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Food Demand Characteristics in Uganda: Estimation and Policy Relevance*

Ole Boysen[§]

Abstract

Uganda was highly successful in reducing poverty over the past two decades but made little progress towards household food security. This underlines the need for designing food security interventions customized for household-specific needs and behaviors. This study estimates Ugandan household demand behavior with a focus on food consumption paying particular attention to household-specific characteristics. The results show that preferences to increase calorie-dense staple consumption, likely associated with food energy deficiency, extend far beyond the percentage of rural Ugandans officially deemed poor. Price elasticities indicate that poor rural households are largely well positioned to compensate staple price increases by substitution as long as they are not already concentrated on the cheapest foods. This flexibility applies less to urban households. The estimated demand elasticities generally vary widely between rural and urban households and depend on expenditure levels. Household-specific characteristics have significant, sometimes pronounced, influences on demand, as do seasons and regions. The results reflect highly differentiated demand behavior which can be utilized to improve the design and evaluation of food security interventions.

1 Introduction

Although statistics suggest that Uganda's total food supply is generally sufficient to satisfy its population's dietary energy requirements, a large share of Ugandans cannot meet their

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daily calorie needs.[1] This indicates that there is a problem with the provision of enough food at the household level which is related to food distribution and access rather than to insufficient national availability. Using the well-known FAO definition of food security[2], several other food security indicators are at similarly serious levels.

The 2013 Comprehensive Food Security and Vulnerability Analysis (CFSVA) for Uganda (UBOS and WFP, 2013) using household survey data from 2009/10 assessed that 48% of the population consumes less than the required daily amount of calories which is similar across all regions. 39% of households have low dietary diversity as their diet consists of only four or less food groups out of seven (cereals, tubers; pulses, nuts; vegetables; fruits; milk; meat, fish, eggs; oil) a week, which varies from 22% in Kampala to 55% in the Western region. Rural and urban Ugandans depend for 71% and 59%, respectively, of their food energy on staples. For 48% of rural and 20% of urban households, staple dependency even exceeds 75%.

Generally, rural households are more likely to be food insecure, as reflected in most indicators except calorie deficiency. The CFSVA identifies several household groups amongst which food insecurity is particularly prevalent. These are the poor, female-headed households, and households primarily depending on subsistence farming. Geographically, the Northern region has the highest incidence of food insecurity indicated by several measures. The Western region has a particularly high prevalence of low dietary diversity.

According to the CFSVA, Ugandans consume a large variety of staples in which matooke, cassava and maize as well as sweet potatoes are the most important ones in terms of calories. Rice and wheat are increasingly consumed particularly by urban and higher income households. Cereals are eaten daily, vegetables six times, pulses four times, and fruits, meat, fish, and milk two times a week in an average Ugandan diet.

Furthermore, the study notes that, based on cross-sectional household survey data, monetary poverty is closely related to food insecurity in Uganda. The likelihood of being food energy deficient, having low dietary diversity, and depending on staples as the major food energy source increases with declining household income. However, this relationship between poverty and food insecurity does not seem to hold over the time dimension, at least not for all food security indicators: Instead of following Uganda's very successful reduction in poverty, shrinking the share of the population living below the national

[1] FAO (2015), data items: "Average dietary energy supply adequacy (%)" and "Prevalence of undernourishment (%)", 1992 to 2014.

[2] FAO (2014, p. 50) defines food security as follows: "A situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. Based on this definition, four food security dimensions can be identified: food availability, economic and physical access to food, food utilization and stability over time." This study centers on the access dimension of food security, and especially households' economic ability to access enough and adequate food under consideration of their preferences.

poverty line from 56% in 1992/93 (WDI, 2015) to 20% in 2012/13 (UBOS, 2014), the share undernourished rose slightly (from 23% in 1992 to 26% in 2014; FAO, 2015). That this happened over a period of sustained strong economic growth (3.4% growth in GDP per capita on average annually over the period 1992 to 2013; WDI, 2015) suggests that neither growth nor increasing income of the poorest will automatically improve food security.

Uganda's positive economic prospects of continued strong growth, foreseen exploitation of new oil deposits, and other far reaching developments, such as the establishment of the East African Community's monetary union and an array of regional and international trade and development agreements, offer good opportunities to enhance food security. But it will need interventions to ensure that enough of the gains are channeled towards and translated into food security for target household groups. Then again, these and other events, such as climate change, severe weather events, diseases, or food price shocks, might pose threats to any progress and require interventions, for example, safety nets, emergency food assistance, or the like, targeted to safeguard vulnerable households.

Ideally, interventions are targeted at specific household groups to improve particular indicators so that they are budget-efficient, i.e., as far as possible, leakages such as benefits to better-off households or substitution with non-food security improving consumption should be avoided, while also minimizing unintended side-effects, such as, for example, distortion of markets at the expense of producers or deterioration of other food security indicators. For example, Simler (2010) warns, in an assessment of the impacts of the 2008 global food price spike, that most Ugandans were able to adapt adequately and that a general policy to reduce food prices would have been rather harmful. Programs targeted at those threatened were needed instead. Good targeting of food security interventions crucially depends on good information, in particular, about the behavior of households and markets.

The present study contributes to the information required by providing evidence-based, detailed and differentiated estimates of household demand behavior for Uganda. The results help, for example, to identify the most cost-efficient intervention which leads to the desired food consumption changes for the target household type. Thus, they are particularly useful to analyze interventions or events with respect to their impacts on the food access and dietary diversity dimensions of food security but also to estimate short-term price responses to specific supply shocks, e.g., due to a drought or food aid delivery. The lack of such important data is underlined by two recent meta-analyses from Green et al. (2013, data supplement) and from Cornelsen et al. (2014) analyzing estimations of own-price and cross-price elasticities of food demand, respectively, which were published between 1990 and 2011/2012. For the 49 countries of Sub-Saharan African (SSA), they found 10 and six studies, respectively, covering only eight countries. Considering that the studies differ enormously in, for instance, data processing, model implementation, and documentation, there is large uncertainty confronted with little evidence for a diverse region.

This study adds to the evidence by supplying a complete set of up-to-date, theoretically consistent, representative microdata-based household demand elasticities for Uganda with a focus on food items. It estimates how household demand differs according to various characteristics covering the household's composition, market access and participation, the head of the household, and seasonal and regional indicators. This serves to differentiate the demand effects for specific household types more precisely thereby facilitating better demand predictions and targeting of interventions.

The elasticities are derived from the estimates of a two-stage budgeting demand system including one non-food and 14 food items based on a 2012/13 Ugandan household survey. In the first budgeting stage of the demand system, households allocate their consumption budget to food and non-food items. In the second budgeting stage, households allocate the food budget to 14 different item groups. The core of the model is a Quadratic Almost Ideal Demand System (QUAIDS; Banks et al., 1997) which allows for non-linear Engel curves and is enhanced to capture influences of the various household characteristics, and to account for zero consumption, i.e., censoring.

Because published demand analysis studies for developing countries are often poorly documented and hard to reproduce, a secondary goal of this paper is to provide a reproducible template for equivalent studies. Thus, we took particular care in documenting in detail each step of this research.

The remainder of this paper is organized as follows. Section 2 introduces the household survey data and describes the approximation of prices and the construction of consumption item aggregates. Section 3 formulates the demand system model and introduces the estimation procedure. Section 4 presents the results and Section 5 concludes by highlighting the implications of the study's findings for food security policy interventions in Uganda.

2 Data and data preparation

Household demand is typically thought of as being determined largely by prices and income and possibly also by other household characteristics. For the estimation of the present demand system, we extract the required data from the 2012/13 Ugandan National Household Survey (UNHS), a nationally representative survey of 6887 households. Its socio-economic module including a detailed expenditure section was administered for ten households in each of the 750 Enumeration Areas (EAs). The interviewing was distributed over the time period between June 2012 and June 2013 and over districts in such a way as to allow capturing seasonality factors. The expenditure section surveys consumption of 61 different food, beverage, and tobacco commodities during the past seven days. For each commodity, it lists the unit of measurement and the quantities and values for four different types of consumption, namely household consumption out of purchases, away from home consumption out of purchases, consumption out of home produce, and out of items received in-kind together with their market and / or farm-gate prices. The subsequent parts of the section survey expenditures on non-durable and frequently purchased services over the past 30 days, expenditures on semi-durable goods and durable goods and services over the past 365 days, and, irrelevant for this study, non-consumption expenditures. For details regarding the UNHS data, see UBOS (2014). The following describes the derivation of the data for the demand system estimation, more specifically, of the prices, income, and expenditure shares as well as additional household characteristics which might influence demand.

2.1 Prices and approximation

"Prices" as such are usually not available from household surveys. Instead, "unit values" are derived by dividing values by quantities. But generally, these quantities and values reported for an item include different varieties, such as flour and grain or different cuts of meat, and these compositions of varieties might vary across households. Consequently, differences in unit values might reflect differences in quality choice rather than differences in the price level for a homogenous good. To correct prices for quality differences and measurement error, we follow the approach in Deaton (1997). The basis for this approach is that households within a cluster are usually surveyed all within a period of a few days and thus should face essentially the same price without any time variation. Under this assumption, differences in unit values can be interpreted as resulting from quality and measurement error. Here, a cluster is defined as consisting of those households belonging to the same EA as these have been surveyed together over a short time span. This results in a total of 750 clusters.

The approach assumes that quality differences are correlated with the value of household assets[3] per capita y and household characteristic[4] variables Z. The coefficients γ_{is} of the unit dummies U_{is} represent factors which convert measurement unit s into the reference unit of item i. The UNHS uses a multitude of units for each item of which many are not directly convertible to kilograms or liters. The conversion between different varieties of a good is inspired by the approach in Capéau and Dercon (2006). The coefficients θ_{im}

[3]Based on household reported asset values, such as houses, furniture, and electronic and transport equipment, see UNHS questionnaire, Section 10, heading "Household Assets".

[4]These include household size, shares of household members of male gender, and the years of schooling and the logarithm of age of the head of the household.

of the variety dummies V_{im} convert different derivatives of a product, such as grain and flour from the same cereal, into a reference product where a constant extraction relationship is assumed. Unit and variety dummy variables are interacted (coefficient δ_{ism}) since the same unit has different meanings for different varieties. For example, a liter of maize cobs has a different conversion factor to kilograms than a liter of maize flour.

The following model is estimated by ordinary least squares (OLS) regressions to determine the conversion factors and the contribution of the other variables to the observed unit values p_i.

$$\begin{aligned}\ln p_i = \alpha_i + \beta_i \ln y + \sum_{l \in L} \kappa_{il} Z_l + \sum_{c \in C} \phi_{ic} D_c + \sum_{s \in S} \gamma_{is} U_{is} + \sum_{m \in M} \theta_{im} V_{im} \\ + \sum_{s \in S} \sum_{m \in M} \delta_{ism} U_{is} V_{im} + \epsilon_i\end{aligned} \tag{1}$$

where p_i: unit value (=value / quantity) of item i, y: value of household assets per capita, Z: vector of household characteristics, D_c: dummy for cluster c, U_{is}: dummy for unit s, and V_{im}: dummy for variety m and L, C, S, and M: sets of household characteristics, cluster, unit, and variety indices, respectively.

According to the above assumptions, unit values are corrected for quality bias by setting all household characteristic variables Z_l to the reference level, i.e., zero, and y to zero. Furthermore, the variables for unit of quantity and code of variety are set to zero to arrive at prices for the respective base unit and variety. Thus, the price is approximated using the equation

$$\ln p_{ic} = \hat{\alpha}_i + \hat{\phi}_{ic} D_c \qquad \forall i \in I, c \in C \tag{2}$$

Not all clusters report incidence of consumption for every item. Thus, where missing, the price has been approximated using the average of the $\hat{\phi}_{ic}$ coefficient estimates over the clusters of the district, or, if also missing, of the region.

The resulting approximated prices p_{ic} are then assigned to all households of the cluster c. These are the prices which are used in the demand system estimations.

2.2 Income and valuation of home consumption of own produce

Besides prices, the main explanatory variable for household demand is income. Household expenditure is commonly used as a measure of income because household-reported income is regarded as unreliable, in particular in poorer countries where self-employment is prevalent. Moreover, expenditure is seen as more constant since households are able to smooth temporary income fluctuations by (dis-)saving (Deaton, 1997: 29–32 and Deaton and Zaidi, 2002: 11–13).

A major issue in determining household expenditure is the valuation of self-produced consumption items, such as foods grown on the own farm or in the back garden, henceforth called *home consumption*. In the UNHS, home consumption items are valued at farm-gate prices. This poses a conceptual problem for the demand system estimation. On the one hand, a farm household can exchange such goods for money only at the farm-gate price. On the other hand, consuming these goods out of own production does not make the household worse off than a household which buys these same goods on the market. Assuming household consumption and production decisions are completely separable and market prices are the true opportunity costs of consumption out of home production, the quantity of home produce should be revalued at market prices. The revaluation of home consumption at market prices also assumes that the household would produce food items of a quality similar to what it buys. The market price in terms of reference unit and variety P_i' is taken either as, if available, the observed market unit value of the household and converted to the reference unit and variety using the equation $P_i' = P_{ism} \cdot \exp(-\hat{\gamma}_{is} - \hat{\theta}_{im} - \hat{\delta}_{ism})$ or the predicted price using Eq. (1). Observed home consumption quantities Q_{ism} of variety m and measured in unit s are converted to quantities of the reference variety and unit Q_i' using the equation $Q_i' = Q_{ism} \cdot \exp(\hat{\gamma}_{is} + \hat{\theta}_{im} + \hat{\delta}_{ism})$. The value of home consumption of item i is then calculated as $V_i' = P_i' Q_i'$.

Home consumption together with consumption out of purchases and consumption of items received in-kind (for free) yields (total) food expenditure. Total expenditure comprises food expenditures plus other consumption expenditure for non-durable, semi-durable, and durable goods and services. All expenditure values are standardized to annual values and denoted in thousands of Ugandan Shillings (UGX).

2.3 Construction of food group aggregates

An individual demand function for each food item would be ideal to depict demand behavior as precisely as possible. However, there are good reasons to reduce the very detailed classification of consumption items to more aggregate groups. First, not every household consumes all of the detailed items during the short seven-day recall period possibly resulting in insufficient sample sizes for econometric estimation of these items. Aggregation also reduces the accompanying econometric problem of handling zero expenditures. Second, the given computing capacity restricts the number of equations and thus items which can be solved within a single holistic demand system model. Third, aggregation attenuates the problem of multicollinearity between prices which is the more severe the more narrowly items are defined.

As described above, items which are close varieties of each other, such as corn grain and flour or fresh and dry cassava, have been aggregated in the previous step. Furthermore, all item purchases which in the survey have been recorded in a column "consumption out of purchases, away from home" have been aggregated to one value and allocated to the newly created item group "food consumed away from home" together with expenditures in restaurants. We suspect that this variable is dominated by quality and service components and thus is only loosely related to the basic item.

Unfortunately, no theoretically-founded approach is available to identify an ideal aggregation (see Abdulai and Aubert, 2004). Hence, we used the following considerations motivated by demand theory, statistics and practical reasons as guidance for the construction of food group aggregates. According to Edgerton (1997), a common assumption allowing to group items together to an aggregate for demand analysis is weak separability. This requires that a change in the price for the item group one causes the demand for each item in group two to react highly similar. Consequently, weak separability implies that items in a group must be close substitutes. An indicator for similar use and thus substitutability of items from a dietary point of view is the similarity of nutrient contents. Swindale and Bilinsky (2006) used this criterion to create a general classification of food items into 12 groups aimed at measuring dietary diversity. We adopt this classification but in addition aim to keep those food staples separate which are most important for the poor.

To review the most important food items in relation to total household expenditure, households have been grouped into quintiles according to their total per capita expenditure (PCE), separately for rural and urban subpopulations. The quintile household groups are denoted by Q_1 to Q_5 where Q_1 represents the poorest and Q_5 the richest 20% of the population.

In line with Engel's Law, the budget share Ugandans spend on food in total tends to decrease with increasing income (here measured by PCE).[5] The poorest and richest 20% of the rural population spend 59% and 46% of their income on food, respectively, while the corresponding figures for the urban population amount to 57% and 30%. The most important separate food item for the poorest quintile in rural areas is cassava with a share of 18% in the total food budget, followed by maize, sweet potatoes, sorghum, and beans with shares between 8% and 12%. For the bottom quintile in urban areas, sweet potatoes are most important with a budget share of 13%, followed by cassava, maize, beans, and matooke with shares between 5% and 11%. Together, these basic foods amount to 55% of all expenditures on food of the poorest rural and to 48% of the poorest urban quintile. Fish and meats each represent 4% of the food budget of rural bottom quintile and 4% and 7% of the urban. Turning to the richer quintiles, these consume smaller shares of the above basic foods, with the exception of matooke whose share is increased. Moreover, the shares consumed of animal products and food consumed away from home in rural, and beef,

[5]The detailed figures are shown in the Online Appendix, Table B.1.

milk, and especially food consumed away from home in urban areas, increase. Generally, food budgets of richer households are distributed more evenly across the various food items indicating more diverse diets.

Thus, beans, cassava, maize, matooke, sorghum, and sweet potatoes seem particularly important for the poor and should be kept as individual items. Nevertheless, with a view to the estimation of the demand system, neither should be the share of households with zero expenditures[6] in an item group too high nor should the average budget share among households consuming that item group be too small. A low budget share of the remaining items of the group "pulses/legumes/nuts" when keeping beans separate led to the inclusion of beans into that group. Irish potatoes, being the only member of the group "roots and tubers" in the survey besides cassava and sweet potatoes, is only consumed by a small share of households and is thus included with sweet potatoes. Eggs have been aggregated into the group "meat and eggs" instead of forming a separate group due to both a high share of zero expenditures and a very low share in the food budget. Similarly, sorghum has a high share of zero expenditures and has a substantial budget share only in the expenditure of the poorest and thus was included in "other cereals". The "other food" group includes all remaining food items such as food consumed away from home or in restaurants and alcoholic beverages.[7] Recall that total expenditure and budget shares include home consumption items revalued at market prices.

In detail, the resulting 15 item groups are *maize*, other cereals (henceforth called *cereals*; consists of bread, millet, rice, sorghum), *potatoes* (sweet potatoes, Irish potatoes), *cassava*, *matooke*, *vegetables* (onions, tomatoes, cabbages, dodo, other vegetables), *fruits* (passion fruits, sweet bananas, mangoes, oranges, other fruits), meat and eggs (henceforth *meat*; beef, pork, goat meat, chicken, other meat, eggs), *fish*, pulses/legumes/nuts (henceforth *legumes*; beans, groundnuts, peas, sim sim), milk, oils and fats (henceforth *fats*; cooking oil, ghee, margarine, butter, etc.), *sugar* (sugar, soda, other juice), other foods (henceforth *other*; salt, infant formula foods, coffee, tea, other drinks, beer, other alcoholic drinks, expenditure in restaurants on food, on soda, and on beer, other foods, food consumed away from home), and *non-food*.

To arrive at the aggregate budget shares for the food groups, the budget shares of the individual items i are summed up over the set of items I_s forming group s.[8] Prices are aggregated using the weighted geometric mean (Stone price index) over prices which are

[6]The term *zero expenditures* describes the fact that there is no observed expenditure for a particular item.

[7]Tobacco products are included in the non-food group.

[8]The set of aggregate groups S comprises {food, non-food} for the first stage demand system and all the 14 aggregated food items for the second stage.

normalized to one:

$$\ln p_{sc} = \sum_{i \in I_s} \bar{w}_i \ln \left(\frac{p_{ic}}{\bar{p}_i} \right) \tag{3}$$

where p: price, c: clusters, $\bar{w}_i$: average of the budget shares for item i over all clusters, and $\bar{p}_i$: mean of prices p_{ic} over all clusters.

