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**Estimating household demand for millet
and sorghum in Niger and Nigeria**

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Abstract

Millet and sorghum are two important crops and source of calories for poor households in semiarid West and Central Africa. This research analyzes the response of household demand for millet and sorghum to income and prices in Niger and Nigeria using the latest Living Standards Measurement Study-Integrated Surveys on Agriculture (LSMS-ISA) data by a two-stage method. In the first stage, a Working-Leser model is estimated to obtain the elasticity of food expenditure with respect to household total expenditure. In the second stage, a Quadratic Almost Ideal Demand System (QUAIDS) model, incorporating household socio-demographic characteristics and regional dummy variables, is estimated for rural and urban households separately. Unconditional expenditure elasticities, own-price elasticities, and cross-price elasticities are obtained by combining the results of first and second stages. Results reveal that millet and sorghum are necessities for households in Niger and Nigeria. As income grows, household demand for the two crops will increase but at a lower rate than income growth in both countries. Demand for sorghum and millet among rural households is less responsive to income and price changes compared with urban households. Considering high population growth rate and increasing urbanization rate in the two countries, it is expected that total demand for millet and sorghum will continue to increase, but their share in household's food budget will decline.

Keywords: millet demand, sorghum demand, quadratic almost ideal demand system, Niger, Nigeria.

JEL classification: Q11, Q12

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1 Introduction

Niger and Nigeria, both of which received their names from the Niger River, are two West African countries that are different in many aspects despite being neighbours. Niger is land-locked, while Nigeria is located on the Gulf of Guinea and rich in oil. In 2014, Niger had a population of 19.1 million, while Nigeria had a population of 177.5 million, which makes Nigeria the most populous country on the continent. Both countries have a high population growth rate, averaging annually 4% in Niger and 2.7% in Nigeria between 2012 and 2014. Nigeria has a higher rate of urbanization than Niger; in 2014, 47% of the population in Nigeria lived in urban areas compared to only 18% of the population in Niger. However, the rate at which urban population is growing is faster in Niger than Nigeria (5.4 % vs. 4.5%).

The most remarkable difference between the two countries is their economic development. In 2014, the average GDP per capita in Nigeria was US\$3,203, which according to the World Bank's country economic classification corresponds to a lower-middle-income country. With an average GDP per capita of only US\$427 in 2014, Niger is one of the least-developed countries. Although the growth rate of GDP was slightly higher in Niger (6.9%) than in Nigeria (6.3%), per capita GDP growth was higher in Nigeria (3.5%) than in Niger (2.7%) since Niger has a faster population growth. Headcount poverty ratio of Niger at the national poverty line was 48.9% in 2011¹, and that of Nigeria was 35%² in 2010/2011. All these facts indicate that Nigeria is economically better-off than Niger.

In Niger and Nigeria, like in most Sahel countries in West and Central Africa (WCA), millet and sorghum are crucial to the diets and livelihood of the rural population. In Niger, consumption of millet and sorghum averages 144 and 38 kg/capita/year over the last two decades, making these crops key to household food security (FAO, 2015). This translates into over 1,000 and 300 daily calories per capita for millet and sorghum, respectively. There is a slight decrease in per capita millet consumption over the last two decades in Niger, which was estimated at 157 kg/year in 1991 compared to 141 kg/year in 2011. Per capita sorghum consumption has increased during the same period, reaching its highest in 2010 at about 48 kg/year.

In Nigeria, per capita millet and sorghum consumption averages respectively 32 and 40 kg/year over the last two decades (FAO, 2015). This makes sorghum a more important food commodity than millet, where the opposite is true in Niger. Consumption trends are also more stable for the two crops in Nigeria. Per capita millet consumption fluctuated only mildly between 1991 and 2010 (estimated at 30 kg/year in both years). For sorghum, per capita consumption was 38 kg/year in 1991, reached its peak in 1996 at about 46 kg/year, and has been decreasing since then. In 2011, per capita consumption of sorghum was estimated to be 32 kg/year. The contribution of millet and sorghum to household diets over the past two decade is on average 260 and 320 kcal/capita/day.

While informative in providing an overview of food commodity consumption, FAO statistics, being based on country aggregate net supply, provide no information on how consumption may vary by different categories of households such as urban/rural and poor/non-poor

¹ Data above are retrieved from World Bank (<http://databank.worldbank.org/>).

² Nigeria Economic Report No. 2, World Bank, 2014

households. Such information is important to understand the importance of sorghum and millet in household diets and how demand for these two crops is expected to evolve with income growth and urbanization. Using nationally representative household survey data, this study attempts to fill these gaps.

The overall objective of this study is to estimate consumption and demand for sorghum and millet in Niger and Nigeria. The specific objectives are to:

1. Document sorghum and millet consumption patterns by population sub-groups; and
2. Estimate the responsiveness of sorghum and millet demand to changes in the crop own price (own-price elasticities), other food group prices (cross-price elasticities), and household expenditures (expenditure elasticities).

The rationale for this study is to inform the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) scientists and the research community regarding changes and drivers in sorghum and millet consumption demand in WCA. The findings will directly influence ICRISAT's research strategy for sorghum and millet in the dryland areas of West Africa, through ICRISAT's leadership of the CGIAR Research Program (CRP) on Dryland Cereals. The findings will provide information on the size and potential growth of demand for dryland cereals in the two most important target countries for this CRP and its competitiveness with other cereals, such as rice.

This study will add to the limited but growing literature on food demand analysis in developing countries by estimating a household food demand system in Niger and Nigeria based on the most recent Living Standards Measurement Study-Integrated Surveys on Agriculture (LSMS-ISA) data. A Quadratic Almost Ideal Demand System (QUAIDS) developed by Banks, Blundell, and Lewbel (1997), comprising of nine food groups, where millet and sorghum are individual food groups, is estimated separately for urban and rural households. Household demographic variables and regional dummy variables are incorporated into the model using the approach proposed by Ray (1983). Results reveal that in Niger and Nigeria millet and sorghum are necessities for both rural and urban households, and the demand for millet and sorghum of rural households is less responsive to changes in expenditure and price compared with urban households.

The remainder of this paper is structured as follows. The data used for analysis and the related surveys are introduced in the next section, and basic household demographic features are presented and compared. Then millet and sorghum consumption in Niger and Nigeria are summarized in section 3. After that, the basics of the QUAIDS model and the composition of the nine food groups are introduced in section 4. Finally, model results are presented in section 5, and conclusions are discussed in the last section.

2 Data

This study makes use of the data most recently collected under the LSMS-ISA project led by the Development Research Group at the World Bank in collaboration with country national statistics institutes. In Niger, the latest *Enquête Nationale sur les Conditions de Vie des Ménages et l'Agriculture* (ECVMA, National Survey of Household Living Conditions and Agriculture) was conducted in 2011 and includes 3,968 households located across 270 Enumeration Areas. The survey is nationally representative, in addition to be representative of Niamey, urban areas, rural areas, and the three ecological zones characterizing the rural areas. After eliminating observations with measurement errors³, 3,859 households are used in the analysis, of which 2,343 are located in rural areas and the remaining 1,516 in urban centres.

The analysis on Nigeria utilizes the second wave data of the General Household Survey-Panel (GHS-Panel) which was conducted in 2012-13. After eliminating the observations with measurement problems, the data set includes 4,533 households; 3,163 households are identified as rural and 1,370 are identified as urban. In both countries, surveys included the following three questionnaires: a household, an agriculture, and a community questionnaire. The household questionnaire contains very detailed information about household food and non-food expenditures and forms the basis for this study.

The food expenditures section includes 125 and 105 food and beverages items for Niger and Nigeria respectively (tobacco and alcoholic drinks are excluded from our food demand analysis⁴). Households were interviewed twice, at post-planting and post-harvest time, in order to capture the seasonality of agriculture and resulting consumption patterns. Households were asked to recall food consumption expenditures in the past seven days at each visit, which included food consumed away from home and food consumed at home that came from purchases, own-production, and in-kind payments or gifts. Expenditures from the two rounds were aggregated and adjusted considering temporal and regional price differences, and rescaled into annual expenditure in order to obtain measures of household food expenditures. The community questionnaire serves to gather information on food prices at the community-level whenever the food items were available for purchase.

Basic household demographics for Niger and Nigeria are summarized in Table 1, disaggregated by rural and urban areas and welfare quintiles⁵. Households in Niger and Nigeria share some similar characteristics. Rural households are larger and have more

³ These observations are excluded mainly because the household did not report food expenditures.

⁴ Tobacco, cigarettes, and alcoholic drinks are excluded from the analysis because this study focuses on demand for food that contributes to the essential nutrition requirements of households.

⁵ Welfare quintiles are obtained using per capita total expenditure (household total expenditure/household size) as a welfare measurement. Household total expenditure includes food expenditure from all sources, all non-food expenditure, rent or imputed value of self-occupied dwelling, and imputed value from using durable goods. The poorest 20% of households belong to quintile 1, while the wealthiest 20% belong to quintile 5. The quintiles in rural and urban areas are obtained separately. Therefore, rural quintile 1 is associated with the poorest 20% households in rural areas, and urban quintile 1 is associated with the poorest 20% in urban areas.

children. Urban households are more likely to be headed by females, and heads of urban households have significantly better education than their rural counterparts. Only 4% of rural household heads in Niger and 24% in Nigeria have a secondary education or higher, while in urban areas these percentages are 27 % and 53%, respectively.

Table 1: Household demographic features of Niger and Nigeria

Country	Group	Welfare quintiles	Household size by age group				% of households with female head	Education of household head (%)		
			Total	under 5	between 5 and 15	between 15 and 60		illiterate	primary education or equivalent	secondary education or higher
Niger	rural	1	8.8	2.7	2.9	2.9	8.07	55.47	42.87	1.66
		2	7.9	2.2	2.5	2.8	7.97	54.26	42.70	3.04
		3	7.0	2.0	2.1	2.5	10.80	52.61	45.82	1.57
		4	6.1	1.6	1.7	2.5	10.93	48.86	45.79	5.35
		5	4.9	1.2	1.1	2.2	9.91	40.07	51.63	8.29
		All	6.6	1.8	1.9	2.5	9.69	49.08	46.43	4.48
	urban	1	8.2	2.0	3.0	2.9	16.62	33.79	59.13	7.08
		2	7.3	1.4	2.4	3.1	21.06	38.06	50.42	11.52
		3	6.6	1.4	1.9	3.1	16.14	29.62	53.37	17.00
		4	6.2	1.3	1.7	3.0	12.12	24.83	47.68	27.49
		5	4.7	0.8	1.0	2.8	15.76	14.16	29.99	55.84
All		6.4	1.3	1.8	3.0	16.15	26.57	46.25	27.18	
All	All	6.6	1.7	1.9	2.6	10.85	45.04	46.40	8.56	
Nigeria	rural	1	8.3	1.5	2.8	3.4	7.34	47.60	42.07	10.34
		2	7.8	1.4	2.4	3.3	8.75	42.15	40.74	17.11
		3	6.8	1.0	2.0	3.0	11.40	40.66	41.23	18.11
		4	6.3	0.9	1.8	2.9	16.59	37.98	39.01	23.02
		5	4.8	0.5	1.0	2.4	23.89	27.21	33.04	39.75
		All	6.5	1.0	1.9	3.0	14.81	37.76	38.57	23.66
	urban	1	7.3	1.3	2.3	3.1	17.43	34.14	35.56	30.29
		2	6.8	0.9	1.7	3.2	20.01	31.50	31.65	36.85
		3	6.0	0.9	1.5	2.9	18.90	17.75	33.75	48.50
		4	5.2	0.6	1.1	2.8	18.74	14.45	27.01	58.55
		5	4.1	0.3	0.7	2.4	18.77	11.47	15.64	72.89
All		5.7	0.7	1.3	2.8	18.79	20.14	27.28	52.58	
All	All	6.2	0.9	1.7	2.9	16.42	30.63	34.00	35.37	

Households from the two countries also differ for some demographics. Average household size is slightly smaller in Nigeria than Niger, and Nigerians have fewer children. Household heads in Nigeria have significantly better education than those in Niger. All these indicate that Nigeria is at a higher level of human development than Niger. In 2012, the human development index (HDI) for Nigeria was 0.471, and ranking 153, while the HDI for Niger was only 0.304 and thus ranking at the bottom of 186 countries⁶.

Household per capita food expenditures and share in total expenditures in Niger and Nigeria, disaggregated by rural and urban areas and welfare quintiles, are presented in Table 2. Rural households allocate a higher proportion of their expenditure to food compared with urban households (71% vs. 54% in Niger, 77% vs. 67% in Nigeria). In both countries and for both

⁶ *Human Development Report 2013*, United Nations Development Programme (UNDP)

rural and urban households, per capita food expenditure increases as households get wealthier. However, in rural areas of both countries, the share of food expenditure in total expenditure stays relatively constant from the first quintile to fourth quintile and only decreases for the best-off quintile, while in urban areas it decreases with each additional wealth quintile (62% to 43% in Niger, 72% to 61% in Nigeria). Food expenditures among rural households in both countries tend to increase at the same rate as income growth.

