Food systems transformation and changing demand for animal proteins: Evidence from Nigeria

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Abstract

Food systems in developing countries have been experiencing a rapid transformation over the last few decades. Rising incomes and urbanization have increased the demand for food and its composition has been changing with the diversification of diets. As predicted by Bennett's law, share of food expenditure on starchy staples has declined and has been replaced by other products including animal proteins. This has triggered a supply response leading to increased production of animal-sourced foods. Despite such increase in meat production, value chains have remained under-developed due to perishable nature of the product, lack of processing, and lack of cold storage facilities. We conduct a disaggregated demand analysis of various foodgroups including animal-sourced foods in order to create a demand-driven and sustainable value chains. Using household level panel data (LSMS) from Nigeria, we estimate EASI demand models to analyze demand for animal-sourced proteins in Nigeria. We account for the heterogeneity in urban and rural as well as regions varying in level of development. Our results suggest that seafood and beef are the most popular forms of animal proteins consumed in Nigeria. However, as incomes increase poultry meat and eggs have a huge potential for growth and might play an important role in addressing the issue of malnutrition in Nigeria. This suggests that it is important to create efficient and fast-moving poultry value chains in order to benefit producers and hence consumers.

1. Introduction

Global demand for animal proteins including meat, seafood, and dairy across the world has tremendously increased over the last several decades. This transformation is occurring in stages at different times in various parts of the world and is associated with rise in incomes and increasing population. During the first stage, as predicted by Bennett's law (Bennett, 1941), increased incomes lead to the transformation of diets away from non-starchy staples to other nutrient-rich products such as animal proteins. As incomes continue to rise, the second stage of stagnation or "peak meat" is reached after which per capita consumption of meat begins to decline (Spiller & Nitzko 2015, Vranken et al. 2014). High income countries in North America and Europe are beginning to enter the second and third stages of transformation although these countries still dominate total meat consumption in the world (Parlasca and Qaim, 2022). However, majority of the world population, particularly in middle and low-income countries, is still in the first stage of dietary transformation and would continue to drive the increase in meat demand (Desiere et al. 2018, Gouel & Guimbard 2019). The most dramatic increase in per capita meat consumption has taken place in Africa, Asia, and Latin America after 1990s with consumption levels nearly comparable to developed countries in Latin America (Parlasca and Qaim, 2022). On the contrary, levels of meat consumption in Africa are the lowest and incredibly lower than the rest of the world. Thus, Africa has just entered the first stage of dietary transformation with huge potential for growth in the coming decades.

In Africa consumption of animal-sourced proteins is critical for addressing the highly prevalent issues of food security and malnutrition (Adesogan et al. 2020, Heady et al. 2018, Akombi et al.,

2017). The changing demand has led to a significant domestic supply response that has triggered the so-called "livestock revolution" (Delgado, 2003; Narrod et al., 2008). According to FAOSTAT data meat production in Africa tripled between 1970 and 2020. Africa's meat production has always been dominated by beef and seafood. However, production patterns are now beginning to change in recent years. Between 1970 and 2020, beef production increased by about 150% and that of seafood increased by 190%. Poultry production, although starting at low levels, has caught up in these decades with a growth rate of whopping 1030%. In fact, in 2020 poultry production in absolute terms at 6.7 million tonnes was higher than that of total beef production (6.2 million tonnes). Despite such increase in meat production, value chains have remained under-developed due to perishable nature of the product, lack of processing, and lack of cold storage facilities. This leads to glut situations in some areas and high consumer prices in others. Therefore, it is necessary to strengthen demand-driven value chains to ensure efficient procurement and marketing.

At the same time, it is important to ensure development of sustainable food systems while Africa's meat production is still in early stages of intensification. These various stages of meat consumption and hence production have significant impacts for food systems, nutrition, and environment. As per capita meat consumption is incredibly low benefits of meat consumption for employment, nutrition, and food security far outweigh environmental and nutrition costs in the developed world (see Parlasca and Qaim, 2022). However, climate change is already posing food security threat in Africa as temperatures are rising.

