant influences on household purchase decisions. To accurately assess the effect of household characteristics on food demand, first Ray's (1983) technique is applied:

$$e(p, z, \mu) = y_0(p, z, \mu) * e^h(p, \mu) \tag{8}$$

where the first term $y_0(p, z, \mu)$ scales the expenditure function that allows to control for household demographics and the last term $e^h(p, \mu)$ represents the expenditure function of the sampled household (representative households). By further decomposing the expenditure function, it becomes

$$y_0(p, z, \mu) = \bar{y}_0(z) * \phi(p, z, \mu) \tag{9}$$

where the first term measures the increase of household expenditure as result of z, by not accounting for any changes in consumption patterns. For instance, a household with five members will incur higher expenditures than one with a single member, even without considering that the composition of goods consumed change. The second term accounts for the changes in the relative prices and the actual goods consumed. Following Ray's (1983) procedure, Poi (2012) suggested a parameterized QUAIDS as

$$\bar{y}_0(z) = 1 + \rho' z$$

and

$$\ln \phi(p, z, \mu) = \frac{\prod_{j=1}^{k} p_j^{\beta_j} \left(\prod_{j=1}^{k} p_j^{\eta_j' z} - 1 \right)}{\frac{1}{\mu} - \sum_{j=1}^{k} \lambda_j \ln p_j}$$

with ρ being a vector of parameters to be estimated[1] and η_j represents the jth column of the $s \times k$ parameter matrix η. Therefore, incorporating demographics into the expenditure function, Equation 6 becomes

$$S_{jk} = \alpha_{jk} + \sum_{i=1}^{n} \gamma_{ij} \ln(p_{jk}) + (\beta_j + \eta' z) \ln \left[\frac{y_k}{\bar{y}_0(z) a(p)} \right] + \frac{\lambda_j}{b(p) c(p, z)} \left[\ln \left\{ \frac{y_k}{\bar{y}_0(z) a(p)} \right\} \right]^2 \tag{10}$$

and

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

such that the adding-up restriction requires that

$$\sum_{j=1}^{k} \eta_{rj} = 0 \text{ for } r = 1, \ldots, s.$$

[1] This functional form has a distinct advantage of resulting in expenditure shares equations as it mimics closely their counterparts without accounting for demographic characteristics.

2.3 Censored data

Further, in the data, there are some food categories with a value of zero in household expenditures, leading to the existence of corner solutions. The reasons for a zero expenditure value might be related to non-preference, non-affordability, non-availability, and infrequent purchases, among others. Failure to account for these missing values in the estimation procedures could lead to biased estimates (Park et al. 1996). To deal with such situations, I apply the Shonkwiler and Yen (1999) approach. In this approach, it is assumed that households make consumption decisions in a two-stage procedure as follows:

$$d_{jk}^{*} = \mathbf{z}_{jk}'\theta_j + \mathbf{y}_{jk}'\psi_j + v_{jk} \tag{11}$$

$$S_{jk}^{*} = \hat{\Phi} S_{jk} + \theta_{jk}\hat{\phi} \tag{12}$$

$$d_{jk} = \begin{cases} 1, \text{if } d_{jk}^{*} > 0 \\ 0, \text{if } d_{jk}^{*} \leq 0 \end{cases} \tag{13}$$

$$S_{jk} = d_{jk} S_{jk}^{*} \tag{14}$$

where j and k are the commodity and household indices, respectively, while $\mathbf{y}$ and $\mathbf{z}$ are the vectors of the exogenous covariates, respectively; S_{jk}^{*} and d_{jk}^{*} are unobserved household budget shares and latent discrete choice decision variables, respectively; and finally, S_{jk} and d_{jk} are the observed dependent variables for household consumption and non-consumption counterparts. In the first stage of this process, households decide whether to purchase or not to purchase each of the food items; in the second stage of the process, they decide how much to spend on each item, conditional on a positive purchase decision in the first stage.

Here the first stage is estimated using a probit model that describes the consumption selection decisions. The predicted estimates from the first stage are used to generate cumulative distribution function $\hat{\Phi}$ and probability density function $\hat{\phi}$, both of which are required to estimate a second-stage augmented QUAIDS in Equation 12.

Following a similar approach to Aepli (2014) and Poi (2012), Equations 10–14 are used to derive expenditures and price elasticities by differentiating Equation 12 with respect to $\ln y_k$ and $\ln p_{jk}$; in doing so the uncompensated price elasticity of good i with respect to the price changes of good j is given as

$$e_{ij}^{m} = -\delta_{ji} + \frac{1}{S_{jk}^{*}}\left(\Phi_j\left\{\gamma_{ij} - \left[\beta_j + \eta' z + \frac{2\lambda_j}{b(p)c(p,z)}\ln\left(\frac{y_k}{\bar{y}_0(z)a(p)}\right)\right]\right.\right.$$
$$\left.\left. * \left(\alpha_j + \sum_{n=1}^{N}\gamma_{jn}\ln(p_n)\right) - \frac{(\beta_j + \eta_j' z)\lambda_j}{b(p)c(p,z)}\left[\ln\left\{\frac{y_k}{\bar{y}_0(z)a(p)}\right\}\right]^2\right\} + \phi_j\right) \tag{15}$$

where δ_{ji} is the Kronecker function, with δ_{ji}=1 if $i=j$, and 0 for $i \neq j$. Expenditure elasticity for good j is given as

$$\sigma_j = 1 + \frac{1}{S_{jk}^*}\left\{\Phi_j\left[\beta_j + n'z + \frac{2\lambda_j}{b(p)c(p,z)}\ln\left(\frac{y_k}{\bar{y}_0(z)a(p)}\right)\right] + \phi_j\right\} \tag{16}$$

Finally, Hicksian price elasticities can be derived from expenditure and Marshallian price elasticities as

$$e_{ij}^h = e_{ij}^m + \eta_j S_{jk}^* \tag{17}$$

3 Data and descriptive statistics

3.1 Data sources

This study uses data from the third wave of the Tanzanian National Panel Survey (NBS 2012–13). The panel survey is a nationally representative household dataset that collects information on a wide range of topics, including agricultural production, off-farm income-generating activities, food and non-food expenditures, as well as other socio-economic characteristics.

The dataset covers 4,416 sampled households from all regions of the Tanzanian main land.[2] The sampled households were stratified into three broad regional categories: (i) Dar es salaam area, consisting of 770 households; (ii) other urban areas, with 883 households; and (iii) rural areas, accounting for 2,763 households. After data cleaning, data on 1,765 households were used for the analysis. This was mainly because of the lack of basic information on household food expenditure. It is important to highlight that the main purpose of this study is to derive and compare price and expenditure responses using both unit values and community prices.

This study imposed the restriction of having households with sufficient information to compute the two sets of prices. Table 1 provides a summary of household demographics that are used in the demand system model to examine their potential influences on household consumption decision; these indicators are also useful to improve the system's explanatory power (e.g., see Boysen 2016). In cross-section data, across various households, consumption behaviour differs, not only with expenditure levels and the prices they face but also depending on other household demographics such as location, household size, and education level of household head (Abdulai 2002; Banks et al. 1997; Tan et al. 2016).

[2] The Zanzibar Archipelago is not considered in this study because there are important differences in food consumption patterns with the Tanzanian mainland. Hence, including households from the island would lead to biased estimates.