Table 2: Food expenditure in Niger and Nigeria

Group	Welfare quintiles	Per capita food expenditure (US\$)		% in total expenditure	
		Niger	Nigeria	Niger	Nigeria
Rural	1	121	160	72.59	79.12
	2	169	247	72.92	79.37
	3	212	323	73.31	78.93
	4	267	427	72.21	77.86
	5	363	744	66.73	72.72
	All	226	380	71.09	77.05
Urban	1	166	260	62.36	71.91
	2	246	395	59.85	70.95
	3	316	496	56.74	68.74
	4	416	637	54.43	66.12
	5	594	975	42.97	60.90
	All	347	552	53.92	66.82
All	1	126	179	72.57	78.22
	2	177	287	72.26	77.98
	3	226	387	72.01	75.93
	4	283	510	69.18	72.91
	5	424	856	58.78	65.20
	All	247	444	68.01	72.91

3 Descriptive statistics on millet and sorghum consumption

3.1 Niger

According to the ECVM/A 2011 data, 97% of households in Niger consumed millet and 52% consumed sorghum during the survey period (Table 3). Average annual per capita expenditure on millet is 55 US\$, and average share in food expenditure is 25%. For sorghum, average annual per capita expenditure and share in food expenditure are 9 US\$ and 4%. According to the national poverty line⁷, 40%⁸ of Niger's households are poor. However, there is a sharp difference in poverty rate between rural and urban areas; 46% of rural households are poor compared to only 14% of urban households. Not surprisingly, millet and sorghum are more important in the diets of poor households compared with non-poor households. Poor households allocate a higher share of their food budget to the two crops, although per capita expenditures on sorghum and millet are similar between poor and non-poor households.

The percentage of rural households that consume sorghum (59%) is more than three-fold that that of urban households (18%), while the rural-urban difference is much smaller for millet (99% vs. 88%). In addition to being more likely to consume millet and sorghum, rural households also have higher consumption level than their urban counterparts. Average per capita expenditure on millet is 2.7 times greater in rural than urban areas, and 4.9 times greater among rural households for sorghum. This confirms that rural households rely more intensively on these two cereal as source of calories. In both rural and urban areas, millet and sorghum consumption in terms of share in food expenditure is greater for poor households than non-poor. Therefore, consumption of millet and sorghum is the greatest among rural poor households and the smallest for urban non-poor households.

⁷ A poverty indicator is provided in the LSMS-ISA datasets based on a national poverty line of 362 US\$/year/person. The poverty line was computed following Ravallion's method (Ravallion, 1998), which first consists of computing the food poverty line. In Niger, the food poverty line corresponds to expenditure needed to fulfill the calorie requirement of 2,400 kcal/person/day. After that, the non-food poverty line is obtained as the non-food expenditure of those households whose per capita food expenditure is at the food poverty line. The food and non-food poverty lines are combined to generate the final poverty line. Households with per capita total expenditure below the poverty line are considered poor, and those above the poverty line are considered non-poor (*ECVM/A-2011 Basic Information Report*, Niger National Institute of Statistics, 2013).

⁸ This is the percentage of households below the poverty line. The World Bank reports the poverty headcount ratio at national poverty line, which is 48.9% in 2011 for Niger.

Table 3: Millet and sorghum consumption in Niger and Nigeria, by rural/urban and poor/non-poor

Crops	Group	Poverty	% of households consuming the product		Per capita expenditure (US\$)		% in household food expenditure	
			Niger	Nigeria	Niger	Nigeria	Niger	Nigeria
Millet	Rural	Poor	99.16	46.57	56	12	35.33	5.48
		Non-poor	99.79	29.00	69	11	24.01	2.25
		All rural	99.50	35.45	62	11	29.18	3.44
	Urban	Poor	92.24	27.54	25	5	15.98	2.01
		Non-poor	87.17	9.66	22	3	6.46	0.47
		All urban	87.85	11.15	23	3	7.75	0.60
	All	Poor	98.74	44.03	54	11	34.15	5.02
		Non-poor	96.52	19.40	56	7	19.46	1.37
		All	97.41	25.61	55	8	25.33	2.29
Sorghum	Rural	Poor	55.80	61.03	9	17	5.51	7.77
		Non-poor	61.43	36.53	13	13	4.38	2.77
		All rural	58.85	45.53	11	15	4.89	4.61
	Urban	Poor	24.39	34.41	2	8	1.66	3.21
		Non-poor	16.88	12.91	2	3	0.62	0.55
		All urban	17.89	14.70	2	4	0.76	0.77
	All	Poor	53.89	57.48	9	16	5.28	7.16
		Non-poor	49.90	24.81	10	8	3.40	1.67
		All	51.49	33.05	9	11	4.15	3.05

Greater consumption of millet and sorghum among poor households is also confirmed by comparing consumption indicators across welfare quintiles (Table 4). From the first to the fifth quintile, the share of millet in household food expenditure drops from 36% to 17%, and the sorghum share decreases from 4% to 3%. This is also true if we distinguish between rural and urban households. The share of millet in food expenditure among the rural (urban) poorest 20% is twice (four times) that of those belonging to the wealthiest quintile. However, the percentage of households that consume millet stays relatively stable across quintiles in both rural and urban areas. There is no clear trend in the consumption of sorghum as households become wealthier in rural Niger. In urban areas, consumption of sorghum drops from the first to the fifth quintile when considering its budget share.

Table 4: Millet and sorghum consumption in Niger and Nigeria, by rural/urban and welfare quintiles

Crops	Group	Welfare quintiles	% of households consuming the product		Per capita expenditure (US\$)		% in household food expenditure	
			Niger	Nigeria	Niger	Nigeria	Niger	Nigeria
Millet	Rural	1	98.41	49.25	49	11	40.80	6.70
		2	99.13	46.90	55	13	32.34	4.81
		3	100.00	40.36	69	13	32.59	3.81
		4	99.95	36.16	69	13	26.97	2.89
		5	99.61	17.45	69	7	20.26	1.02
	Urban	1	92.55	21.29	25	5	15.50	1.56
		2	90.45	15.33	22	5	9.27	1.05
		3	91.35	11.89	23	3	8.12	0.55
		4	89.68	7.66	23	2	5.92	0.26
		5	79.73	5.42	20	1	3.57	0.11
	All	1	98.31	44.65	45	8	36.21	4.64
		2	98.74	40.90	49	10	28.06	3.29
		3	99.43	29.44	61	9	28.15	2.52
		4	98.40	20.60	63	9	23.32	1.79
		5	93.72	8.01	58	5	17.28	0.65
Sorghum	Rural	1	48.21	65.67	6	16	5.04	9.58
		2	58.09	60.25	11	18	6.48	6.90
		3	57.60	50.70	10	17	4.55	4.90
		4	66.25	45.00	13	16	5.12	3.57
		5	60.20	22.93	14	8	3.91	1.15
	Urban	1	26.38	27.72	2	6	1.66	2.26
		2	27.27	17.66	3	5	1.32	1.10
		3	19.50	15.52	2	4	0.66	0.71
		4	15.09	12.58	2	3	0.49	0.37
		5	8.15	7.02	1	1	0.17	0.12
	All	1	50.73	60.58	6	12	4.43	6.64
		2	55.95	49.91	10	13	5.53	4.56
		3	55.25	38.02	8	12	3.84	3.24
		4	60.26	25.18	11	11	4.32	2.24
		5	38.97	11.52	11	5	3.24	0.74

Notice that in Table 2, rural households belonging to the second wealth quintile have similar average per capita food expenditure as urban households in the poorest quintile; this is also true for rural households in the fourth quintile and urban households in the second quintile. However, rural households in the second and fourth quintile allocate 32% and 27% of their food budget to millet, while urban households in the first and second quintile allocate only 16% and 9% of their food budget to millet. These large differences also exist for sorghum. Therefore, even when rural and urban residents have similar per capita food expenditure, their diet can be very different, an indication that urbanization has induced changes in food consumption habits. These differences in food consumption patterns by locality (for the same

level of per capita food expenditures) supports estimating household food demand for rural and urban areas separately.

Descriptive statistics on millet and sorghum consumption according to the eight main regions in Niger, i.e. Agadez, Diffa, Dosso, Maradi, Tahoua, Tillabéri, Zinder, and Niamey, are presented in Table 5. Only 76% of households in Niamey consume millet in the reference period, while in the other seven regions almost all households consume the cereal. Consumption of millet is the smallest for households located in the Niamey region: average per capita expenditure on millet in Niamey is only 24% of the national average. Per capita expenditure on millet is also lower than the national average in the region of Agadez, and higher than the national average in the other six regions. Millet consumption is most important in the regions of Tahoua and Tillabéri with per capita millet expenditures that are 117% and 110% of the national average respectively. Consumption of sorghum is trivial in Niamey. The proportion of households consuming sorghum, average per capita expenditure, and budget share are higher than the national average in Tahoua and Zinder. Consumption of sorghum is the greatest for households in Tahoua; its average per capita expenditure is 176% of the national average. In sum, consumption of both cereal is largest in Tahoua and smallest in Niamey in terms of both per capita expenditure and budget share. Compared with millet, sorghum consumption has larger spatial variations.

Table 5: Millet and sorghum consumption in Niger and Nigeria, by regions/zones

Country	Regions/Zones	Millet			Sorghum		
		% of households consuming the product	Per capita expenditure (US\$)	% in household food expenditure	% of households consuming the product	Per capita expenditure (US\$)	% in household food expenditure
Niger	Agadez	98.57	37	13.13	23.43	3	1.36
	Diffa	98.73	62	23.81	28.21	5	1.67
	Dosso	98.79	60	27.70	43.62	8	3.52
	Maradi	99.20	53	26.75	51.38	8	3.57
	Tahoua	99.20	64	28.08	75.33	16	7.21
	Tillabéri	98.22	61	29.38	39.25	6	3.17
	Zinder	98.75	55	26.05	63.20	11	4.83
	Niamey	76.35	13	3.53	8.34	1	0.29
Nigeria	North Central	23.12	5	1.39	57.55	13	3.43
	North East	51.79	17	5.68	67.84	20	7.26
	North West	85.84	22	7.66	87.86	26	9.25
	South East	0.41	0*	0.01	1.44	0*	0.02
	South South	0.68	0*	0.00	0.31	0*	0.00
	South West	0.11	0*	0.00	2.93	0*	0.06

* These values are so small that they became zero after converting local currency (Naira) to US\$.

3.2 Nigeria

Only one quarter of Nigerian households consumed millet and one third consumed sorghum during the survey period (Table 3). Average annual per capita expenditure on millet is 8 US\$, and average share in food expenditure is 2%. For sorghum, average annual per capita expenditure is 11 US\$, and its share in food expenditure averages 3%. At the national poverty

line, 25%⁹ of households in Nigeria are poor. In rural areas, the household poverty rate reaches 37% compared with 8% in urban areas. Poor households are more than twice as likely to consume sorghum and millet during the reference period, and have on average higher per capita expenditures and expenditure shares for these two cereal crops compared with non-poor households. Rural households, no matter poor or non-poor, consume more millet and sorghum than urban households. Rural average per capita expenditure on millet (sorghum) is 3.6 (3.9) times that of urban households.

The percentage of households that consume sorghum and millet and the food expenditure share for these two cereal crops drops from the first to the fifth quintile for both rural and urban households (Table 4). However, average per capita expenditure on the two crops is the largest for households in the second quintile in rural areas, although per capita expenditure on millet is very similar for rural households in the second, third, and fourth quintiles. In urban areas, households in the third to the fifth quintiles devote less than 1% of the food budget to sorghum and millet.

In Nigeria, like in Niger, average per capita food expenditure is similar among rural households in the second quintile and urban households in the poorest quintile, and among rural households in the fourth quintile and urban households in the second quintile. As in Niger, large differences in sorghum and millet consumption exist when comparing rural and urban households with similar per capita food expenditure. For instance, while 47% of rural households belonging to the second quintile consume millet, only 21% of urban households in the poorest quintile consume millet. This corresponds to an average per capita expenditure on millet that is 1.7 times greater among rural households in the second quintile compared with urban households in the poorest quintile. The same trend is found for sorghum. About 45% of rural households in the fourth wealth quintile consume sorghum compared with 18% of urban households in the second wealth quintile. The former has average sorghum expenditures about 1.8 times greater than the later. Once more, descriptive statistics indicate that urbanization induces changes in food consumption patterns, justifying separate model estimation for rural and urban households.