In order to achieve efficient and sustainable meat value chains, it is important to understand consumer demand for different sources of animal proteins. The literature on food demand, mostly focusing on nutrition rather than markets and food systems, has examined demand for animal proteins as a foodgroup. However, only a few studies have conducted a disaggregated analysis of animal protein demand (Aborisade and Carpio, 2017; Desiere et al., 2018; Zhao and Staatz, 2017). These studies use cross-sectional data that do not allow demand analysis over time. Moreover, the intercountry analysis conducted in these studies is largely at the national level. This is a glaring gap in the literature as no study has analyzed consumer demand for different foodgroups at a disaggregated level over spatial categories such as agroecological zones as well as regions with varying levels of development. Our study aims to contribute to this goal by conducting a disaggregated demand analysis for different types of meats with Nigeria as a case.

Nigeria presents an interesting case because it is the most populous country with the highest GDP in Africa. Rising incomes and urbanization have increased the demand for food and its composition has been changing with the diversification of diets. As predicted by Bennett's law, share of food expenditures are being replaced by other products including animal proteins (Tschirley et al., 2015; Muyanga et al., 2019). Large and positive expenditure elasticities for animal proteins have been noted in various countries including Nigeria (Zhou and Staatz, 2016).

In response to these observed gaps in the literature, this paper analyzes the consumption patterns, food expenditure, and price elasticities of poultry meat and eggs in Nigeria using data from a nationally representative panel survey spanning 6 years. To account for potential variation in employment, market access and use, lifestyle and preferences, we stratify our analysis by urban and rural areas. We also distinguish between Nigeria's richer south and poorer north to account for economic and agro-ecological variation in demand for and access to anima-sourced foods. With panel data on the same households over multiple periods we are better able to track changes over time. Also, using panel data allows us to control for time invariant factors in order to estimate consumer demand. This has not been done before particularly at a disaggregated level in Africa.

Thus, this paper contributes to the literature in the following ways. First, our demand analysis includes different types of animal-sourced foods including eggs and poultry meat. Second, we conduct spatial analysis to examine how demand patterns for products vary over poor and rich regions of urban and rural areas. Third, using panel data for demand estimation allows us to understand how demand is evolving over time.

2. Nigeria's meat production and consumption

On an average, in Nigeria, animal protein accounts for 20% of the food budget in urban areas and 15% in rural areas (Liverpool-Tasie et al., 2017). Particularly, poultry production took off rapidly in many developing countries including Nigeria (Liverpool-Tasie et al., 2017). In Nigeria chicken and egg outputs grew by 220% and 320% respectively between 1980 and 2019.

Although the poultry subsector is expanding rapidly, per capita consumption numbers for Nigeria are very low as compared to other regions in Africa. Nigeria's per capita poultry meat consumption in 2014 was about 1.41kg per year (Sahel Capital, 2015). Our calculations from LSMS survey in 2018 indicate this number to be about 2.25kg. These numbers are very low as compared to 7kg Ghana, 20kg in South Africa, and about 40 kg in USA. Similarly, per capita annual egg consumption (as per LSMS 2018) in Nigeria is also low at 20 eggs as compared to other countries, say 250 eggs in the US. However, FAO predicts that overall meat consumption in Nigeria is expected to increase by 75% in the next decade. This suggests that there is a huge potential for the growing poultry sector to meet the demand for animal protein in the future. Also, due to characteristics such as a short production cycle and low capital investments (Heise et al., 2015) poultry including meat and eggs are potentially important for addressing malnutrition in a developing country like Nigeria.

For poultry producers to be able to tap the growing demand for animal protein, fast moving supply chains are crucial as chicken and eggs have a short shelf-life. This is because contrary to the conventional belief, poultry sector in Nigeria, although comprising several small-scale poultry farms, is highly commercialized. Despite the increasing production, the relative numbers for per capita chicken and egg consumption are quite low. In fact, egg producers have often faced glut situations in the last few years that forced them to sell away eggs at a very low price (Bailey, 2019). This indicates that well-functioning supply chains are extremely important for poultry products to reach the high demand areas. Thus, understanding how consumption patterns

have evolved over time and factors influencing them are important for proper functioning of poultry markets.