Table 1 summarizes the resulting expenditure shares and approximated prices for the food group aggregates. The standard deviations for item prices indicate wide price dispersion which is a necessary condition for estimating demand systems from cross-sectional household data. These figures have been calculated as simple sample statistics without sample household weighting.

Table 1: Summary statistics of expenditure shares and prices for food item groups

	Rural						Urban					
	Exp. share				Price		Exp. share				Price	
Item	Mean	S.d.	Zeros	NMS	Mean	S.d.	Mean	S.d.	Zeros	NMS	Mean	S.d.
All food	0.58	0.16	0.00	0.53	0.88	0.19	0.44	0.17	0.00	0.22	1.06	0.17
Maize	0.09	0.14	0.40	0.53	0.98	0.20	0.06	0.10	0.34	0.23	1.04	0.18
Cereals	0.08	0.13	0.42	0.40	0.93	0.29	0.09	0.11	0.26	0.11	1.02	0.20
Potatoes	0.10	0.15	0.42	0.78	0.95	0.33	0.06	0.10	0.37	0.33	1.06	0.30
Cassava	0.12	0.16	0.33	0.68	0.96	0.27	0.04	0.08	0.53	0.37	1.10	0.29
Matooke	0.08	0.13	0.61	0.70	0.96	0.42	0.08	0.11	0.45	0.24	1.10	0.33
Vegetables	0.08	0.09	0.06	0.48	0.85	0.32	0.06	0.05	0.12	0.16	1.13	0.33
Fruits	0.03	0.06	0.50	0.72	0.80	0.42	0.04	0.07	0.39	0.28	1.15	0.54
Meat	0.09	0.13	0.53	0.28	0.95	0.17	0.11	0.12	0.39	0.12	1.06	0.15
Fish	0.04	0.08	0.63	0.10	0.95	0.40	0.04	0.06	0.55	0.04	1.13	0.41
Legumes	0.12	0.11	0.17	0.56	1.00	0.38	0.09	0.09	0.16	0.27	0.98	0.28
Milk	0.03	0.06	0.67	0.36	0.93	0.25	0.04	0.06	0.49	0.10	1.17	0.29
Fats	0.02	0.03	0.41	0.04	0.98	0.23	0.03	0.03	0.26	0.04	1.00	0.24
Sugar	0.03	0.05	0.45	0.07	1.00	0.12	0.06	0.06	0.19	0.05	0.97	0.11
Other	0.10	0.18	0.03	0.09	0.91	0.26	0.20	0.29	0.03	0.08	1.08	0.32

The "zeros" column shows the share of households which reported zero expenditures on the particular food group. Zero expenditure observations are included in the calculation of means and standard deviations. "NMS" shows the mean non-market share of expenditure of households consuming the item (see Section 2.4). Source: own computation based on processed UNHS data.

2.4 Household-specific characteristics

In cross-sectional data, as utilized in this study, household demand behavior differs not only according to expenditure levels and prices faced but also depending on various other characteristics, such as the household composition, characteristics of the household head, market dependency, seasons, and locations, see, e.g., Blundell and Stoker (2005), Browning (1992), or Deaton (1986). Table 2 summarizes total PCE and other indicators for household characteristics which are incorporated into the demand system model to analyze their influences on household demand and to improve the system's explanatory power.

PCEs are also given by quintile to indicate its distribution across the population. To account for effects due to differences in household composition, variables for the number of household members, the share of male members, the share of members in the age brackets below 5 and from 5 to 18 are included. These might affect the preferences for certain foods, e.g., the presence of children might increase households' preference for dairy products.

The head of the household is assumed to have the command over the household budget. The age of the head accounts for any cohort-related and the gender for gender-specific preferences. Binary variables for the educational attainment of the head are included as more educated people tend to more healthy diets and possibly higher quality foods. The indicator is one for the highest education level completed and zero otherwise.

Influences on consumption patterns arising from engagement in subsistence farming are captured by a binary variable which is one if a household consumes any food out of own production and zero otherwise. Subsistence farming households might, for instance, consume a larger share of particular high-value foods. The variable 'non-market share' represents the share of total food consumption which is not sourced from markets but instead is taken out of the own production or received as gift in-kind. This share amounts to 54% for rural and 24% for urban households. Households are likely less flexible in switching their consumption away from such items so that substantial effects on the budget shares are expected. Ownership of a motor vehicle or a mobile phone is included to capture their effects on market access and information.

As described in UBOS and WFP (2013), the largest part of Uganda has a bimodal climate with two rainy seasons. In between those seasons, the harvesting takes place over the periods from June to August and from November to January. In the model, the growing and harvesting season in which the household was surveyed is represented by binary variables which capture seasonal preference and availability effects. In addition, binary variables for the 10 Ugandan subregions, which are given in the UNHS and have been constructed according to common socio-demographic characteristics (UBOS, 2014), are used to indicate the geographical location of the household. They might capture differences in availability, e.g., due to poor transportation infrastructure, agricultural conditions, or regional preferences.

Not reported for the sake of brevity are the sets of binary variables for indicating the type of water source of the household (used in the probit model of the second budgeting stage) and for indicating the 112 Ugandan administrative districts (used in the first budgeting stage demand and the second budgeting stage probit model).

The rural and urban samples comprise 4,942 and 1,945 households representing 71.8% and 28.2% of the population, respectively.

Table 2: Summary of household characteristics used for the demand system estimations

	Rural		Urban		
Variable	Mean	S.d.	Mean	S.d.	Unit
Per capita expenditure					
all households	1,094.32	969.87	2,289.42	2,400.32	thousand UGX
quintile 1	380.07	100.01	584.49	165.57	thousand UGX
quintile 2	627.85	59.52	1,098.03	143.99	thousand UGX
quintile 3	855.80	73.66	1,638.72	191.51	thousand UGX
quintile 4	1,181.42	130.40	2,499.63	341.68	thousand UGX
quintile 5	2,424.50	1,450.01	5,611.67	3,562.51	thousand UGX
Household assets per capita	2,030.31	6,255.92	5,771.03	20,992.59	thousand UGX
Household members	5.29	2.78	4.42	2.73	Number
Share male	0.50	0.24	0.50	0.28	Fraction
Share of members aged					
below 5	0.17	0.18	0.15	0.17	Fraction
from 5 to 17	0.34	0.25	0.26	0.25	Fraction
Male household head	0.70		0.66		0/1
Age of household head	44.02	16.18	38.59	14.63	Years
Educational attainment of head					
completed none*	0.72		0.45		0/1
completed primary	0.18		0.22		0/1
completed secondary	0.08		0.22		0/1
completed tertiary	0.03		0.10		0/1
Subsistence farming	0.90		0.47		0/1
Non-market share	0.54	0.29	0.24	0.29	Fraction
Owns motor vehicle	0.07		0.13		0/1
Owns mobile phone	0.52		0.81		0/1
Season of survey					
Feb.–May	0.37		0.28		0/1
Jun.–Aug.*	0.28		0.25		0/1
Nov.–Jan.	0.18		0.30		0/1
Sep.–Oct.	0.18		0.16		0/1
Subregion					
Central I*	0.11		0.20		0/1
Central II	0.12		0.10		0/1
East Central	0.12		0.09		0/1
Eastern	0.18		0.09		0/1
Kampala			0.19		0/1
Mid-North	0.12		0.09		0/1
Mid-West	0.12		0.11		0/1
North-East	0.03		0.01		0/1
South-western	0.13		0.09		0/1
West-Nile	0.08		0.03		0/1

The * symbols mark the reference levels for categorical variables (which are omitted from the regression equations). The calculations utilize the sample household weights. Source: own computation based on processed UNHS data.

3 Demand system model

This study is based on a two-stage budgeting demand system whose first budgeting stage demand model is motivated by the non-availability of price data for non-food items and the second budgeting stage model focuses on food consumption. The separation of the budgeting process into two stages requires the assumption of weak separability between consumption decisions (see, e.g. Deaton, 1986). Households first decide how much of the budget to spend on food versus non-food and then in the second stage allocate the food budget to different food items.

3.1 First budgeting stage demand model

The demand model at the first budgeting stage is represented by a Working-Leser demand equation (4). For rural households, it is extended with a term quadratic in the natural logarithm of total PCE ($\ln(M)$) as discussed, e.g., in Deaton (1986).

$$w_F = \alpha'_F + \sum_{k \in K} \mu_{Fk} z_k + \gamma_F \ln(p_F) + \beta_F \ln(M) + \lambda_F \ln(M)^2 \tag{4}$$

where w_F: share of food expenditure in total household expenditure, z_k: level of household-specific characteristic $k \in K$ and p_F: aggregate food price index. To account for household characteristic-related heterogeneity, the demographic translation approach introduced by Pollak and Wales (1981) is implemented. This shows in Eq. (4) where the ordinary intercept α_F has been substituted by $\alpha'_F + \sum_{k \in K} \mu_{Fk} z_k$.

The equations for the expenditure η_F (5) and uncompensated (Marshallian) price ε_F (6) elasticities of food demand are derived from Eq. (4). The compensated (Hicksian) price elasticity ε_F^H (7) is derived from the above elasticities using the Slutsky equation.

$$\eta_F = 1 + \frac{\beta_F}{w_F} + \frac{2\lambda_F \ln(M)}{w_F} \tag{5}$$

$$\varepsilon_F = -1 + \frac{\gamma_F}{w_F} \tag{6}$$

$$\varepsilon_F^H = \varepsilon_F + \eta_F w_F \tag{7}$$

Assuming budget shares add up to one, the expenditure elasticity for non-food (NF) demand is calculated as $\eta_{NF} = \frac{1 - w_F \cdot \eta_F}{1 - w_F}$. For non-zero λ_F values, expenditure elasticities vary with the level of PCE.

3.2 Second budgeting stage demand system

The demand system at the second budgeting stage develops a more detailed picture of food demand and is based on the aggregation to 14 food item groups as described in Section 2.3.

3.2.1 The Quadratic Almost Ideal Demand System

The functional form chosen for the demand system estimation is the Quadratic Almost Ideal Demand System (QUAIDS) introduced by Banks et al. (1997). It extends the Almost Ideal Demand System (AIDS) of Deaton and Muellbauer (1980) to allow the representation of non-linear Engel curves.[9] The AIDS restricts budget shares to be linear in the natural logarithm of expenditure while the QUAIDS adds the flexibility of a term quadratic in the natural logarithm of expenditure. In consequence, the QUAIDS allows income elasticities to vary with the level of expenditure such that a good might be a luxury at one end of the income distribution but a necessity at the other. The QUAIDS in its budget share form is formally defined as follows.

$$w_i = \alpha_i + \sum_{j \in I} \gamma_{ij} \ln p_j + \beta_i \ln \left(\frac{M_F}{a(p)} \right) + \frac{\lambda_i}{b(p)} \left(\ln \left(\frac{M_F}{a(p)} \right) \right)^2 \quad \forall i \in I \tag{8}$$

where $a(p)$ is the translog price index defined by

$$\ln a(p) = \alpha_0 + \sum_{j \in I} \alpha_j \ln p_j + \frac{1}{2} \sum_{j \in I} \sum_{l \in I} \gamma_{jl} \ln p_j \ln p_l \tag{9}$$

and $b(p)$ the Cobb-Douglas price aggregator

$$b(p) = \prod_{j \in I} p_j^{\beta_j} \tag{10}$$

and w_i, p_i, and M_F denote budget share and price of food item group i, and total food PCE, respectively. I represents the set of food item groups. The AIDS arises as a special case when all $\lambda_i = 0$.

The demand system needs to satisfy additional constraints to ensure consistency with demand system theory. These are additivity of budget shares so that $\sum_{i \in I} w_i = 1$:

$$\sum_{i \in I} \alpha_i = 1, \qquad \sum_{i \in I} \beta_i = 0, \qquad \sum_{i \in I} \lambda_i = 0, \qquad \sum_{i \in I} \gamma_{ij} = 0 \quad \forall j \in I, \tag{11}$$

[9] For studies which discuss the advantages of rank 3, such as the QUAIDS, over rank 2 demand systems, see, for example, Decoster and Vermeulen (1998) and Cranfield et al. (2003).

homogeneity of degree zero in p:

$$\sum_{j \in I} \gamma_{ij} = 0 \quad \forall i \in I, \tag{12}$$

and Slutsky symmetry:

$$\gamma_{ij} = \gamma_{ji} \quad \forall i, j \in I. \tag{13}$$

To introduce household-specific characteristics to the system, again the demographic translation approach is implemented by substituting

$$\alpha_i = \alpha_i' + \sum_{k \in K} \mu_{ik} z_k \tag{14}$$

in Eqs. (8) and (9). This requires adding one constraint to the system of equations which forces the effect of each demand shifter to cancel out across items:

$$\sum_{i \in I} \mu_{ik} = 0 \quad \forall k \in K \tag{15}$$

3.2.2 Censoring

In household surveys, households frequently report zero expenditure for particular items. Households might report zero expenditure on an item during the recall period of the survey for a variety of reasons, such as non-preference, non-affordability, infrequent purchases or sufficient inventory, or non-availability. Table 1 documents incidence of such censoring by food groups.

Including all these expenditures as zero budget shares in the demand system regression would bias the estimates. Several approaches to solve this problem have been developed. The most popular was the one by Heien and Wessells (1990) until Shonkwiler and Yen (1999) (henceforth SY) showed the inconsistency of that estimator and proposed a consistent one. Although Tauchmann (2005) shows that the SY estimator is inefficient and alternatives have been suggested, e.g., in Dong et al. (2004), it remains popular in current applications due to the simplicity of its estimation. It is also applied in this study.

The SY approach assumes that a household decides on its consumption in a two-step process as in the model below.

$$d_i^* = \sum_{k \in K} \tau_{ik} z_k + \sum_{j \in I} \tau_{i,\ln(p_j)} \ln(p_j) + \tau_{i,\ln(M_F)} \ln(M_F) + \upsilon_i \tag{16}$$

$$w_i^* = \hat{\Phi}_i w_i + \theta_i \hat{\phi}_i + \psi_i \tag{17}$$

$$d_i^o = \begin{cases} 1 & \text{if } d_i^* > 0 \text{ and} \\ 0 & \text{if } d_i^* \leq 0 \end{cases} \tag{18}$$

$$w_i^o = d_i^o w_i^* \tag{19}$$

where i: food item index, z_k: variables for household-specific characteristics $k \in K$, d_i^o and w_i^o: observed dependent variables for the consumption versus non-consumption decision and budget shares respectively, and d_i^* and w_i^* their unobserved, latent counterparts, and υ_i and ψ_i: error terms.

In the first step, the household decides on consuming or not consuming each of the items and then it decides on the share of the budget to spend on each item in the second step, conditional on a positive consumption decision from the first step. The first step equations (16) are estimated using a probit model. The predictions of the d_i^* values from this model are then transformed to the cumulative distribution (CDF, $\hat{\Phi}_i = \Phi(\hat{d}_i^*)$) and probability density functions (PDF, $\hat{\phi}_i = \phi(\hat{d}_i^*)$) which are required for the second step, the estimation of the augmented QUAIDS model where the budget share Eq. (8) is extended by Eq. (17).

3.2.3 Elasticities

The elasticity formulas for the non-linear QUAIDS are derived from Eqs. (8, 9, and 10) and the equations for the augmentations by the demographic translation and SY censoring (14, 16, and 17). As noted by Saha et al. (1997), and elaborated for the SY approach by Lazaridis (2004), the derivation of elasticities from such two-step decision models, as employed here to account for censoring, also needs to consider the marginal effect from the probit model step if an independent variable common to both steps is involved. This applies also to the price and expenditure variables in our model. Consequently, the marginal effects from Eq. (16) are incorporated into the demand elasticity equations listed below. These elasticities are conditional on the first-stage estimations on total food demand and are denoted by the subscript $_{|F}$.

Conditional expenditure elasticities:

$$\eta_{i|F} = 1 + \frac{1}{w_i^*} \left[\Phi_i \left(\beta_i + \frac{2\lambda_i}{b(p)} \ln \left(\frac{M_F}{a(p)} \right) \right) + \tau_{i,\ln(M_F)} \phi_i (w_i - \theta_i d_i^*) \right] \tag{20}$$

Conditional uncompensated price elasticities:

$$\varepsilon_{ij|F} = -\delta_{ij} + \frac{1}{w_i^*}\left[\Phi_i\left[\gamma_{ij} - \left(\beta_i + \frac{2\lambda_i}{b(p)}\ln\left(\frac{M_F}{a(p)}\right)\right)\left(\alpha_j + \sum_{k\in I}\gamma_{jk}\ln p_k\right) - \frac{\lambda_i\beta_j}{b(p)}\left(\ln\left(\frac{M_F}{a(p)}\right)\right)^2\right] + \tau_{i,\ln(p_j)}\phi_i(w_i - \theta_i d_i^*)\right] \tag{21}$$

with Kronecker δ defined as $\delta_{ij} = \begin{cases} 1 & \text{if } i = j \text{ and} \\ 0 & \text{otherwise.} \end{cases}$

Conditional compensated price elasticities are again derived using the Slutsky equation:

$$\varepsilon^H_{ij|F} = \varepsilon_{ij|F} + \eta_{i|F} w_j^* \tag{22}$$

To calculate the unconditional demand elasticities from the results of both budgeting stages, we utilize the following equations taken from Carpentier and Guyomard (2001).

Unconditional expenditure elasticities:

$$\eta_i = \eta_{i|F}\eta_F \tag{23}$$

Unconditional uncompensated price elasticities:

$$\varepsilon_{ij} = \varepsilon_{ij|F} + w_j\left(\frac{1}{\eta_{j|F}} + \varepsilon_F\right) \times \eta_{i|F}\eta_{j|F} + w_F w_j \eta_F \eta_{i|F} \times (\eta_{j|F} - 1) \tag{24}$$

Unconditional compensated price elasticities:

$$\varepsilon^H_{ij} = \varepsilon^H_{ij|F} + w_{j|F}\varepsilon^H_F \eta_{i|F}\eta_{j|F} \tag{25}$$

3.3 Estimation

The first budgeting stage Working-Leser equation is estimated by OLS regressions. The second budgeting stage QUAIDS model is estimated as a system with one budget share equation per food item group. Two of the two-stage budgeting demand systems are estimated separately, one for rural and one for urban households.

The typical estimation of a non-censored QUAIDS is based on a system with one budget share equation omitted (to avoid singularity of the covariance matrix). The coefficients of the omitted equation are then recovered from the estimated coefficients of the other equations in conjunction with the additivity assumption of demand system theory.

As discussed extensively in Pudney (1989, p.155 ff.), such a formulation cannot be guaranteed to satisfy the additivity property universally if adopted for censored demand systems. Pudney argues that in case there is a natural choice for a residual item group, one option is to omit its demand equation and calculate the budget share as a residual. But he also notes that the estimation results will not be invariant to the choice of this item and that there exists a probability of the predicted expenditure for this item being negative for some individuals. An alternative option is suggested by Yen et al. (2002) who recommend that a SY-based demand system should be estimated on the full set of share equations thereby not enforcing the additivity property on the system. Here, we follow option two[10] and estimate the full set of share equations with only the homogeneity (12), symmetry (13), and canceling out for each shifter term (15) restrictions enforced.

Furthermore, only equations of food groups with at least 5% of censored observations are augmented with the probability terms in the described way. This excludes "other foods" but could also, with low probability, exclude "vegetables" in the rural regression when subsamples are selected for bootstrapping. The terms quadratic in expenditure improve the fit of the QUAIDS if Engel curves are non-linear in $\ln(M_F)$ but are redundant if they are linear (Banks et al., 1997). We determine for which items the corresponding λ coefficients are significantly different from zero at least at the 10% level in the results from a preliminary, non-bootstrapped QUAIDS regression and fix the remaining λ coefficients to zero. This way, the quadratic term is included for the items matooke, potatoes, meat, fish, other, vegetables, legumes, and sugar in the rural regressions and for matooke, cassava, meat, fish, milk, other, fats, fruits, and vegetables in the urban.