Consumption expenditure indicators broken down by Niger's six zones, i.e. North Central, North East, North West, South East, South South, and South West are presented in Table 5. Expenditure on millet and sorghum drops dramatically from Northern Nigeria to the coastal South (Table 5). In the three Southern zones, less than 1% of households consume millet resulting in trivial per capita expenditure and budget share for millet. Consumption of millet is the greatest in the North West, where 86% of households consume millet, average per capita expenditure (22 US\$/year) is 2.7 times the national average, and millet budget share (8%) is more than three times the national average. Consumption of sorghum is also trivial in the three

⁹ The Nigeria data set does not include a poverty line or poverty indicator. However, according to *Nigeria Economic Report* by the World Bank, the poverty headcount at national poverty line from the GHS 2012-13 is 33.1% (World Bank, 2014). We created a poverty indicator replicating this statistics using per capita total expenditure and population sampling weights. Households at 33.1% and below the weighted cumulative distribution function for per capita total expenditure are considered poor, and the remaining non-poor. According to the same report, this poverty rate is obtained based a national poverty line of 419 US\$/person/year in 2010 prices calculated from the GHS panel data. The national poverty line is based on a calorie requirement of 3,000 kcal/person/day.

Southern zones of Nigeria where the proportion of households consuming sorghum is less than 3%. Sorghum consumption is more important in the three Northern zones, ranging from 58% of households consuming sorghum in the North Central to 88% in the North West zone. In the later zone, average per capita expenditure on sorghum (26 US\$/year) is 2.4 times greater than the national average and sorghum budget share (9%) is three times the national average. In sum, millet and sorghum consumption follows similar spatial patterns, i.e. consumption is highest in the North West zone, low in the Southern zones, and in between for the North Central and North East zones.

Comparing Nigeria with Niger, the two countries are similar in that consumption of sorghum and millet is greater among poor households than non-poor households, and greater among rural households than urban households considering the budget share of the two crops. Therefore, the rural poor rely most heavily on millet and sorghum, and the urban non-poor consume the least in both countries. In Niger, rural poor households spend 41% of their food budget on millet and sorghum, while only 7% of the food budget of urban non-poor households is spent on these two cereal crops. In Nigeria, the food budget share allocated to millet and sorghum combined is 13% for the rural poor, while only 1% for the urban non-poor.

The two countries are different first in that millet and sorghum are more important for households in Niger than Nigeria. While almost all households in Niger consume millet and half of them consume sorghum, only one quarter of Nigerian households consume millet and one-third consume sorghum. Second, while households in Niger consume more millet than sorghum, Nigerian households do the opposite. Average household expenditure on sorghum is 29% higher than that of millet in Nigeria. Third, in Nigeria the percentage of households consuming the two types of cereal crops decreases through wealth quintiles while in Niger, the percentage remains comparatively constant across quintiles. In fact, the percentage of households in rural Niger that consume sorghum is the largest for the fourth quintile. Therefore, as income grows in Nigeria, not only expenditure on millet and sorghum drops, but also fewer households consume the two crops.

4 Methods and empirical estimation

We assume a two-stage budgeting model, where households first decide how much to spend on food in the first stage, and then decide how to allocate their food budget into different food categories in the second stage (Deaton and Muellbauer, 1980). Aggregation of food consumption into several groups is necessary for two reasons. First, it reduces the number of parameters that need to be estimated. Second, since most of households do not consume every food item, grouping them into categories reduces the potential bias that can result from censoring (i.e. when expenditure is null). Food items are grouped into nine categories: 1) millet, 2) sorghum, 3) other cereal, including maize, rice, wheat, etc., 4) meat, egg, fish, and dairy products, 5) fruits and vegetables, 6) legumes, nuts, and seeds, 7) tubers and roots, 8) oils, fats, sweets, spices, and condiments, and 9) beverages, and other food¹⁰.

Millet and sorghum are kept separately being the focus of the analysis, which is also justified given their importance in the diet of poor households. Household food expenditure on these two types of cereal is expected to decrease with household wealth. The other seven food categories were created by combining food items that are expected to have relatively similar nutritional properties and income elasticities. “Other cereal”, which include for example maize, rice, and wheat, which are starchy items that provide mainly calories but are considered higher quality grains compared to millet and sorghum. These food items are expected to replace calories from sorghum and millet as income grows. In other words, other cereals are expected to be substitute for millet and sorghum. “Meat, egg, fish, and dairy products” are a major source of proteins and have high income elasticity. “Fruits and vegetables” are major sources of micronutrients, such as mineral and vitamins, and consumption is expected to increase with household income. “Legumes, nuts, and seeds” are cheaper sources of protein compared to animal sources, and thus these food items are expected to be more important in the diet of poor households. “Tubers and roots” provide mainly calories and expenditure shares on these food items are expected to decrease as income rises. “Oils, fats, sugar, spices, and condiments” are considered auxiliary food items, not contributing significantly to household nutritional status. “Other foods” include mainly beverages and food taken away from home and a few processed food items. One reason for grouping these food items together is they can be seen as luxuries. Another reason to separate food eaten at home from outside the home is that food eaten outside includes service fees (Boysen, 2012). Finally, the share of these food items in total food expenditure is generally small.

For each food group i , a Stone price index p_i is computed:

$$p_i = \sum_{t=1}^{k_i} w_{it} \frac{p_{it}}{\bar{p}_{it}}, \quad (1)$$

¹⁰ Aggregation of individual food item into their respective food categories and descriptive statistics on expenditures per food item are presented in appendix (Table A1).

where p_{it} ¹¹ is the price of product t in group i in a particular geographical cluster; \bar{p}_{it} is the sample median of p_{it} across clusters; w_{it} is the budget share of product t in group i ; k_i is the number of food items in group i .

Descriptive statistics on the percentage of households consuming each food group and their corresponding expenditures and share in food expenditures are reported in Table 6. For rural households in Niger, millet is the most important food with an average share in food expenditure of 29%. For urban households, 'other cereal' and 'meat, egg, fish, seafood and dairy products' are the most important food groups, representing about a quarter of the food budget each. Rural households spend less on meat and other animal sources of protein than urban households (14% vs. 24%), and more on legumes, nuts and seeds (7% vs. 3%). Rural households also spend less on vegetables and fruits (6% vs. 9%). For Nigeria, the largest budget share is allocated to 'meat, fish, seafood, eggs, and dairy products', and the difference between rural and urban is trivial. The budget share allocated to 'other cereal' (15%) is nearly three times of millet and sorghum combined (5%). An interesting difference between the food expenditure structures in Niger and Nigeria is that households in Nigeria spend more on 'roots and tubers' than households in Niger (16% vs. 3%).

¹¹ For Niger, the prices of food products are obtained from both household and community data. Community price is used when it is available for a product. Otherwise, price is obtained from household data. If a household consumes a product, unit value is calculated by dividing its value by quantity. If in an administration area there are more than five observations, the median of the observations is used as the price of the region. Otherwise the price is obtained from a higher level of administration area. For Nigeria, since household data and community data use two different sets of products, only the household data is used. Household data is processed by the same method as that of Niger. All prices are normalized at regional medians.

Table 6: Food consumption by groups, Niger and Nigeria

Food group	Group	% of households consuming the product		Per capita expenditure (US\$)		% in household food expenditure	
		Niger	Nigeria	Niger	Nigeria	Niger	Nigeria
Millet	Rural	99.50	35.45	62	11	29.18	3.44
	Urban	87.85	11.15	23	3	7.75	0.60
	All	97.41	25.61	55	8	25.33	2.29
Sorghum	Rural	58.85	45.53	11	15	4.89	4.61
	Urban	17.89	14.70	2	4	0.76	0.77
	All	51.49	33.05	9	11	4.15	3.05
Other cereals	Rural	89.12	98.12	37	55	14.72	14.67
	Urban	99.50	99.04	86	69	25.71	14.75
	All	90.99	98.49	45	60	16.70	14.70
Meat, egg, fish, seafood, and dairy products	Rural	96.51	96.04	35	81	14.17	19.69
	Urban	98.63	99.41	93	110	23.97	20.76
	All	96.89	97.40	45	92	15.93	20.12
Vegetables and fruits	Rural	99.40	99.13	13	37	6.11	9.41
	Urban	99.60	99.42	33	50	9.26	9.05
	All	99.44	99.25	17	42	6.68	9.26
Legumes, nuts, and seeds	Rural	97.37	90.03	14	26	6.68	7.16
	Urban	95.66	92.44	11	27	3.33	6.09
	All	97.06	91.01	14	26	6.08	6.72
Tubers and roots	Rural	82.37	87.78	7	51	2.98	16.28
	Urban	92.22	96.32	13	60	3.71	14.73
	All	84.14	91.23	8	54	3.11	15.65
Oils, fats, sweets, spices, and condiments	Rural	99.97	99.82	26	73	12.22	13.18
	Urban	99.61	99.10	44	93	13.53	10.93
	All	99.91	99.53	29	80	12.46	12.27
Other food	Rural	92.01	86.87	20	54	9.03	11.58
	Urban	97.95	95.96	38	117	11.99	22.33
	All	93.08	90.55	23	78	9.56	15.93

Two-stage modeling

In the first-stage, a Working-Leser model representing the Engel curve relationship between food expenditure and total expenditures is estimated. The Working-Leser model is specified as follows:

$$\ln m = a_0 + a_1 \ln M + b \ln P + \sum_k c_k z_k + \varepsilon \quad (2)$$

where m is household food expenditure and M is total expenditure, P is the food price index, and z is a set of household demographic features. The elasticity of food expenditure with respect to total expenditure is $n_f = a_1$.

In the second stage, household demand for each food group is modelled using a QUAIDS model where household demographic features are incorporated following Ray's (1983). The budget share of good i in food expenditure w_i is modelled as:

$$w_i = \alpha_i + \sum_{j=1}^k \gamma_{ij} \ln p_j + (\beta_i + \boldsymbol{\eta}'_i \mathbf{z}) \ln \left(\frac{m}{\bar{m}_0(\mathbf{z})a(\mathbf{p})} \right) + \frac{\lambda_i}{b(\mathbf{p})c(\mathbf{p}, \mathbf{z})} \left[\ln \left(\frac{m}{\bar{m}_0(\mathbf{z})a(\mathbf{p})} \right) \right]^2, i = 1, \dots, k \quad (3)$$

where p_j is price of good j ; $\ln a(\mathbf{p})$ is the transcendental logarithm price index:

$$\ln a(\mathbf{p}) = \alpha_0 + \sum_{i=1}^k \alpha_i \ln p_i + \frac{1}{2} \sum_{i=1}^k \sum_{j=1}^k \gamma_{ij} \ln p_i \ln p_j \quad (4)$$

$b(\mathbf{p})$ is the Cobb-Douglas price aggregator:

$$b(\mathbf{p}) = \prod_{i=1}^k p_i^{\beta_i} \quad (5)$$

\mathbf{z} is the set of demographic variables and regional dummy variables. In this study, household demographic includes household composition¹², and the education¹³ and gender of the household head. $\bar{m}_0(\mathbf{z})$ scales the real expenditure on food and the η parameters scale the price of the different food groups:

$$\bar{m}_0(\mathbf{z}) = 1 + \boldsymbol{\rho}' \mathbf{z} \quad (6)$$

$$c(\mathbf{p}, \mathbf{z}) = \prod_{i=1}^k p_i^{\boldsymbol{\eta}'_i \mathbf{z}} \quad (7)$$

The following restrictions

$$\sum_{i=1}^k \alpha_i = 1, \sum_{i=1}^k \gamma_{ij} = 0 \forall j, \sum_{j=1}^k \gamma_{ij} = 0 \forall i, \sum_{i=1}^k \beta_i = 0, \gamma_{ij} = \gamma_{ji} \quad (8)$$

$$\sum_{i=1}^k \eta_{ir} = 0 \forall r \quad (9)$$

¹² Household composition is represented by the number of household members in each of the four age groups: 0 to 5, 6 to 15, 16 to 59, and 60 years old and above.

¹³ Education is classified into three levels: a). never attend school or cannot read/write, b). primary education, religious education, or never attend school but able to read/write, c). secondary education and higher. For rural Niger, since most of the household heads are illiterate, only two levels are considered: a) never attend school or cannot read/write, and b). have some education or able to read/write.

are imposed on the parameters such that the demand system satisfies the adding-up condition:

$$\sum_i w_i = 1 \quad (10)$$

and homogeneity of degree zero in prices and food expenditure:

$$w_i(\delta \mathbf{p}, \delta m) = w_i(\mathbf{p}, m), \delta > 0 \quad (11)$$

Using model estimated parameters, conditional uncompensated price elasticity ε_{ij}^c and food expenditures elasticity η_i^c are derived and computed at sample means. Formula for elasticities can be found in Poi (2012). The unconditional expenditure elasticity for the i th food group is obtained by multiplying η_i^c by η_f (Edgerton, 1997)

$$\eta_i^u = \eta_i^c \cdot \eta_f \quad (12)$$

5 Results

Models were estimated¹⁴ separately for rural and urban areas because food consumption patterns are expected to significantly differ between the two areas due to differences in food preferences and food availability. The quadratic specification was tested against the linear one by testing for the joint significance of the λ coefficients using a Wald test. The null hypothesis is rejected for rural and urban regressions in both countries, confirming that the quadratic model is superior to the linear model to explain household food demand. Food demand responds to changes in food expenditure in a nonlinear way. Demand elasticities for each food group with respect to food expenditure, total expenditure, and prices are reported in Tables 7 and 8 for rural and urban Niger respectively. Demand elasticities for rural and urban Nigeria are reported in Tables 9 and 10 respectively. The estimated coefficients of QUAIDS models can be found in the appendices (Tables A2 to A4 for Niger and Tables A5 to A7 for Nigeria).