In addition, the existing studies have focused on poultry meat while eggs have remained largely excluded. With changing preferences, eggs have made their way into people's everyday diets (Liverpool-Tasie et al., 2017). Yet, the common belief that eggs are mainly consumed for subsistence have led to an underdeveloped egg supply chain. Coupled with highly perishable nature, eggs are still an expensive source of animal protein (Headey et al., 2017). To exploit the potential of eggs to solve the problem of malnutrition, understanding demand patterns of eggs becomes extremely important. This could further help develop appropriate supply chains to cater to the increasing demand at affordable prices.

3. Data

We use Living Standards Measurement Study-Integrated Surveys on Agriculture (LSMS-ISA) data collected by the World Bank for Nigeria in 2010/11, 2012/13, 2015/16. Each of the 5000 households was surveyed twice in each year during the post-planting season and post- harvest season. As same individuals were interviewed in every round of data collection this data generates a panel across 8 years. The nationally representative survey covering urban and rural areas of all 6 geopolitical zones in Nigeria captures heterogeneity across agricultural patterns as well as demography. The data also includes information about household characteristics, assets, production, and food consumption from own production, purchases, and gifts.

The detailed consumption data includes quantities consumed per week and expenditure for several food items belonging to the following categories: cereals and tubers, pulses, dairy, beef, poultry and eggs, seafood, other meats, dairy products, fruits, vegetables, and other foods. The categorization of food items into different groups is guided by other consumption studies in developing countries (Fashogbon and Oni, 2013; Dolislager, 2017). We compute expenditure of household food consumption of the categories. We compute price indices for each of the categories as a weighted average of prices derived from each transaction for different items. To convert nominal prices into real prices we use the consumer price index using 2010 as the base year.

4. Consumption patterns

Table 1: Annual consumption of animal-sourced proteins in Nigeria by region

	2010			2012			2015		
	North	South	All	North	South	All	North	South	All
				Share of consumers					
Animal proteins	0.82	0.96	0.90	0.85	0.99	0.93	0.83	0.99	0.92
Fish and seafood	0.49	0.88	0.71	0.48	0.91	0.72	0.49	0.90	0.72
Eggs	0.07	0.21	0.15	0.07	0.21	0.14	0.10	0.31	0.21
Poultry	0.11	0.11	0.11	0.07	0.09	0.08	0.06	0.11	0.09
Beef	0.46	0.48	0.47	0.41	0.53	0.48	0.38	0.50	0.44
Mutton	0.07	0.02	0.04	0.08	0.00	0.04	0.06	0.01	0.03
Goat	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
Pork	0.07	0.05	0.06	0.11	0.04	0.07	0.15	0.04	0.09
Wild game meat	0.01	0.02	0.02	0.01	0.02	0.02	0.01	0.03	0.02
Fresh milk	0.17	0.02	0.08	0.19	0.01	0.09	0.19	0.00	0.09
				Per capita annual quantity (in kg)					
Animal proteins	24.2	37.1	31.4	20.7	28.8	25.2	17.9	34.1	27.0
Fish and seafood	7.7	20.8	15.1	5.7	15.8	11.3	6.4	19.3	13.5
Eggs	0.7	1.4	1.1	2.3	1.0	1.6	0.6	1.8	1.3
Poultry	2.0	2.0	2.0	1.3	1.6	1.5	0.8	2.3	1.6
Beef	6.6	6.5	6.5	4.6	6.6	5.7	3.7	7.7	5.9
Mutton	0.8	0.3	0.5	0.9	0.0	0.4	0.6	0.0	0.3
Goat	0.3	0.3	0.3	0.1	0.1	0.1	0.2	0.1	0.1
Pork	0.8	0.7	0.7	1.2	0.5	0.8	1.5	0.7	1.1

Wild game meat	0.3	0.4	0.3	0.1	0.9	0.5	0.1	0.6	0.4
Fresh milk	3.9	0.6	2.0	3.8	0.1	1.7	3.7	0.1	1.7