The estimation of the QUAIDS proceeds in two steps. In step one, the binary decision to consume is estimated by single equation probit models, one for each food item. The probit models include the same variables as the subsequent QUAIDS model but, in addition, sets of binary variables for the type of water source of the household and for the administrative district of the household to facilitate the identification of the model. The rationale for using the type of water source is that the presence of particular water sources or distribution systems indicates the level of infrastructural development of a location and/or that the location has access and is accessible to certain vehicles. Particular foods might be unavailable in some areas due to poor infrastructure and market access. The choice to consume particular foods might also be related to the local agricultural conditions as well as preferences due to local culture which is controlled for by the district indicator variables. The step two QUAIDS model equations instead include households' subregions as more parsimonious indicators to account for geographic location effects.

In step two, the predicted outcomes from the probit models are transformed by the CDF and PDF and the values included as independent variables in the censored QUAIDS model which is then estimated using the Iterative Linear Least Squares Estimator sug-

[10] Anecdotal evidence by Akbay et al. (2008) who compared elasticities resulting from the two options found them to be similar.

gested by Blundell and Robin (1999).[11] The basic mechanism is as follows. Initially, the QUAIDS is estimated by Seemingly Unrelated Regression[12] with $a(p)$ approximated by the Stone price index and $b(p)$ by setting all β_k to one. Using the resulting coefficients, $a(p)$ and $b(p)$ are re-calculated and the QUAIDS is re-estimated. This procedure is repeated until the iteration-to-iteration change of the coefficients is very small and the process has thus converged.

As discussed by Deaton and Muellbauer (1980, p. 316), the α_0 parameter is difficult to estimate but can be set to a fixed value a priori. We follow Banks et al. (1997, Footnote 8) and set α_0 to a value just below the minimum of $\ln(M_F)$ in the respective (rural or urban) subsample.

The standard errors of the coefficients of the two-step censored estimation procedures are biased as the estimation of the second budgeting stage depends on regressors which have been estimated with error. Murphy and Topel (1985) developed an analytical method to correct for this bias. In this study, however, the non-parametric bootstrap procedure is utilized to derive unbiased standard errors for the QUAIDS coefficients as well as the standard errors for the conditional second budgeting stage elasticities and the unconditional elasticities. The standard errors of the unconditional elasticities also depend on the error introduced by incorporating the aggregate food elasticities which have been estimated with error by the Working-Leser regression. Thus, the bootstrap procedure for the unconditional elasticities requires the estimation of both budgeting stages of the demand system for each replication.[13] The statistical significance of these coefficients and elasticities is established by calculating basic bootstrap confidence intervals (see Davison and Hinkley, 1997) for α-levels of 0.1, 0.05, and 0.01 from 1500 bootstrap replications.

4 Results

This section starts with discussing the estimation results of the two budgeting stages of the demand system before the analysis turns to the expenditure and price elasticities derived as well as to the effects of household-specific characteristics on demand.

[11] All computations were carried out using the software R (R Core Team, 2014). The procedure is implemented loosely building on and extending code from the `micEconAids` package (Henningsen, 2014). We checked the coefficients of this QUAIDS procedure without censoring and socio-demographic variables against those estimated with the STATA procedure suggested in Poi (2008) to validate the procedure. The estimated coefficients turned out to be very close to each other.

[12] This utilizes the R package `systemfit` (Henningsen and Hamann, 2007).

[13] The prices approximated in Section 2.1 are assumed to be exogenous to the demand model and thus are not re-estimated during the bootstrap procedure.

4.1 Demand system regressions

The estimated coefficients from the first budgeting stage Working-Leser model regression can be found in the Appendix (Table A.1). The adjusted R^2 values for the rural and urban regressions are 0.27 and 0.40, respectively, and are reasonable given the nature of cross-sectional data. The rural and urban regressions largely include the same independent variables with a few modifications: The coefficients for the season a household was surveyed in turned out not to be significantly different from zero in the rural regression and thus was removed. Likewise, the 'share of members aged below 5' was deleted from the urban regression.

Most coefficients are significant at the 1% level. The exceptions are the ones for the educational achievement of the household head in the urban regression of which only completion of the tertiary level appears significant.

Turning to the second budgeting stage QUAIDS estimations, first the specification of the QUAIDS model is tested against the alternative of the more restrictive AIDS model using a likelihood ratio test (see, e.g., Greene, 2012). The null hypotheses that the λ coefficients of all demand equations in the system are jointly zero is rejected for the rural and the urban model at the 1% significance level indicating that the QUAIDS specification is preferable in this case.[14] Thus, the quadratic terms of the QUAIDS specification significantly increase the explanatory power of the model.

The adjusted R^2 statistics are shown as measures of the goodness-of-fit for the individual QUAIDS budget share equations in the rural results range from 0.1 for fruits to 0.45 for matooke and in the urban results from 0 for fruits to 0.38 for cassava. Measures generalized to assess the overall fit to simultaneous equation systems are the ordinary R^2 and McElroy R^2 (see, e.g., Edgerton et al., 1996) which yield values of 0.29 and 0.22 for the rural and 0.27 and 0.16 for the urban system, respectively.

The complete sets of estimated coefficients from the rural and urban censored QUAIDS regressions are available in the Appendix (Tables A.2 and A.3). λ_i coefficients turned out to be significant at the 5% level for the six items matooke, potatoes, other, vegetables, legumes, and sugar in the rural regression and for the four items meat, fish, other, and fats (cassava and milk at 10% level) in the urban, suggesting non-linear Engel curves for these items in the respective regressions.

The ϕ_i coefficients of the censoring terms are significant at the 5% level for all food groups except for maize, matooke, fruits, and fats in both regressions, and also for fish and legumes in the rural, and instead also sugar in the urban regressions highlighting the necessity to adjust for zero expenditure observations.

[14] The χ^2 statistic for the rural and urban tests are 564.9 and 141.3, respectively, with 8 and 9 degrees of freedom, respectively, corresponding to p-values of near zero.

All coefficients have a statistically significant effect on at least one of the budget share equations in either estimation, most in several ones.

4.2 Elasticities

This section proceeds by first discussing the expenditure elasticities of food demand and then the price elasticities. All the elasticities here are unconditional, i.e., the aggregate food elasticities from the first budgeting stage and then the unconditional elasticities derived involving the estimation results from the demand models of both budgeting stages.

The elasticities have been evaluated at the sample household-weighted means for all independent variables over the particular subpopulation, i.e., differences between the urban and rural as well as across expenditure quintiles reflect differences in mean PCE and price levels but also differences in means of other household characteristics. As pointed out by Table 2, the PCE also differs strongly between rural and urban households where the latter have a much higher level as well as a larger (absolute and relative) gap between the bottom and top quintiles. The share of food in total expenditures follows the same pattern (Table B.2).

4.2.1 Expenditure elasticities

For the most part, the expenditure elasticities of total food (η_F, Table 3) and of individual food items' demand (η_i, Table 4) are significantly different from zero at the 5% level.[15] They are predominantly higher for rural than urban households but decrease strongly with increasing expenditure quintile within both subpopulations. Total food demand is generally inelastic (less than one) – in line with Engel's Law – with respect to total PCE but, interestingly, elastic (great than one) for the poorest two rural quintiles so that these expand their food share in total expenditure if their budget increases. This might be attributable to vital spending on non-food items, such as fuel, medicine or clothing, which has priority over nutrition needs. In fact, these poorest rural households also have very high expenditure elasticities for, amongst others, staple foods. For instance, if their expenditure budget increases by 1%, they raise their consumption of matooke by 2.9% and of potatoes by 1.8%. Thus, additional income is spend more than proportionally on calorie-dense staples, but also on animal proteins, fruits, fats and sugar (10 foods altogether) which hints that general income support might be rather effective to improve food security for rural bottom quintiles. In fact, demand for all starchy staples except cassava remains elastic up to including the third quintile. By contrast, the demand of the poorest urban quintile is expenditure elastic only for five products including matooke as the only staple. This likely

[15]Four of the six vegetable expenditure elasticities for rural households fail to reject the null hypothesis of being equal to zero.

reflects that the poorest urban quintile has an about 50% higher PCE level than the rural one which likely more than compensates for the higher prices the urbanites face. Cassava and legumes are generally less preferred sources of calories and protein, respectively, which also shows in the rather low elasticities compared to their alternatives.

Table 3: Distribution of food demand elasticities calculated from the Working-Leser regressions by quintiles

	Rural						Urban					
	Mean	Q_1	Q_2	Q_3	Q_4	Q_5	Mean	Q_1	Q_2	Q_3	Q_4	Q_5
η_F	0.94▼	1.07▼	1.01▼	0.97▼	0.93▼	0.81▼	0.81▼	0.93▼	0.89▼	0.84▼	0.79▼	0.65▼
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)
ε_F	-0.91▼	-0.92▼	-0.92▼	-0.92▼	-0.91▼	-0.90▼	-0.60▼	-0.70▼	-0.66▼	-0.61▼	-0.57▼	-0.44▼
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.09)	(0.07)	(0.07)	(0.08)	(0.09)	(0.12)
ε_F^H	-0.38▼	-0.28▼	-0.32▼	-0.35▼	-0.39▼	-0.51▼	-0.25▼	-0.17▼	-0.22▼	-0.24▼	-0.26▼	-0.24•
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.08)	(0.06)	(0.07)	(0.08)	(0.09)	(0.12)
η_{NF}	1.08▼	0.90▼	0.99▼	1.04▼	1.09▼	1.18▼	1.14▼	1.09▼	1.11▼	1.12▼	1.14▼	1.15▼
	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)	(0.02)	(0.01)	(0.01)	(0.01)

Symbols °, •, and ▼ indicate coefficients significantly different from zero at level 0.1, 0.05, and 0.01, respectively. Standard errors are given in parenthesis. Source: own computation.

Meat, fish, and milk remain expenditure elastic throughout all rural and the poorest three urban quintiles. The expenditure elasticity for fruits is many times higher than that for vegetables which is in accord with what a study on fruit and vegetable consumption in SSA by Ruel et al. (2005) found for Uganda. Fruits demand of the lower quintiles is indeed expenditure elastic. The pattern of expenditure elasticities for other food, including, amongst others, beverages, food consumed away from home and in restaurants, is an outlier because the elasticities first rise together with the expenditure level of the quintile but eventually fall. No (statistically significant) inferior items are found. The lowest elasticities found for the richest rural and urban quintiles are 0.13 for cassava and 0.16 for vegetables, respectively.

Ranking the food items according to their elasticity of the bottom quintile for rural and urban households, the pattern appears quite similar (differing by up to three places). Only other food is ranked five places higher for urban households and thus has a more prominent role when additional income is allocated.

4.2.2 Price elasticities

All own-price price elasticities of total food (ε_F) and all uncompensated own-price elasticities[16] of individual food items (ε_{ii}, Table 5) are negative and largely significant at the

[16]The compensated own-price elasticities are slightly smaller compared to the uncompensated but do not provide additional insights. They are presented in the Online Appendix.

Table 4: Distribution of unconditional expenditure elasticities for food items by quintiles

η_i	Rural						Urban					
	Mean	Q_1	Q_2	Q_3	Q_4	Q_5	Mean	Q_1	Q_2	Q_3	Q_4	Q_5
Maize	1.01▼	1.42▼	1.17▼	1.05▼	0.95▼	0.76▼	0.60▼	0.81▼	0.70▼	0.63▼	0.53▼	0.33▼
	(0.05)	(0.07)	(0.06)	(0.05)	(0.05)	(0.05)	(0.06)	(0.05)	(0.06)	(0.06)	(0.08)	(0.09)
Cereals	0.95▼	1.37▼	1.19▼	1.01▼	0.91▼	0.59▼	0.49▼	0.69▼	0.58▼	0.52▼	0.47▼	0.34▼
	(0.06)	(0.07)	(0.08)	(0.07)	(0.07)	(0.07)	(0.08)	(0.09)	(0.07)	(0.08)	(0.07)	(0.07)
Potatoes	1.03▼	1.83▼	1.28▼	1.08▼	0.93▼	0.63▼	0.67▼	0.85▼	0.77▼	0.70▼	0.60▼	0.40▼
	(0.06)	(0.23)	(0.09)	(0.06)	(0.05)	(0.04)	(0.07)	(0.06)	(0.06)	(0.07)	(0.09)	(0.10)
Cassava	0.55▼	0.86▼	0.71▼	0.59▼	0.48▼	0.13•	0.58▼	0.65▼	0.61▼	0.58▼	0.52▼	0.45•
	(0.04)	(0.05)	(0.04)	(0.04)	(0.05)	(0.06)	(0.08)	(0.09)	(0.07)	(0.08)	(0.12)	(0.28)
Matooke	1.53▼	2.86▼	1.95▼	1.62▼	1.28▼	0.91▼	0.95▼	1.73•	1.11▼	0.95▼	0.82▼	0.61▼
	(0.11)	(0.56)	(0.20)	(0.12)	(0.07)	(0.04)	(0.08)	(0.47)	(0.11)	(0.07)	(0.06)	(0.06)
Vegetables	0.05	0.37▼	0.19▼	0.05	-0.02	-0.24	0.33▼	0.52▼	0.42▼	0.34▼	0.29▼	0.16▼
	(0.08)	(0.08)	(0.07)	(0.09)	(0.15)	(0.72)	(0.04)	(0.07)	(0.05)	(0.04)	(0.04)	(0.06)
Fruits	1.24▼	1.71▼	1.43▼	1.28▼	1.16▼	0.95▼	0.97▼	1.16▼	1.06▼	1.00▼	0.92▼	0.77▼
	(0.07)	(0.15)	(0.09)	(0.07)	(0.06)	(0.05)	(0.11)	(0.31)	(0.18)	(0.12)	(0.09)	(0.07)
Meat	1.92▼	2.83▼	2.31▼	2.05▼	1.84▼	1.43▼	1.37▼	2.36▼	1.78▼	1.47▼	1.26▼	0.89▼
	(0.08)	(0.33)	(0.16)	(0.10)	(0.06)	(0.05)	(0.07)	(0.22)	(0.12)	(0.08)	(0.06)	(0.06)
Fish	1.62▼	2.22▼	1.88▼	1.69▼	1.60▼	1.23▼	1.25▼	1.75▼	1.49▼	1.30▼	1.19▼	0.90▼
	(0.12)	(0.30)	(0.18)	(0.13)	(0.12)	(0.08)	(0.08)	(0.29)	(0.12)	(0.08)	(0.08)	(0.08)
Legumes	0.66▼	0.80▼	0.70▼	0.67▼	0.67▼	0.61▼	0.51▼	0.70▼	0.62▼	0.53▼	0.46▼	0.26▼
	(0.03)	(0.06)	(0.04)	(0.04)	(0.03)	(0.04)	(0.05)	(0.03)	(0.04)	(0.07)	(0.04)	(0.08)
Milk	1.55▼	2.28▼	1.84▼	1.64▼	1.43▼	1.11▼	1.02▼	1.78▼	1.30▼	1.07▼	0.90▼	0.61▼
	(0.16)	(0.53)	(0.26)	(0.18)	(0.13)	(0.09)	(0.09)	(0.34)	(0.14)	(0.09)	(0.07)	(0.06)
Fats	0.77▼	1.18▼	0.93▼	0.82▼	0.71▼	0.52▼	0.53▼	0.87▼	0.70▼	0.58▼	0.48▼	0.27▼
	(0.05)	(0.06)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.16)	(0.10)	(0.06)	(0.05)	(0.06)
Sugar	1.17▼	1.97▼	1.41▼	1.24▼	1.08▼	0.81▼	0.63▼	0.88▼	0.71▼	0.65▼	0.61▼	0.48▼
	(0.06)	(0.15)	(0.09)	(0.06)	(0.05)	(0.05)	(0.06)	(0.08)	(0.06)	(0.06)	(0.06)	(0.05)
Other	1.08▼	0.87▼	0.98▼	1.10▼	1.16▼	1.05▼	1.32▼	1.18▼	1.53▼	1.38▼	1.24▼	0.97▼
	(0.10)	(0.12)	(0.14)	(0.13)	(0.11)	(0.09)	(0.09)	(0.24)	(0.16)	(0.10)	(0.08)	(0.07)

Symbols °, •, and ▼ indicate coefficients significantly different from zero at level 0.1, 0.05, and 0.01, respectively. Source: own computation.

5% level.

Total food demand is estimated to be price inelastic and more price responsive for rural than urban households. Demand of the bottom rural quintile for all items except cassava, vegetables, legumes, and fats is elastic whereas that of the bottom urban quintile is elastic only for five items. It might imply that rural households are in a better position to counteract price changes by substitution and thus are less vulnerable to price increases of these items. Demand gets predominantly less elastic with higher expenditure quintiles which likely can be attributed to the declining share of food in total expenditure as this reduces the need to adjust to price changes.

Of the starchy staples, only cassava is price inelastic among the poorest rural households, indicating that they have rather good substitutes available and can compensate price

Table 5: Distribution of unconditional uncompensated own-price elasticities for food items by quintiles