The estimated coefficients of the demographic variables and regional dummy variables, ρ and η (reported in Tables A3 and A4 for Niger and Table A6 and A7 for Nigeria), are tested jointly to determine whether their influences on the elasticities of demand for food are significant. In Niger, all variables are jointly significant at the exception of the gender of the household head in the urban model. In Nigeria, the ρ coefficients, i.e. those scaling food expenditures, are only statistically significant for the regional dummy variables. However, all of the variables (demographic and regional dummy variables) are significant when testing for the joint significance of ρ and η . Therefore, food demand in Niger and Nigeria is sensitive to household composition and characteristics as well as their geographical location.

5.1 Niger

Conditional and unconditional expenditure elasticities

In Niger, the expenditure elasticity for food with respect to total household expenditure is 0.938 in rural areas and 0.814 in urban areas. This means that additional income will be mainly spent on food. The response is greater for rural households, consistent with the higher poverty rate in rural areas. The demand elasticities for millet (sorghum) with respect to food expenditure are 0.348 (0.557) for rural households and 0.847 (0.750) for urban households. Therefore, the unconditional demand elasticities for millet (sorghum) with respect to total household expenditure are 0.326 (0.523) for rural households and 0.689 (0.611) for urban households.

If the unconditional expenditure elasticity for product i is η_i , then household expenditure on product i will change by $\eta_i\%$ as a result of a 1% change in total expenditure. A product is regarded as a *luxury* if $\eta_i > 1$, it is regarded as a *necessity* if $0 < \eta_i < 1$, and it is considered an *inferior good* if $\eta_i < 0$. Since unconditional expenditure elasticities for the two goods are positive and less than one, millet and sorghum are necessities for households in rural and urban Niger. Future growth in per capita income will generate an increase in demand for sorghum and millet in both rural and urban areas, but the growth in demand is expected to be smaller than the income growth. For both crops, expenditure elasticities in rural areas are lower than those in

¹⁴ The models were estimated in Stata, and corresponding elasticities, using the “quaidis” by Poi (2012).

Table 7: Expenditure and price elasticities, rural Niger

Food groups	Group 1: Millet	Group 2: Sorghum	Group 3: Other cereals	Group 4: Meat, egg, fish, seafood, and dairy products	Group 5: Vegetabl es and fruits	Group 6: Legumes, nuts, and seeds	Group 7: Tubers and roots	Group 8: Oils, fats, sugar, spices, and condiments	Group 9: Other food	
Food expenditure elasticity	0.348*** (0.029)	0.557*** (0.105)	1.294*** (0.024)	1.500*** (0.025)	1.051*** (0.020)	0.762*** (0.040)	1.271*** (0.041)	0.750*** (0.017)	1.204*** (0.037)	
Unconditional expenditure elasticity	0.326*** (0.027)	0.523*** (0.099)	1.214*** (0.025)	1.407*** (0.027)	0.986*** (0.021)	0.715*** (0.038)	1.193*** (0.040)	0.703*** (0.017)	1.130*** (0.036)	
Conditional uncompensated price elasticities	Group 1	-0.613*** (0.053)	-0.050 (0.214)	-0.077** (0.030)	-0.371*** (0.027)	-0.024 (0.038)	0.257*** (0.073)	0.057 (0.079)	0.141*** (0.028)	-0.203*** (0.041)
	Group 2	0.000 (0.028)	-0.900*** (0.258)	-0.011 (0.016)	-0.089*** (0.014)	0.014 (0.033)	0.188*** (0.061)	-0.078 (0.072)	0.056*** (0.021)	0.014 (0.022)
	Group 3	0.114*** (0.029)	0.064 (0.118)	-1.039*** (0.028)	-0.015 (0.018)	-0.044* (0.023)	-0.013 (0.044)	-0.055 (0.046)	-0.039** (0.017)	-0.030 (0.029)
	Group 4	-0.127*** (0.025)	-0.450*** (0.098)	0.024 (0.018)	-0.811*** (0.025)	0.004 (0.019)	-0.054 (0.037)	0.018 (0.039)	-0.010 (0.015)	-0.003 (0.027)
	Group 5	0.036** (0.014)	0.072 (0.094)	-0.031*** (0.009)	-0.026*** (0.008)	-0.922*** (0.024)	0.015 (0.031)	-0.071* (0.037)	0.008 (0.011)	-0.032*** (0.012)
	Group 6	0.079*** (0.017)	0.343*** (0.109)	-0.028*** (0.011)	-0.048*** (0.009)	-0.003 (0.020)	-0.948*** (0.052)	-0.035 (0.042)	0.010 (0.013)	-0.121*** (0.015)
	Group 7	0.035*** (0.012)	-0.070 (0.082)	-0.008 (0.007)	-0.002 (0.006)	-0.023 (0.015)	-0.008 (0.027)	-1.031*** (0.045)	0.015 (0.009)	-0.020** (0.010)
	Group 8	0.148*** (0.019)	0.309*** (0.107)	-0.100*** (0.013)	-0.109*** (0.011)	-0.020 (0.020)	0.029 (0.037)	0.001 (0.042)	-0.998*** (0.019)	0.025 (0.017)
	Group 9	-0.019 (0.021)	0.125 (0.086)	-0.024 (0.016)	-0.030** (0.014)	-0.033** (0.017)	-0.228*** (0.033)	-0.077** (0.033)	0.066*** (0.013)	-0.834*** (0.037)

urban areas. So demand for millet and sorghum among rural households is less responsive to changes in income compared with urban households.

The conditional (unconditional) expenditure elasticities for other cereal are 1.294 (1.214) in rural areas and 0.937 (0.762) in urban areas, which are higher than those of millet and sorghum. Therefore, as income increases, demand for other cereals will grow at a higher rate than demand for millet and sorghum. The two most important foods in the other cereal category are maize and rice, representing 26% and 36% of expenditures on other cereal in rural areas, and 22% and 49% in urban areas. The unconditional expenditure elasticities for other cereals are greater than one in rural areas, meaning that these food items are considered as luxuries. Consequently, rural households demand for other cereals is expected to grow at a higher rate than the per capita income growth rate.

Uncompensated own-price elasticity

If the own-price elasticity of demand for product i is ε_i , its demand will change by $\varepsilon_i\%$ as a result of a 1% change in its own price. The uncompensated own-price elasticities for millet (sorghum) are -0.613 (-0.900) in rural areas and -0.845 (-0.932) in urban areas. The negative signs, consistent with expectations, indicate that the demand for the two cereal crops decreases as prices increase. The absolute values for the own-price elasticities are lower in

Table 8: Expenditure and price elasticities, urban Niger

Food groups	Group 1: Millet	Group 2: Sorghum	Group 3: Other cereals	Group 4: Meat, egg, fish, seafood, and dairy products	Group 5: Vegetables and fruits	Group 6: Legumes, nuts, and seeds	Group 7: Tubers and roots	Group 8: Oils, fats, sugar, spices, and condiments	Group 9: Other food	
Food expenditure elasticity	0.847*** (0.020)	0.750*** (0.052)	0.937*** (0.030)	1.618*** (0.040)	1.184*** (0.030)	0.816*** (0.030)	1.194*** (0.059)	0.875*** (0.022)	0.419*** (0.063)	
Unconditional expenditure elasticity	0.689*** (0.020)	0.611*** (0.044)	0.762*** (0.028)	1.316*** (0.039)	0.964*** (0.029)	0.664*** (0.027)	0.971*** (0.051)	0.712*** (0.022)	0.341*** (0.052)	
Conditional uncompensated price elasticities	Group 1	-0.845*** (0.049)	0.318 (0.246)	0.038 (0.028)	-0.136*** (0.017)	-0.170*** (0.035)	0.022 (0.048)	-0.518*** (0.127)	-0.008 (0.024)	0.070*** (0.024)
	Group 2	0.040 (0.032)	-0.932*** (0.261)	-0.021* (0.011)	-0.004 (0.006)	-0.033** (0.015)	0.009 (0.026)	-0.122* (0.073)	0.011 (0.011)	-0.006 (0.009)
	Group 3	0.075*** (0.027)	-0.093 (0.079)	-0.778*** (0.036)	-0.302*** (0.025)	-0.204*** (0.035)	-0.014 (0.039)	-0.102 (0.085)	0.039* (0.022)	0.133*** (0.038)
	Group 4	-0.044*** (0.015)	0.062 (0.042)	-0.108*** (0.021)	-0.920*** (0.032)	-0.022 (0.024)	0.016 (0.023)	0.157*** (0.049)	-0.029* (0.015)	0.128*** (0.034)
	Group 5	-0.044*** (0.013)	-0.067 (0.044)	-0.051*** (0.013)	-0.049*** (0.010)	-0.813*** (0.027)	-0.031 (0.022)	0.145*** (0.047)	-0.007 (0.012)	0.133*** (0.015)
	Group 6	0.007 (0.011)	0.023 (0.046)	-0.013 (0.009)	-0.029*** (0.006)	-0.037*** (0.013)	-0.918*** (0.026)	0.004 (0.044)	0.004 (0.009)	0.041*** (0.009)
	Group 7	-0.070*** (0.019)	-0.129 (0.084)	-0.005 (0.013)	0.009 (0.008)	0.059*** (0.019)	0.014 (0.029)	-0.891*** (0.101)	0.031** (0.013)	0.039*** (0.012)
	Group 8	0.010 (0.016)	0.089 (0.054)	0.012 (0.015)	-0.131*** (0.012)	-0.060*** (0.021)	0.027 (0.025)	0.090 (0.057)	-0.961*** (0.019)	0.127*** (0.020)
	Group 9	0.023* (0.012)	-0.021 (0.034)	-0.010 (0.018)	-0.055*** (0.019)	0.096*** (0.020)	0.060*** (0.019)	0.042 (0.040)	0.043*** (0.013)	-1.084*** (0.042)

rural than urban areas. Therefore, demand for millet and sorghum among rural households is less responsive not only to income but also to price compared with urban households. This is consistent with expectations since a larger proportion of rural households consume millet and sorghum that came from their own production. For example, among rural households who consume sorghum, 37% consume sorghum that came from own production. In urban areas, only 7% of households who consume sorghum reported consuming from their own production. Thus, the smaller own price elasticities (in absolute values) in rural areas reflect that rural households cannot adjust their consumption decisions as quickly in response to price changes partially because a higher share of consumption is obtained from own production.

Uncompensated cross-price elasticity

If the cross-price elasticity of product i with respect to j is ε_{ij} , the demand for product i will change by $\varepsilon_{ij}\%$ in response to a 1% change in the price of product j . If $\varepsilon_{ij} > 0$, product i is regarded as a *substitute* for product j ; if $\varepsilon_{ij} < 0$, product i is regarded as a *complement* for product j . Although most of the cross-price elasticities are either very small or statistically insignificant, a few are worth mentioning. In rural Niger, the elasticity of demand for millet with respect to the price of other cereal is 0.114, and with respect to the price of meat, egg, fish, and dairy products is -0.127. Thus, other cereal are weak substitutes for millet, and the food

group 'meat, egg, fish, and dairy products' is a complement. The demand elasticity for sorghum with respect to the price of legumes, nuts, and seeds is 0.343, with respect to the price of oils, fats, sugar, spices and condiments is 0.309, and with respect to the price of meat, egg, fish, and dairy products is -0.45. Thus, the group foods 'legumes, nuts, and seeds' and 'oils, fats, sugar, spices and condiments' are substitutes for sorghum, and the food group 'meat, egg, fish, and dairy products', a complement.

In urban areas, the elasticities of demand for millet and sorghum with respect to the price of other food groups are either less than 0.1 in absolute value, or statistically insignificant. Therefore, the demand for millet and sorghum responds little or not at all to the price of other food. Worth noting is the elasticity of the demand for tubers and roots with respect to millet price which is -0.518 and statistically significant, meaning that millet is a complement for tubers and roots in urban areas.