Table 1: Mean and standard deviation (SD) of demographics and household characteristics

Demographic variables	Mean	SD	Min	Max
Sex_hhd: dummy=1 if household head is male; 0 otherwise	0.73	0.45	0	1
Educ_hhd: dummy=1 if household head has formal education; 0 otherwise	0.76	0.42	0	1
Hhsize: number of people living in each sampled household	5.10	3.20	1	20
Age_hhd: age of the household head in each sampled household	47.3	16.51	17	107
Mar_stat_hhd: dummy=1 if household head is formally married; 0 otherwise	0.78	0.40	0	1
Share of household members whose age is ≤6 years	0.18	0.17	0	0.75
Share of household members whose age is between 7 and 17 years	0.21	0.19	0	0.84
Share of household members whose age is between 18 and 59 years	0.50	0.25	0	1
Share of household members whose age is ≥60 years	0.11	0.23	0	1
Rural: dummy=1 if the household resides in a rural area; 0 otherwise	0.68	0.46	0	1
Dar es Salaam area: dummy=1 if household location is Dar es Salaam; 0 otherwise	0.14	0.34	0	1
Other urban: dummy=1 if household is in other urban areas except Dar es Salaam; 0 otherwise	0.17	0.38	0	1
East region 1: dummy=1 if household is in eastern region; 0 otherwise	0.33	0.47	0	1
South region 2: dummy=1 if household is in southern region; 0 otherwise	0.30	0.45	0	1
West region 3: dummy=1 if household is in western region; 0 otherwise	0.24	0.43	0	1
North region 4: dummy=1 if household is in northern region; 0 otherwise	0.11	0.31	0	1

Source: author's computation using data from the Tanzanian National Panel Survey, Wave 3 (see NBS 2012–13).

3.2 Quality effects and unit values

Unlike community prices, the use of unit values as market price representatives has raised concerns and debates among researchers. As suggested by Deaton (1988), the use of raw unit values as proxy for market prices may induce measurement errors and bias estimates. Furthermore, several studies have revealed that even expenditures and quantities used to derive unit values are usually contaminated by differences in variations (e.g., cassava flour and roots, maize flour or grain), and even these differences could potentially result from food compositions and these compositions may vary across households and regions (Boysen 2016; Deaton and Dupriez 2011). Therefore, these raw unit value differences, if used unadjusted, might induce huge differences and unrealistic estimates as a result of quality choice rather than differences in price levels in the case of homogeneous products. To deal with these biases of unit values, two approaches have been proposed. First, Cox and Wohlgenant (1986) suggest that the quality effects and measurement error of unit values can be corrected by regressing proxies of quality variations (such as household size, education of household head, ratio of household dependency members, etc.) on the unit values. This enables quality-adjusted prices that vary across households (Aepli 2014). Additionally, Aepli and Finger (2013) and Majumder et al. (2012) suggested that households located in the same region face the same prices, and as a result regional dummy variables are included in the hedonic price equation. The present study follows Cox and Wohlgenant (1986) and extends it as suggested by Majumder et al. (2012). Therefore, the process of deriving quality-adjusted unit values starts by defining the hedonic price function evaluated at predicted cluster dummy values and constant terms.

$$v_{ihrc} - (v_{irc})_{mean} = \alpha_1 D_a + \alpha_2 D_r + \alpha_3 D_c + \psi y_{ihrc} + \sum_n \gamma_i Z_{ihrc} + \varepsilon_{ihrc} \tag{18}$$

where v_{ihrc} stands for unit values paid by household *h* for food item *i* in region *r* and particular cluster *c*, $(v_{ihrc})_{\text{mean}}$ is the mean unit value in region *r* and cluster *c* where the household lives; y_{ihrc} denotes household food expenditure; ε_{ihrc} is the error term; and D_a, D_r, and D_c are dummies for area, region, and cluster, respectively, where household *h* lives. Z_{ihrc} defines household characteristics that include gender of household head, whether household head has formal education, household size, and number of household members economically active. Least squares are used to estimate mean deviation of each household unit value $(v_{irc}^{d})_{mean}$ for food item *i* in region *r* and cluster *c*. The area, region, and cluster quality-adjusted market price p_{ic} is adjusted by adding the cluster mean unit value to the estimated residuals from Equation 17 to obtain:

$$(p_{ic})_{mean} = (v_{irc})_{mean} + (\hat{\varepsilon}_{ihrc})_{mean} \qquad (19)$$

Therefore, each household in region *r* and cluster *c* is assumed to face the vector of quality-adjusted mean price value derived from Equations 18 and 19 when buying a food item *i* where household *h* resides. The derived quality and demographically adjusted unit values are subsequently used as market food price and incorporated into estimating the QUAIDS (see Table 2). To provide a more descriptive analysis, I estimated the statistical correlations between the unit value and community prices and the results are reported in Appendix Table A1. The results from Appendix Table A1 indicate small correlation of the two prices across different food categories.

Table 2: Household expenditures (in Tanzanian shilling) in Tanzania using food group items

Food items	Cereals	Starches	Sugar	Nuts	Vegetable	Fruits	Meat	Milk	Oil
Share of each food item	0.38	0.04	0.06	0.10	0.12	0.03	0.19	0.02	0.07
Ratios of zero purchases	0.28	0.58	0.31	0.45	0.18	0.64	0.25	0.82	0.06
Ratio of household/food purchase	0.69	0.34	0.68	0.54	0.81	0.27	0.68	0.12	0.98
First quartile	3,475	1,000	1,000	1,200	1,001.155	500	1,500	1,050	500
Second quartile	8,525	2,000	1,650	2,400	2,200	1,200	3,500	2,100	1,200
Third quartile	16,000	3,500	2,200	4,300	4,100	2,500	7,500	4,000	2,050
Fourth quartile	180,000	21,600	52,500	320,000	33,482.7	11,400	73,000	32,250	9,050
Mean expenditure per item	7,884.2	924.4	1,277.6	2,061.5	2,437.7	535.7	3,921.9	422.6	1,465.7
Standard deviation	10,959.7	1,956.9	1,876.3	9,250.1	2,806.6	1,397.0	6,122.7	1,743.5	1,298.5
Skewness	3.9	3.7	12.6	27.8	2.7	4.0	3.5	7.8	1.5
Kurtosis	39.0	21.1	318.5	886.2	14.9	19.1	20.5	92.0	3.0

Source: author's computation using data from the Tanzanian National Panel Survey, Wave 3 (see NBS 2012–13).

4 Results and discussion

To estimate and compare the expenditure or price elasticities between unit values and community prices, this study used the QUAIDS model by Banks et al. (1997). Due to censored expenditure observations where, for each food group item, more than 5% of values is censored (see second row of Table 2), censoring was corrected for by estimating the QUAIDS model augmented with the cumulative and probability density functions obtained from the probit model described earlier. Before demand system estimations, it was necessary to account for potential quality effects biases that may raise from using unit values. The procedure described in Equations 18 and 19 gives quality and demographically adjusted unit values that are consistent to represent market prices. In addition, to estimate food demand systems, both household and demographic attributes that might influence consumer preferences were considered. In doing so, the study used household location, a regional indicator variable to capture demographic influences on household consumption decisions. Other socio-economic variables, such as gender of household head, size of household, marital status of household head, and age of household head, were included to account for household characteristics in purchase decisions.