ε_{ii}	Rural						Urban					
	Mean	Q_1	Q_2	Q_3	Q_4	Q_5	Mean	Q_1	Q_2	Q_3	Q_4	Q_5
Maize	-1.45$^{\blacktriangledown}$	-1.61$^{\blacktriangledown}$	-1.49$^{\blacktriangledown}$	-1.45$^{\blacktriangledown}$	-1.44$^{\blacktriangledown}$	-1.45$^{\blacktriangledown}$	-1.51$^{\blacktriangledown}$	-1.41$^{\blacktriangledown}$	-1.39$^{\blacktriangledown}$	-1.48$^{\blacktriangledown}$	-1.60$^{\blacktriangledown}$	-1.86$^{\blacktriangledown}$
	(0.11)	(0.14)	(0.12)	(0.11)	(0.12)	(0.13)	(0.22)	(0.16)	(0.17)	(0.21)	(0.27)	(0.38)
Cereals	-1.82$^{\blacktriangledown}$	-1.92$^{\blacktriangledown}$	-2.01$^{\blacktriangledown}$	-1.90$^{\blacktriangledown}$	-1.89$^{\blacktriangledown}$	-1.71$^{\blacktriangledown}$	-0.95$^{\blacktriangledown}$	-0.94$^{\blacktriangledown}$	-0.95$^{\blacktriangledown}$	-0.95$^{\blacktriangledown}$	-0.95$^{\blacktriangledown}$	-0.95$^{\blacktriangledown}$
	(0.15)	(0.14)	(0.17)	(0.17)	(0.17)	(0.18)	(0.15)	(0.14)	(0.13)	(0.15)	(0.14)	(0.17)
Potatoes	-0.99$^{\blacktriangledown}$	-1.42$^{\blacktriangledown}$	-1.16$^{\blacktriangledown}$	-1.01$^{\blacktriangledown}$	-0.91$^{\blacktriangledown}$	-0.66$^{\blacktriangledown}$	-0.63$^{\blacktriangledown}$	-0.77$^{\blacktriangledown}$	-0.71$^{\blacktriangledown}$	-0.63$^{\blacktriangledown}$	-0.52$^{\blacktriangledown}$	-0.29
	(0.10)	(0.27)	(0.13)	(0.09)	(0.08)	(0.08)	(0.14)	(0.09)	(0.11)	(0.14)	(0.17)	(0.24)
Cassava	-0.57$^{\blacktriangledown}$	-0.73$^{\blacktriangledown}$	-0.67$^{\blacktriangledown}$	-0.59$^{\blacktriangledown}$	-0.52$^{\blacktriangledown}$	-0.22°	-0.60$^{\blacktriangledown}$	-0.77$^{\blacktriangledown}$	-0.69$^{\blacktriangledown}$	-0.61$^{\blacktriangledown}$	-0.45	0.03
	(0.09)	(0.09)	(0.07)	(0.08)	(0.09)	(0.14)	(0.22)	(0.11)	(0.17)	(0.22)	(0.35)	(0.71)
Matooke	-0.95$^{\blacktriangledown}$	-1.21$^{\bullet}$	-1.03$^{\blacktriangledown}$	-0.98$^{\blacktriangledown}$	-0.87$^{\blacktriangledown}$	-0.76$^{\blacktriangledown}$	-1.07$^{\blacktriangledown}$	-1.65	-1.12$^{\blacktriangledown}$	-1.02$^{\blacktriangledown}$	-0.93$^{\blacktriangledown}$	-0.88$^{\blacktriangledown}$
	(0.14)	(0.37)	(0.18)	(0.14)	(0.09)	(0.08)	(0.22)	(0.83)	(0.23)	(0.17)	(0.15)	(0.15)
Vegetables	-0.47$^{\blacktriangledown}$	-0.73$^{\blacktriangledown}$	-0.62$^{\blacktriangledown}$	-0.49$^{\blacktriangledown}$	-0.40$^{\blacktriangledown}$	0.05	-0.56$^{\blacktriangledown}$	-0.71$^{\blacktriangledown}$	-0.63$^{\blacktriangledown}$	-0.57$^{\blacktriangledown}$	-0.53$^{\blacktriangledown}$	-0.41$^{\bullet}$
	(0.09)	(0.04)	(0.06)	(0.09)	(0.14)	(0.80)	(0.12)	(0.08)	(0.10)	(0.12)	(0.13)	(0.18)
Fruits	-1.21$^{\blacktriangledown}$	-1.55$^{\blacktriangledown}$	-1.33$^{\blacktriangledown}$	-1.21$^{\blacktriangledown}$	-1.13$^{\blacktriangledown}$	-1.05$^{\blacktriangledown}$	-0.62$^{\blacktriangledown}$	-0.63$^{\blacktriangledown}$	-0.63$^{\blacktriangledown}$	-0.64$^{\blacktriangledown}$	-0.63$^{\blacktriangledown}$	-0.61$^{\blacktriangledown}$
	(0.08)	(0.16)	(0.10)	(0.08)	(0.07)	(0.07)	(0.10)	(0.14)	(0.11)	(0.09)	(0.08)	(0.08)
Meat	-1.50$^{\blacktriangledown}$	-1.86$^{\blacktriangledown}$	-1.59$^{\blacktriangledown}$	-1.51$^{\blacktriangledown}$	-1.48$^{\blacktriangledown}$	-1.39$^{\blacktriangledown}$	-0.37	-0.50	-0.48	-0.37	-0.28	-0.16
	(0.19)	(0.33)	(0.24)	(0.20)	(0.18)	(0.15)	(0.23)	(0.43)	(0.30)	(0.25)	(0.22)	(0.20)
Fish	-1.37$^{\blacktriangledown}$	-1.49$^{\blacktriangledown}$	-1.43$^{\blacktriangledown}$	-1.37$^{\blacktriangledown}$	-1.38$^{\blacktriangledown}$	-1.29$^{\blacktriangledown}$	-1.28$^{\blacktriangledown}$	-1.37$^{\blacktriangledown}$	-1.34$^{\blacktriangledown}$	-1.28$^{\blacktriangledown}$	-1.27$^{\blacktriangledown}$	-1.23$^{\blacktriangledown}$
	(0.13)	(0.19)	(0.15)	(0.13)	(0.14)	(0.11)	(0.13)	(0.17)	(0.14)	(0.13)	(0.13)	(0.13)
Legumes	-0.76$^{\blacktriangledown}$	-0.80$^{\blacktriangledown}$	-0.79$^{\blacktriangledown}$	-0.76$^{\blacktriangledown}$	-0.76$^{\blacktriangledown}$	-0.70$^{\blacktriangledown}$	-0.81$^{\blacktriangledown}$	-0.86$^{\blacktriangledown}$	-0.84$^{\blacktriangledown}$	-0.81$^{\blacktriangledown}$	-0.80$^{\blacktriangledown}$	-0.73$^{\blacktriangledown}$
	(0.05)	(0.04)	(0.04)	(0.05)	(0.05)	(0.06)	(0.11)	(0.06)	(0.09)	(0.16)	(0.11)	(0.23)
Milk	-1.42$^{\blacktriangledown}$	-1.87°	-1.57$^{\bullet}$	-1.46$^{\blacktriangledown}$	-1.32$^{\blacktriangledown}$	-1.17$^{\blacktriangledown}$	-1.28$^{\blacktriangledown}$	-1.57$^{\blacktriangledown}$	-1.36$^{\blacktriangledown}$	-1.27$^{\blacktriangledown}$	-1.21$^{\blacktriangledown}$	-1.15$^{\blacktriangledown}$
	(0.36)	(0.74)	(0.46)	(0.37)	(0.31)	(0.24)	(0.27)	(0.44)	(0.30)	(0.26)	(0.23)	(0.23)
Fats	-0.21	-0.43$^{\blacktriangledown}$	-0.30$^{\bullet}$	-0.22	-0.15	-0.03	-0.61$^{\blacktriangledown}$	-0.72$^{\blacktriangledown}$	-0.68$^{\blacktriangledown}$	-0.62$^{\blacktriangledown}$	-0.59$^{\blacktriangledown}$	-0.53$^{\blacktriangledown}$
	(0.15)	(0.13)	(0.14)	(0.14)	(0.16)	(0.17)	(0.15)	(0.13)	(0.14)	(0.14)	(0.15)	(0.17)
Sugar	-0.94$^{\blacktriangledown}$	-1.10$^{\blacktriangledown}$	-0.98$^{\blacktriangledown}$	-0.94$^{\blacktriangledown}$	-0.92$^{\blacktriangledown}$	-0.88$^{\blacktriangledown}$	-0.99$^{\blacktriangledown}$	-1.14$^{\blacktriangledown}$	-1.01$^{\blacktriangledown}$	-0.99$^{\blacktriangledown}$	-0.97$^{\blacktriangledown}$	-0.96$^{\blacktriangledown}$
	(0.17)	(0.24)	(0.19)	(0.18)	(0.17)	(0.15)	(0.23)	(0.27)	(0.22)	(0.22)	(0.22)	(0.23)
Other	-2.27$^{\blacktriangledown}$	-1.88$^{\blacktriangledown}$	-2.62$^{\blacktriangledown}$	-2.68$^{\blacktriangledown}$	-2.34$^{\blacktriangledown}$	-1.94$^{\blacktriangledown}$	-0.88$^{\blacktriangledown}$	-0.63	-0.79$^{\bullet}$	-0.87$^{\blacktriangledown}$	-0.88$^{\blacktriangledown}$	-0.82$^{\blacktriangledown}$
	(0.14)	(0.11)	(0.18)	(0.19)	(0.16)	(0.10)	(0.20)	(0.43)	(0.35)	(0.23)	(0.17)	(0.13)

Symbols $^{\circ}$, $^{\bullet}$, and $^{\blacktriangledown}$ indicate coefficients significantly different from zero at level 0.1, 0.05, and 0.01, respectively. Source: own computation.

changes well. The urban poorest appear more restricted as their demand is only price elastic for maize and matooke. This is supported by the compensated cross-price elasticities[17] (ε_{ij}^{H}, Tables 6 and 7) which exhibit more strong substitutional relationships between the staples for rural than for urban households. This matches the assessment of the FANTA-2 (2010) study, that Ugandan households have a variety of staple foods to choose from to counteract price increases. However, matooke appears to be a special case as the cross-price elasticities show no substitution between matooke and the other staples. Instead, when the price of matooke increases, it is mainly substituted by legumes. Cassava is often regarded as inferior to other staple options and correspondingly features the lowest price elasticity. It is cheap and when its price increases, there is no further alternative for cheap calories. The urban demand elasticities for potatoes exhibit comparable low elasticities.

Table 6: Unconditional compensated price elasticities of food item demand for a mean rural household

ε_{ij}^{H}	Maize	Cereals	Potatoes	Cassava	Matooke	Vegetables	Fruits	Meat	Fish	Legumes	Milk	Fats	Sugar	Other
Maize	-1.39▼	0.24▼	0.13•	0.49▼	0.10°	0.04	-0.01	-0.02	0.12•	-0.08°	0.18•	-0.09•	-0.16°	0.24▼
	(0.11)	(0.07)	(0.06)	(0.07)	(0.07)	(0.04)	(0.04)	(0.10)	(0.05)	(0.05)	(0.08)	(0.05)	(0.09)	(0.06)
Cereals	0.27°	-1.78▼	0.24▼	0.02	-0.05	-0.17•	0.24▼	-0.19	0.14°	0.12	-0.09	0.05	0.15	0.37▼
	(0.14)	(0.15)	(0.09)	(0.12)	(0.10)	(0.08)	(0.06)	(0.16)	(0.08)	(0.08)	(0.14)	(0.09)	(0.17)	(0.09)
Potatoes	0.13	0.24▼	-0.92▼	-0.01	0.03	0.14•	0.05	0.27▼	0.11°	-0.06	-0.03	-0.01	0.07	-0.03
	(0.10)	(0.07)	(0.09)	(0.08)	(0.07)	(0.06)	(0.04)	(0.12)	(0.06)	(0.06)	(0.10)	(0.08)	(0.14)	(0.07)
Cassava	0.37▼	-0.06	-0.19▼	-0.53▼	-0.07	0.08•	-0.03	-0.06	-0.15▼	0.15▼	0.13°	-0.07	-0.10	0.32▼
	(0.08)	(0.06)	(0.06)	(0.09)	(0.06)	(0.04)	(0.03)	(0.09)	(0.05)	(0.05)	(0.08)	(0.05)	(0.11)	(0.06)
Matooke	-0.04	0.21	-0.04	0.18	-0.90▼	-0.05	-0.18•	0.02	0.27•	0.33•	0.09	0.17	-0.04	-0.00
	(0.20)	(0.16)	(0.14)	(0.17)	(0.14)	(0.12)	(0.08)	(0.23)	(0.11)	(0.12)	(0.21)	(0.16)	(0.28)	(0.13)
Vegetables	0.03	-0.23▼	0.17°	-0.14°	0.01	-0.47▼	0.10•	0.18	0.11°	-0.04	0.05	0.04	0.23▼	0.12
	(0.10)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.04)	(0.12)	(0.06)	(0.06)	(0.08)	(0.04)	(0.07)	(0.09)
Fruits	0.10	0.15°	0.10	-0.13	-0.29▼	0.14•	-1.18▼	0.01	0.07	0.15•	0.09	-0.21•	-0.22	0.23•
	(0.12)	(0.09)	(0.09)	(0.11)	(0.09)	(0.07)	(0.08)	(0.14)	(0.07)	(0.07)	(0.12)	(0.08)	(0.18)	(0.09)
Meat	-0.05	-0.07	0.17•	0.01	-0.02	0.11•	-0.05	-1.40▼	0.11°	0.31▼	-0.19•	-0.03	-0.09	-0.15•
	(0.09)	(0.08)	(0.09)	(0.07)	(0.08)	(0.05)	(0.05)	(0.19)	(0.07)	(0.06)	(0.08)	(0.03)	(0.05)	(0.08)
Fish	0.13	-0.22	0.22	-0.59▼	-0.15	0.25°	-0.14	0.16	-1.34▼	0.33•	-0.08	0.27	-0.11	-0.00
	(0.21)	(0.16)	(0.15)	(0.19)	(0.14)	(0.12)	(0.09)	(0.23)	(0.13)	(0.13)	(0.21)	(0.17)	(0.31)	(0.11)
Legumes	-0.07	0.04	-0.04	0.07°	-0.07°	0.00	0.00	0.25▼	0.11▼	-0.71▼	0.03	0.04•	0.06°	0.10•
	(0.06)	(0.05)	(0.04)	(0.04)	(0.04)	(0.03)	(0.02)	(0.07)	(0.04)	(0.05)	(0.05)	(0.02)	(0.03)	(0.04)
Milk	-0.07	0.03	0.13	0.45°	0.12	0.13	-0.04	-0.71•	-0.32°	0.07	-1.40▼	0.22	0.45	0.29
	(0.29)	(0.20)	(0.17)	(0.24)	(0.18)	(0.15)	(0.11)	(0.30)	(0.15)	(0.16)	(0.36)	(0.20)	(0.37)	(0.17)
Fats	-0.18	-0.03	0.09	-0.12	-0.12	0.18•	-0.18▼	-0.04	0.11	0.09	0.19	-0.20	0.10	0.12
	(0.12)	(0.09)	(0.08)	(0.10)	(0.08)	(0.08)	(0.05)	(0.13)	(0.07)	(0.08)	(0.13)	(0.15)	(0.14)	(0.10)
Sugar	-0.24•	0.01	-0.03	0.16•	-0.05	0.29▼	-0.03	-0.20	0.04	0.16•	0.16	0.10°	-0.91▼	0.21▼
	(0.11)	(0.09)	(0.06)	(0.08)	(0.06)	(0.07)	(0.04)	(0.12)	(0.05)	(0.06)	(0.10)	(0.06)	(0.17)	(0.07)
Other	0.44▼	0.28•	-0.03	0.28•	0.11	-0.19▼	0.19▼	0.38•	-0.12	-0.00	-0.18°	-0.03	0.20▼	-2.23▼
	(0.14)	(0.11)	(0.12)	(0.12)	(0.12)	(0.07)	(0.06)	(0.16)	(0.09)	(0.08)	(0.13)	(0.05)	(0.07)	(0.14)

Symbols °, •, and ▼ indicate coefficients significantly different from zero at level 0.1, 0.05, and 0.01, respectively. Source: own computation.

Fruits have a much higher price elasticity – even greater than one – than vegetables among rural households. Fruits also tend to be more elastic than vegetables among urban households but the elasticities are much closer.

[17] Uncompensated cross-price elasticities are available in the Online Appendix.

Table 7: Unconditional compensated price elasticities of food item demand for a mean urban household

ε_{ij}^{H}	Maize	Cere-als	Pota-toes	Cas-sava	Mato-oke	Vege-tables	Fruits	Meat	Fish	Legu-mes	Milk	Fats	Sugar	Other
Maize	-1.48▼	0.37▼	0.13	0.37▼	-0.11	-0.02	-0.04	-0.03	0.13	0.11	0.20	0.09	-0.01	0.02
	(0.22)	(0.13)	(0.11)	(0.14)	(0.12)	(0.09)	(0.07)	(0.19)	(0.10)	(0.11)	(0.13)	(0.07)	(0.14)	(0.16)
Cereals	0.39▼	-0.93▼	-0.03	-0.02	0.10	-0.01	0.19▼	-0.23°	0.18•	0.16°	0.12	0.01	-0.04	0.30•
	(0.11)	(0.15)	(0.09)	(0.10)	(0.10)	(0.07)	(0.07)	(0.14)	(0.07)	(0.10)	(0.11)	(0.05)	(0.11)	(0.12)
Potatoes	0.32•	0.21°	-0.60▼	0.14	-0.15	-0.03	0.02	0.44•	0.26▼	-0.14	-0.13	0.05	0.14	0.10
	(0.16)	(0.14)	(0.14)	(0.12)	(0.13)	(0.10)	(0.08)	(0.19)	(0.09)	(0.11)	(0.13)	(0.10)	(0.20)	(0.15)
Cassava	0.43	0.02	0.05	-0.59•	0.08	-0.01	-0.07	0.10	-0.38•	0.15	-0.38°	-0.08	0.44	0.05
	(0.28)	(0.22)	(0.17)	(0.22)	(0.20)	(0.17)	(0.10)	(0.29)	(0.16)	(0.18)	(0.24)	(0.17)	(0.35)	(0.20)
Matooke	-0.44	0.34	0.19	0.09	-1.04▼	-0.14	0.15	0.04	-0.13	0.63▼	0.05	0.15	-0.55	0.06
	(0.27)	(0.23)	(0.16)	(0.16)	(0.22)	(0.17)	(0.11)	(0.28)	(0.14)	(0.17)	(0.22)	(0.15)	(0.37)	(0.20)
Vegetables	-0.06	-0.04	-0.06	-0.05	-0.00	-0.55▼	0.01	-0.01	0.21▼	0.08	0.09	-0.00	0.14	0.39▼
	(0.13)	(0.13)	(0.08)	(0.10)	(0.09)	(0.12)	(0.05)	(0.12)	(0.07)	(0.10)	(0.12)	(0.06)	(0.10)	(0.13)
Fruits	-0.09	0.31•	0.10	-0.11	-0.18	0.14	-0.60▼	-0.32°	-0.04	0.18	0.03	-0.22•	-0.10	0.22
	(0.17)	(0.17)	(0.13)	(0.13)	(0.14)	(0.10)	(0.10)	(0.18)	(0.10)	(0.12)	(0.15)	(0.10)	(0.20)	(0.17)
Meat	-0.02	-0.18°	0.12	-0.08	-0.27▼	0.05	-0.04	-0.29	0.21▼	0.21•	-0.11	-0.11°	-0.24	-0.32▼
	(0.13)	(0.11)	(0.09)	(0.10)	(0.10)	(0.07)	(0.06)	(0.23)	(0.08)	(0.09)	(0.10)	(0.06)	(0.13)	(0.13)
Fish	0.27•	0.17	0.17•	-0.17	-0.15	0.25▼	-0.07	0.30•	-1.25▼	0.37▼	-0.09	-0.07	-0.05	-0.32•
	(0.13)	(0.11)	(0.09)	(0.11)	(0.11)	(0.07)	(0.07)	(0.14)	(0.13)	(0.10)	(0.10)	(0.07)	(0.13)	(0.17)
Legumes	0.02	0.14	-0.23▼	0.02	0.10	0.09	-0.02	0.09	0.19▼	-0.79▼	0.22▼	-0.02	0.23▼	-0.02
	(0.11)	(0.10)	(0.07)	(0.09)	(0.08)	(0.06)	(0.05)	(0.11)	(0.07)	(0.11)	(0.09)	(0.03)	(0.19)	(0.11)
Milk	0.15	0.27	0.06	-0.06	-0.18	0.04	0.12	-0.43	-0.05	0.43•	-1.26▼	-0.02	-0.34	0.21
	(0.25)	(0.22)	(0.16)	(0.17)	(0.17)	(0.15)	(0.10)	(0.27)	(0.12)	(0.17)	(0.27)	(0.12)	(0.30)	(0.18)
Fats	0.42▼	0.05	-0.13	0.09	-0.09	0.03	0.00	-0.30°	-0.05	-0.04	0.03	-0.60▼	-0.16	0.58▼
	(0.17)	(0.13)	(0.11)	(0.12)	(0.11)	(0.11)	(0.06)	(0.16)	(0.08)	(0.12)	(0.11)	(0.15)	(0.17)	(0.14)
Sugar	0.07	-0.04	-0.12	0.10	-0.00	0.12	0.00	0.03	0.05	0.33▼	0.04	-0.00	-0.97▼	0.29▼
	(0.15)	(0.13)	(0.09)	(0.10)	(0.10)	(0.09)	(0.06)	(0.15)	(0.07)	(0.09)	(0.11)	(0.07)	(0.23)	(0.11)
Other	-0.05	0.12	-0.02	-0.03	0.24•	0.07	0.06	-0.21	-0.11	-0.07	0.05	0.10▼	0.07	-0.81▼
	(0.12)	(0.10)	(0.12)	(0.12)	(0.12)	(0.06)	(0.07)	(0.15)	(0.11)	(0.09)	(0.09)	(0.04)	(0.06)	(0.20)

Symbols °, •, and ▼ indicate coefficients significantly different from zero at level 0.1, 0.05, and 0.01, respectively. Source: own computation.

Meat[18], fish, and milk are price elastic across all expenditure quintiles and subpopulations, as expected for nutrient-rich, high-value foods. The cross-price elasticities show that meat, fish, and legumes are largely substitutable but milk is not included.