5.2 Nigeria

Conditional and unconditional expenditure elasticities

In Nigeria, the demand elasticity for food with respect to total household expenditure is 0.984 in rural areas and 0.887 in urban areas. The elasticities for millet (sorghum) with respect to food expenditure are 0.924 (0.895) for rural households and 1.134 (1.127) for urban households. Therefore, the unconditional expenditure elasticities for millet (sorghum) are 0.909 (0.880) for rural households and 1.006 (1.000) for urban households. Therefore, consumption of millet and sorghum among rural households will increase proportionally less than the income growth, while the demand growth rate of the two crops in urban areas is expected to be similar to the income growth rate. The unconditional expenditure elasticity for other cereal is 0.927 in rural areas and 0.856 in urban areas. So as the result of higher income, the demand for other cereals is expected to increase at a similar rate as the demand for millet in rural areas but at a slower pace than the demand for sorghum and millet in urban areas. In Nigeria, rice (both local and imported) is the major food in this other cereal group. In rural areas, rice represents 66% of the expenditure of this group, and in urban areas, 65%.

Uncompensated own-price elasticity

Own-price elasticities for millet and sorghum in rural Nigeria (-0.800 and -0.754) are lower than those in urban areas (-0.968 and -0.878) in absolute value. So demand for millet and sorghum in rural areas is less responsive to price changes than in urban areas. Own-consumption also likely plays a role in explaining the difference in own-price elasticities between urban and rural areas. Of rural households who consume millet (sorghum), 67% (62%) consume millet (sorghum) that came from own production. For urban households, only 33% (28%) of those who consumed millet (sorghum) consume self-produced millet (sorghum).

Uncompensated cross-price elasticity

In both rural and urban areas, the cross-price elasticities between millet and sorghum are negative and significant, and particularly large in rural areas. Millet and sorghum are complements for each other. Also in both rural and urban areas, the elasticities of the demand for millet and sorghum with respect to the price of tubers and roots are positive and significant, and with respect to the price of legumes, nuts, and seeds the elasticities are negative.

Table 9: Expenditure and price elasticities, rural Nigeria

Food groups	Group 1: Millet	Group 2: Sorghum	Group 3: Other cereals	Group 4: Meat, egg, fish, seafood, and dairy products	Group 5: Vegetables and fruits	Group 6: Legumes, nuts, and seeds	Group 7: Tubers and roots	Group 8: Oils, fats, sugar, spices, and condiments	Group 9: Other food	
Food expenditure elasticity	0.924*** (0.062)	0.895*** (0.054)	0.942*** (0.018)	1.030*** (0.018)	0.900*** (0.025)	1.072*** (0.029)	0.630*** (0.022)	1.334*** (0.030)	1.201*** (0.026)	
Unconditional expenditure elasticity	0.909*** (0.062)	0.880*** (0.053)	0.927*** (0.019)	1.013*** (0.018)	0.886*** (0.025)	1.054*** (0.029)	0.619*** (0.022)	1.313*** (0.030)	1.182*** (0.026)	
Conditional uncompensated price elasticities	Group 1	-0.800*** (0.235)	-1.077*** (0.148)	0.003 (0.037)	-0.009 (0.027)	-0.088* (0.046)	-0.469*** (0.073)	0.391*** (0.035)	-0.048** (0.022)	0.132*** (0.033)
	Group 2	-1.429*** (0.197)	-0.754*** (0.231)	-0.009 (0.041)	0.081*** (0.028)	-0.079 (0.051)	-0.184** (0.082)	0.236*** (0.037)	-0.038* (0.023)	0.020 (0.034)
	Group 3	0.019 (0.198)	-0.033 (0.162)	-0.556*** (0.064)	0.076** (0.035)	-0.209*** (0.059)	-0.484*** (0.094)	-0.261*** (0.046)	-0.130*** (0.031)	0.223*** (0.044)
	Group 4	-0.038 (0.191)	0.467*** (0.153)	0.120** (0.048)	-0.825*** (0.059)	0.033 (0.065)	0.032 (0.087)	-0.371*** (0.055)	-0.039 (0.041)	-0.060 (0.055)
	Group 5	-0.303* (0.155)	-0.208 (0.130)	-0.139*** (0.037)	0.004 (0.031)	-0.744*** (0.069)	-0.053 (0.070)	0.237*** (0.039)	-0.069** (0.028)	-0.095** (0.039)
	Group 6	-1.155*** (0.182)	-0.329** (0.153)	-0.217*** (0.044)	0.014 (0.030)	-0.027 (0.052)	-0.150 (0.112)	0.192*** (0.039)	-0.191*** (0.025)	0.076** (0.037)
	Group 7	2.211*** (0.201)	0.963*** (0.164)	-0.340*** (0.051)	-0.371*** (0.045)	0.377*** (0.067)	0.363*** (0.091)	-0.749*** (0.077)	0.103** (0.041)	-0.605*** (0.057)
	Group 8	-0.162 (0.100)	-0.059 (0.080)	-0.062** (0.027)	0.017 (0.027)	-0.050 (0.038)	-0.314*** (0.047)	0.169*** (0.032)	-1.029*** (0.045)	0.106*** (0.036)
	Group 9	0.734*** (0.171)	0.135 (0.136)	0.258*** (0.044)	-0.017 (0.040)	-0.113* (0.060)	0.187** (0.079)	-0.474*** (0.051)	0.108*** (0.041)	-0.999*** (0.073)

Therefore, tubers and roots are substitutes for millet and sorghum, and legumes, nuts, and seeds are complements. Since tubers and roots are another source of cheap calories, it is not surprising consumers consider them as substitutes for millet and sorghum.

Comparing Niger with Nigeria, the two countries are similar in that unconditional expenditure elasticities and own-price elasticities for millet and sorghum in rural areas are lower than in urban areas. Therefore, in both countries demand for millet and sorghum in rural areas is less responsive to expenditure and price change than in urban areas. Niger and Nigeria are different in several aspects. First, the unconditional expenditure elasticities for millet and sorghum in Nigeria (0.909 and 0.880 in rural areas, 1.006 and 1.000 in urban areas) are higher than in Niger (0.348 and 0.557 in rural areas, 0.847 and 0.750 in urban areas). Second, the own-price elasticities for millet (-0.613 in rural areas and -0.845 in urban areas) are smaller in absolute value in Niger than in Nigeria, but it is the opposite for sorghum: own-price elasticities are larger in Niger (-0.900 in rural and -0.932 in urban) than in Nigeria (-0.754 in rural and -0.878 in urban). Households in Niger are more responsive to fluctuations in the price of sorghum while Nigerian households are more responsive to changes in the price of millet. This is consistent with the fact that households in Niger consume more millet than sorghum, while households in Nigeria consume more sorghum than millet.

Table 10: Expenditure and price elasticities, urban Nigeria

Food groups		Group 1: Millet	Group 2: Sorghum	Group 3: Other cereals	Group 4: Meat, egg, fish, seafood, and dairy products	Group 5: Vegetables and fruits	Group 6: Legumes, nuts, and seeds	Group 7: Tubers and roots	Group 8: Oils, fats, sugar, spices, and condiments	Group 9: Other food
Food expenditure elasticity		1.134*** (0.033)	1.127*** (0.032)	0.965*** (0.025)	0.924*** (0.021)	0.908*** (0.036)	0.957*** (0.027)	0.705*** (0.024)	1.305*** (0.039)	1.215*** (0.047)
Unconditional expenditure elasticity		1.006*** (0.032)	1.000*** (0.031)	0.856*** (0.025)	0.820*** (0.022)	0.806*** (0.033)	0.849*** (0.027)	0.626*** (0.023)	1.158*** (0.038)	1.078*** (0.044)
Conditional uncompensated price elasticities	Group 1	-0.968*** (0.161)	-0.239** (0.104)	0.008 (0.027)	-0.04* (0.021)	0.050 (0.035)	-0.150*** (0.046)	0.055** (0.022)	0.061*** (0.016)	0.024 (0.018)
	Group 2	-0.318** (0.137)	-0.878*** (0.157)	0.011 (0.033)	-0.003 (0.025)	0.019 (0.043)	-0.126** (0.055)	0.080*** (0.027)	-0.013 (0.021)	-0.007 (0.022)
	Group 3	0.011 (0.145)	0.016 (0.133)	-0.617*** (0.083)	0.064 (0.051)	0.088 (0.088)	-0.139 (0.100)	-0.192*** (0.057)	-0.128** (0.052)	-0.144*** (0.055)
	Group 4	-0.318** (0.147)	-0.051 (0.136)	0.073 (0.069)	-1.050*** (0.090)	0.106 (0.107)	0.304*** (0.099)	0.017 (0.072)	-0.105 (0.070)	-0.071 (0.078)
	Group 5	0.153 (0.118)	0.032 (0.110)	0.047 (0.056)	0.048 (0.050)	-0.900*** (0.117)	-0.210** (0.083)	-0.024 (0.054)	0.065 (0.052)	-0.147** (0.058)
	Group 6	-0.385*** (0.115)	-0.247** (0.104)	-0.066 (0.047)	0.109*** (0.034)	-0.151** (0.061)	-0.453*** (0.094)	0.021 (0.038)	-0.113*** (0.031)	-0.029 (0.034)
	Group 7	0.270** (0.128)	0.298** (0.120)	-0.266*** (0.062)	-0.019 (0.058)	-0.063 (0.094)	0.007 (0.088)	-0.527*** (0.084)	0.025 (0.058)	-0.342*** (0.066)
	Group 8	0.298*** (0.077)	-0.030 (0.072)	-0.059 (0.045)	-0.024 (0.045)	0.130* (0.072)	-0.169*** (0.059)	0.088* (0.046)	-1.244*** (0.081)	0.160** (0.071)
	Group 9	0.123 (0.092)	-0.028 (0.085)	-0.096* (0.054)	-0.009 (0.057)	-0.187** (0.090)	-0.021 (0.073)	-0.224*** (0.060)	0.148* (0.080)	-0.658*** (0.128)

6 Conclusions and discussion

This study contributes to the understanding of consumption and demand for sorghum and millet in Niger and Nigeria. Using nationally representative household survey data, we presented disaggregated consumption statistics by household economic status and locality. Household food demand was estimated using a QUAIDS model with household demographics for rural and urban areas separately in each country. Findings from this study provide information on the potential growth rate of demand for sorghum and millet and will guide research strategies for these two crops.

Results reveal that millet is of high importance in the diet of households in Niger and particularly the poorest households in rural areas. The latter devote about 40% of their food budget to millet but have lower per capita expenditure on millet than households in the upper wealth quintiles. Sorghum is consumed by 59% and 18% of rural and urban households in Niger. Compared with Niger, millet and sorghum are less important in the diet of Nigerian households; a quarter of households in Nigeria consume millet and a third consume sorghum. However, sorghum plays an important role in the diet of the poorest rural households in Nigeria as indicated by its average share of 10% in the household food budget for this group.

The claim that urbanization has shifted consumer food preferences was strongly supported by the descriptive statistics. In both countries, urban households consume less sorghum and millet than rural households even at similar income level. Significant variation in millet and sorghum consumption is also observed across regions. In Niger, consumption of the two crops is lower in the Agadez region and especially in the capital city of Niamey, in terms of per capita expenditure and budget share. In the other six regions, sorghum consumption shows more spatial variation than millet. In Nigeria, consumption of the two crops presents an almost identical spatial pattern: relatively high in the North, and trivial in the South.

Demand for sorghum and millet is more responsive to income changes in Nigeria than Niger. In Niger, the unconditional expenditure elasticity of millet is 0.326 in rural areas and 0.689 in urban areas, and that of sorghum is 0.523 in rural areas and 0.611 in urban areas. In Nigeria, the expenditure elasticity for millet is 0.909 in rural areas and 1.006 in urban areas while sorghum has an expenditure elasticity of 0.880 in rural areas and 1.000 in urban areas. Therefore, in both countries, the unconditional expenditure elasticity for sorghum and millet is higher in urban areas than rural areas, meaning higher demand growth rate in urban centres. Based on population growth rate, per capita income growth rate, and expenditure elasticity estimates¹⁵, the rate of growth in the demand for sorghum and millet is estimated for both countries. In Niger, the demand for sorghum is expected to grow at 5.1% and 7.0% annually in rural and urban areas while the demand for millet is estimated to grow at a rate of 4.6% and 7.3% respectively. Combining rural and urban estimates, demand for sorghum in Niger is expected to grow at a rate of 5.2% annually and the demand for millet is estimated to have a rate of growth of 4.8%. In Nigeria, the growth rate in the demand for sorghum is estimated to

¹⁵ The growth rate of demand for food or a given crop can be estimated by $D = p + ng$, where p is the population growth rate, n is the expenditure elasticity for the crop of interest, and g is the per capita income growth rate. Growth rates of demand for sorghum and millet are computed using population growth rate and per capita income growth rate reported in the introduction and estimated expenditure elasticities in this study.

be 4.2% in rural areas and 8.0% in urban areas, and demand for millet is expected to grow at 4.3% and 8.0% annually in rural and urban areas respectively. This corresponds to an expected national growth rate of 4.9% in the demand for sorghum and 5.0% in the demand for millet.