Source: Authors' calculations from LSMS data

Table 1 presents share of households consuming different types of animal proteins and annual per capita consumption in Nigeria and Table 2 presents prices by foodgroups and region. Several findings emerge. First, more than 90% of households in our sample consume some form of animal protein and the share has remained nearly constant between 2010 and 2015. Second, seafood followed by beef are the most popular forms of animal protein with share of consumers at about 72% and 44% respectively and has remained steady over time. This is followed by eggs with share of consumers at 21% that has increased from about 14% in 2015. Second, there is great variation in consumption across North and South. About 99% of our households in the South consume some form of animal proteins in a week, only 83% in the North do so. Third, only 50% of our sample in the North consumed seafood in the past week whereas 90% of those in the South consumed seafood in some form. Fourth, overall milk consumption in Nigeria is very low with less than 10% households that consumed milk in the past week. Moreover, milk consumption is predominant in the North (19%) than in the South (0.001%). Fifth, consumption of other sources of animal proteins such as mutton, goat, wild game meat, and pork is low. Mutton and pork are consumed by higher share of households in the North than in the South.

Table 2: Price per kg of different foodgroups

	wave 1			wave 2			wave 3		
	North	South	All	North	South	All	North	South	All
Cereals	109	189	148	119	235	187	117	196	165
Fruit and vegetables	207	247	231	192	203	200	175	155	163
Animal proteins	464	568	524	476	501	492	378	398	390
Fish and seafood	313	429	369	377	385	382	283	332	310
Eggs	350	429	417	402	482	482	280	270	270
Poultry	566	650	625	756	724	727	566	566	566
Beef	665	750	700	641	679	650	560	589	566

Mutton	600	750	700	662	643	643	503	503	503
Goat	650	681	667	482	502	495	409	440	440
Pork	571	678	625	563	644	603	472	503	503
Wild game meat	583	667	650	849	1146	882	488	472	484
Fresh milk	108	256	137	129	670	161	64	87	78

Source: Authors' calculations

Overall these findings suggest that while seafood and beef are more popular sources of animal proteins, there is scope for increasing consumption of poultry and eggs which are cheaper and faster to produce with lesser impact for the environment.

5. Econometric Analysis

Our demand analysis focuses on different sources of animal proteins along with other food groups. We categorize different products into groups – Fish and seafood, beef, poultry meat, eggs, other meats (mutton, goat, wild game meat, pork), milk, cereals and tubers, pulses, fruits and vegetables, other foods. Our analysis assumes that households follow a two-stage budgeting process (Deaton and Muellbauer, 1980). In the first stage, households allocate budget between food and nonfood expenditures. In the second stage, budget allocated to food expenditure is further allocated different foodgroups. Our analysis estimates full food demand system by allowing for substitution between different foodgroups including disaggregated animal-protein sources.

Most studies in the literature estimate demand system for food using parametric methods under the assumption that goods depict linear or quadratic Engel curves. However, recent studies have shown that Engel curves for some products are highly nonlinear (Blundell˜Richard and

Kristensen; 2007). In order to overcome this problem, we use a more flexible demand system called Exact Affine Stone Index (EASI) developed Pendakur (2008), and Lewbel and Pendakur (2009). Additionally, EASI allows us to include unobserved heterogeneity in individual preferences and time-specific factors in the model (Lewbel and Pendakur, 2009).

5.1.The EASI demand system

We follow Lewbel and Pendakur (2009) demand estimation with a pooled cross-section data. Consider cost (expenditure) function $C(u, \boldsymbol{p}, z, \varepsilon)$ where u denotes the utility level, $\boldsymbol{p}$ is the price vector of foodgroups, z denotes a vector of observable characteristics that affect preference (demographic variables such as household size, age, education), and ε represents unobserved preference characteristics such as taste parameters. Given log prices $\boldsymbol{p}$, the minimum log-expenditure required for an individual with characteristics z, ε to attain utility level u is the log cost function $x = C(u, \boldsymbol{p}, z, \varepsilon)$. Hicksian (compensated) budget share functions using Shephard's lemma are given by $w = \omega(u, \boldsymbol{p}, z, \varepsilon) = \nabla_p C(u, \boldsymbol{p}, z, \varepsilon)$. Indirect utility function, V, is expressed as: $u = V(\boldsymbol{p}, z, \varepsilon, x) = C^{-1}(\boldsymbol{p}, ., z, \varepsilon)$. By expressing utility as a function g of $w, \boldsymbol{p}, z, x$, the implicit utility function, expressed in terms of observable data, is defined as $y = g(w, \boldsymbol{p}, z, x)$. This implicit utility function is further used calculate the Marshallian budget shares as follows:

$$w = \sum_{r=0}^{R} b_r y^r + Cz + Dzy + \sum_{l=0}^{L} z_l A_l p + Bpy + \varepsilon - - - -(1)$$

Where p is a vector of J foodgroup prices and z is a vector of L demographic variables, and ε captures unobserved heterogeneity. y is a measure of real food consumption and is is transformed following Lewbel and Pendakur (2009). Further we follow Lewbel and Pendakur (2009) to calculate price and income elasticities of different foodgroups.