The estimated parameters of QUAIDS models are reported in Appendix Table A2 and this represents the unrestricted version of the food demand system in Tanzania for both community prices and unit values. The table provides estimated parameters on log household income estimates, its quadratic form, log of price of each food group item, as well as a set of household demographics. The models, in both unit values and community prices, exhibit a reasonably high coefficient of determination. Most of the estimated parameters are more significant for unit values than they are for community prices, probably because quality effects and measurement errors were fully accounted for. But more importantly, this study found similar signs from using either of the proxies of market prices. Appendix Table A2 shows also that most of the parameters from household demographic attributes exhibit statistically significant values, an indication that household food demand depends greatly on household characteristics. The ϕ_j parameter values from censored observations are all statistically significant at 1% in each food group, and thus underscore the importance of adjusting zero household expenditure in the observations.

In the next section, I present and discuss the results from the demand system and elasticities of both unit values and community prices that have been derived at the sample mean point. I also provide a comparative analysis to explain the degree of differences between income and price elasticities that emerged from using two market price datasets.

4.1 Expenditure elasticities

The expenditure elasticities obtained from the QUAIDS model estimated using community price and unit value approaches are reported in Table 3. The estimates from each food group item are statistically significant at the 1% level. In addition, the results from the two approaches (community prices and unit values) seem to bring almost the same estimates for the elasticity values. The magnitude of the elasticities differs significantly from one food group item to another. In general, results indicate that four out of nine food group expenditure elasticities have 'elastic' elasticities (greater than one), and this is an indication that households spend more on food than on non-food items in case their income increases. Appendix Figure A1 provides more information between the two estimation approaches. It is important to mention that wider confidence intervals for the category 'fruits' reflect the high level of discrepancies of elasticities from the two approaches.

Table 3: Expenditure elasticities from unit values and community prices

	Cereals	Starches	Sugar	Nuts	Vegetable	Fruits	Meat	Milk	Oil
Commodity prices	1.00***	1.06***	0.95***	0.99***	1.15***	0.73***	0.97***	1.24***	0.92***
	(0.01)	(0.04)	(0.04)	(0.03)	(0.04)	(0.08)	(0.01)	(0.06)	(0.02)
Unit values	1.01***	1.05***	0.96***	0.98***	1.19***	0.66***	0.96***	1.24***	0.89***
	(0.01)	(0.04)	(0.04)	(0.03)	(0.04)	(0.08)	(0.02)	(0.07)	(0.02)

Note: standard errors are reported in parentheses. ***, **, and * represent statistical significance at 1%, 5%, and 10%, respectively.

Source: author's computation using data from the Tanzanian National Panel Survey, Wave 3 (see NBS 2012–13).

At first glance, it seems that elasticity estimates gravitate around one, thus indicating that a 1% increase in total food expenditure induces a similar relative variation in the demand for each food group. Further, to make this general finding more nuanced, a statistical test was conducted to determine whether or not the expenditure elasticity for each food group is significantly different from one. The results of this statistical test (based on the computation of *t*-values) indicate that the null hypothesis that expenditure elasticity is equal to one is not rejected for cereals, starches, sugar, and nuts.[3] On the other hand, the null hypothesis is rejected for vegetables, fruits, meat, milk, and oil. In this latter group, note that vegetables and milk are characterized by expenditure elasticities close to 1.2, whereas for fruits the expenditure elasticity is much lower than one (around 0.7). It is also interesting to note that there are significant differences between elasticities. Comparing elasticity estimates obtained from community prices or unit values reveals that that they are not different from each other for the nine food groups. Finally, it should be pointed out that all the estimated expenditure elasticities are conditional as they represent the response of households to changes in total food expenditures and not income.

4.2 Price elasticities

All Marshallian and Hicksian price elasticity estimates based on community prices and unit values are computed at sample mean and reported in Appendix Tables A3–A6. Almost all own-price elasticities for food items are negative (as shown in Figures 1 and 2), which indicates that the negativity condition is mostly fulfilled. The positive own-price elasticity is observed from Hicksian elasticities for the milk food category. The majority of price elasticities are significant at a 5% level. Furthermore, uncompensated own-price elasticities of food categories are reported in Figure 1; the size and magnitude of these elasticities are in line with those found in other studies (Boysen 2016; Friedman et al. 2017; Melo et al. 2015) and follow similar trends. The average values of own-price (Marshallian) elasticities for the nine food groups all gravitate around −1, ranging between −0.912 and −1.076 for community prices and between −0.85 and −1.070 for unit values. The results show that despite significant differences from using community prices and unit values, especially standard errors, signs (i.e. positive/negative values), and magnitude of the uncompensated own-price elasticities are all negative, consistent with the economic theory.

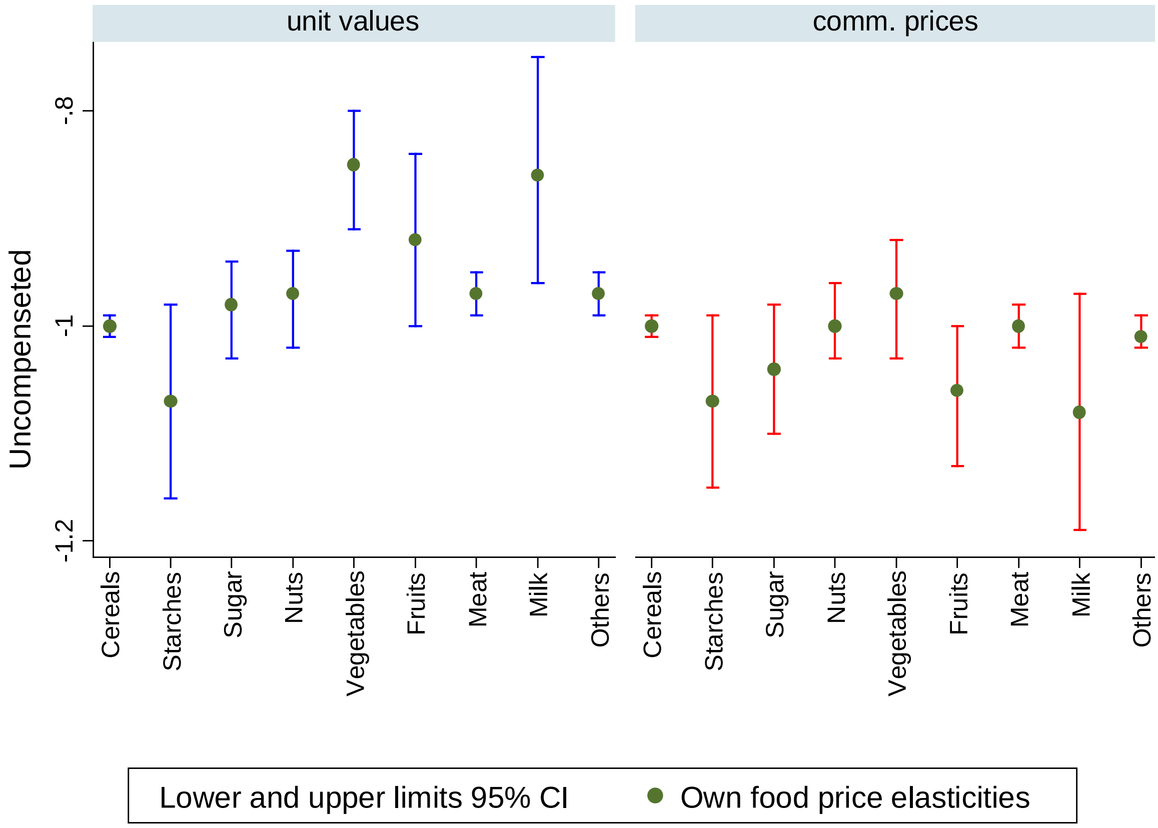
The Hicksian price elasticities computed with community prices and unit values are separately reported in Appendix Tables A4 and A6. These Hicksian elasticities provide a more accurate picture of substitutability between different commodity groups as they capture pure substitution effects. In this respect, it also is important to note that some of the Hicksian cross-price elasticities have different signs from that of uncompensated elasticities, and this reaffirms that household income effects play a significant role in food demand. Furthermore, a negative cross-price elasticity stipulates that pairs of food groups are net complements (e.g., vegetables and starches, milk and cereals, and milk and starches with cross-price elasticities of −0.157, −0.121, and −1.772, respectively). These negative relationships are quite reasonable in the context of Tanzania. For instance, the complementarity of vegetables and starches makes sense because one of the main meals of Tanzanian households is based on a combination of vegetables and some starches like Irish and sweet potatoes or cassava. On the other hand, a positive cross-price elasticity indicates that food group items are net substitutes between each other. In the results of this study, some food groups have relatively higher substitution possibilities; this pattern is especially noted for vegetables and fruits, where the cross-price elasticity equals 0.028, sugar and cereals (0.319), fruits and starches (1.372), and milk and nuts (0.502), among others.