Fats are essential for cooking without good substitution options which is reflected in the rather inelastic demand. Sugar demand is elastic for the poorest and only slightly inelastic for the richest. Demand of rural households for other food displays the largest price elasticity and it even expands to -2.7 with increasing quintile before it drops again. This contrasts strongly with urban demand where it is always inelastic.

The cross-price elasticities reveal 15 rural and 6 urban significant net complementary relationships between foods which often are due to one food's consumption being contingent on another food in popular dishes. The complements most consistently emerging from these elasticities are the pairs cassava and fish as well as fruits and fats. These elasticities also show 42 rural (highest of 0.49 between maize and cassava) and 30 urban (highest of 0.63 between matooke and legumes) significant net substitutional relationships.

[18]Results for urban households are not significant.

4.2.3 Effects of household-specific characteristics on demand

To analyze the effects of individual household-specific characteristics on demand, we construct a "typical" household. Then, a single characteristic is modified by a meaningful unit increment, e.g., increasing the household size from six to seven members or switching the gender of the head, and the percentage change in the quantity demanded is simulated with the demand model.

The reference is a "typical" household for the respective subpopulation, constructed by setting a variable's level to the mode of the observations if it is categorical or binary data and to the median if it is ordinal or numeric data. The levels of all variables not shown in the tables below are set to their mean apart from those for total PCE and food PCE which have been set at their medians. In addition, the binary variables for the administrative districts are set to the means over the subset of households from the corresponding subregion only. Thus, the district variables are always set in accordance with the subregion. Note, the calculated effects are unconditional.

The household characteristics influence the budget allocation of the household by affecting all layers of the model, more specifically, the intercept of the first-stage Working-Leser model, the probability of consumption of the various foods which then enter the QUAIDS budget share equations in form of the PDF and CDF, and the QUAIDS intercepts which also enter the translog price index $a(p)$. Thus, the relationship between a household characteristic and a particular budget share is non-linear.

The results are presented in Tables 8 and 9. The budget shares in the top row illustrate the weight of the simulated percentage changes with respect to total budget allocation. Note that non-food accounts for about half of the expenditures in either household and thus even small changes weigh heavily. Many characteristics significantly influence the demand and many of these effects appear similarly for the rural and urban households. We explore some examples below.

Starting with the household composition, an increase of the size of the typical rural household from seven to eight members causes, in particular, cutting back on other food and non-food and increasing spending on most other food items. A typical urban household also cuts back on other food but has a more differentiated pattern of decreases and increases in food item demands. The share of males in a household being higher in the equivalent of one person manifests itself in a large increase of other food and also non-food consumption at the expense of most remaining food items. Similarly, a higher share of children below five is reflected in reduced non-food and other food and increased, in particular, animal product consumption. By contrast, the rural and urban typical households seem to have rather different strategies to cope with an increased share of children in the age bracket from five to 17.

Table 8: Percentage changes in quantities demanded from modifying characteristics of a typical rural household

	Reference level	New level	Maize	Cereals	Pota-toes	Cas-sava	Mato-oke	Vege-tables	Fruits	Meat	Fish	Legu-mes	Milk	Fats	Sugar	Other	Non-food
Budget share			4.99	3.27	4.08	11.86	0.93	5.71	0.70	4.11	0.90	5.28	1.52	1.46	2.54	3.34	49.32
Household members	7	8	4.68▼	1.00	3.22▼	2.74▼	9.65▼	-6.11▼	5.66▼	6.11▼	10.69▼	-0.46	9.78▼	-0.82	0.66°	-18.70▼	-0.72▼
Share male	3/7	4/7	-3.84▼	-4.64▼	-2.88	-3.56▼	-7.71•	0.11▼	4.79▼	-1.96▼	-5.67•	-4.01▼	-4.90•	-2.05▼	-1.56▼	21.04▼	1.42▼
Share of members aged																	
below 5	1/7	2/7	7.55▼	1.69	1.88	0.26	8.98	-1.22▼	17.87▼	12.07▼	25.79▼	2.23•	11.39°	5.80▼	6.72▼	-8.58▼	-3.38▼
from 5 to 17	2/7	3/7	5.43▼	2.84	5.32°	-1.80°	1.99	1.04▼	12.17▼	5.41▼	7.81°	0.55	-4.88	0.97	2.42▼	-2.99▼	-1.53▼
Male household head	1	0	10.28▼	12.77•	-3.07	0.32	12.46	-3.20▼	13.69•	-17.79▼	-12.89	1.61	2.14	12.51▼	10.57▼	-61.16▼	2.93°
Age of household head	42	47	-0.90•	2.52▼	-1.08	0.38	2.50	0.69▼	-5.30▼	-1.49▼	-3.83▼	1.09▼	-0.15	-1.84▼	1.55▼	-2.48▼	0.09
Educational attainment	none																
of head		primary	7.50•	9.02	-8.33	-8.70▼	33.24	-9.83▼	0.49	1.04	13.12	-8.48▼	16.93	6.28•	11.53▼	-3.26▼	1.43
		secondary	-2.40	4.44	-14.22°	-16.56▼	13.71	-7.97▼	16.67	-2.60	-15.83	-0.19	14.03	9.91•	16.28▼	-8.81▼	5.09
		tertiary	3.40	-19.64•	-3.51	-19.24▼	44.93	-19.92▼	65.61•	-4.01	-0.87	-5.48	28.58	-1.54	-2.78	-49.54▼	9.99°
Subsistence farming	1	0	-32.45▼	-17.22°	-8.42	-45.31▼	-86.15▼	1.53▼	-95.18▼	-51.00▼	-61.08▼	-23.48▼	-54.82▼	-43.61▼	-37.95▼	308.10▼	10.78▼
Non-market share	0.59	0.69	-5.06▼	-1.60	15.80▼	0.25	-0.30	4.24▼	3.43▼	-12.17▼	-19.52▼	5.53▼	-4.29•	-9.52▼	-11.19▼	0.91▼	0.42
Non-market share	0.59	0	-5.05	3.44	-67.69▼	-43.73▼	-90.18▼	-21.93▼	-107.94▼	10.97▼	41.30°	-46.26▼	-36.58▼	8.84•	27.43▼	283.08▼	5.75▼
Owns motor vehicle	0	1	-21.88▼	-1.35	-34.16▼	-8.79•	29.03	-9.27▼	3.01	-13.40▼	-8.62	-14.98▼	-10.34	-0.00	1.61	23.41▼	9.25▼
Owns mobile phone	0	1	-15.14▼	-20.10▼	-27.42▼	-12.02▼	0.36	-7.84▼	5.41▼	-10.82▼	-0.96	-14.37▼	16.17▼	13.24▼	13.68▼	-6.00▼	10.11▼
Season of survey	Feb.–May																
		Jun.–Aug.	122.31▼	2.84	-7.66	-5.42	-57.81▼	-9.46▼	-5.81	-0.94	-25.18▼	35.01▼	-6.70	12.60▼	4.09°	-38.49▼	-9.33▼
		Sep.–Oct.	117.89▼	-11.27°	19.95	-24.23▼	-48.18▼	-11.82▼	-47.53▼	7.32▼	58.09•	28.69▼	1.89	0.75	13.09▼	-36.40▼	-7.07▼
		Nov.–Jan.	77.72▼	-9.28	76.81▼	-46.03▼	-32.87•	-13.43▼	-24.24▼	5.81▼	-9.09	22.09▼	-23.64•	-0.22	3.71	-8.13▼	-1.59
Subregion	Eastern																
		Mid-North	-49.61▼	51.49°	-38.19▼	-10.10	-96.82▼	-29.96▼	200.16•	5.28•	173.68°	81.41▼	-62.86▼	37.65▼	-34.40▼	1.98	-0.24
		North-East	109.23▼	352.69▼	-133.20▼	-86.00▼	-67.84▼	45.73▼	87.22°	35.43▼	-86.85▼	-26.17▼	100.32	-9.48	-48.91▼	104.40▼	-13.92▼
		Central I	-71.21▼	-8.46	29.84	-39.34▼	1028.62	-36.75▼	359.92•	-1.25	220.03•	-14.18▼	33.32	-29.63▼	3.44	15.07▼	-9.30▼
		Central II	-60.09▼	-19.20°	67.66	-19.77▼	628.31	-41.09▼	365.87•	-3.92•	234.09•	2.12	62.20	-17.20▼	2.61	-29.48▼	-9.55▼
		East Central	1.44	-54.56▼	210.37•	-18.40•	306.14	-26.26▼	157.20•	-26.63▼	158.90°	-11.63	61.73	6.15	22.30▼	2.94	-17.36▼
		Mid-West	-66.42▼	4.58	69.91	8.00°	822.38	-22.64▼	162.89•	20.70▼	80.51	64.11▼	-40.52▼	-32.94▼	-48.59▼	-34.51▼	-19.51▼
		West-Nile	-73.25▼	-3.62	11.87	84.79▼	-83.14▼	-20.59▼	128.27•	39.73▼	305.24•	55.59▼	-85.29▼	-48.31▼	-23.26▼	26.18▼	-22.95▼
		South-western	-63.55▼	13.25	185.71•	-74.95▼	1779.15	-28.91▼	195.92•	-26.86▼	-78.90▼	32.46▼	24.98	-68.38▼	-63.05▼	20.53▼	-21.50▼

Symbols °, •, and ▼ indicate coefficients significantly different from zero at level 0.1, 0.05, and 0.01, respectively. The top row shows the typical household's budget shares. The total PCE and food PCE for this household are 853,738 UGX and 472,057 UGX, respectively. Source: own computation.

Table 9: Percentage changes in quantities demanded from modifying characteristics of a typical urban household

	Reference level	New level	Maize	Cereals	Pota-toes	Cas-sava	Mato-oke	Vege-tables	Fruits	Meat	Fish	Legu-mes	Milk	Fats	Sugar	Other	Non-food
Budget share			2.38	4.22	2.68	1.79	6.29	2.47	2.91	5.54	3.02	4.03	2.49	1.56	3.31	2.49	54.82
Household members	6	7	4.87▼	-1.92▼	-1.84•	11.95▼	1.00•	-6.76▼	4.11▼	7.35▼	8.31▼	-0.50	0.26	-2.45▼	-2.83▼	-33.48▼	0.19
Share male	3/6	4/6	-3.94▼	-1.67°	8.29▼	-11.21▼	-11.95▼	-0.14▼	-6.77▼	-5.86▼	-14.69▼	-4.54▼	-4.14▼	-4.29▼	-1.74▼	67.22▼	1.10▼
Share of members aged																	
below 5	1/6	2/6	8.35▼	-3.66▼	3.37	-0.80	5.97▼	-1.13▼	3.33▼	4.08▼	13.82▼	-1.35▼	14.17▼	0.78•	-1.89▼	-39.54▼	-0.86▼
from 5 to 17	2/6	3/6	0.87	0.55	4.92•	-7.69°	-1.90•	-0.73	-4.83▼	-8.98▼	-2.64▼	-5.96▼	-0.06	-6.12▼	-0.04	7.03▼	1.79•
Male household head	1	0	4.92•	-15.83▼	-5.25	-7.82	-12.22▼	-4.88•	-0.58	-3.89	-14.66▼	-6.88▼	-4.00	-5.86▼	-7.75▼	-18.04▼	6.51▼
Age of household head	39	44	4.33▼	0.15	2.60▼	3.00	2.75▼	0.91▼	-0.85•	-2.30▼	-1.88▼	4.59▼	1.15•	-0.38•	0.32▼	-15.68▼	-0.09
Educational attainment	primary																
of head		none	14.57▼	3.83	3.84	-14.05	-3.77	-10.13▼	-4.04	-9.93▼	-1.36	-8.19▼	-10.15▼	-6.06▼	-0.44	12.62▼	2.22
		secondary	13.89▼	10.71▼	-7.65°	-7.85	-4.09	-1.03	10.62▼	-14.86▼	16.08▼	-10.38▼	-0.11	-8.06▼	1.37	-19.55▼	1.58
		tertiary	-18.05▼	-4.62	-8.48	-22.59°	-24.12▼	-16.92▼	12.69▼	-20.87▼	6.42°	-22.15▼	-1.11	2.75	-12.70▼	-7.44•	9.62▼
Subsistence farming	1	0	-33.09▼	7.91▼	3.01	-12.66	-9.43▼	-6.29▼	-30.74▼	-20.38▼	-37.25▼	-20.01▼	-11.86•	-5.37▼	2.53▼	165.36▼	2.71▼
Non-market share	0.19	0.29	-3.39▼	-2.50▼	18.35▼	6.94•	2.21▼	0.83•	3.45▼	-2.14▼	-11.11▼	4.09▼	-0.36	-3.78▼	-0.85•	14.57▼	-1.22▼
Non-market share	0.19	0	-26.24▼	11.86▼	-28.19▼	-23.97•	-13.52▼	-7.59▼	-35.52▼	-15.47▼	-19.11▼	-26.74▼	-10.16•	1.52	3.87▼	132.80▼	4.91▼
Owns motor vehicle	0	1	-22.03▼	-14.55▼	-31.59▼	-8.87	-7.99•	-17.27▼	-10.27▼	-6.27•	-19.73▼	-25.66▼	-1.53	-16.23▼	-7.92▼	-3.67	10.94▼
Owns mobile phone	1	0	42.58▼	26.11▼	45.18▼	57.77▼	8.79▼	31.15▼	-1.06	17.68▼	29.43▼	42.17▼	-10.69▼	14.77▼	10.23▼	-49.28▼	-15.14▼
Season of survey	Nov.–Jan.																
		Jun.–Aug.	103.89▼	24.16▼	-2.22	30.22	26.60▼	12.43•	22.06•	32.16▼	-18.38▼	68.60▼	28.23•	12.95•	23.75▼	-102.51▼	-17.76▼
		Sep.–Oct.	56.23▼	12.80°	-36.13▼	-18.39	0.92	1.16	-9.71°	4.54	-25.97▼	28.42▼	7.92	-11.39▼	13.21▼	-8.64▼	-2.27
		Feb.–May	-33.13▼	-7.88•	-6.46	37.55°	17.80▼	0.23	-4.08	11.25▼	-0.55	5.34•	-0.65	-16.75▼	2.69	-17.58▼	-1.06
Subregion	Central 1																
		Mid-North	77.05▼	3.77	23.32	108.31°	-99.93▼	58.64▼	-43.61▼	31.55▼	36.68▼	63.41▼	-72.49▼	65.20▼	-24.87▼	114.10▼	-9.30•
		North-East	303.32▼	33.70▼	-111.86▼	-104.55▼	-100.00▼	145.25▼	-45.04•	2.51	-76.77▼	46.54▼	-65.50▼	58.96▼	-3.35	223.09▼	-7.66°
		Central II	19.51▼	-5.76	14.42	-25.33	-19.70•	5.00	-26.71▼	-22.89▼	-14.62•	-5.37	-15.72▼	-2.66	-9.04•	32.13▼	6.57°
		East Central	119.90▼	-4.18	136.39▼	4.34	-59.09▼	6.43	-46.65▼	-13.16▼	22.37▼	-16.73▼	-12.65°	15.32▼	-0.62	103.67▼	-5.93
		Eastern	101.50▼	23.66•	49.52•	86.92	-99.27▼	84.25▼	-40.64▼	-17.88°	13.58	23.61▼	-27.63	9.54°	2.78	65.34▼	-4.58
		Kampala	32.30▼	10.37°	36.02▼	-26.07	-26.82▼	7.24•	-27.95▼	8.39•	-39.11▼	20.81▼	-16.83▼	-6.08•	-18.67▼	105.01▼	-1.80
		Mid-West	-4.32	36.60▼	106.32▼	232.10•	-10.40	24.95▼	-8.69	9.41°	56.05▼	24.94▼	-26.59°	14.29	-25.36▼	35.32▼	-20.03▼
		West-Nile	-20.50	-1.50	81.63•	466.85▼	-95.90▼	26.86▼	-39.16▼	22.07•	76.40▼	-5.06	-83.86▼	-8.23•	-0.54	79.22▼	-11.97•
		South-western	24.70▼	24.35•	46.86	-95.21▼	41.02▼	-1.85	-25.98▼	-23.59°	-41.59°	3.11	-9.40	-17.67▼	-43.57▼	57.39▼	0.04

Symbols °, •, and ▼ indicate coefficients significantly different from zero at level 0.1, 0.05, and 0.01, respectively. The top row shows the typical household's budget shares. The total PCE and food PCE for this household are 1,626,397 UGX and 674,381 UGX, respectively. Source: own computation.

A female-headed household spends its budget rather differently. Compared to a male-headed household, it consumes less other food and animal products but more non-food. The head being five years older shifts the budget from other food, fruits, meat, and fish to lower-priced foods. The head's education level has a number of significant effects on the consumption pattern. A rural household with a more educated head, for instance, consumes less cassava, vegetables, and other food.

The first indicator for market dependence and access is subsistence farming. Not being engaged in any subsistence farming means that the non-market share originates completely from gifts in-kind. This reduces consumption of most foods, some very strongly, and raises that of other food and non-food consumption. Note that this effect is much larger for the rural household because the non-market share is threefold as high. A 10 percentage point higher non-market share is reflect, for instance, in higher potatoes, vegetables and fruit consumption as well as lower animal products but higher legumes consumption. The urban household with no non-market share (implies that the subsistence variable is zero) trades off the consumption of most food items against more cereals, sugar, other food and non-food. Owning a motor vehicle tends to shift budget from food to non-food. Ownership of a mobile phone has strikingly strong effects across all food items and also shifts consumption towards non-food.

The season in which the consumption of the household was recorded significantly influences the allocation to most items, most strongly for maize (over 120%), but surprisingly also for non-food. The consumption peaks of crops largely fall together with their main harvesting seasons (FAO, 2010, p. 12). Part of this variation is likely attributable to poor storage options.

Corresponding to the diversity of climate conditions and ethnicities across Uganda (FANTA-2, 2010), the subregion the household is located in strongly determines availability of and preferences for foods. These significantly contribute to the explanation of differences in consumption for most items and exceed 500% in the extreme. The sometimes poor transportation infrastructure affects local availability and might be another factor causing such extremes.

4.3 Discussion

Some limitations of this study should be noted. The most important one, in our opinion, is the assumption of separability of household consumption and production decisions so that a household first decides on its production and then, based on the given income, determines its consumption. This implies the absence of failures in all of the markets of the products the household consumes as well as in all of its relevant factor markets (see de Janvry et al., 1991). The Ugandan case, where many households consume a substantial share of their food out of own production and where transaction costs, such as costs for transportation and information, are high in many regions, challenges this assumption. Nevertheless, we have revalued consumption out of own production with market prices. In consequence, if, for instance, the price increases for one item and induces a household to sell part of its own produce instead of self-consuming it, its revenue would actually be determined by the lower farm-gate price and thus the expenditure shares for the substitutes would rise less than predicted by the estimates. Furthermore, subsistence farming households cannot change their consumption bundles immediately given the long cycles in agricultural production. Consequently, reactions to expenditure and price changes are likely smaller in the short run than if all households would source those items from markets. But also larger reactions are conceivable in the long run, for example, if households massively switch the crops they produce due to price changes. Another factor similarly limiting households' reactions to expenditure and price changes is food received in-kind.

Methodologically, there are a number of areas where the estimation could be improved, albeit not easily. Two examples follow. The absence of a non-food price index clearly biases the results to an unknown extent although it can be assumed that the change in the aggregate index would be limited. Having three model layers which are estimated separately reduces its efficiency as does the separate estimation of the prices.