5.2. Estimation Strategy

Estimation of demand systems often faces the problem of zero consumption and endogeneity. First, we deal with the issue of zero consumption of foodgroups. In our sample, we have several households that have zero consumption of many foodgroups including different sources of animal proteins. Therefore, we employ a two-stage procedure to impute consumption values for households with zero consumption. In the first stage we estimate a correlated random effects (CRE) multivariate probit model (Wooldridge, 2010). In the second stage, we calculate cumulative distribution function and normal probability density function for each foodgroup. This is further used to generate new consumption shares for all foodgroups. However, the new budget shares do not satisfy the additivity condition as required by demand theory. In order to make budget shares additive, we reweight the transformed shares using the approach of Steele and Weatherspoon (2016).

Second, we deal with the issue of allocation of consumption across animal protein forms with respect to the demand of animal proteins as a category relative to demand for other foodgroups. We address this using instrumental variable approach of Lewbel and Pendakur (2009). Finally, estimate EASI models separately for urban and rural areas of North and South in order to capture regional differences in consumption of animal proteins. We estimate the EASI demand system in R software using an interative linear three-stage least squares (3SLS) (Horeau et al., 2012).

6. Regression Results

We estimate expenditure and price elasticities for different foodgroups. Table 3 reports expenditure elasticities for different sources of animal proteins and other foodgroups. Several points emerge.

First, as incomes rise, Nigerians increase consumption of all sources of animal-sourced proteins. However, among all types, seafood has the lowest expenditure elasticity in both North and South. In fact, expenditure elasticity for seafood in the South is lower at 0.73 as compared to the North at 0.94. This indicates that fish and seafood are a necessity in all regions of Nigeria as suggested by share of consumers for fish and seafood and per capita annual consumption noted in Table 1.

Second, seafood is followed by beef having second lowest expenditure elasticities among animal proteins in both regions. Our data on share of consumers and per capita annual consumption in Table 1 also indicated importance of beef. Beef elasticity in the South (0.98) is slightly lower than that in the North (1.08). Also, expenditure elasticity of beef in urban areas is lower than that in the rural areas. This suggests that beef is more of a necessity in the South as compared to the North. Also, beef is a necessity in urban areas more than the rural areas. This indicates that as incomes rise, demand for beef will increase more in the rural areas as compared to the urban areas and will also increase more in the North than in the South.

Third, expenditure elasticities of poultry meat are the highest followed by that of poultry eggs across urban and rural areas in both regions. This suggests that poultry is a luxury among Nigerian consumers. Despite dramatic increases in poultry production, it still remains a luxury in

Nigerian diets. However, this indicates a huge potential for growth in poultry industry as incomes rise. Also, such high demand for poultry also means that chicken and eggs, if made available and accessible to all, could help deal with the problem of malnutrition in Nigeria. Fifth, expenditure elasticities for milk suggest that it is a luxury in all areas except for urban areas of the South. Even in urban South which is the richest among these regions milk expenditure is elasticity is quite high at 0.98. These results together with consumption data in Table 1 suggest that milk consumption in Nigeria is very low.