These results suggest that if the price of vegetables increases by 1%, this will elicit an increase of 0.02% of fruits expenditure. Similarly, if the sugar price goes up by 1%, cereals expenditures will

[3] The *t*-statistical test results are not reported here in the text, but they are available on request.

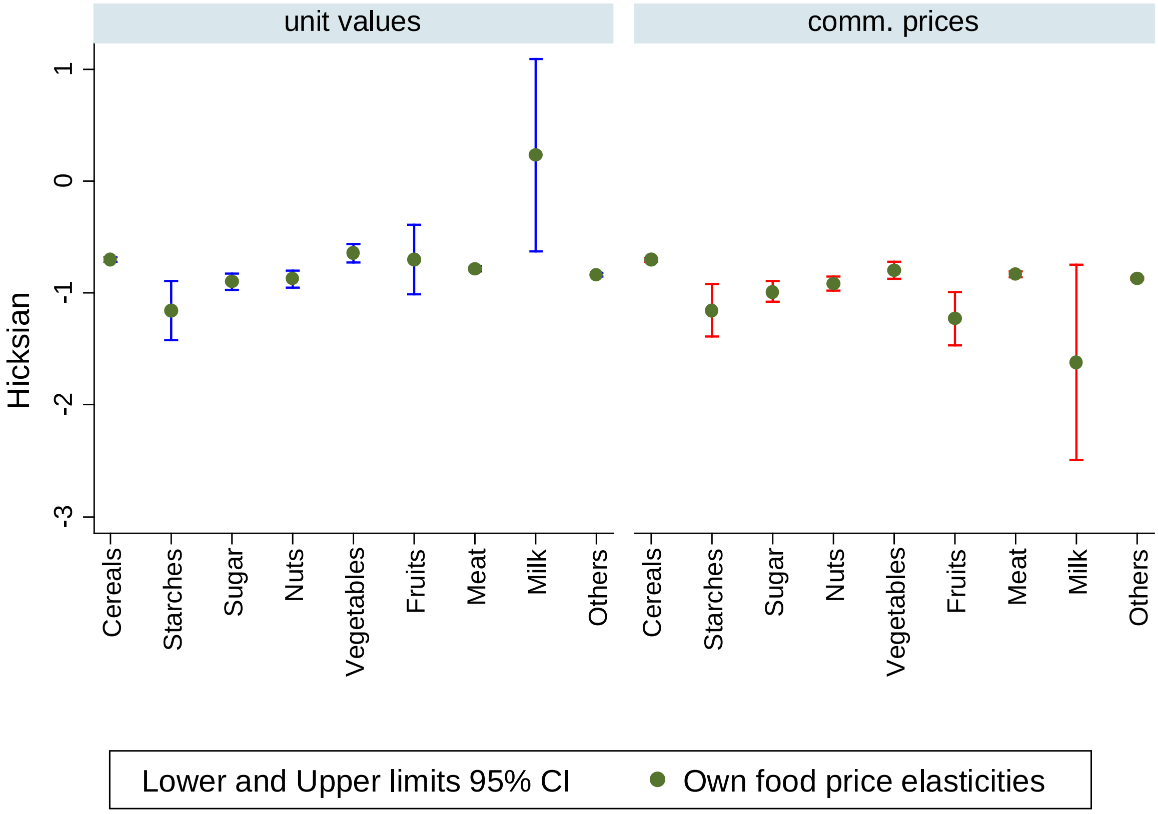
increase by 0.3%. It is important to note that some cross-price elasticities are relatively small and statistically not significant, indicating very limited substitution possibilities between pairs of food groups.

Figure 1: Distribution of Marshallian own-price elasticities



Source: author’s computation based on study data.

Figure 2: Distribution of Hicksian own-price elasticities



Source: author's computation based on study data.

4.3 Comparing price and expenditure elasticity estimates based on two price approaches

This section provides a comparison of expenditure and own-price elasticities by computing the absolute percentage deviations between two sets of expenditure and own-price elasticities. Table 4 presents this comparison for elasticity estimates computed at sample mean levels. From an inspection of the results presented in Table 4, three noticeable patterns emerge. First, the expenditure elasticity estimates based on the unit values are not different from those derived with community prices. Overall, and with the exception of fruits, vegetables, and edible oils, the percentage deviation between the two expenditure elasticity estimates is about or lower than 1%. However, for the fruits category, this difference is much more significant (8.6%).

Second, looking at own-price elasticities, the impact of the two price approaches leads to elasticity estimates that differ much more significantly than expenditure elasticities. This pattern is even more pronounced for Hicksian own-price elasticities than for Marshallian ones. In addition, with the exception of food groups cereals and starches, all the other Marshallian own-price elasticity estimates differ by more than 2% from each other, whether they are established using unit values or community prices. Third, this discrepancy is mostly pronounced for vegetables (12.2%), fruits (13.6%), and milk (20.7%). The most significant elasticity estimate differences occur with Hicksian own-price elasticities where percentage deviations are greater than 3.5% for seven food groups, whereas for cereals and starches the percentage deviation is quite insignificant, close to zero.

Table 4: Comparison of elasticity estimates using unit values and community prices

	Exp_uv	Exp_cp	Abs. change	Marsh_uv	Marsh_cp	Abs. change	Slusky_uv	Slusky_cp	Abs. change
Cereals	1.01	1.00	0.68	1.00	1.00	0.06	0.70	0.70	0.30
Starches	1.05	1.06	1.18	1.07	1.07	0.06	1.16	1.16	0.30
Sugar	0.96	0.95	0.86	0.98	1.04	5.32	0.90	0.99	8.41
Nuts	0.98	0.99	1.24	0.97	1.00	2.53	0.87	0.92	4.92
Vegetables	1.19	1.15	3.47	0.85	0.97	12.23	0.64	0.80	19.34
Fruits	0.66	0.73	8.58	0.92	1.06	13.57	0.70	1.23	43.20
Meat	0.96	0.97	1.28	0.97	1.00	3.15	0.79	0.83	5.18
Milk	1.24	1.24	0.39	0.86	1.08	20.69	0.23	1.62	114.13
Oil	0.89	0.92	2.73	0.97	1.01	3.70	0.84	0.87	3.94

Source: author's computation using data from the Tanzanian National Panel Survey, Wave 3 (see NBS 2012–13).