To get a sense of the credibility of the estimated elasticities, it is helpful to contrast them with findings from similar research. A search for demand analysis literature regarding Uganda's nearer neighbor countries revealed five studies which present expenditure and price elasticities estimated from nationally representative household surveys. However, four of these report only conditional elasticities. Only the study on Malawi by Ecker and Qaim (2011) using a 2004/05 household survey provides unconditional elasticities suitable for direct comparison with our results. Because elasticities vary quite strongly with, amongst others, the expenditure level, they are not expected to be identical. Nevertheless, their expenditure elasticities for aggregate food are quite similar and a couple of elasticities for comparable food groups lie within or at least near the range of elasticities over household quintiles found here. These are maize, legumes, fats, and sugar for both rural and urban households and potatoes for rural, and vegetables, meat, and milk for urban households. Ecker and Qaim do not provide aggregate food price elasticities. The own-price elasticities for fruits in both areas for potatoes, pulses, and sugar in rural areas are somewhat in the same range. However, for other food items we find much larger elasticities, for instance, for fruits and fish expenditure and for fish and milk own-price elasticities. Such differences might reflect country-specific differences in demand behavior and / or differences in the estimation approach, starting, for instance, from the household data itself over aggregation of items and estimation of prices to model type and specification.[19]

5 Summary and conclusion

Despite Uganda's great reduction in poverty, decreasing the poor population by more than a half over the past two decades, progress in improving household food security has not kept that pace. One example is the increase in the share of the food energy-deficient population over that period. This underlines that household food security does not automatically improve with decreasing poverty but requires additional, specific and targeted interventions. In the light of sufficient total food availability and the various positive economic developments involving Uganda, there is reason for optimism if the government and other stakeholders succeed in channeling some of the expected gains towards improvement of household food security and safeguarding the vulnerable.

The present study analyzes household demand behavior and estimates demand elasticities which are useful for, amongst others, improving the design and evaluation of food security interventions. More specifically, a complete two-stage budgeting demand system model differentiating one non-food and 14 food items is estimated, separately for rural and urban subpopulations, based on a 2012/13 Ugandan household survey. The model allows for non-linear Engel curves, explicitly accounts for zero expenditures, and controls for various household-specific characteristics. The results are utilized to calculate expenditure and price elasticities of demand as well as the effects of household characteristics on demand.

A number of findings stand out. The food demand of the poorest 40% of rural households is expenditure elastic and this applies strongly for individual staple foods. For instance, the elasticity found for matooke is 2.9. This likely is due to essential non-food consumption needs which have priority even over basic nutrition needs. The demand elasticities vary markedly with rising expenditure level and particularly those for staples decrease strongly. However, this strong preference to increase consumption of calorie-dense foods extends beyond the bottom 22.8% of the rural population officially deemed poor. This provides evidence that food energy deficiency is indeed strongly connected to insufficient monetary access to food and poverty lines might be only a weak instrument to draw conclusions on the sufficiency of food energy intake. Moreover, for many items, demand is very expenditure elastic for the poorest household quintiles but rather inelastic for the richest showing that the flexibility to depict non-linear Engel curves, which is a feature of the QUAIDS model specification, is highly relevant for Ugandan household

[19] In contrast to the approach taken here, their approach differs, for instance, by more disaggregated food item definitions, by the use of a three-stage budgeting demand system, and by not including the marginal effects from the probit model in their elasticity calculations.

demand. Food demand of urban households is much less expenditure elastic.

The demand of the bottom rural household quintile is price elastic for most foods, including staples, indicating that these households have good options to substitute when individual food prices change. This is also reflected in significant cross-price elasticities. It confirms earlier assessments, e.g., by Benson et al. (2008), that Ugandans generally are in a good position to mitigate staple price increases through substitution strategies but they also warn that this is not the case for households whose consumption is already concentrated on the cheapest calories, e.g., cassava. These assessments apply to a lesser extent to the urban counterparts. Price elasticities tend to decrease with increasing expenditure level.

The household composition, characteristics of the head, market access indicators, and the season in which the consumption of the household was recorded and its location all play significant roles in the determination of the consumption pattern. The influences of the latter two are particularly pronounced and likely also a result of weak food distribution systems and storage facilities.

This study has outlined a practical approach to derive detailed and consistent demand behavior estimates and aimed at providing sufficient detail to serve as a template for equivalent studies. Although there are areas for improvement of this study, the comparisons of our findings to those from the literature and to common observations about Ugandan agriculture and food consumption give them intuitive credibility.

The large variations in expenditure and price elasticities across household quintiles and rural and urban areas, as well as the strong effects of household characteristics on demand patterns show that any food security intervention needs not only to be highly differentiated between various household types because of differing current consumption levels but also because of widely differing consumption adaptation behavior. This study adds detailed estimates useful for that purpose.

The price and income elasticities of demand found can directly be used in back-of-the-envelope calculations to translate changes in the price of food or household incomes, e.g., sudden food price increases or income transfers to households, into changes in the quantity of food demanded by households (see, e.g., Donovan et al., 2006). Or, in the opposite direction, to translate changes in the supply of food, for instance, after a drought or through food aid deliveries, into changes in food prices and purchasing power. Such approaches are applied, e.g., for the assessment of market conditions by the World Food Programme (WFP, 2007) for the planning of food aid interventions. In addition, the elasticities can help in estimating the effects of price or income changes on staple food dependency or dietary diversity via measuring if the food budget gets concentrated or diversified with respect to food items. In conjunction with food nutrient content data, these elasticities also facilitate the calculation of demand effects in terms of other food security indicators, such as consumption of food energy or of specific macro- and micronutrients (see, e.g., Ecker and Qaim, 2011). Moreover, demand elasticities are an essential input for many types of applied economic models which include markets, like, for example, computable general equilibrium, microsimulation or agent-based models, used to evaluate alternative policy options or the impacts of arbitrary (economic) events.

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A Appendix

Table A.1: Estimated coefficients from the first-stage Working-Leser regressions

	Rural		Urban	
	Estimate	S.e.	Estimate	S.e.
Intercept	-0.91$^{\blacktriangledown}$	(0.12)	0.21	(0.20)
ln(food price)	0.05$^{\blacktriangledown}$	(0.01)	0.17$^{\blacktriangledown}$	(0.03)
ln(PCE)	0.47$^{\blacktriangledown}$	(0.03)	0.16$^{\blacktriangledown}$	(0.05)
(ln(PCE))^2	-0.04$^{\blacktriangledown}$	(0.00)	-0.02$^{\blacktriangledown}$	(0.00)
ln(household size)	-0.03$^{\blacktriangledown}$	(0.01)	-0.03$^{\blacktriangledown}$	(0.01)
Share of members aged				
below 5	0.08$^{\blacktriangledown}$	(0.02)		
from 5 to 17	0.04$^{\blacktriangledown}$	(0.01)	-0.05$^{\blacktriangledown}$	(0.02)
Non-market share	0.06$^{\blacktriangledown}$	(0.01)	0.08$^{\blacktriangledown}$	(0.01)
Owns motor vehicle	-0.07$^{\blacktriangledown}$	(0.01)	-0.06$^{\blacktriangledown}$	(0.01)
Owns mobile phone	-0.05$^{\blacktriangledown}$	(0.00)	-0.08$^{\blacktriangledown}$	(0.01)
Male household head	0.02$^{\blacktriangledown}$	(0.00)	0.03$^{\blacktriangledown}$	(0.01)
Educational attainment of head				
primary	-0.02$^{\blacktriangledown}$	(0.01)	0.01	(0.01)
secondary	-0.06$^{\blacktriangledown}$	(0.01)	-0.01	(0.01)
tertiary	-0.10$^{\blacktriangledown}$	(0.01)	-0.04$^{\blacktriangledown}$	(0.01)
Season of survey				
Sep.–Oct.			-0.06$^{\blacktriangledown}$	(0.02)
Nov.–Jan.			-0.08$^{\blacktriangledown}$	(0.02)
Feb.–May			-0.07$^{\blacktriangledown}$	(0.02)
Observations	4,942		1,945	
RMSE	0.14		0.13	
R^2	0.29		0.43	
Adjusted R^2	0.27		0.40	

Symbols $^{\circ}$, $^{\bullet}$, and $^{\blacktriangledown}$ indicate coefficients significantly different from zero at level 0.1, 0.05, and 0.01, respectively. For reference levels of the categorical variables see Table 2. The coefficients for administrative districts are not shown for the sake of brevity. Source: own computation.

Table A.2: Estimated coefficients from the QUAIDS regression for rural households

	Maize	Cereals	Pota-toes	Cas-sava	Mato-oke	Vege-tables	Fruits	Meat	Fish	Legu-mes	Milk	Fats	Sugar	Other
α	0.212▼	0.376▼	-0.232	0.383▼	-0.347°	0.569▼	0.062	-0.723▼	-0.038	0.514▼	0.192▼	0.091▼	-0.069°	0.567▼
β	-0.023▼	-0.058▼	0.236▼	-0.080▼	0.157•	-0.175▼	-0.003	0.205°	0.074	-0.158▼	-0.025▼	-0.011▼	0.055•	-0.108▼
γ														
Matooke	0.014	0.025°	-0.068▼	0.023	0.003	0.059°	-0.014▼	-0.079°	-0.030	0.039°	0.011	0.001	-0.023°	0.039°
Potatoes	0.004	0.037▼	-0.059	-0.004	-0.068▼	0.081•	0.009°	-0.058	-0.029	0.055•	0.012•	0.004	-0.031	0.047
Cassava	0.046▼	-0.030▼	-0.004	0.037▼	0.023	-0.050▼	-0.007°	0.039°	-0.014	-0.037▼	0.001	-0.009▼	0.013▼	-0.006
Cereals	0.017°	-0.026•	0.037▼	-0.030▼	0.025°	-0.050▼	0.014▼	0.038•	0.012	-0.030▼	-0.010°	-0.006•	0.006	0.003
Maize	-0.043▼	0.017°	0.004	0.046▼	0.014	-0.016•	-0.007	0.007	0.018•	-0.031▼	-0.002	-0.008▼	-0.018▼	0.017•
Meat	0.007	0.038•	-0.058	0.039°	-0.079°	0.102•	-0.003	-0.187	-0.003	0.113•	-0.000	0.006	-0.035°	0.063°
Fish	0.018•	0.012	-0.029	-0.014	-0.030	0.026	0.002	-0.003	-0.009	0.031°	-0.011	0.002	-0.006	0.010
Milk	-0.002	-0.010°	0.012•	0.001	0.011	-0.015▼	-0.007•	-0.000	-0.011	-0.014•	0.035▼	0.002	0.014▼	-0.015•
Other	0.017•	0.003	0.047	-0.006	0.039°	-0.052▼	0.010•	0.063°	0.010	-0.039▼	-0.015•	-0.005°	0.023•	-0.094▼
Fats	-0.008▼	-0.006•	0.004	-0.009▼	0.001	-0.005•	-0.005▼	0.006	0.002	-0.004°	0.002	0.022▼	0.007•	-0.005°
Fruits	-0.007	0.014▼	0.009°	-0.007°	-0.014▼	0.002	0.014▼	-0.003	0.002	-0.003	-0.007•	-0.005▼	-0.003	0.010•
Vegetables	-0.016•	-0.050▼	0.081•	-0.050▼	0.059°	-0.042°	0.002	0.102•	0.026	-0.071▼	-0.015▼	-0.005•	0.032▼	-0.052▼
Legumes	-0.031▼	-0.030▼	0.055•	-0.037▼	0.039°	-0.071▼	-0.003	0.113•	0.031°	-0.032°	-0.014•	-0.004°	0.022•	-0.039▼
Sugar	-0.018▼	0.006	-0.031	0.013▼	-0.023°	0.032▼	-0.003	-0.035°	-0.006	0.022•	0.014▼	0.007•	0.000	0.023•
δ														
ln(household size)	0.025▼	-0.023▼	0.003	0.015°	0.024▼	-0.040▼	0.003	0.065▼	0.026▼	-0.015▼	0.006	-0.008▼	-0.002	-0.078▼
Share male	-0.023°	0.005	0.033▼	-0.037▼	-0.004	0.001	0.009	-0.018	-0.011	-0.018°	-0.013	-0.003	-0.006	0.085▼
Share of members aged														
below 5	0.025	-0.017	-0.055•	-0.067▼	0.012	-0.021•	0.026•	0.087▼	0.057▼	-0.012	-0.008	0.004	0.010	-0.041°
from 5 to 17	0.032°	0.017	-0.021	-0.043▼	0.001	0.000	0.024▼	0.038°	0.009	-0.007	-0.034•	-0.001	0.001	-0.016
ln(age head)	-0.001	0.019▼	-0.016°	0.011	0.018	0.006	-0.010•	-0.017°	-0.014	0.009	0.001	-0.000	0.006•	-0.013
Male household head	-0.018▼	-0.007	-0.002	0.003	-0.012	-0.001	-0.007°	0.019•	0.003	-0.005	0.000	-0.004•	-0.006▼	0.034▼
Subsistence farming	0.016	-0.047▼	-0.067▼	0.035▼	0.075▼	-0.002	0.034▼	0.079▼	0.017	-0.001	0.016°	0.008▼	0.013▼	-0.177▼
Non-market share	-0.048▼	0.044▼	0.187▼	0.010	0.052▼	0.031▼	0.013°	-0.176▼	-0.083▼	0.057▼	-0.002	-0.025▼	-0.059▼	-0.001
Owns motor vehicle	-0.010	0.011	-0.015	-0.012	0.006	0.002	0.004	-0.002	-0.010	0.000	-0.002	0.003	0.003	0.023•
Owns mobile phone	-0.010	-0.012•	-0.028▼	-0.011°	0.013	0.001	0.005	-0.003	0.008	-0.007	0.019▼	0.008▼	0.016▼	0.002
Educational attainment of head														
primary	0.006	-0.002	0.000	-0.012°	0.014•	-0.006▼	-0.000	0.007	-0.002	-0.007°	-0.005	0.001	0.005•	0.000
secondary	0.003	-0.010°	-0.015°	-0.028▼	0.022•	0.002	0.003	0.010	-0.007	0.006	0.002	0.002	0.009▼	0.000
tertiary	0.006	-0.019°	-0.012	-0.018	0.008	-0.004	0.014•	0.019°	0.005	0.007	0.011	0.001	0.003	-0.023°
Season of survey														
Sep.–Oct.	-0.006	-0.006	-0.018•	-0.018▼	0.020•	-0.002	-0.013▼	0.010	0.021▼	-0.006	0.013•	-0.003	0.006•	0.001
Nov.–Jan.	-0.031▼	-0.014°	0.002	-0.012	0.037▼	-0.004	-0.007	0.008	0.009	-0.013▼	0.009	-0.004•	0.003	0.017•
Feb.–May	-0.075▼	-0.002	-0.001	0.034▼	0.018°	0.010▼	0.005	0.000	0.021▼	-0.024▼	-0.005	-0.004°	0.002	0.022▼
Subregion														
Central II	0.026▼	-0.011	0.023•	0.029▼	-0.059▼	-0.006°	0.002	-0.006	0.024•	0.008	0.001	0.003	-0.003	-0.030•
East Central	0.081▼	-0.036▼	0.103▼	0.039▼	-0.104▼	-0.001	-0.008	-0.053▼	0.015	-0.005	-0.012	0.005•	-0.006	-0.017
Eastern	0.081▼	-0.014	0.021°	0.115▼	-0.110▼	0.026▼	-0.049▼	-0.013	-0.018	-0.001	-0.015°	0.006•	-0.010•	-0.017
Mid-North	0.051▼	-0.012	0.033▼	0.051▼	-0.149▼	0.004	0.002	0.006	-0.019°	0.074▼	-0.035▼	0.016▼	-0.012•	-0.011
Mid-West	-0.002	-0.000	0.027▼	0.053▼	-0.030▼	0.004	-0.017▼	0.007	-0.010	0.043▼	-0.003	-0.000	-0.034▼	-0.039▼
North-East	0.181▼	0.132▼	-0.240▼	-0.058▼	-0.050	0.062▼	0.004	0.015	-0.103▼	-0.010	0.036°	0.004	-0.009	0.034•
South-western	-0.010	0.013	0.088▼	-0.049▼	0.090▼	-0.001	-0.025▼	-0.052▼	-0.013	0.013°	-0.003	-0.005	-0.041▼	-0.006
West-Nile	0.017	-0.010	0.016	0.184▼	-0.207▼	0.003	-0.006	0.024°	-0.009	0.029▼	0.000	-0.012▼	-0.022▼	-0.008
λ	–	–	-0.032▼	–	-0.019•	0.014▼	–	-0.007	-0.008	0.014▼	–	–	-0.006•	0.014▼
ϕ	0.013	-0.043▼	-0.058▼	-0.021°	0.013	-0.028°	0.006	0.150▼	-0.013	-0.015	-0.041▼	0.006°	0.030▼	–
Regression statistics:														
R^2	0.21	0.34	0.35	0.43	0.45	0.35	0.11	0.13	0.16	0.20	0.13	0.19	0.21	0.26
Adjusted R^2	0.20	0.33	0.35	0.42	0.45	0.35	0.10	0.13	0.15	0.19	0.13	0.18	0.21	0.26

Symbols °, •, and ▼ indicate coefficients significantly different from zero at level 0.1, 0.05, and 0.01, respectively. Source: own computation.