Table 3: Expenditure elasticities for different animal-source proteins by rural and urban areas in different regions

	Income elasticities by region					
	North			South		
	Urban	Rural	All	Urban	Rural	All
Fish and seafood	0.96	0.93	0.94	0.76	0.71	0.73
Beef	0.94	1.09	1.05	0.93	1.02	0.98
Eggs	1.27	1.46	1.28	1.17	1.32	1.25
Poultry	1.51	1.71	1.57	1.66	1.73	1.69
other meats	1.19	1.15	1.17	1.50	1.35	1.40
milk & milk prod	1.05	1.18	1.12	0.97	1.08	1.04
Cereals and Tubers	1.00	0.99	1.01	0.95	1.01	0.99
Pulses	0.69	0.68	0.71	0.66	0.65	0.65
Other foods	0.66	0.63	0.67	0.92	0.79	0.84
Fruit and vegetables	0.65	0.56	0.61	0.71	0.61	0.65

Source: Authors' calculations

Table 4 shows own- and cross-price elasticities for different foodgroups including various sources of animal-proteins. As expected and consistent with the demand theory, increase in price decreases quantity consumed for all foodgroups and animal proteins. Highest sensitivity to prices is noted for poultry meat in all regions. Also price elasticity lower than -1 indicates that poultry meat is a luxury. This means that a 1% increase in poultry meat prices reduces its consumption

by more than 1%. The lowest price sensitivity is noted for the category of other meats including mutton, goat, pork, wildgame meat. We suspect that these are special products consumed occasionally as indicated by our descriptive statistics in Table 1. For example, mutton is part of festivities and is consumed in small quantities irrespective of prices. This might be the reason for low price sensitivity for this category. Similarly eggs have a lower sensitivity to prices. This might be because egg is a cheaper source of protein and a daily part of diets of people who consume eggs. Also per capita consumption of eggs is low and might be the reason for lower sensitivity to prices. Among products that are widely consumed i.e. seafood and beef, beef is less sensitive to prices than seafood in the North while in the South seafood has lower price sensitivity. This further suggests that beef dominates meat consumption in the North whereas seafood is a dominant product in the South.

Table 4: Compensated Own- and cross-price elasticities by urban and rural areas and regions

	Cereals and Tubers	Pulses	Other foods	FV	Seafood	Eggs	Poultry	Beef	other meats	milk & milk prod
North-rural										
Cereals and Tubers	-1.01	0.05	0.05	0.08	0.03	-0.03	-0.15	-0.01	-0.02	-0.03
Pulses	0.00	-0.83	0.01	0.11	-0.01	-0.11	-0.08	0.03	-0.10	-0.09
Other foods	-0.01	0.00	-0.98	-0.02	-0.01	0.05	0.17	-0.04	-0.03	0.00
FV	0.00	0.05	-0.02	-0.84	0.00	-0.17	-0.03	-0.01	-0.01	-0.05
Seafood	0.01	0.02	0.02	0.04	-0.99	-0.16	0.00	-0.01	0.05	-0.08
Eggs	0.01	-0.01	0.07	-0.08	-0.02	-0.87	-0.04	-0.02	-0.01	0.02
Poultry	-0.01	0.01	0.18	0.03	0.04	-0.04	-1.01	-0.08	-0.10	0.04
Beef	0.00	0.09	-0.01	0.05	0.01	-0.10	-0.29	-0.93	-0.06	-0.01
other meats	0.01	-0.05	0.01	0.05	0.06	-0.06	-0.27	-0.04	-0.87	-0.03
milk	0.00	-0.03	0.06	-0.01	-0.03	0.04	0.05	0.01	-0.03	-0.98
North-urban										
Cereals and Tubers	-1.02	0.06	0.04	0.10	0.00	-0.01	-0.11	0.00	-0.02	-0.01
Pulses	0.01	-0.87	-0.09	0.13	0.02	-0.05	-0.02	0.02	-0.10	-0.05