From the above patterns, it is useful to note that the discrepancies become more and more important for most food groups, with the exception of cereals and starches. Indeed although for the other seven food groups, the discrepancies between unit value and community price elasticity estimates are not so important for expenditure elasticities, they become increasingly significant when we shift from Marshallian own-price elasticities to their corresponding Hicksian counterparts. Finally, another point to consider is that the elasticity results are similar for cereals and starches. For these two food commodities, there are no differences between elasticity values computed with unit values and community prices. This might imply that these two food categories are consumed by almost everyone and their prices are less contaminated by measurement errors. At the other end of the spectrum, there are significant differences for the other food categories (fruits, vegetables, and milk), and this might explain why reported community prices from these commodities are more contaminated by measurement errors or quality effects.

5 Conclusion

Analysis of household demand for goods and services, particularly food in developing countries, is often constrained by the lack of reliable data on commodity prices. As a result, studies rely on unit values and community prices as proxies for commodity prices. Price estimates from these approaches, however, are plausibly measured with error, and hence may induce biases in the price and expenditure elasticities associated with these approaches.

In this study, I highlight the possible divergence in the elasticities from using these approaches to derive proxies for commodity prices by analysing the price and expenditure elasticities for food by households in Tanzania. I then compare the elasticities associated with unit values and community price approaches to ascertain the magnitude of the differences between the approaches. Estimations are done using an augmented QUAIDS model that corrects for censored distribution of expenditure shares.

Findings show that expenditure elasticity estimates for each food item are statistically significant at the 1% level in both price approaches. In addition, results from the two approaches (community prices and unit values) seem to have almost the same estimates for almost all food categories, with the exception of fruits. In most cases, expenditure elasticities are characterized by values close to one, an indication that the majority of Tanzanian households make up an important share of household food spending, suggesting that there is still a high proportion of poor households.

For price elasticities, results show that elasticity estimates based on community prices and unit values exhibit similar signs and magnitudes. Food price elasticities in the context of developing countries like Tanzania are very useful for food policy where a high proportion of household income is still spent on food. This study reveals that the estimated Marshallian own-price elasticities are all negative and thus consistent with the economic theory. The deviations from Hicksian own-price elasticities are relatively higher than that their corresponding Marshallian counterparts. Specifically, the deviations between own-price elasticities are remarkably higher, notably milk, fruits, and vegetables with 114.13%, 43.20%, 19.34% in Hicksian elasticities, and 20.69%, 13.57%, and 12.23% in Marshallian own-price elasticities, respectively. These differences in elasticities from using community prices and unit values may also result from the quality of community prices data. Relying on the assumption of the law of one price in local markets, prices of respective items within a given locality (from vendors and local integral leaders) are collected and referred to as community prices. However, if the technique used by enumerators to collect these type of data did not consider the probability of consumers to bargain, the community prices can be expected to be considerably higher than unit values that are reported by households after bargaining with the sellers. Finally, both unit values and community prices can lead to bias estimates if not taken carefully. Using unit value data, economists need to account for quality effects and zero purchase, whereas the issue of measurement error remains an unavoidable challenge in community prices data.

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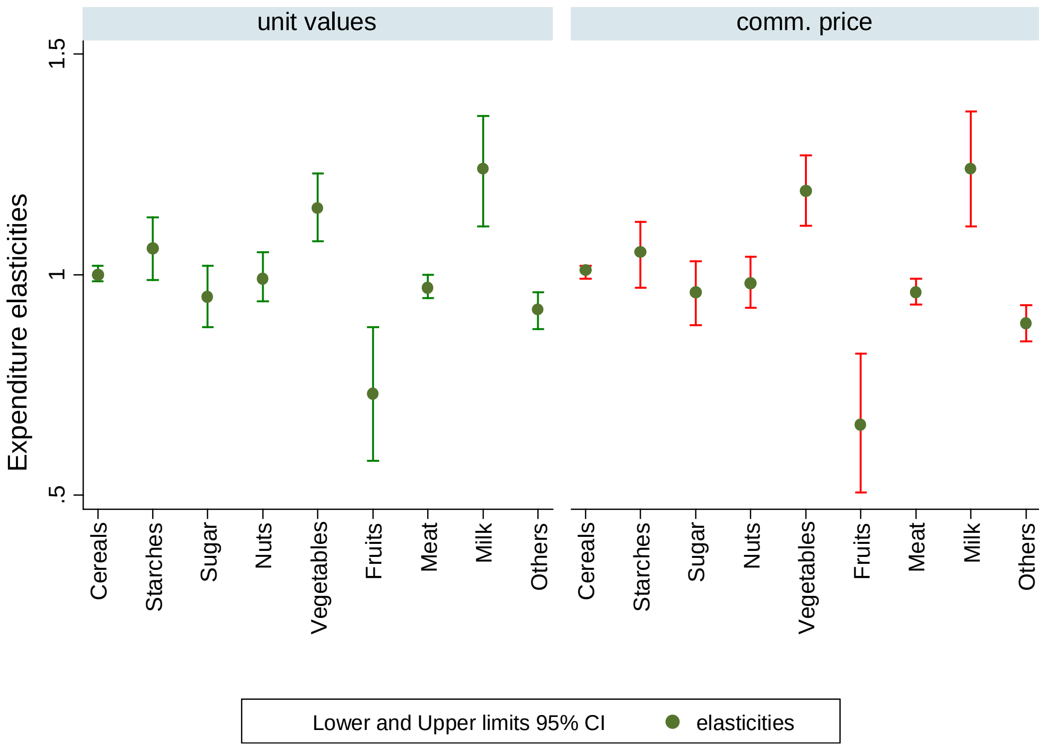
Appendix

Table A1: Means, coefficient of variation, and correlations between community prices and unit values

Food categories	Community prices		Unit values		Correlation between unit values and community prices
	Mean (SD)	Coefficient of variation	Mean (SD)	Coefficient of variation	
Cereals	0.983 (0.193)	0.196	0.829 (0.301)	0.363	0.208
Starches	0.994 (0.135)	0.136	0.266 (0.303)	1.138	−0.010
Sugar	1.007 (0.144)	0.143	0.558 (0.358)	0.642	0.153
Nuts	0.997 (0.181)	0.182	0.669 (0.331)	0.495	0.127
Vegetables	0.999 (0.369)	0.369	0.996 (0.385)	0.386	0.114
Fruits	0.987 (0.185)	0.188	0.386 (0.379)	0.981	0.090
Meat products	0.990 (0.179)	0.181	0.836 (0.378)	0.452	−0.013
Milk	0.997 (0.142)	0.142	0.205 (0.286)	1.393	0.219
Oil and spices	0.892 (0.431)	0.483	1.027 (0.350)	0.341	0.117

Source: author's computation using data from the Tanzanian National Panel Survey, Wave 3 (see NBS 2012–13).

Figure A1: Distribution of expenditure elasticities from unit values and community prices



Source: author's computation based on study data.