Therefore, in both countries and for both crops, the growth rate of demand is expected to be higher in urban areas than in rural areas. In Niger, sorghum demand is expected to grow faster than millet, while in Nigeria the former is expected to grow slightly slower than the latter. Although national demand and household demand for the two crops continue to increase, their share in household food budget will decrease because of increasing urbanization and the lower share of the two crops in the diet of urban households.

In both countries, the uncompensated own-price elasticities for sorghum and millet are larger in absolute value in urban areas than rural areas. Therefore, a price increase will generate a greater response among urban households, meaning a greater shift away from sorghum and millet. Since the diet of poor households is heavy in sorghum and millet, an increase in the price of these cereal crops could have significant impact on their well-being.

Given the limited amount of additional land that can be put into cultivation, additional demand for sorghum and millet will have to be met mainly through increase in productivity. Therefore, research efforts aiming at developing improved varieties that are high yielding and perform well under climate changes, such as more frequent droughts and floods, should help meet the additional demand. In addition, varieties that perform well despite climatic stress should help limit price fluctuations for example associated with production shocks, which should particularly benefit poor households who rely more heavily on sorghum and millet for nutrition.

The major limitation of this study is that it ignores censoring, i.e. not every household consumes every product. Censoring is particularly severe for sorghum and millet consumption. Ignoring censoring may potentially lead to biased estimated coefficients. There are also some potential endogeneity issues with prices. These limitations may be addressed in further analysis.

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Appendices

Table A1: Food products and classification of Niger and Nigeria

Code	Food product	% of food expenditure	% of food expenditure, urban	% of food expenditure, rural	Food Group
Niger					
701	Corn	5.495	6.157	5.350	3
702	Millet	25.197	7.693	29.032	1
703	Rice	7.028	12.922	5.737	3
704	Wheat flour	0.116	0.142	0.110	3
705	Sorghum	4.128	0.754	4.868	2
706	Fonio	0.100	0.006	0.120	3
707	Other grains	0.033	0.026	0.035	3
708	Corn starch	0.216	0.764	0.096	3
709	Cassava Flour	1.316	1.188	1.344	7
710	Pasta	2.460	3.324	2.271	3
711	Bread	0.841	1.857	0.619	3
712	Biscuit	0.276	0.274	0.277	9
713	Bean fritters	1.250	0.741	1.362	6
714	Corn fritters	0.310	0.330	0.306	3
715	Cakes	0.751	0.518	0.802	9
716	Other pastries	0.027	0.106	0.010	9
717	Salad	0.084	0.387	0.018	5
718	Fresh Onion	0.953	1.866	0.753	5
719	Fresh Okra	0.103	0.207	0.081	5
720	Fresh tomato	0.182	0.862	0.033	5
721	Fresh pepper	0.046	0.220	0.008	5
722	Eggplant	0.013	0.068	0.001	5
723	Carrot	0.009	0.050	0.000	5
724	Green Bean	0.167	0.024	0.199	5
725	Cucumber	0.015	0.071	0.003	5
726	Pea	0.035	0.184	0.003	6
727	Squash	0.299	0.798	0.190	5
728	Other Vegetable	0.067	0.222	0.033	5
729	Dried tomato	0.750	0.296	0.849	5
730	Dry okra	1.078	0.981	1.100	5
731	Beans	2.474	1.318	2.727	6
732	Dry pea	0.010	0.014	0.009	6
733	Bambara groundnut	0.094	0.006	0.113	6
734	Other pulses	0.140	0.145	0.139	6
735	Maggi cube	1.497	1.602	1.474	8
736	Tomato paste	0.453	1.674	0.186	8
737	Peanuts in shell	0.264	0.072	0.305	6
738	Shelled peanuts	0.092	0.050	0.101	6
739	Groundnut cake	0.568	0.184	0.653	6
740	Soumbala	1.132	0.702	1.226	8
741	Baobab leaves	0.762	0.430	0.835	5
742	Yodo	0.372	0.123	0.427	5
743	Other leafy vegetables	0.082	0.087	0.082	5
744	Malahya	0.572	0.417	0.605	8
745	Salt	0.877	0.531	0.953	8
746	Pimento	0.661	0.500	0.696	8
747	Other spices	0.599	0.890	0.535	8
748	Cassava tuber	0.458	0.116	0.533	7
749	Yam tuber	0.478	0.891	0.387	7
750	Potato	0.206	1.044	0.023	7
751	Taro and cocoyam	0.015	0.036	0.011	7
752	Sweet potato	0.615	0.402	0.662	7
753	Other tubers	0.005	0.003	0.006	7

Code	Food product	% of food expenditure	% of food expenditure, urban	% of food expenditure, rural	Food Group
754	Mango	0.034	0.121	0.015	5
755	Pineapple	0.023	0.105	0.005	5
756	Orange	0.216	0.412	0.173	5
757	Other citrus	0.042	0.145	0.019	5
758	Sweet banana	0.090	0.435	0.014	5
759	Watermelon	0.020	0.089	0.005	5
760	Dates	0.660	0.762	0.637	5
761	Sugar cane	0.497	0.274	0.546	5
762	Melon	0.012	0.054	0.003	5
763	Palmyra/Doumier(fruit)	0.028	0.035	0.027	5
764	Cola nut	1.117	0.586	1.234	6
765	Other fruits & pineapple	0.030	0.066	0.022	5
766	Beef	2.756	6.098	2.024	4
767	Camel meat	0.143	0.106	0.151	4
768	Mutton	2.639	5.468	2.019	4
769	Goat meat	2.841	1.441	3.148	4
770	Poultry	2.035	2.298	1.978	4
771	GIBLETS	0.369	0.649	0.307	4
772	Game	0.006	0.008	0.006	4
773	Other meats	0.029	0.037	0.027	4
774	Fresh fish	0.350	0.777	0.256	4
775	Smoked Fish	0.162	0.240	0.145	4
776	Stockfish	0.056	0.061	0.055	4
777	Canned fish	0.057	0.220	0.021	4
778	Other canned fish	0.003	0.015	0.001	4
779	Palm oil	2.848	3.107	2.792	8
780	Peanut oil	1.005	0.702	1.071	8
781	Cottonseed oil	0.013	0.027	0.010	8
782	Corn oil	0.007	0.009	0.006	8
783	Other oils	0.099	0.357	0.043	8
784	Peanut butter	0.170	0.662	0.062	8
785	Eggs	0.199	0.581	0.116	4
786	Fresh milk	0.748	0.515	0.799	4
787	Curd	2.140	0.763	2.442	4
788	Powdered milk	0.673	2.310	0.314	4
789	Cheese	0.037	0.043	0.036	4
790	Butter	0.171	0.069	0.193	4
791	Yogurt	0.409	2.049	0.049	4
792	Other dairy products	0.022	0.058	0.014	4
793	Sugar	2.413	2.215	2.457	8
794	Cocoa	0.036	0.040	0.035	9
795	Honey	0.022	0.025	0.021	8
796	Confectionery	0.008	0.007	0.009	8
797	Other food	0.011	0.012	0.010	9
798	Tobacco	0.140	0.107	0.147	Excluded
799	Cigarette	0.432	0.629	0.389	Excluded
800	Coffee in cans	0.086	0.114	0.080	9
801	Tea bag	1.161	0.853	1.228	9
802	Other teas	0.035	0.048	0.032	9
803	Fruit juice	0.132	0.614	0.027	9
804	Juice powder	0.264	0.624	0.186	9
805	Soft Drinks	0.090	0.401	0.022	9
806	Mineral water	0.027	0.092	0.012	9
807	Alcoholic beverages	0.010	0.013	0.010	Excluded
808	Bowl of millet with milk	1.018	0.939	1.035	9
809	Bowl of millet without milk	0.739	0.586	0.772	9
810	Preparation based on millet	0.966	0.320	1.108	9
811	Preparation of sorghum	0.276	0.062	0.323	9

Estimating household demand for millet and sorghum in Niger and Nigeria

Code	Food product	% of food expenditure	% of food expenditure, urban	% of food expenditure, rural	Food Group
812	Preparation made from corn	0.670	0.618	0.682	9
813	Other preparations	0.208	0.267	0.195	9
814	Boiled beans	0.158	0.210	0.147	9
815	Rice cowpea	0.555	0.839	0.493	9
816	Rice with baobab leaf	0.158	0.242	0.140	9
817	Rice & tomato sauce	0.500	1.151	0.357	9
818	Fried rice with fish/chicken	0.198	0.424	0.148	9
819	Rice with peanut butter sauce	0.146	0.472	0.074	9
820	Pasta	0.415	0.547	0.386	9
821	Other meal purchased	0.422	1.112	0.271	9
822	Coffee hot drink	0.049	0.143	0.028	9
823	Tea hot drink	0.093	0.148	0.081	9
824	Non-alcoholic beverages made outside the home	0.028	0.093	0.014	9
825	Alcoholic beverages taken out of home	0.003	0.004	0.003	Excluded
Nigeria					
10	guinea corn/sorghum	9.242	5.223	10.124	2
11	millet	8.933	5.380	9.692	1
13	rice-local	8.998	8.212	9.235	3
14	rice-imported	8.527	8.581	8.459	3
16	maize flour	5.893	4.366	6.441	3
17	yam flour	6.191	5.993	6.650	7
18	cassava flour	4.015	3.135	4.562	7
19	wheat flour	3.597	3.431	3.928	3
20	maize (unshelled/on the cob)	2.815	3.233	2.576	3
21	maize shelled	6.333	4.711	6.854	3
22	other grains and flour	3.218	2.630	4.110	3
25	bread	3.279	3.681	2.885	3
26	cake	1.427	1.051	1.748	9
27	buns/pofpof/donuts	0.828	0.671	1.073	9
28	biscuits	0.877	0.851	0.905	9
29	meat pie/sausage roll	1.992	1.740	2.329	9
30	cassava-roots	6.343	4.971	6.634	7
31	yam-roots	9.187	7.171	10.989	7
32	gari-white	4.113	3.523	4.778	7
33	gari -yellow	5.182	4.598	5.652	7
34	cocoyam	3.537	3.464	3.575	7
35	plantains	4.709	3.764	5.742	7
36	sweet potatoes	2.249	1.782	2.411	7
37	potatoes	3.725	3.099	4.184	7
38	other roots and tuber	7.299	2.236	8.513	7
40	soya beans	3.286	1.435	3.900	6
41	brown beans	5.238	5.103	5.443	6
42	white beans	5.410	4.769	5.729	6
43	groundnuts	1.615	0.882	2.082	6
44	other nuts/seeds/pulses	2.580	1.991	3.011	6
50	palm oil	7.180	6.398	7.724	8
51	butter/margarine	2.744	1.681	3.738	8
52	groundnut oil	4.186	3.147	4.973	8
53	other oils and fats	3.304	2.765	3.757	8
60	bananas	1.829	1.381	2.252	5
61	orange/tangerine	1.539	1.430	1.643	5
62	mangoes	1.553	1.170	1.806	5
63	avocado pear	0.919	0.809	0.995	5
64	pineapples	2.166	2.211	2.098	5
65	canned	1.655	1.760	1.545	5

Estimating household demand for millet and sorghum in Niger and Nigeria

Code	Food product	% of food expenditure	% of food expenditure, urban	% of food expenditure, rural	Food Group
66	other fruits	2.668	1.984	3.462	5
70	tomatoes	2.522	2.507	2.534	5
71	tomatoes puree(canned)	1.317	1.088	1.520	5
72	onions	1.333	1.302	1.353	5
73	garden eggs/egg plant	0.865	0.770	0.928	5
74	okra-fresh	1.334	1.059	1.479	5
75	okra-dried	1.995	1.499	2.127	5
76	pepper	2.258	2.287	2.238	5
77	vegetables leaves	0.888	0.881	0.893	5
78	other vegetables	1.483	1.151	1.783	5
80	chicken	9.390	7.610	11.092	4
81	duck	5.896	4.893	7.031	4
82	other domestic poultry	6.160	6.572	4.388	4
83	agricultural eggs	1.970	2.117	1.620	4
84	local eggs	2.227	3.853	1.513	4
85	other eggs (not chicken)	4.999	5.246	4.878	4
90	beef	8.680	8.674	8.685	4
91	mutton	7.118	5.405	7.837	4
92	pork	4.761	3.794	5.134	4
93	goat	5.778	5.142	6.065	4
94	wild game meat	19.225	12.442	21.319	4
95	canned beef/corned beef	9.112	3.729	28.371	4
96	other meat (excl. poultry)	3.607	2.751	4.643	4
100	fish-fresh	8.204	6.727	9.005	4
101	fish-frozen	6.872	7.247	6.477	4
102	fish-smoked	4.096	4.087	4.102	4
103	fish-dried	7.613	6.762	8.053	4
104	snails	4.981	4.705	5.107	4
105	seafood	3.241	2.559	3.534	4
106	canned fish/seafood	1.425	1.489	1.395	4
107	other fish or seafood	3.275	2.361	3.644	4
110	fresh milk	3.153	1.481	3.535	4
111	milk powder	2.097	1.928	2.345	4
112	baby milk powder	4.857	5.155	4.271	4
113	milk tinned (unsweetend)	3.164	2.680	4.077	4
114	cheese (wara)	2.185	0.898	3.039	4
115	other milk products	2.191	1.593	2.539	4
120	coffee	0.541	0.496	0.694	9
121	chocolate drinks	2.602	2.469	2.775	9
122	tea	2.150	1.250	3.303	9
130	sugar	1.697	1.263	2.013	8
131	jams	2.607	4.010	1.810	8
132	honey	6.613	7.391	5.507	8
133	other sweets confectionary	0.668	0.331	0.793	8
140	condiment	0.987	0.844	1.083	8
150	bottled water	4.324	4.760	3.580	9
151	sachet water	2.178	2.585	1.493	9
152	malt drinks	2.729	2.795	2.658	9
153	soft drinks	2.144	2.146	2.141	9
154	fruit juice canned	2.432	2.416	2.453	9
155	other non-alcoholic drinks	8.705	6.369	10.228	9
0	Food away from home	14.544	19.043	11.035	9

Note: For Niger, food items 808-825 refer to food consumed away from home, and included in the "other food" category. For Nigeria, food away from home is reported in a separate data file; it is aggregated and recoded as 0.