Other foods	0.00	-0.07	-0.98	-0.01	-0.03	0.04	0.16	-0.03	0.00	-0.01
FV	0.02	0.08	0.00	-0.86	0.00	-0.11	-0.05	0.01	-0.02	-0.04
Seafood	0.00	0.06	-0.02	0.02	-0.98	-0.12	-0.04	0.01	0.07	-0.03
Eggs	0.02	0.00	0.11	-0.11	-0.04	-0.91	-0.06	-0.01	-0.03	0.03
Poultry	-0.02	0.03	0.25	0.00	0.02	-0.04	-1.03	-0.07	-0.11	0.06
Beef	-0.01	0.06	-0.02	0.05	0.00	-0.07	-0.22	-0.79	-0.13	-0.03
other meats	0.00	-0.06	0.05	0.01	0.07	-0.04	-0.17	-0.06	-0.85	0.00
milk	0.00	-0.03	0.02	-0.04	-0.02	0.03	0.05	-0.01	-0.01	-0.98
South-Rural										
Cereals and Tubers	-0.93	0.00	-0.07	0.00	0.00	0.01	-0.09	0.01	0.00	-0.01
Pulses	-0.03	-0.94	-0.04	0.00	0.01	0.03	0.08	0.01	-0.04	-0.02
Other foods	-0.05	-0.02	-0.92	-0.07	-0.01	0.05	0.20	-0.03	0.01	0.01
FV	-0.03	0.00	-0.07	-0.94	0.06	-0.04	0.04	0.01	0.01	0.00
Seafood	-0.04	0.02	-0.03	0.11	-0.87	-0.12	-0.02	0.01	0.04	-0.05
Eggs	0.03	0.08	0.10	0.01	-0.04	-0.99	-0.23	0.05	-0.14	0.01
Poultry	0.00	0.09	0.19	0.09	0.04	-0.12	-1.08	-0.06	-0.16	0.02
Beef	0.01	0.07	-0.03	0.09	0.06	0.04	-0.26	-0.97	-0.13	-0.02
other meats	0.02	0.02	0.05	0.07	0.07	-0.11	-0.24	-0.04	-0.81	-0.03
milk	0.00	0.03	0.06	0.06	0.00	-0.02	-0.02	-0.01	-0.09	-0.98
South-Urban										
Cereals and Tubers	-0.90	0.04	-0.08	-0.05	0.02	0.01	-0.14	0.01	-0.09	0.02
Pulses	0.00	-0.91	-0.12	0.00	-0.01	0.01	0.09	-0.01	-0.02	-0.01
Other foods	-0.04	-0.09	-0.96	-0.05	-0.04	0.02	0.19	-0.01	0.08	-0.01
FV	-0.03	0.00	-0.05	-0.89	0.00	-0.03	0.05	0.01	0.06	-0.02
Seafood	-0.01	0.00	-0.08	0.00	-0.99	-0.04	0.00	0.07	0.09	-0.03
Eggs	0.03	0.07	0.07	0.00	0.01	-0.98	-0.22	0.06	-0.23	0.01
Poultry	-0.02	0.15	0.26	0.13	0.06	-0.09	-1.15	-0.05	-0.29	0.05
Beef	0.01	0.01	-0.02	0.05	0.12	0.04	-0.21	-0.95	-0.17	-0.02
other meats	-0.01	0.03	0.10	0.10	0.09	-0.08	-0.23	-0.03	-0.87	0.01
milk	0.02	0.02	-0.02	0.00	0.00	-0.02	0.01	-0.01	-0.04	-0.98

Source: Authors' calculations

7. Conclusion

Our analysis of food demand system in Nigeria suggests that different sources of animal proteins are consumed more in the richer South than the poorer North. Moreover, seafood and beef are popular products with seafood dominating consumption in the South and beef in the North.

However, in terms of per capita consumption, seafood is ranked first in rural and urban areas of both North and South. Yet quantities consumed in the South far exceed those in the North. Further, we see that poultry, particularly eggs are becoming more popular in recent times. However, consumption of other meats such as mutton, goat, pork, and wild game meat along with milk is very low.

Our results for income elasticities indicate that consumption of all animal-sourced food increases with income. However, highest income elasticity is observed for poultry meat in all regions. This suggests that poultry has a huge potential as incomes rise and urbanization takes place. Increasing poultry consumption might be able to address issues of malnutrition in Nigeria. Also, poultry is considered less resource-intensive than beef production as grazing cattle requires large amounts of grass and water. Moreover, milk consumption levels are incredibly low but demand for milk increases with rising incomes. However, Nigeria depends on milk imports even when the consumption levels are low. Our results suggest that Nigeria could ramp up its dairy sector and could gain from the rising milk demand.

Thus, our results suggest that creating demand-driven value chains of animal-proteins plays a crucial role in reducing malnutrition and catering to increasing demand in Nigeria. At the same time, such detailed analysis will also contribute to creation of sustainable value chains.

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