Table A.3: Estimated coefficients from the QUAIDS regression for urban households

	Maize	Cereals	Potatoes	Cassava	Matooke	Vegetables	Fruits	Meat	Fish	Legumes	Milk	Fats	Sugar	Other
α	0.096°	0.320▼	0.153▼	0.325▼	0.000	0.226▼	0.084	-0.472▼	-0.273▼	0.128▼	-0.059	0.042	0.154▼	0.661▼
β	-0.029▼	-0.054▼	-0.034▼	-0.114•	0.049	-0.056▼	-0.029	0.286▼	0.128▼	-0.039▼	0.062	0.021°	-0.018▼	-0.173▼
γ														
Matooke	-0.007	0.017	0.003	0.028	0.019	0.001	-0.006	-0.054°	-0.033•	0.007	-0.005	-0.006	-0.001	0.038
Potatoes	-0.001	-0.011	0.042▼	-0.003	0.003	-0.012▼	-0.000	0.028•	0.024▼	-0.035▼	0.001	-0.005	-0.013•	-0.018
Cassava	0.021	-0.026•	-0.003	-0.001	0.028	-0.019•	-0.015	0.048	0.009	-0.014°	0.005	0.004	-0.002	-0.037•
Cereals	0.024•	-0.017	-0.011	-0.026•	0.017	-0.017•	0.015°	-0.006	0.028▼	-0.004	0.013	-0.000	-0.014	-0.002
Maize	-0.040•	0.024•	-0.001	0.021	-0.007	-0.009	-0.011	0.007	0.020•	-0.006	0.012	0.013▼	-0.000	-0.023°
Meat	0.007	-0.006	0.028•	0.048	-0.054°	0.025	-0.000	0.001	-0.045•	0.023°	-0.058•	-0.022•	0.006	0.047
Fish	0.020•	0.028▼	0.024▼	0.009	-0.033•	0.026▼	0.001	-0.045•	-0.052•	0.028▼	-0.020°	-0.006°	0.007	0.015
Milk	0.012	0.013	0.001	0.005	-0.005	0.009	0.011	-0.058•	-0.020°	0.023▼	-0.014	-0.003	0.005	0.022
Other	-0.023°	-0.002	-0.018	-0.037•	0.038	-0.009	-0.005	0.047	0.015	-0.032▼	0.022	0.019▼	0.002	-0.016
Fats	0.013▼	-0.000	-0.005	0.004	-0.006	-0.001	0.001	-0.022•	-0.006°	-0.005	-0.003	0.014▼	-0.002	0.019▼
Fruits	-0.011	0.015°	-0.000	-0.015	-0.006	-0.004	0.024▼	-0.000	0.001	-0.007	0.011	0.001	-0.002	-0.005
Vegetables	-0.009	-0.017•	-0.012▼	-0.019•	0.001	0.014°	-0.004	0.025	0.026▼	-0.003	0.009	-0.001	0.001	-0.009
Legumes	-0.006	-0.004	-0.035▼	-0.014°	0.007	-0.003	-0.007	0.023°	0.028▼	0.011	0.023▼	-0.005	0.014•	-0.032▼
Sugar	-0.000	-0.014	-0.013•	-0.002	-0.001	0.001	-0.002	0.006	0.007	0.014•	0.005	-0.002	-0.001	0.002
δ														
ln(household size)	0.020•	-0.017•	-0.017▼	0.011	0.014	-0.022▼	0.021▼	0.074▼	0.061▼	0.005	-0.004	-0.005°	-0.008	-0.132▼
Share male	-0.014	0.004	0.062▼	-0.013	-0.086▼	-0.000	-0.024•	-0.045▼	-0.088▼	-0.028▼	-0.005	-0.007•	-0.008	0.252▼
Share of members aged														
below 5	0.026	-0.037•	-0.011	0.006	0.034	-0.005	0.012	0.029	0.079▼	-0.009	0.033•	-0.000	-0.010	-0.148▼
from 5 to 17	0.015	0.028•	0.025	-0.007	-0.001	0.005	-0.011	-0.062▼	-0.005	-0.025°	0.004	-0.010•	0.010	0.035
ln(age head)	0.023°	0.004	0.009	0.008	0.025°	0.005	0.002	-0.026•	-0.015	0.039▼	0.007	-0.001	0.002	-0.082▼
Male household head	-0.007	0.010°	-0.002	-0.006	0.005	-0.002	-0.004	-0.003	0.007	-0.001	-0.002	-0.001	-0.000	0.007
Subsistence farming	0.017°	-0.011•	-0.013•	-0.006	0.015	0.004	0.018▼	0.021▼	0.040▼	0.020▼	-0.000	0.001	-0.002	-0.103▼
Non-market share	-0.028	-0.029°	0.126▼	0.025	0.022	-0.007	0.014	-0.041•	-0.131▼	0.020°	-0.004	-0.021▼	-0.023•	0.077•
Owns motor vehicle	-0.004	-0.002	-0.020▼	0.007	0.006	-0.002	-0.000	0.010	-0.004	-0.013▼	0.007	-0.000	0.007	0.008
Owns mobile phone	-0.013	-0.007	-0.016°	-0.022•	0.015	-0.006	0.014°	0.002	-0.009	-0.020•	0.020•	0.001	0.006	0.036•
Educational attainment of head														
primary	-0.012	-0.009°	-0.011	0.011	0.001	0.005°	0.002	0.010	0.000	0.007	0.004	0.001	-0.001	-0.009
secondary	0.000	0.005	-0.011°	-0.005	-0.004	0.007•	0.011•	-0.011	0.018•	-0.001	0.008	-0.000	0.003	-0.020
tertiary	-0.016•	-0.001	-0.011	0.012	-0.023•	0.001	0.019•	-0.007	0.019•	-0.006	0.012•	0.008•	-0.002	-0.006
Season of survey														
Sep.–Oct.	-0.010	0.016°	-0.007	-0.005	-0.007	0.002	-0.015•	-0.013	0.001	-0.018•	0.002	-0.004	0.004	0.055▼
Nov.–Jan.	-0.039▼	-0.001	0.014	0.002	-0.007	0.004	-0.013•	-0.012	0.033▼	-0.040▼	-0.005	0.002	-0.002	0.064▼
Feb.–May	-0.062▼	-0.008	0.018°	0.021•	0.013	0.003	-0.018▼	0.001	0.030•	-0.037▼	-0.006	-0.005•	-0.002	0.052▼
Subregion														
Central II	0.016	0.007	0.020°	-0.005	-0.012	0.006	-0.012	-0.018	-0.009	-0.002	-0.011	0.001	-0.004	0.023
East Central	0.062▼	-0.011	0.081▼	-0.000	-0.068▼	-0.004	-0.030▼	-0.040•	0.014	-0.027▼	-0.019•	0.002	-0.009	0.050•
Eastern	0.055▼	0.011	0.018	0.033	-0.090▼	0.037▼	-0.037•	-0.040°	0.004	0.007	-0.015	-0.003	-0.009	0.027
Kampala	0.015°	0.014°	0.026▼	0.005	-0.026•	-0.000	-0.014•	0.001	-0.048▼	0.012•	-0.017•	-0.004°	-0.019▼	0.056▼
Mid-North	0.040▼	-0.019°	0.026•	-0.010	-0.119▼	0.023▼	-0.024•	0.022	0.018°	0.042▼	-0.044▼	0.016▼	-0.024▼	0.053•
Mid-West	-0.012	0.010	0.050▼	0.015	-0.035°	0.001	-0.020•	-0.017	0.044▼	0.001	-0.018°	0.002	-0.027▼	0.007
North-East	0.156▼	0.008	-0.028	-0.005	-0.223▼	0.070▼	-0.012	0.001	-0.056•	0.028°	-0.055▼	0.017•	-0.013	0.111▼
South-western	0.011	0.019°	0.048▼	-0.026	0.042•	-0.004	-0.023•	-0.017	-0.034•	-0.002	-0.007	-0.007°	-0.031▼	0.031
West-Nile	-0.015	0.001	0.052•	0.099▼	-0.097▼	0.002	-0.035▼	0.003	0.042▼	-0.023°	-0.036•	-0.011▼	-0.011	0.029
λ	–	–	–	0.012°	-0.009	0.003	0.004	-0.030▼	-0.013•	–	-0.010°	-0.005▼	–	0.036▼
ϕ	0.013	-0.037▼	-0.070▼	-0.078▼	-0.004	-0.028▼	-0.001	0.067▼	0.082▼	0.021•	0.020•	0.002	0.013	–
Regression statistics:														
R^2	0.25	0.12	0.31	0.39	0.24	0.30	0.02	0.17	0.07	0.28	0.12	0.13	0.09	0.34
Adjusted R^2	0.23	0.11	0.29	0.38	0.22	0.28	0.00	0.15	0.05	0.26	0.10	0.11	0.07	0.33

Symbols °, •, and ▼ indicate coefficients significantly different from zero at level 0.1, 0.05, and 0.01, respectively. Source: own computation.

B Supporting information

Table B.1: Distribution of detailed items' budget shares by quintiles

	Rural						Urban						
	Mean	Q_1	Q_2	Q_3	Q_4	Q_5	Mean	Q_1	Q_2	Q_3	Q_4	Q_5	Food group
Out of total consumption:													
Food	56.4	59.3	60.8	59.6	56.3	46.0	44.7	57.0	51.5	45.4	39.7	29.9	
Non-food	43.6	40.7	39.2	40.4	43.7	54.0	55.3	43.0	48.5	54.6	60.3	70.1	
Out of food consumption:													
Matooke	8.9	3.0	7.2	10.1	11.2	12.9	9.0	5.2	9.5	10.9	10.4	8.7	Matooke
Sweet potatoes	9.3	9.4	9.6	11.8	9.3	6.7	5.9	12.6	6.7	5.2	3.1	1.6	Sweet & Irish Potatoes
Cassava	12.3	17.5	16.0	11.6	9.8	6.6	5.2	11.1	5.6	4.7	2.9	1.9	Cassava
Irish potatoes	1.8	0.7	1.4	1.9	2.9	2.4	1.7	1.1	1.6	1.8	2.4	1.8	Sweet & Irish Potatoes
Rice	1.7	0.6	1.5	1.9	1.8	2.5	4.1	2.4	4.6	4.3	4.6	4.6	Other cereals
Maize	10.3	11.5	11.4	10.4	9.7	8.6	7.7	10.1	11.9	7.5	5.9	3.0	Maize
Bread	0.8	0.2	0.3	0.7	1.0	1.6	3.1	0.7	1.9	3.8	4.4	4.7	Other cereals
Millet	1.6	1.7	1.8	1.7	1.6	1.2	1.2	1.6	1.6	0.9	1.2	0.6	Other cereals
Sorghum	2.6	8.1	2.0	1.2	0.9	0.6	0.9	3.3	0.6	0.5	0.2	0.1	Other cereals
Beef	3.6	1.9	2.7	3.5	4.4	5.4	5.7	3.1	3.8	6.8	7.6	7.1	Meat & eggs
Pork	1.0	0.6	0.8	0.9	1.3	1.4	1.0	0.8	1.1	1.0	0.8	1.0	Meat & eggs
Goat meat	1.2	0.5	1.1	1.3	1.3	1.8	1.1	1.2	0.9	0.8	1.5	1.2	Meat & eggs
Other meat	0.2	0.3	0.2	0.1	0.1	0.2	0.2	0.1	0.1	0.2	0.2	0.2	Meat & eggs
Chicken	2.4	1.0	2.5	2.6	2.3	3.7	2.2	1.4	1.6	2.2	2.3	3.3	Meat & eggs
Fish	4.1	3.6	3.9	4.3	4.1	4.4	4.4	3.7	4.4	5.3	4.7	3.8	Fish
Eggs	0.4	0.1	0.3	0.5	0.6	0.6	0.8	0.3	0.5	0.8	1.1	1.3	Meat & eggs
Fresh milk	3.0	1.3	2.6	3.6	3.5	3.8	4.1	2.5	4.2	4.2	4.3	5.3	Milk
Infant formula foods	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.6	0.0	0.1	0.1	0.1	Other foods
Cooking oil	1.8	2.1	1.9	1.8	1.8	1.6	2.3	2.6	2.4	2.6	2.1	1.7	Oils & fats
Ghee	0.2	0.1	0.1	0.3	0.2	0.3	0.3	0.1	0.2	0.3	0.3	0.4	Oils & fats
Margarine, butter, etc.	0.1	0.0	0.0	0.1	0.1	0.1	0.3	0.1	0.5	0.1	0.3	0.4	Oils & fats
Passion fruits	0.4	0.1	0.2	0.3	0.5	1.0	0.7	0.3	0.5	0.6	0.8	1.3	Fruits
Sweet bananas	0.8	0.3	0.4	0.9	1.0	1.3	1.0	0.5	0.8	1.3	1.2	1.4	Fruits
Mangoes	0.9	1.1	0.9	1.1	0.9	0.7	0.8	0.9	0.9	0.9	0.7	0.6	Fruits
Oranges	0.2	0.2	0.3	0.3	0.2	0.2	0.4	0.4	0.3	0.2	0.5	0.4	Fruits
Other fruits	1.1	0.7	0.7	1.0	1.4	1.6	1.1	1.1	0.8	1.1	0.9	1.4	Fruits
Onions	0.9	0.8	0.9	0.8	0.9	0.9	1.2	1.2	1.2	1.3	1.1	1.0	Vegetables
Tomatoes	1.6	1.4	1.5	1.6	1.7	1.8	2.2	2.1	2.5	2.3	2.2	1.8	Vegetables
Cabbages	0.6	0.6	0.7	0.5	0.5	0.6	0.7	0.7	0.8	0.6	0.6	0.6	Vegetables
Dodo	1.8	2.8	2.1	1.7	1.4	0.9	1.0	1.7	1.4	0.8	0.5	0.4	Vegetables
Other vegetables	2.0	5.6	2.1	1.1	0.8	0.6	1.1	3.0	1.1	0.7	0.5	0.5	Vegetables
Beans	7.8	8.0	8.5	7.4	9.0	6.4	6.6	8.8	8.7	6.8	5.1	3.3	Pulses, legumes, nuts
Groundnuts	2.7	2.2	2.8	3.1	2.7	2.7	2.8	3.2	3.2	3.0	2.3	2.1	Pulses, legumes, nuts
Peas	0.7	1.3	0.8	0.5	0.7	0.2	0.4	0.6	0.3	0.2	0.3	0.7	Pulses, legumes, nuts
Sim sim	0.7	1.2	0.9	0.4	0.6	0.3	0.4	1.1	0.4	0.1	0.3	0.1	Pulses, legumes, nuts
Sugar	3.3	2.0	3.8	3.3	3.6	3.7	4.9	3.9	5.5	5.4	5.3	4.2	Sugar, soda, other juice
Coffee	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.1	Other foods
Tea	0.2	0.2	0.3	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	Other foods
Salt	0.6	1.1	0.7	0.5	0.5	0.4	0.4	0.8	0.5	0.4	0.3	0.2	Other foods
Soda	0.5	0.1	0.2	0.4	0.6	1.3	1.2	0.2	0.6	1.1	1.9	2.5	Sugar, soda, other juice
Beer	0.4	0.1	0.3	0.2	0.4	1.2	0.8	0.0	0.2	0.7	1.2	1.8	Other foods
Other alcoholic drinks	1.5	2.8	1.5	1.2	0.9	0.9	0.5	0.9	0.5	0.2	0.4	0.3	Other foods
Other foods	1.2	1.9	1.0	0.7	0.8	1.4	1.1	1.5	0.9	0.9	1.0	1.3	Other foods
Food consumed away from home	2.7	1.4	2.0	2.4	2.7	5.2	9.1	2.2	4.4	6.9	11.8	20.4	Other foods
Other juice	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.0	0.2	0.3	0.2	0.6	Sugar, soda, other juice

Source: own computation based on processed UNHS data.

Table B.2: Distribution of budget shares across food item groups by quintiles

	Rural						Urban					
	Mean	Q_1	Q_2	Q_3	Q_4	Q_5	Mean	Q_1	Q_2	Q_3	Q_4	Q_5
Share in total budget:												
Non-food	0.44	0.41	0.39	0.40	0.44	0.54	0.55	0.43	0.49	0.55	0.60	0.70
Food	0.56	0.59	0.61	0.60	0.56	0.46	0.45	0.57	0.51	0.45	0.40	0.30
Share in food budget:												
Maize	0.10	0.12	0.11	0.10	0.10	0.09	0.08	0.10	0.12	0.07	0.06	0.03
Cereals	0.07	0.11	0.06	0.05	0.05	0.06	0.09	0.08	0.09	0.09	0.10	0.10
Potatoes	0.11	0.10	0.11	0.14	0.12	0.09	0.08	0.14	0.08	0.07	0.05	0.03
Cassava	0.12	0.18	0.16	0.12	0.10	0.07	0.05	0.11	0.06	0.05	0.03	0.02
Matooke	0.09	0.03	0.07	0.10	0.11	0.13	0.09	0.05	0.10	0.11	0.10	0.09
Vegetables	0.07	0.11	0.07	0.06	0.05	0.05	0.06	0.09	0.07	0.06	0.05	0.04
Fruits	0.03	0.02	0.03	0.04	0.04	0.05	0.04	0.03	0.03	0.04	0.04	0.05
Meat	0.09	0.05	0.08	0.09	0.10	0.13	0.11	0.07	0.08	0.12	0.14	0.14
Fish	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.04
Legumes	0.12	0.13	0.13	0.11	0.13	0.10	0.10	0.14	0.13	0.10	0.08	0.06
Milk	0.03	0.01	0.03	0.04	0.04	0.04	0.04	0.03	0.04	0.04	0.04	0.05
Fats	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03
Sugar	0.04	0.02	0.04	0.04	0.04	0.05	0.06	0.04	0.06	0.07	0.07	0.07
Other	0.07	0.07	0.06	0.05	0.05	0.09	0.13	0.06	0.07	0.10	0.15	0.25

The calculations utilize the sample household weights. Source: own computation based on processed UNHS data.

Table B.3: Distribution of unconditional compensated own-price elasticities for food items by quintiles