Table A2: Estimated coefficients, Niger

	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9
Rural									
α	-0.267** (0.105)	-0.021 (0.041)	0.379*** (0.066)	0.357*** (0.058)	0.052** (0.022)	0.061** (0.027)	0.052*** (0.019)	-0.04 (0.042)	0.427*** (0.061)
β	-0.115*** (0.034)	-0.01 (0.019)	0.041 (0.028)	0.002 (0.023)	-0.007 (0.011)	0.018 (0.013)	0.006 (0.009)	-0.073*** (0.015)	0.138*** (0.017)
Y_1	0.113*** (0.024)	-	-	-	-	-	-	-	-
Y_2	0.002 (0.008)	0.003 (0.007)	-	-	-	-	-	-	-
Y_3	-0.026** (0.011)	-0.003 (0.003)	0.013* (0.007)	-	-	-	-	-	-
Y_4	-0.073*** (0.009)	-0.016*** (0.003)	0.026*** (0.004)	0.069*** (0.006)	-	-	-	-	-
Y_5	0.000 (0.004)	0.001 (0.002)	-0.003 (0.002)	0.002 (0.002)	0.006*** (0.002)	-	-	-	-
Y_6	0.008* (0.005)	0.008*** (0.003)	-0.003 (0.002)	-0.006*** (0.002)	0.000 (0.002)	0.003 (0.003)	-	-	-
Y_7	0.000 (0.003)	-0.002 (0.002)	0.001 (0.002)	0.004*** (0.001)	-0.002 (0.001)	-0.001 (0.001)	-0.001 (0.001)	-	-
Y_8	0.035*** (0.007)	0.009** (0.004)	-0.02*** (0.005)	-0.014*** (0.004)	0.000 (0.002)	-0.001 (0.002)	0.000 (0.002)	0.005 (0.005)	-
Y_9	-0.06*** (0.016)	-0.002 (0.007)	0.015 (0.01)	0.009 (0.008)	-0.004 (0.004)	-0.008 (0.005)	0.000 (0.003)	-0.013* (0.007)	0.064*** (0.015)
λ	0.000 (0.004)	0.000 (0.002)	-0.002 (0.003)	-0.011*** (0.003)	-0.001 (0.001)	0.003* (0.002)	0.000 (0.001)	-0.003 (0.002)	0.015*** (0.003)
Urban									
α	0.022*** (0.007)	0.001 (0.002)	0.171*** (0.012)	0.455*** (0.016)	0.098*** (0.004)	0.008*** (0.003)	0.034*** (0.003)	0.063*** (0.007)	0.147*** (0.012)
β	-0.04*** (0.01)	-0.001 (0.004)	-0.109*** (0.016)	0.189*** (0.017)	0.008 (0.006)	-0.018*** (0.004)	0.001 (0.005)	-0.084*** (0.008)	0.054*** (0.017)
Y_1	0.033*** (0.01)	-	-	-	-	-	-	-	-
Y_2	0.008 (0.006)	0.002 (0.007)	-	-	-	-	-	-	-
Y_3	0.015*** (0.005)	-0.003 (0.002)	0.056*** (0.008)	-	-	-	-	-	-
Y_4	-0.031*** (0.004)	-0.001 (0.001)	-0.051*** (0.006)	0.09*** (0.009)	-	-	-	-	-
Y_5	-0.012*** (0.003)	-0.002** (0.001)	-0.012*** (0.003)	0.004* (0.002)	0.015*** (0.002)	-	-	-	-
Y_6	0.002 (0.002)	0.001 (0.001)	0.000 (0.002)	-0.007*** (0.001)	-0.002** (0.001)	0.004*** (0.001)	-	-	-
Y_7	-0.015*** (0.004)	-0.004* (0.002)	-0.001 (0.003)	0.006*** (0.002)	0.005*** (0.001)	0.000 (0.001)	0.004 (0.003)	-	-
Y_8	0.004 (0.003)	0.002 (0.001)	0.011*** (0.003)	-0.026*** (0.003)	-0.003** (0.002)	0.002* (0.001)	0.004** (0.002)	0.01*** (0.003)	-
Y_9	-0.004 (0.003)	-0.002* (0.001)	-0.015*** (0.004)	0.017*** (0.005)	0.009*** (0.001)	0.000 (0.001)	0.002 (0.001)	-0.004 (0.002)	-0.002 (0.005)
λ	-0.013*** (0.003)	0.000 (0.001)	-0.038*** (0.005)	0.033*** (0.005)	-0.002 (0.002)	-0.006*** (0.001)	-0.002 (0.001)	-0.023*** (0.002)	0.052*** (0.005)

Table A3: Estimated coefficients of demographic variables, rural Niger

	ρ	η_1	η_2	η_3	η_4	η_5	η_6	η_7	η_8	η_9
Number of children under 6	7.284 (4.444)	0.000 (0.001)	0.000 (0.000)	0.000 (0.000)	-0.001 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000** (0.000)	0.001*** (0.000)	0.000 (0.000)
Number of children between 6 and 15	8.607 (5.306)	0.000 (0.000)	0.000 (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	0.000*** (0.000)	0.000 (0.000)	0.000 (0.000)	0.001*** (0.000)	0.001** (0.000)
Number of adults under 60	10.373 (6.351)	0.001 (0.001)	0.000 (0.000)	-0.002*** (0.001)	-0.001 (0.000)	0.000 (0.000)	0.001*** (0.000)	0.000 (0.000)	0.001*** (0.000)	0.001** (0.000)
Number of seniors 60 and over	11.104 (6.854)	0.001 (0.001)	-0.001 (0.000)	0.001 (0.001)	-0.001 (0.001)	0.000 (0.000)	-0.001* (0.000)	0.001*** (0.000)	0.001** (0.000)	-0.001* (0.001)
Household head gender, 1 if female	2.525 (2.001)	0.006** (0.002)	0.002* (0.001)	-0.007*** (0.002)	0.003* (0.002)	-0.001 (0.000)	0.001** (0.001)	0.000 (0.000)	0.001 (0.001)	-0.005*** (0.001)
Household head education, 1 if has some education or equivalent	1.396 (1.328)	0.005*** (0.002)	0.001 (0.001)	-0.005*** (0.001)	-0.001 (0.001)	-0.002*** (0.000)	0.000 (0.000)	0.000 (0.000)	0.001* (0.000)	0.001 (0.001)
Region, 1 if Diffa	-9.862* (5.681)	-0.020*** (0.004)	0.001 (0.001)	0.002 (0.002)	0.012*** (0.003)	-0.004*** (0.001)	-0.009*** (0.001)	0.001* (0.001)	0.007*** (0.001)	0.010*** (0.002)
Region, 1 if Dosso	-7.507* (4.366)	-0.032*** (0.005)	-0.006*** (0.001)	0.006*** (0.002)	0.024*** (0.004)	0.002** (0.001)	-0.009*** (0.002)	-0.004*** (0.001)	0.015*** (0.002)	0.004** (0.002)
Region, 1 if Maradi	-8.141* (4.723)	-0.023*** (0.004)	-0.004*** (0.001)	0.021*** (0.004)	0.007*** (0.002)	-0.002*** (0.001)	-0.012*** (0.002)	-0.005*** (0.001)	0.016*** (0.002)	0.002 (0.002)
Region, 1 if Tahoua	-4.362 (3.014)	-0.028*** (0.005)	-0.012*** (0.002)	0.027*** (0.004)	0.010*** (0.002)	0.001 (0.001)	-0.007*** (0.001)	-0.003*** (0.001)	0.014*** (0.002)	-0.002 (0.002)
Region, 1 if Tillaberi	-7.616* (4.485)	-0.034*** (0.006)	-0.005*** (0.001)	0.008*** (0.002)	0.026*** (0.004)	0.002** (0.001)	-0.002** (0.001)	-0.001 (0.001)	0.016*** (0.002)	-0.009*** (0.002)
Region, 1 if Zinder	-6.301* (3.776)	-0.021*** (0.004)	-0.008*** (0.002)	0.014*** (0.003)	0.011*** (0.003)	-0.003*** (0.001)	-0.015*** (0.002)	-0.002*** (0.001)	0.014*** (0.002)	0.010*** (0.002)

Table A4: Estimated coefficients of demographic variables, urban Niger

	ρ	η_1	η_2	η_3	η_4	η_5	η_6	η_7	η_8	η_9
Number of children under 6	0.147*** (0.04)	-0.003*** (0.001)	-0.001*** (0.000)	-0.004*** (0.001)	0.002 (0.002)	0.000 (0.001)	0.000 (0.000)	0.000 (0.000)	-0.002*** (0.001)	0.008*** (0.002)
Number of children between 6 and 15	0.224*** (0.032)	-0.003*** (0.001)	0.000 (0.000)	-0.005*** (0.001)	0.002 (0.002)	0.001*** (0.000)	-0.001** (0.000)	-0.001 (0.000)	0.001*** (0.001)	0.004*** (0.001)
Number of adults under 60	0.170*** (0.027)	0.001 (0.001)	0.000 (0.000)	-0.008*** (0.001)	0.007*** (0.001)	-0.001** (0.000)	0.000 (0.000)	0.000 (0.000)	-0.002*** (0.001)	0.004*** (0.001)
Number of seniors 60 and over	0.292*** (0.086)	-0.004* (0.002)	-0.002** (0.001)	-0.001 (0.003)	0.006 (0.004)	-0.003** (0.001)	-0.004*** (0.001)	0.000 (0.001)	-0.002 (0.001)	0.009*** (0.004)
Household head gender, 1 if female	-0.11 (0.092)	0.000 (0.003)	-0.001 (0.001)	-0.007* (0.004)	0.010* (0.006)	-0.001 (0.002)	0.000 (0.001)	-0.002* (0.001)	-0.005** (0.002)	0.006 (0.005)
Household head education, 1 if has primary education or equivalent	0.216** (0.101)	0.006** (0.003)	0.001 (0.001)	0.008** (0.004)	-0.008 (0.005)	-0.004*** (0.002)	0.001 (0.001)	-0.001 (0.001)	0.000 (0.002)	-0.002 (0.005)
Household head education, 1 if has secondary education or higher	0.078 (0.105)	0.012*** (0.003)	0.002** (0.001)	0.025*** (0.005)	-0.028*** (0.006)	-0.009*** (0.002)	0.004*** (0.001)	-0.003* (0.001)	0.006*** (0.002)	-0.010* (0.006)
Region, 1 if Agadez	0.052 (0.225)	-0.030*** (0.007)	-0.001 (0.002)	0.007 (0.009)	0.024 (0.016)	0.010** (0.004)	-0.008*** (0.002)	0.002 (0.003)	-0.020*** (0.006)	0.016 (0.010)
Region, 1 if Diffa	-0.144 (0.23)	-0.033*** (0.006)	0.000 (0.003)	0.000 (0.009)	-0.007 (0.012)	0.018*** (0.004)	-0.020*** (0.003)	0.007** (0.003)	-0.006 (0.004)	0.042*** (0.011)
Region, 1 if Dosso	1.663*** (0.439)	-0.016*** (0.004)	-0.004** (0.001)	-0.006 (0.006)	0.014 (0.009)	0.002 (0.003)	-0.008*** (0.001)	0.001 (0.002)	-0.001 (0.003)	0.017* (0.009)
Region, 1 if Maradi	-0.310** (0.136)	-0.047*** (0.005)	-0.004** (0.002)	-0.018*** (0.006)	0.049*** (0.009)	-0.006** (0.003)	-0.014*** (0.002)	-0.003 (0.002)	-0.004 (0.003)	0.046*** (0.007)
Region, 1 if Tahoua	0.379* (0.216)	-0.054*** (0.005)	-0.008*** (0.002)	0.018*** (0.006)	0.011 (0.008)	0.008*** (0.002)	-0.010*** (0.001)	0.001 (0.002)	0.004 (0.003)	0.03*** (0.007)
Region, 1 if Tillaberi	2.085*** (0.733)	-0.046*** (0.005)	-0.006*** (0.002)	0.014** (0.007)	0.002 (0.009)	0.003 (0.003)	-0.003** (0.002)	-0.003 (0.002)	0.003 (0.003)	0.037*** (0.010)
Region, 1 if Zinder	0.102 (0.177)	-0.037*** (0.004)	-0.005*** (0.002)	0.017*** (0.005)	0.027*** (0.008)	0.003 (0.002)	-0.017*** (0.002)	-0.003* (0.002)	0.008*** (0.003)	0.007 (0.007)