Table A2: QUAIDS estimates using community prices and unit values

	Community prices		Unit values	
	Coefficients	*P*-values	Coefficients	*P*-values
$\alpha 1$	0.381***	(0.036)	0.361***	(0.036)
$\alpha 2$	0.934***	(0.042)	0.953***	(0.042)
$\alpha 3$	−0.156***	(0.033)	−0.161***	(0.033)
$\alpha 4$	0.132***	(0.041)	0.150***	(0.041)
$\alpha 5$	−0.487***	(0.052)	−0.533***	(0.053)
$\alpha 6$	0.091**	(0.039)	0.119***	(0.040)
$\alpha 7$	0.363***	(0.040)	0.379***	(0.040)
$\alpha 8$	0.064	(0.163)	0.014	(0.162)
$\alpha 9$	0.054**	(0.023)	0.086***	(0.023)
$\beta 1$	0.000	(0.003)	0.003	(0.004)
$\beta 2$	0.007	(0.004)	0.005	(0.005)
$\beta 3$	−0.006	(0.004)	−0.005	(0.004)
$\beta 4$	−0.001	(0.004)	−0.003	(0.004)
$\beta 5$	0.027***	(0.007)	0.034***	(0.007)
$\beta 6$	−0.022***	(0.006)	−0.027***	(0.006)
$\beta 7$	−0.007*	(0.004)	−0.010**	(0.004)
$\beta 8$	0.027***	(0.008)	0.027***	(0.008)
$\beta 9$	−0.013***	(0.003)	−0.016***	(0.003)
$\gamma 11$	0.001	(0.002)	0.002	(0.002)
$\gamma 12$	−0.001	(0.001)	−0.001	(0.002)
$\gamma 13$	0.007***	(0.002)	0.002	(0.002)
$\gamma 14$	−0.004*	(0.002)	0.000	(0.002)
$\gamma 15$	0.002	(0.001)	0.001	(0.002)
$\gamma 16$	−0.000	(0.002)	−0.002	(0.003)
$\gamma 17$	−0.000	(0.002)	0.001	(0.002)
$\gamma 18$	−0.004*	(0.002)	−0.004	(0.003)
$\gamma 19$	−0.004***	(0.001)	−0.003**	(0.001)
$\gamma 22$	−0.002	(0.002)	−0.003	(0.003)
$\gamma 23$	−0.000	(0.002)	−0.009***	(0.002)
$\gamma 24$	0.002	(0.002)	0.007***	(0.002)
$\gamma 25$	0.001	(0.002)	0.002	(0.003)
$\gamma 26$	−0.001	(0.002)	0.004	(0.003)
$\gamma 27$	0.001	(0.001)	0.002	(0.002)
$\gamma 28$	−0.002	(0.002)	0.000	(0.003)
$\gamma 29$	−0.001	(0.001)	−0.000	(0.002)
$\gamma 33$	−0.004	(0.004)	0.003	(0.003)
$\gamma 34$	−0.000	(0.002)	−0.002	(0.002)
$\gamma 35$	0.002	(0.002)	0.008***	(0.002)
$\gamma 36$	−0.004**	(0.002)	0.005*	(0.003)
$\gamma 37$	−0.003	(0.002)	−0.002	(0.002)
$\gamma 38$	0.006**	(0.003)	−0.004	(0.003)
$\gamma 39$	−0.001	(0.001)	−0.004***	(0.001)
$\gamma 44$	0.000	(0.003)	0.004	(0.003)
$\gamma 45$	−0.002	(0.002)	−0.009***	(0.002)
$\gamma 46$	0.004**	(0.002)	−0.008***	(0.003)
$\gamma 47$	−0.001	(0.002)	−0.000	(0.002)
$\gamma 48$	−0.004	(0.003)	0.008**	(0.003)
$\gamma 49$	0.003**	(0.001)	0.006***	(0.002)

γ55	−0.008**	(0.004)	0.008	(0.005)
γ56	0.001	(0.002)	0.004	(0.003)
γ57	0.003*	(0.002)	−0.006**	(0.002)
γ58	−0.001	(0.003)	−0.011***	(0.004)
γ59	0.003*	(0.002)	−0.004*	(0.002)
γ66	−0.007**	(0.003)	0.003	(0.004)
γ67	0.003**	(0.001)	−0.000	(0.002)
γ68	0.010***	(0.003)	−0.006	(0.004)
γ69	−0.001	(0.001)	−0.002	(0.002)
γ77	−0.002	(0.002)	0.004**	(0.002)
γ78	−0.003	(0.002)	0.002	(0.002)
γ79	0.001	(0.001)	0.002	(0.001)
γ88	−0.007	(0.005)	0.017***	(0.005)
γ89	0.003*	(0.002)	0.008***	(0.002)
γ99	−0.002	(0.001)	0.003**	(0.001)
λ1	0.000	(0.000)	−0.000	(0.000)
λ2	−0.000	(0.000)	−0.000	(0.000)
λ3	0.000	(0.000)	0.000	(0.000)
λ4	0.000	(0.000)	0.000	(0.000)
λ5	−0.001***	(0.000)	−0.002***	(0.000)
λ6	0.001***	(0.000)	0.001***	(0.000)
λ7	0.000*	(0.000)	0.001**	(0.000)
λ8	−0.001***	(0.000)	−0.001***	(0.000)
λ9	0.001***	(0.000)	0.001***	(0.000)
η11	0.016***	(0.006)	0.017***	(0.006)
η12	0.008	(0.006)	0.011*	(0.006)
η13	0.004	(0.008)	0.004	(0.008)
η14	0.025***	(0.003)	0.024***	(0.003)
η15	−0.010**	(0.004)	−0.010**	(0.005)
η16	−0.103***	(0.014)	−0.103***	(0.014)
η17	−0.120***	(0.010)	−0.121***	(0.010)
η18	−0.154***	(0.013)	−0.156***	(0.013)
η19	−0.159***	(0.011)	−0.159***	(0.011)
η21	−0.034***	(0.009)	−0.033***	(0.009)
η22	−0.291***	(0.014)	−0.295***	(0.014)
η23	−0.019**	(0.009)	−0.013	(0.009)
η24	−0.099***	(0.005)	−0.100***	(0.005)
η25	−0.070***	(0.008)	−0.067***	(0.008)
η26	0.418***	(0.028)	0.437***	(0.028)
η27	0.084***	(0.012)	0.091***	(0.012)
η28	−0.059***	(0.014)	−0.060***	(0.014)
η29	0.166***	(0.021)	0.169***	(0.021)
η31	−0.008*	(0.005)	−0.009*	(0.005)
η32	0.059***	(0.007)	0.062***	(0.007)
η33	0.037***	(0.006)	0.036***	(0.006)
η34	0.030***	(0.004)	0.032***	(0.004)
η35	0.048***	(0.005)	0.049***	(0.005)
η36	0.071***	(0.010)	0.068***	(0.010)
η37	−0.009	(0.007)	−0.011	(0.007)
η38	−0.053***	(0.011)	−0.057***	(0.011)
η39	−0.023*	(0.013)	−0.032**	(0.013)
η41	−0.068***	(0.007)	−0.068***	(0.007)