ε_{ii}^{H}	Rural						Urban					
	Mean	Q_1	Q_2	Q_3	Q_4	Q_5	Mean	Q_1	Q_2	Q_3	Q_4	Q_5
Maize	-1.39$^{\blacktriangledown}$	-1.52$^{\blacktriangledown}$	-1.41$^{\blacktriangledown}$	-1.38$^{\blacktriangledown}$	-1.38$^{\blacktriangledown}$	-1.41$^{\blacktriangledown}$	-1.48$^{\blacktriangledown}$	-1.35$^{\blacktriangledown}$	-1.35$^{\blacktriangledown}$	-1.46$^{\blacktriangledown}$	-1.59$^{\blacktriangledown}$	-1.86$^{\blacktriangledown}$
	(0.11)	(0.14)	(0.12)	(0.11)	(0.12)	(0.13)	(0.22)	(0.16)	(0.17)	(0.21)	(0.27)	(0.38)
Cereals	-1.78$^{\blacktriangledown}$	-1.84$^{\blacktriangledown}$	-1.97$^{\blacktriangledown}$	-1.86$^{\blacktriangledown}$	-1.86$^{\blacktriangledown}$	-1.69$^{\blacktriangledown}$	-0.93$^{\blacktriangledown}$	-0.90$^{\blacktriangledown}$	-0.92$^{\blacktriangledown}$	-0.93$^{\blacktriangledown}$	-0.93$^{\blacktriangledown}$	-0.94$^{\blacktriangledown}$
	(0.15)	(0.15)	(0.17)	(0.17)	(0.17)	(0.18)	(0.15)	(0.14)	(0.13)	(0.15)	(0.14)	(0.17)
Potatoes	-0.92$^{\blacktriangledown}$	-1.37$^{\blacktriangledown}$	-1.07$^{\blacktriangledown}$	-0.91$^{\blacktriangledown}$	-0.84$^{\blacktriangledown}$	-0.62$^{\blacktriangledown}$	-0.60$^{\blacktriangledown}$	-0.70$^{\blacktriangledown}$	-0.66$^{\blacktriangledown}$	-0.61$^{\blacktriangledown}$	-0.50$^{\blacktriangledown}$	-0.29
	(0.09)	(0.27)	(0.12)	(0.09)	(0.08)	(0.08)	(0.14)	(0.10)	(0.11)	(0.15)	(0.17)	(0.24)
Cassava	-0.53$^{\blacktriangledown}$	-0.64$^{\blacktriangledown}$	-0.60$^{\blacktriangledown}$	-0.54$^{\blacktriangledown}$	-0.49$^{\blacktriangledown}$	-0.22°	-0.59$^{\bullet}$	-0.72$^{\blacktriangledown}$	-0.66$^{\blacktriangledown}$	-0.59$^{\bullet}$	-0.44	0.03
	(0.09)	(0.09)	(0.07)	(0.08)	(0.09)	(0.14)	(0.22)	(0.11)	(0.17)	(0.22)	(0.35)	(0.71)
Matooke	-0.90$^{\blacktriangledown}$	-1.21$^{\bullet}$	-1.00$^{\blacktriangledown}$	-0.92$^{\blacktriangledown}$	-0.79$^{\blacktriangledown}$	-0.70$^{\blacktriangledown}$	-1.04$^{\blacktriangledown}$	-1.64	-1.08$^{\blacktriangledown}$	-0.98$^{\blacktriangledown}$	-0.89$^{\blacktriangledown}$	-0.86$^{\blacktriangledown}$
	(0.14)	(0.37)	(0.18)	(0.14)	(0.10)	(0.08)	(0.22)	(0.83)	(0.23)	(0.17)	(0.15)	(0.15)
Vegetables	-0.47$^{\blacktriangledown}$	-0.70$^{\blacktriangledown}$	-0.61$^{\blacktriangledown}$	-0.49$^{\blacktriangledown}$	-0.40$^{\blacktriangledown}$	0.05	-0.55$^{\blacktriangledown}$	-0.68$^{\blacktriangledown}$	-0.62$^{\blacktriangledown}$	-0.57$^{\blacktriangledown}$	-0.52$^{\blacktriangledown}$	-0.40$^{\bullet}$
	(0.08)	(0.04)	(0.06)	(0.08)	(0.14)	(0.80)	(0.12)	(0.08)	(0.10)	(0.12)	(0.13)	(0.18)
Fruits	-1.18$^{\blacktriangledown}$	-1.53$^{\blacktriangledown}$	-1.30$^{\blacktriangledown}$	-1.18$^{\blacktriangledown}$	-1.10$^{\blacktriangledown}$	-1.03$^{\blacktriangledown}$	-0.60$^{\blacktriangledown}$	-0.61$^{\blacktriangledown}$	-0.61$^{\blacktriangledown}$	-0.62$^{\blacktriangledown}$	-0.61$^{\blacktriangledown}$	-0.60$^{\blacktriangledown}$
	(0.08)	(0.16)	(0.10)	(0.08)	(0.07)	(0.07)	(0.10)	(0.14)	(0.11)	(0.09)	(0.08)	(0.08)
Meat	-1.40$^{\blacktriangledown}$	-1.81$^{\blacktriangledown}$	-1.51$^{\blacktriangledown}$	-1.41$^{\blacktriangledown}$	-1.38$^{\blacktriangledown}$	-1.30$^{\blacktriangledown}$	-0.29	-0.42	-0.39	-0.29	-0.21	-0.11
	(0.19)	(0.33)	(0.23)	(0.20)	(0.18)	(0.15)	(0.23)	(0.43)	(0.30)	(0.25)	(0.22)	(0.20)
Fish	-1.34$^{\blacktriangledown}$	-1.46$^{\blacktriangledown}$	-1.40$^{\blacktriangledown}$	-1.34$^{\blacktriangledown}$	-1.35$^{\blacktriangledown}$	-1.26$^{\blacktriangledown}$	-1.25$^{\blacktriangledown}$	-1.34$^{\blacktriangledown}$	-1.31$^{\blacktriangledown}$	-1.25$^{\blacktriangledown}$	-1.24$^{\blacktriangledown}$	-1.22$^{\blacktriangledown}$
	(0.13)	(0.19)	(0.15)	(0.13)	(0.14)	(0.11)	(0.13)	(0.17)	(0.14)	(0.13)	(0.13)	(0.13)
Legumes	-0.71$^{\blacktriangledown}$	-0.72$^{\blacktriangledown}$	-0.73$^{\blacktriangledown}$	-0.71$^{\blacktriangledown}$	-0.71$^{\blacktriangledown}$	-0.67$^{\blacktriangledown}$	-0.79$^{\blacktriangledown}$	-0.79$^{\blacktriangledown}$	-0.80$^{\blacktriangledown}$	-0.79$^{\blacktriangledown}$	-0.78$^{\blacktriangledown}$	-0.73$^{\blacktriangledown}$
	(0.05)	(0.04)	(0.04)	(0.05)	(0.05)	(0.06)	(0.11)	(0.06)	(0.09)	(0.16)	(0.11)	(0.23)
Milk	-1.40$^{\blacktriangledown}$	-1.86°	-1.56$^{\bullet}$	-1.44$^{\blacktriangledown}$	-1.30$^{\blacktriangledown}$	-1.15$^{\blacktriangledown}$	-1.26$^{\blacktriangledown}$	-1.55$^{\blacktriangledown}$	-1.34$^{\blacktriangledown}$	-1.25$^{\blacktriangledown}$	-1.19$^{\blacktriangledown}$	-1.14$^{\blacktriangledown}$
	(0.36)	(0.74)	(0.46)	(0.37)	(0.30)	(0.24)	(0.27)	(0.44)	(0.30)	(0.26)	(0.23)	(0.23)
Fats	-0.20	-0.41$^{\blacktriangledown}$	-0.29$^{\bullet}$	-0.21	-0.14	-0.02	-0.60$^{\blacktriangledown}$	-0.71$^{\blacktriangledown}$	-0.67$^{\blacktriangledown}$	-0.61$^{\blacktriangledown}$	-0.59$^{\blacktriangledown}$	-0.53$^{\blacktriangledown}$
	(0.15)	(0.13)	(0.14)	(0.14)	(0.16)	(0.17)	(0.15)	(0.14)	(0.14)	(0.14)	(0.15)	(0.17)
Sugar	-0.91$^{\blacktriangledown}$	-1.08$^{\blacktriangledown}$	-0.94$^{\blacktriangledown}$	-0.91$^{\blacktriangledown}$	-0.89$^{\blacktriangledown}$	-0.86$^{\blacktriangledown}$	-0.97$^{\blacktriangledown}$	-1.12$^{\blacktriangledown}$	-0.99$^{\blacktriangledown}$	-0.97$^{\blacktriangledown}$	-0.96$^{\blacktriangledown}$	-0.95$^{\blacktriangledown}$
	(0.17)	(0.24)	(0.18)	(0.18)	(0.17)	(0.15)	(0.23)	(0.27)	(0.22)	(0.22)	(0.22)	(0.23)
Other	-2.23$^{\blacktriangledown}$	-1.84$^{\blacktriangledown}$	-2.59$^{\blacktriangledown}$	-2.65$^{\blacktriangledown}$	-2.30$^{\blacktriangledown}$	-1.90$^{\blacktriangledown}$	-0.81$^{\blacktriangledown}$	-0.60	-0.74$^{\bullet}$	-0.81$^{\blacktriangledown}$	-0.81$^{\blacktriangledown}$	-0.76$^{\blacktriangledown}$
	(0.14)	(0.11)	(0.18)	(0.19)	(0.16)	(0.10)	(0.20)	(0.43)	(0.35)	(0.22)	(0.17)	(0.13)

Symbols $^{\circ}$, $^{\bullet}$, and $^{\blacktriangledown}$ indicate coefficients significantly different from zero at level 0.1, 0.05, and 0.01, respectively. Source: own computation.

Table B.4: Unconditional, uncompensated price elasticities ε_{ij} of food item demand for a mean rural household

ε_{ij}	Maize	Cere-als	Pota-toes	Cas-sava	Mato-oke	Vege-tables	Fruits	Meat	Fish	Legu-mes	Milk	Fats	Sugar	Other
Maize	-1.45$^{\blacktriangledown}$	0.20$^{\blacktriangledown}$	0.06	0.42$^{\blacktriangledown}$	0.07	0.00	-0.03	-0.07	0.11$^{\bullet}$	-0.16$^{\blacktriangledown}$	0.17$^{\bullet}$	-0.10$^{\bullet}$	-0.18$^{\bullet}$	0.21$^{\blacktriangledown}$
	(0.11)	(0.07)	(0.06)	(0.07)	(0.07)	(0.05)	(0.04)	(0.10)	(0.05)	(0.05)	(0.08)	(0.05)	(0.09)	(0.06)
Cereals	0.20	-1.82$^{\blacktriangledown}$	0.18$^{\bullet}$	-0.05	-0.08	-0.20$^{\bullet}$	0.22$^{\blacktriangledown}$	-0.24	0.13	0.05	-0.11	0.03	0.12	0.34$^{\blacktriangledown}$
	(0.14)	(0.15)	(0.09)	(0.12)	(0.10)	(0.08)	(0.06)	(0.16)	(0.08)	(0.08)	(0.14)	(0.09)	(0.17)	(0.09)
Potatoes	0.06	0.20$^{\blacktriangledown}$	-0.99$^{\blacktriangledown}$	-0.08	-0.01	0.11°	0.03	0.22$^{\bullet}$	0.10	-0.13$^{\bullet}$	-0.04	-0.02	0.04	-0.06
	(0.10)	(0.07)	(0.10)	(0.08)	(0.07)	(0.06)	(0.04)	(0.12)	(0.06)	(0.06)	(0.10)	(0.08)	(0.14)	(0.07)
Cassava	0.33$^{\blacktriangledown}$	-0.08	-0.23$^{\blacktriangledown}$	-0.57$^{\blacktriangledown}$	-0.09	0.06°	-0.04	-0.09	-0.16$^{\blacktriangledown}$	0.11$^{\bullet}$	0.12	-0.08°	-0.12	0.30$^{\blacktriangledown}$
	(0.08)	(0.06)	(0.06)	(0.09)	(0.06)	(0.04)	(0.03)	(0.09)	(0.05)	(0.05)	(0.08)	(0.05)	(0.11)	(0.06)
Matooke	-0.14	0.15	-0.15	0.07	-0.95$^{\blacktriangledown}$	-0.11	-0.21$^{\bullet}$	-0.06	0.24$^{\bullet}$	0.22	0.07	0.15	-0.07	-0.05
	(0.20)	(0.16)	(0.14)	(0.17)	(0.14)	(0.12)	(0.08)	(0.23)	(0.11)	(0.12)	(0.21)	(0.16)	(0.28)	(0.13)
Vegetables	0.03	-0.23$^{\blacktriangledown}$	0.17°	-0.14$^{\bullet}$	0.01	-0.47$^{\blacktriangledown}$	0.10$^{\bullet}$	0.17	0.11°	-0.05	0.04	0.04	0.23$^{\blacktriangledown}$	0.12
	(0.10)	(0.08)	(0.08)	(0.08)	(0.08)	(0.09)	(0.04)	(0.13)	(0.06)	(0.06)	(0.08)	(0.04)	(0.07)	(0.09)
Fruits	0.01	0.10	0.01	-0.22$^{\bullet}$	-0.33$^{\blacktriangledown}$	0.10	-1.21$^{\blacktriangledown}$	-0.06	0.05	0.07	0.07	-0.22$^{\bullet}$	-0.25	0.19$^{\bullet}$
	(0.12)	(0.09)	(0.09)	(0.11)	(0.09)	(0.07)	(0.08)	(0.14)	(0.07)	(0.08)	(0.12)	(0.08)	(0.18)	(0.09)
Meat	-0.18°	-0.15°	0.03	-0.13°	-0.09	0.05	-0.09°	-1.50$^{\blacktriangledown}$	0.07	0.18$^{\blacktriangledown}$	-0.22$^{\bullet}$	-0.06$^{\bullet}$	-0.14$^{\bullet}$	-0.22$^{\blacktriangledown}$
	(0.09)	(0.08)	(0.09)	(0.07)	(0.08)	(0.05)	(0.05)	(0.19)	(0.07)	(0.06)	(0.08)	(0.03)	(0.05)	(0.08)
Fish	0.02	-0.28	0.11	-0.71$^{\blacktriangledown}$	-0.21	0.19	-0.17°	0.08	-1.37$^{\blacktriangledown}$	0.21	-0.11	0.25	-0.14	-0.06
	(0.21)	(0.16)	(0.15)	(0.19)	(0.14)	(0.12)	(0.09)	(0.23)	(0.13)	(0.12)	(0.21)	(0.17)	(0.31)	(0.12)
Legumes	-0.12$^{\bullet}$	0.01	-0.09$^{\bullet}$	0.03	-0.10$^{\bullet}$	-0.02	-0.01	0.22$^{\blacktriangledown}$	0.10$^{\bullet}$	-0.76$^{\blacktriangledown}$	0.02	0.03$^{\bullet}$	0.04	0.08°
	(0.06)	(0.05)	(0.04)	(0.04)	(0.04)	(0.03)	(0.02)	(0.07)	(0.04)	(0.05)	(0.05)	(0.02)	(0.03)	(0.04)
Milk	-0.17	-0.03	0.02	0.34	0.07	0.07	-0.07	-0.79$^{\bullet}$	-0.35$^{\bullet}$	-0.05	-1.42$^{\blacktriangledown}$	0.20	0.41	0.24
	(0.29)	(0.20)	(0.17)	(0.24)	(0.18)	(0.15)	(0.11)	(0.30)	(0.15)	(0.16)	(0.36)	(0.20)	(0.37)	(0.17)
Fats	-0.23$^{\bullet}$	-0.06	0.04	-0.18°	-0.14$^{\bullet}$	0.16°	-0.19$^{\blacktriangledown}$	-0.08	0.09	0.04	0.18	-0.21	0.08	0.10
	(0.12)	(0.09)	(0.08)	(0.10)	(0.08)	(0.08)	(0.05)	(0.13)	(0.07)	(0.08)	(0.13)	(0.15)	(0.15)	(0.10)
Sugar	-0.31$^{\bullet}$	-0.04	-0.11°	0.07	-0.09	0.24$^{\blacktriangledown}$	-0.06	-0.26$^{\bullet}$	0.01	0.08	0.14	0.08	-0.94$^{\blacktriangledown}$	0.18$^{\bullet}$
	(0.11)	(0.09)	(0.07)	(0.08)	(0.06)	(0.07)	(0.04)	(0.12)	(0.05)	(0.06)	(0.10)	(0.06)	(0.17)	(0.07)
Other	0.37$^{\blacktriangledown}$	0.23$^{\bullet}$	-0.11	0.20°	0.07	-0.23$^{\blacktriangledown}$	0.17$^{\blacktriangledown}$	0.32$^{\bullet}$	-0.14°	-0.08	-0.20°	-0.05	0.17$^{\bullet}$	-2.27$^{\blacktriangledown}$
	(0.14)	(0.12)	(0.12)	(0.12)	(0.12)	(0.07)	(0.06)	(0.16)	(0.09)	(0.08)	(0.13)	(0.05)	(0.07)	(0.14)

Symbols $^{\circ}$, $^{\bullet}$, and $^{\blacktriangledown}$ indicate coefficients significantly different from zero at level 0.1, 0.05, and 0.01, respectively. Source: own computation.

Table B.5: Unconditional, uncompensated price elasticities ε_{ij} of food item demand for a mean urban household

ε_{ij}	Maize	Cere-als	Pota-toes	Cas-sava	Mato-oke	Vege-tables	Fruits	Meat	Fish	Legu-mes	Milk	Fats	Sugar	Other
Maize	-1.51$^{\blacktriangledown}$	0.35$^{\blacktriangledown}$	0.10	0.36$^{\bullet}$	-0.13	-0.04	-0.05	-0.07	0.12	0.08	0.19	0.08	-0.02	-0.01
	(0.22)	(0.13)	(0.11)	(0.14)	(0.12)	(0.09)	(0.07)	(0.19)	(0.10)	(0.11)	(0.13)	(0.07)	(0.14)	(0.16)
Cereals	0.37$^{\blacktriangledown}$	-0.95$^{\blacktriangledown}$	-0.05	-0.04	0.08	-0.03	0.18$^{\blacktriangledown}$	-0.26°	0.17$^{\bullet}$	0.14	0.11	0.00	-0.05	0.27$^{\bullet}$
	(0.11)	(0.15)	(0.09)	(0.10)	(0.10)	(0.07)	(0.07)	(0.14)	(0.07)	(0.10)	(0.11)	(0.05)	(0.11)	(0.12)
Potatoes	0.30$^{\bullet}$	0.18	-0.63$^{\blacktriangledown}$	0.12	-0.18°	-0.05	0.01	0.40$^{\bullet}$	0.24$^{\blacktriangledown}$	-0.17	-0.14	0.04	0.12	0.06
	(0.16)	(0.14)	(0.14)	(0.12)	(0.13)	(0.10)	(0.08)	(0.19)	(0.09)	(0.11)	(0.13)	(0.10)	(0.20)	(0.15)
Cassava	0.41	-0.01	0.03	-0.60$^{\blacktriangledown}$	0.06	-0.02	-0.08	0.07	-0.39$^{\bullet}$	0.13	-0.39°	-0.09	0.42	0.02
	(0.28)	(0.22)	(0.17)	(0.22)	(0.20)	(0.17)	(0.11)	(0.29)	(0.15)	(0.18)	(0.24)	(0.17)	(0.35)	(0.20)
Matooke	-0.48	0.29	0.16	0.06	-1.07$^{\blacktriangledown}$	-0.17	0.13	-0.02	-0.15	0.59$^{\blacktriangledown}$	0.03	0.14	-0.57	0.01
	(0.27)	(0.23)	(0.16)	(0.16)	(0.22)	(0.17)	(0.11)	(0.28)	(0.14)	(0.17)	(0.22)	(0.15)	(0.37)	(0.20)
Vegetables	-0.07	-0.05	-0.07	-0.06	-0.01	-0.56$^{\blacktriangledown}$	0.00	-0.02	0.20$^{\blacktriangledown}$	0.07	0.09	-0.01	0.13	0.37$^{\blacktriangledown}$
	(0.13)	(0.13)	(0.08)	(0.10)	(0.09)	(0.12)	(0.05)	(0.12)	(0.07)	(0.10)	(0.12)	(0.06)	(0.10)	(0.13)
Fruits	-0.13	0.27°	0.06	-0.13	-0.21	0.11	-0.62$^{\blacktriangledown}$	-0.37$^{\bullet}$	-0.06	0.14	0.01	-0.23$^{\bullet}$	-0.12	0.17
	(0.17)	(0.17)	(0.13)	(0.13)	(0.14)	(0.10)	(0.10)	(0.18)	(0.10)	(0.12)	(0.15)	(0.10)	(0.20)	(0.17)
Meat	-0.07	-0.25$^{\bullet}$	0.07	-0.12	-0.32$^{\blacktriangledown}$	0.01	-0.07	-0.37	0.18$^{\bullet}$	0.15°	-0.14	-0.13$^{\bullet}$	-0.28°	-0.38$^{\blacktriangledown}$
	(0.13)	(0.11)	(0.09)	(0.10)	(0.10)	(0.07)	(0.06)	(0.23)	(0.08)	(0.09)	(0.10)	(0.06)	(0.13)	(0.13)
Fish	0.23$^{\bullet}$	0.11	0.13	-0.21°	-0.19°	0.21$^{\blacktriangledown}$	-0.09	0.23	-1.28$^{\blacktriangledown}$	0.32$^{\blacktriangledown}$	-0.11	-0.08	-0.08	-0.38$^{\bullet}$
	(0.13)	(0.11)	(0.09)	(0.11)	(0.11)	(0.07)	(0.07)	(0.14)	(0.13)	(0.10)	(0.10)	(0.07)	(0.13)	(0.17)
Legumes	-0.00	0.11	-0.25$^{\blacktriangledown}$	0.01	0.08	0.07	-0.03	0.06	0.18$^{\blacktriangledown}$	-0.81$^{\blacktriangledown}$	0.21$^{\blacktriangledown}$	-0.02	0.21$^{\blacktriangledown}$	-0.05
	(0.11)	(0.10)	(0.07)	(0.09)	(0.08)	(0.06)	(0.05)	(0.12)	(0.07)	(0.11)	(0.08)	(0.03)	(0.19)	(0.12)
Milk	0.11	0.22	0.03	-0.09	-0.22	0.02	0.10	-0.48°	-0.07	0.38$^{\bullet}$	-1.28$^{\blacktriangledown}$	-0.03	-0.37	0.16
	(0.25)	(0.22)	(0.16)	(0.17)	(0.17)	(0.15)	(0.10)	(0.27)	(0.12)	(0.17)	(0.27)	(0.12)	(0.30)	(0.18)
Fats	0.40$^{\bullet}$	0.03	-0.15	0.07	-0.11	0.02	-0.01	-0.33$^{\bullet}$	-0.06	-0.07	0.02	-0.61$^{\blacktriangledown}$	-0.17	0.55$^{\blacktriangledown}$
	(0.17)	(0.13)	(0.11)	(0.12)	(0.11)	(0.11)	(0.06)	(0.17)	(0.08)	(0.12)	(0.11)	(0.15)	(0.17)	(0.14)
Sugar	0.04	-0.07	-0.14°	0.08	-0.02	0.11	-0.01	-0.01	0.03	0.31$^{\blacktriangledown}$	0.02	-0.01	-0.99$^{\blacktriangledown}$	0.26$^{\blacktriangledown}$
	(0.15)	(0.13)	(0.09)	(0.10)	(0.10)	(0.09)	(0.06)	(0.15)	(0.07)	(0.09)	(0.11)	(0.07)	(0.23)	(0.11)
Other	-0.09	0.06	-0.07	-0.06	0.19°	0.04	0.03	-0.28°	-0.14	-0.13	0.02	0.08$^{\blacktriangledown}$	0.04	-0.88$^{\blacktriangledown}$
	(0.12)	(0.11)	(0.12)	(0.12)	(0.12)	(0.06)	(0.07)	(0.15)	(0.11)	(0.09)	(0.09)	(0.04)	(0.06)	(0.20)

Symbols $^{\circ}$, $^{\bullet}$, and $^{\blacktriangledown}$ indicate coefficients significantly different from zero at level 0.1, 0.05, and 0.01, respectively. Source: own computation.