Table A5: Estimated coefficients, Nigeria

	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9
Rural									
α	0.002 (0.012)	-0.021 (0.013)	0.120*** (0.016)	0.178*** (0.022)	0.190*** (0.016)	0.014 (0.014)	0.578*** (0.031)	-0.054** (0.023)	-0.008 (0.023)
β	0.017*** (0.004)	0.032*** (0.004)	0.016*** (0.005)	-0.002 (0.006)	-0.036*** (0.005)	0.019*** (0.004)	-0.096*** (0.009)	0.035*** (0.007)	0.016** (0.007)
Y_1	0.005 (0.006)	-	-	-	-	-	-	-	-
Y_2	-0.041*** (0.005)	0.005 (0.008)	-	-	-	-	-	-	-
Y_3	-0.001 (0.005)	-0.004 (0.006)	0.061*** (0.009)	-	-	-	-	-	-
Y_4	-0.002 (0.005)	0.016*** (0.006)	0.016** (0.007)	0.035*** (0.012)	-	-	-	-	-
Y_5	-0.007 (0.004)	-0.005 (0.005)	-0.019*** (0.005)	0.002 (0.006)	0.020*** (0.007)	-	-	-	-
Y_6	-0.033*** (0.005)	-0.014** (0.006)	-0.034*** (0.006)	0.003 (0.006)	-0.001 (0.005)	0.057*** (0.008)	-	-	-
Y_7	0.064*** (0.006)	0.041*** (0.006)	-0.047*** (0.008)	-0.070*** (0.009)	0.024*** (0.007)	0.031*** (0.006)	0.001 (0.014)	-	-
Y_8	-0.005* (0.003)	-0.003 (0.003)	-0.009** (0.004)	0.003 (0.005)	-0.004 (0.004)	-0.022*** (0.003)	0.031*** (0.006)	-0.006 (0.006)	-
Y_9	0.020*** (0.005)	0.004 (0.005)	0.037*** (0.006)	-0.003 (0.008)	-0.010* (0.006)	0.013** (0.005)	-0.075*** (0.008)	0.014*** (0.005)	0.000 (0.011)
λ	-0.002*** (0.000)	-0.004*** (0.000)	-0.004*** (0.000)	0.000 (0.000)	0.003*** (0.000)	-0.002*** (0.000)	0.003*** (0.001)	0.004*** (0.000)	0.002*** (0.000)
Urban									
α	-0.007* (0.004)	-0.007 (0.005)	0.150*** (0.012)	0.262*** (0.017)	0.129*** (0.012)	0.072*** (0.007)	0.332*** (0.022)	-0.022 (0.023)	0.091*** (0.027)
β	0.009*** (0.002)	0.015*** (0.002)	0.007 (0.005)	-0.033*** (0.007)	-0.023*** (0.005)	-0.003 (0.003)	-0.061*** (0.008)	0.047*** (0.009)	0.044*** (0.010)
Y_1	0.001 (0.004)	-	-	-	-	-	-	-	-
Y_2	-0.009** (0.004)	0.004 (0.006)	-	-	-	-	-	-	-
Y_3	0.000 (0.004)	0.001 (0.005)	0.053*** (0.012)	-	-	-	-	-	-
Y_4	-0.007* (0.004)	0.000 (0.005)	0.011 (0.010)	-0.014 (0.018)	-	-	-	-	-
Y_5	0.005 (0.003)	0.002 (0.004)	0.008 (0.008)	0.007 (0.010)	0.008 (0.011)	-	-	-	-
Y_6	-0.010*** (0.003)	-0.009** (0.004)	-0.010 (0.007)	0.020*** (0.007)	-0.015** (0.006)	0.037*** (0.006)	-	-	-
Y_7	0.009*** (0.004)	0.013*** (0.004)	-0.038*** (0.009)	-0.010 (0.011)	-0.010 (0.009)	0.000 (0.006)	0.060*** (0.014)	-	-
Y_8	0.008*** (0.002)	-0.002 (0.003)	-0.010 (0.007)	-0.004 (0.009)	0.013* (0.007)	-0.012*** (0.004)	0.015** (0.007)	-0.032*** (0.010)	-
Y_9	0.004 (0.003)	-0.001 (0.003)	-0.015* (0.008)	-0.003 (0.011)	-0.018** (0.008)	-0.002 (0.005)	-0.040*** (0.010)	0.023** (0.010)	0.052*** (0.018)
λ	-0.001*** (0.000)	-0.002*** (0.000)	-0.006*** (0.001)	0.002*** (0.001)	0.003*** (0.001)	-0.001*** (0.000)	0.000 (0.001)	0.003*** (0.001)	0.003*** (0.001)

Table A6: Estimated coefficients of demographic variables, rural Nigeria

	ρ	η_1	η_2	η_3	η_4	η_5	η_6	η_7	η_8	η_9
Number of children under 6	0.000 (0.000)	0.000 (0.000)	0.001*** (0.000)	0.001*** (0.000)	0.000 (0.000)	0.000** (0.000)	0.000 (0.000)	0.000 (0.000)	-0.001** (0.000)	-0.001** (0.000)
Number of children between 6 and 15	0.000 (0.000)	0.000*** (0.000)	0.001*** (0.000)	0.001*** (0.000)	0.000** (0.000)	0.000*** (0.000)	0.000 (0.000)	0.000** (0.000)	-0.001** (0.000)	-0.001*** (0.000)
Number of adults under 60	0.000 (0.000)	0.000* (0.000)	0.000*** (0.000)	0.001*** (0.000)	0.000 (0.000)	0.000** (0.000)	0.000 (0.000)	0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)
Number of seniors 60 and over	0.000 (0.000)	0.000** (0.000)	0.001*** (0.000)	0.001*** (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.001** (0.000)	-0.002*** (0.001)	-0.001*** (0.000)
Household head gender, 1 if female	0.000 (0.000)	-0.002*** (0.001)	-0.002** (0.001)	0.001 (0.001)	0.001 (0.001)	0.000 (0.001)	-0.001 (0.001)	-0.002 (0.001)	0.004** (0.002)	0.001 (0.002)
Household head education, 1 if has primary education or equivalent	-0.001 (0.001)	0.000 (0.000)	0.001* (0.000)	0.001** (0.001)	-0.003*** (0.001)	0.000 (0.000)	0.000 (0.000)	0.001 (0.001)	-0.002* (0.001)	0.001 (0.001)
Household head education, 1 if has secondary education or higher	-0.001 (0.001)	-0.002*** (0.000)	-0.001** (0.001)	0.003*** (0.001)	0.000 (0.001)	-0.002*** (0.001)	-0.001** (0.001)	0.000 (0.001)	-0.005*** (0.001)	0.007*** (0.001)
Zone, 1 if north east	-0.995*** (0.004)	0.007*** (0.001)	0.016*** (0.002)	0.022*** (0.002)	0.005* (0.003)	0.000 (0.002)	0.006*** (0.002)	0.013*** (0.005)	-0.047*** (0.005)	-0.022*** (0.004)
Zone, 1 if north west	-0.998*** (0.001)	0.013*** (0.002)	0.024*** (0.002)	0.024*** (0.003)	0.000 (0.003)	-0.001 (0.002)	0.007*** (0.002)	0.015*** (0.005)	-0.054*** (0.005)	-0.027*** (0.004)
Zone, 1 if south east	0.285 (0.447)	-0.006*** (0.001)	-0.014*** (0.002)	-0.004** (0.002)	0.011*** (0.002)	0.010*** (0.001)	0.006*** (0.001)	-0.004 (0.007)	-0.009* (0.005)	0.010** (0.004)
Zone, 1 if south south	0.445 (0.51)	-0.006*** (0.001)	-0.010*** (0.002)	-0.013*** (0.002)	0.021*** (0.003)	0.006*** (0.002)	0.000 (0.001)	0.005 (0.006)	-0.008 (0.005)	0.005 (0.004)
Zone, 1 if south west	-0.700*** (0.176)	-0.003** (0.001)	-0.007*** (0.002)	-0.001 (0.003)	0.011*** (0.002)	0.006*** (0.001)	0.001 (0.001)	0.014** (0.006)	-0.012* (0.007)	-0.009** (0.004)

Table A7: Estimated coefficients of demographic variables, urban Nigeria

	ρ	η_1	η_2	η_3	η_4	η_5	η_6	η_7	η_8	η_9
Number of children under 6	0.000 (0.000)	0.000*** (0.000)	0.000* (0.000)	0.003*** (0.000)	-0.001* (0.000)	0.000 (0.000)	0.000 (0.000)	0.001* (0.000)	0.001* (0.001)	-0.004*** (0.001)
Number of children between 6 and 15	0.000 (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.002*** (0.000)	-0.001** (0.000)	0.000 (0.000)	0.000*** (0.000)	0.001*** (0.000)	0.000 (0.000)	-0.002*** (0.001)
Number of adults under 60	0.000 (0.000)	0.000 (0.000)	0.000** (0.000)	0.002*** (0.000)	0.000 (0.000)	-0.001*** (0.000)	0.000 (0.000)	0.000 (0.000)	-0.001*** (0.000)	-0.001 (0.000)
Number of seniors 60 and over	0.000 (0.000)	0.000** (0.000)	0.001*** (0.000)	0.001 (0.001)	0.000 (0.001)	0.000 (0.001)	0.001 (0.000)	0.002** (0.001)	0.002** (0.001)	-0.007*** (0.002)
Household head gender, 1 if female	0.000 (0.000)	0.000 (0.000)	-0.001 (0.001)	0.004** (0.002)	-0.003* (0.002)	0.003* (0.002)	0.001 (0.001)	0.004** (0.002)	0.005** (0.002)	-0.012*** (0.003)
Household head education, 1 if has primary education or equivalent	0.000 (0.000)	0.001** (0.000)	-0.001 (0.000)	0.004** (0.002)	-0.002 (0.002)	-0.004*** (0.001)	0.000 (0.001)	-0.001 (0.001)	0.001 (0.002)	0.001 (0.003)
Household head education, 1 if has secondary education or higher	0.000 (0.000)	0.000 (0.000)	-0.002*** (0.000)	0.002 (0.001)	0.003** (0.001)	-0.003** (0.001)	0.000 (0.001)	-0.001 (0.001)	-0.002 (0.002)	0.002 (0.002)
Zone, 1 if north east	-0.999*** (0.001)	0.008*** (0.001)	0.008*** (0.002)	0.050*** (0.005)	0.006 (0.006)	-0.006 (0.004)	0.011*** (0.003)	0.029*** (0.007)	-0.058*** (0.008)	-0.048*** (0.009)
Zone, 1 if north west	-0.999*** (0.001)	0.010*** (0.001)	0.011*** (0.002)	0.053*** (0.005)	0.003 (0.006)	-0.006 (0.004)	0.011*** (0.003)	0.029*** (0.007)	-0.057*** (0.008)	-0.053*** (0.009)
Zone, 1 if south east	0.451 (0.594)	-0.002** (0.001)	-0.007*** (0.001)	-0.013** (0.005)	0.014*** (0.005)	0.012*** (0.003)	0.007*** (0.002)	-0.010 (0.010)	-0.015* (0.008)	0.014 (0.011)
Zone, 1 if south south	2.014** (0.976)	-0.003** (0.001)	-0.006*** (0.001)	-0.023*** (0.006)	0.017*** (0.005)	0.008** (0.004)	-0.004 (0.003)	-0.011 (0.009)	0.017 (0.010)	0.005 (0.010)
Zone, 1 if south west	-0.696*** (0.138)	-0.001 (0.001)	-0.005*** (0.001)	0.004 (0.004)	0.006** (0.003)	0.005** (0.002)	0.001 (0.002)	0.015** (0.006)	-0.018*** (0.007)	-0.008 (0.007)