η42	0.115***	(0.010)	0.110***	(0.010)
η43	−0.054***	(0.008)	−0.054***	(0.008)
η44	0.020***	(0.005)	0.017***	(0.005)
η45	0.046***	(0.007)	0.044***	(0.007)
η46	−0.016	(0.016)	−0.012	(0.016)
η47	−0.094***	(0.009)	−0.100***	(0.009)
η48	−0.105***	(0.013)	−0.106***	(0.013)
η49	−0.152***	(0.017)	−0.152***	(0.017)
η51	0.059***	(0.008)	0.061***	(0.008)
η52	0.099***	(0.014)	0.097***	(0.014)
η53	0.014*	(0.008)	0.017**	(0.008)
η54	0.050***	(0.006)	0.050***	(0.006)
η55	−0.003	(0.008)	−0.009	(0.008)
η56	−0.330***	(0.021)	−0.328***	(0.021)
η57	0.017*	(0.010)	0.024**	(0.010)
η58	0.140***	(0.012)	0.142***	(0.012)
η59	−0.174***	(0.019)	−0.166***	(0.019)
η61	0.036***	(0.006)	0.037***	(0.006)
η62	0.024**	(0.011)	0.021*	(0.011)
η63	0.014*	(0.007)	0.013*	(0.007)
η64	0.023***	(0.003)	0.024***	(0.003)
η65	0.029***	(0.006)	0.025***	(0.006)
η66	0.043**	(0.019)	0.039**	(0.019)
η67	0.060***	(0.013)	0.060***	(0.013)
η68	0.031***	(0.010)	0.035***	(0.010)
η69	0.095***	(0.012)	0.096***	(0.013)
η71	0.038***	(0.008)	0.038***	(0.008)
η72	−0.128***	(0.012)	−0.129***	(0.012)
η73	0.030***	(0.008)	0.030***	(0.008)
η74	−0.030***	(0.005)	−0.031***	(0.005)
η75	−0.043***	(0.007)	−0.041***	(0.007)
η76	0.105***	(0.015)	0.108***	(0.015)
η77	0.123***	(0.011)	0.127***	(0.011)
η78	0.164***	(0.013)	0.165***	(0.013)
η79	0.210***	(0.015)	0.213***	(0.015)
η81	−0.042***	(0.013)	−0.040***	(0.013)
η82	−0.036	(0.046)	−0.016	(0.046)
η83	−0.017***	(0.005)	−0.017***	(0.005)
η84	0.007	(0.007)	0.004	(0.007)
η85	0.010	(0.017)	0.010	(0.016)
η86	0.018	(0.038)	0.014	(0.038)
η87	−0.114**	(0.057)	−0.129**	(0.057)
η88	−0.065*	(0.033)	−0.068**	(0.033)
η89	−0.079***	(0.026)	−0.088***	(0.026)
η91	−0.002	(0.003)	−0.003	(0.003)
η92	−0.058***	(0.004)	−0.059***	(0.004)
η93	0.041***	(0.004)	0.039***	(0.004)
η94	−0.032***	(0.002)	−0.032***	(0.002)
η95	−0.013***	(0.003)	−0.012***	(0.003)
η96	0.075***	(0.007)	0.071***	(0.007)
η97	0.081***	(0.005)	0.077***	(0.005)
η98	0.077***	(0.007)	0.077***	(0.007)

$\eta 99$	0.209***	(0.006)	0.207***	(0.006)
$\phi 1$	0.162***	(0.024)	0.164***	(0.024)
$\phi 2$	−0.553***	(0.048)	−0.591***	(0.048)
$\phi 3$	0.029**	(0.013)	0.035***	(0.013)
$\phi 4$	0.251***	(0.022)	0.251***	(0.022)
$\phi 5$	1.670***	(0.063)	1.663***	(0.063)
$\phi 6$	−0.084***	(0.027)	−0.083***	(0.027)
$\phi 7$	−0.386***	(0.032)	−0.390***	(0.033)
$\phi 8$	0.020	(0.108)	0.046	(0.107)
$\phi 9$	0.271***	(0.006)	0.271***	(0.006)

Note: standard deviations are reported in parentheses. The letters α_j, β_j, γ_j, λ_j, η_j, ϕ_j, respectively, represent the parameter values estimated from Equation 12.

Source: author's computation using data from the Tanzanian National Panel Survey, Wave 3 (see NBS 2012–13).

Table A3: Marshallian food elasticities in Tanzanian household data using community prices

	Cereals	Starches	Sugar	Nuts	Vegetables	Fruits	Meat	Milk	Oil and spices
Cereals	−0.998***	−0.001	0.016***	−0.008*	0.004	−0.001	−0.001	−0.009	−0.009***
	(0.007)	(0.009)	(0.005)	(0.004)	(0.005)	(0.004)	(0.005)	(0.005)	(0.003)
Starches	−0.026	−1.063***	0.007	0.013	0.035*	−0.016	−0.009	−0.017	−0.016*
	(0.018)	(0.041)	(0.017)	(0.016)	(0.021)	(0.015)	(0.017)	(0.021)	(0.009)
Sugar	0.077***	0.045	−1.040***	0.005	−0.007	−0.030*	−0.007	0.055**	−0.003
	(0.022)	(0.040)	(0.031)	(0.021)	(0.019)	(0.017)	(0.021)	(0.028)	(0.010)
Nuts	−0.021	0.020	−0.002	−0.999***	−0.015	0.031**	−0.002	−0.026	0.021**
	(0.017)	(0.031)	(0.017)	(0.018)	(0.016)	(0.014)	(0.015)	(0.017)	(0.008)
Vegetables	−0.049***	−0.136***	0.035***	−0.031***	−0.968***	−0.011	−0.039**	−0.013	0.005
	(0.017)	(0.040)	(0.011)	(0.012)	(0.029)	(0.013)	(0.018)	(0.029)	(0.010)
Fruits	0.096***	0.235***	−0.093***	0.092***	−0.125***	−1.055***	0.137***	0.129**	0.002
	(0.037)	(0.080)	(0.029)	(0.029)	(0.042)	(0.033)	(0.034)	(0.055)	(0.016)
Meat	0.009	0.029*	−0.016*	0.001	−0.002	0.014***	−1.000***	−0.012	0.006
	(0.009)	(0.016)	(0.008)	(0.007)	(0.009)	(0.006)	(0.010)	(0.009)	(0.004)
Milk	−0.123***	−0.234***	0.090***	−0.066***	0.110***	0.057**	−0.116***	−1.073***	0.011
	(0.033)	(0.068)	(0.030)	(0.025)	(0.036)	(0.025)	(0.030)	(0.053)	(0.015)
Oil and spices	0.008	0.068***	−0.018**	0.031***	−0.025*	0.001	0.039***	0.024	−1.004***
	(0.011)	(0.021)	(0.009)	(0.009)	(0.015)	(0.009)	(0.011)	(0.018)	(0.007)

Note: standard errors are reported in parentheses. ***, **, and * represent statistical significance at 1%, 5%, and 10%, respectively.

Source: author’s computation using data from the Tanzanian National Panel Survey, Wave 3 (see NBS 2012–13).

Table A4: Hicksian food elasticities in Tanzanian household data using community prices

	Cereals	Starches	Sugar	Nuts	Vegetables	Fruits	Meat	Milk	Oil and spices
Cereals	−0.703***	0.038***	0.103***	0.070***	0.149***	0.020***	0.175***	0.001	0.136***
	(0.008)	(0.013)	(0.008)	(0.006)	(0.008)	(0.006)	(0.006)	(0.008)	(0.004)
Starches	0.264***	−1.139***	0.114*	0.134**	0.270***	−0.022	0.177***	−0.034	0.126***
	(0.037)	(0.117)	(0.055)	(0.047)	(0.075)	(0.044)	(0.039)	(0.062)	(0.029)
Sugar	0.385***	0.104*	−0.985***	0.083**	0.123***	−0.025	0.153***	0.095**	0.133***
	(0.027)	(0.057)	(0.047)	(0.031)	(0.035)	(0.025)	(0.027)	(0.041)	(0.016)
Nuts	0.251***	0.078	0.076*	−0.918***	0.115***	0.078***	0.171***	−0.035	0.186***
	(0.023)	(0.055)	(0.033)	(0.033)	(0.035)	(0.025)	(0.023)	(0.032)	(0.017)
Vegetables	0.288***	−0.120*	0.138***	0.059***	−0.790***	0.012	0.160***	0.001	0.183***
	(0.012)	(0.047)	(0.016)	(0.013)	(0.040)	(0.016)	(0.017)	(0.036)	(0.013)
Fruits	0.359***	0.874***	−0.347***	0.341***	−0.465**	−1.205***	0.508***	0.478**	0.008
	(0.086)	(0.286)	(0.120)	(0.103)	(0.189)	(0.122)	(0.090)	(0.205)	(0.070)
Meat	0.295***	0.082***	0.054***	0.081***	0.136***	0.042***	−0.830***	−0.004	0.153***
	(0.010)	(0.022)	(0.013)	(0.010)	(0.016)	(0.008)	(0.012)	(0.013)	(0.007)
Milk	−0.157	−1.817***	0.981***	−0.302	1.337***	0.533***	−0.438**	−1.566***	0.533***
	(0.183)	(0.540)	(0.264)	(0.197)	(0.358)	(0.208)	(0.184)	(0.438)	(0.140)
Oil and spices	0.276***	0.107***	0.055***	0.107***	0.106***	0.021**	0.201***	0.037**	−0.868***
	(0.008)	(0.021)	(0.010)	(0.009)	(0.017)	(0.009)	(0.009)	(0.018)	(0.007)

Note: standard errors are reported in parentheses. ***, **, and * represent statistical significance at 1%, 5%, and 10%, respectively.

Source: author’s computation using data from the Tanzanian National Panel Survey, Wave 3 (see NBS 2012–13).

Table A5: Marshallian food elasticities in Tanzanian household data using unit values

	Cereals	Starches	Sugar	Nuts	Vegetables	Fruits	Meat	Milk	Oil and spices
Cereals	−0.998***	−0.009	0.005	−0.001	0.006	−0.006	0.000	−0.009	−0.007**
	(0.007)	(0.010)	(0.005)	(0.005)	(0.006)	(0.006)	(0.005)	(0.007)	(0.003)
Starches	−0.024	−1.070***	−0.071***	0.048**	0.045*	0.029	0.001	−0.001	−0.006
	(0.025)	(0.047)	(0.020)	(0.021)	(0.025)	(0.020)	(0.021)	(0.026)	(0.015)
Sugar	0.030	−0.038	−0.985***	−0.011	0.043*	0.044**	−0.002	−0.030	−0.033***
	(0.021)	(0.041)	(0.022)	(0.020)	(0.024)	(0.021)	(0.019)	(0.027)	(0.011)
Nuts	0.008	0.060*	−0.017	−0.974***	−0.068***	−0.049***	0.005	0.051**	0.040***
	(0.018)	(0.034)	(0.016)	(0.022)	(0.020)	(0.017)	(0.016)	(0.021)	(0.011)
Vegetables	−0.064***	−0.168***	0.074***	−0.078***	−0.855***	0.001	−0.104***	−0.066*	−0.039***
	(0.020)	(0.043)	(0.015)	(0.016)	(0.031)	(0.017)	(0.020)	(0.035)	(0.012)
Fruits	0.092**	0.372***	0.003	−0.045	−0.128***	−0.917***	0.123***	−0.069	0.003
	(0.046)	(0.087)	(0.035)	(0.036)	(0.049)	(0.042)	(0.038)	(0.065)	(0.020)
Meat	0.018**	0.044***	−0.014**	0.004	−0.042***	0.003	−0.969***	0.008	0.010**
	(0.009)	(0.017)	(0.007)	(0.008)	(0.011)	(0.007)	(0.010)	(0.011)	(0.005)
Milk	−0.121***	−0.229***	0.007	0.031	0.030	−0.081***	−0.075**	−0.85***	0.053***
	(0.038)	(0.070)	(0.030)	(0.030)	(0.040)	(0.028)	(0.032)	(0.053)	(0.018)
Oil and spices	0.021*	0.102***	−0.046***	0.055***	−0.085***	−0.001	0.053***	0.057***	−0.968***
	(0.013)	(0.025)	(0.010)	(0.012)	(0.017)	(0.011)	(0.012)	(0.022)	(0.009)

Note: standard errors are reported in parentheses. ***, **, and * represent statistical significance at 1%, 5%, and 10%, respectively.

Source: author's computation using data from the Tanzanian National Panel Survey, Wave 3 (see NBS 2012–13).

Table A6: Hicksian food elasticities in Tanzania household data using unit values

	Cereals	Starches	Sugar	Nuts	Vegetables	Fruits	Meat	Milk	Oil and spices
Cereals	−0.701***	0.028*	0.088***	0.082***	0.154***	0.013	0.178***	0.001	0.140***
	(0.008)	(0.015)	(0.007)	(0.007)	(0.010)	(0.008)	(0.006)	(0.010)	(0.005)
Starches	0.261***	−1.159***	−0.117*	0.233***	0.296***	0.111*	0.202***	0.014	0.150***
	(0.056)	(0.135)	(0.063)	(0.062)	(0.086)	(0.060)	(0.053)	(0.077)	(0.046)
Sugar	0.319***	−0.019	−0.902***	0.060**	0.198***	0.086***	0.162***	−0.032	0.091***
	(0.024)	(0.059)	(0.035)	(0.029)	(0.041)	(0.031)	(0.023)	(0.039)	(0.018)
Nuts	0.298***	0.151**	0.046	−0.872***	0.013	−0.070**	0.179***	0.109***	0.219***
	(0.026)	(0.061)	(0.032)	(0.039)	(0.042)	(0.032)	(0.025)	(0.040)	(0.021)
Vegetables	0.283***	−0.157***	0.190***	0.004	−0.643***	0.028	0.089***	−0.065	0.135***
	(0.016)	(0.051)	(0.021)	(0.018)	(0.042)	(0.021)	(0.019)	(0.044)	(0.016)
Fruits	0.270**	1.372***	−0.008	−0.188	−0.512**	−0.69***	0.412***	−0.262	−0.026
	(0.124)	(0.312)	(0.144)	(0.126)	(0.212)	(0.157)	(0.110)	(0.240)	(0.087)
Meat	0.304***	0.103***	0.054***	0.083***	0.074***	0.025**	−0.78***	0.025	0.155***
	(0.010)	(0.024)	(0.011)	(0.011)	(0.018)	(0.011)	(0.012)	(0.016)	(0.008)
Milk	−0.121	−1.772***	0.295*	0.502**	0.678*	−0.603**	−0.091	0.229	0.879***
	(0.227)	(0.561)	(0.273)	(0.236)	(0.384)	(0.236)	(0.207)	(0.439)	(0.172)
Oil and spices	0.282***	0.140***	0.024**	0.129***	0.041**	0.018*	0.210***	0.071***	−0.835***
	(0.010)	(0.024)	(0.011)	(0.011)	(0.019)	(0.011)	(0.010)	(0.022)	(0.009)

Note: standard errors are reported in parentheses. ***, **, and * represent statistical significance at 1%, 5%, and 10%, respectively,

Source: author's computation using data from the Tanzanian National Panel Survey, Wave 3 (see NBS 2012–13).