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ARTICLE

Farming households' food demand in South West Nigeria: An application of Substitution Elasticity Demand System (SEDS)

Olugbenga A. Egbetokun* and Gavin C.G. Fraser

Department of Economics and Economic History, Rhodes University, Grahamstown, South Africa
* Corresponding Author: o.egbetokun@ru.ac.za

Abstract

Food constitutes a key component of a number of fundamental welfare dimensions, such as food security, nutrition and health. It makes up the largest share of total household expenditure in low-income countries, accounting on average for about 50% of the households' budgets. Most demand analysis use existing models, but this study applied a new model – SEDS to analyse food demand among farming households in South West Nigeria. A multi-stage sampling technique was employed study to select 342 respondents. Primary data was collected through the use of a structured questionnaire. Data collected include information on a number of different food groups consumed by households, socioeconomic characteristics, demographic factors and income. The analytical techniques used were descriptive analysis and the Substitution Elasticity Demand System (SEDS). The result of SEDS shows that own price elasticities were less than 1 except for root and tuber, and fats and oil. It was found that cereals, legumes, fruit and vegetables and animal protein were price inelastic, i.e. necessities, and roots and tubers and fats and oils were price elastic, i.e. luxury goods.

Keywords: Food; Demand systems; Household; Elasticity and Substitution.

JEL classification: D12; D60; D90

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1. Introduction

Food is one of the most basic necessities of life. Every human being needs a minimum amount of it for existence and a balanced diet to maintain sound health. However, where there are availability issues there is a great deal of deprivation and ignorance among the rural and even urban masses about a balanced diet. Normally this leads to various health problems, which ultimately affect the economic growth and prosperity of a country (Begum et al., 2010; Colen et al., 2018). Food constitutes a key component of a number of fundamental welfare dimensions, such as food security, nutrition and health. It makes up the largest share of total household expenditure in low-income countries, accounting on average for about 50% of the households' budgets (Murcott et al., 2013; Oteh et al., 2014).

Food consumption patterns and behaviour differ across nations and cultures. In Nigeria, food consumption patterns have undergone remarkable changes over the last few years. Specifically there has been an increase in the consumption of starchy foods like cassava, yams, maize and rice and some decreases in the consumption of protein based food items such as fish and meats (Oloyede, 2005). However, the nature and patterns of food expenditure also reflect the socioeconomic characteristics of households. A household's relative expenditure on food is a reliable indicator of vulnerability. It describes the household's capacity to cope with price increases, as well as its ability to remain productive by investing in health services, education, and other productive assets for its members. Furthermore, spending in excess of 65% of households' total expenditure on food is a clear indication of households' vulnerability, which, in turn, forces them to choose between meeting their food and non-food needs or reduce consumption of one or both below their needs (Thirumarpan, 2013).

Households have varying degrees of spending capacity which influences their spending patterns. According to Engel's law of expenditure in 1857, the proportion of expenditure spent on food is inversely related to total income (Adeniyi et al., 2012). Drescher and Roosen (2013) further opined that food is important in household expenditure because of the amount of income dedicated to food. They further submitted that, for most households, spending on food is the largest expense followed by housing (rent, mortgage payments, opportunity cost or implied rent). However, for richer households, it comes second after housing expenditure. Households with less income tend to spend higher percentages of income on food and this leaves less for education, housing and transportation. In Nigeria, food consumption among the households could be said to be poor. This is evident as most households in Nigeria are not able to provide for their food consumption needs as it was estimated in 2004 that over 40% of Nigeria's population is food insecure (Fasoranti, 2011) and about 52% of people in Nigeria live below the poverty line (Ahmed, Eugene and Abah, 2015). In March 2017 the Food and Agriculture Organization (FAO) declared that about 7.1 million people in Nigeria are facing acute food insecurity and in need of urgent lifesaving and livelihood protection (Food and Agriculture Organization, 2017). Despite various policies, strategies and programmes on fine-tuning the food consumption pattern, the living standard is still below its potential (Ogunniyi et al., 2017). The paper is organized into the following after introduction, theoretical framework, research methodology, results and discussion and the last section is the conclusion.

2. Theoretical Framework

The general consumer behaviour theory depicts demand functions are derived by assuming that the consumer maximizes his/her utility subject to a budget constraint. Study of demand in economics is aimed at describing the behaviour of consumers. This was actualized by Alfred Marshall in the 1930s and is still in use as a starting point for economic theory today (Marshall, 1948).

Effective food demand is equal to food consumption. Food consumption is a component of the food system at which people's nutritional needs are met at individual or household level. Familiarity with modern consumption theories requires understanding three fundamental models: Keynes' Absolute Income Hypothesis (AIH), Friedman's Permanent Income Hypothesis (PIH), and Modigliani's Life-Cycle Hypothesis (LCH). Although, these were developed in the context of income-induced consumption with the assumption that a particular consumer is having a regular source of income. However, this study looked at the microeconomic analysis of the demand theory among people who do not have a regular flow of income. Modern consumption research is however based on varying degrees on at least one of these approaches. The substitution elasticity demand system (SEDS) was employed in this study to assess and analyze the food consumption behaviour of farming households in South West Nigeria.

The concept of consumer demand refers to the variations in the quantities of a commodity that a consumer is expected to buy at specified (different) prices and time period, assuming that his income, prices of other (substitute) commodities, tastes and preferences, and all other factors remain constant.

In mathematical form, according to Bektas et al. (2011),

$$Q_d = f\left(P^o, y, P^1, b, t, P, z\right)$$

Where,
Q_d = quality of commodity demand
P^o = price of commodity
y = consumer's income
P^1 = prices of related commodities (substitute or complement)
b = tastes and preference
t = time period
P = population
z = other factors

Demand theory suggests an inverse (negative) relationship between the quantities demanded of that product and its (own) price. The relationship is called a direct price effect, meaning that as price of the commodity falls, the quantity demanded increases and as price increases, the quantity demanded will decrease with other factors remaining constant. Hence, equation (1) can be expressed, ceteris paribus, as

$$Q_d = f(p)$$

Relationships between the quantity demanded of one commodity and the prices of other commodities may be positive, negative or zero. This is called crossprice effect. Relationships are expected to be positive for substitute products. For complementary products, the relationship is likely to be negative. That is an increase in the price of one commodity may lead to a decrease in demand for the other. The relationship is expected to be zero for independent products, meaning that the price of one product does not affect the demand for other. Also, predicted by economic theory is a direct relationship between the consumer's income and the quantity demanded of a product at any given price $[q = f(y)]$. That is, as consumer's income increases (y), demand (q) is expected to increase.

Many different factors may affect a product's elasticity of demand, but generally it is true to say that essential goods have inelastic demand, while luxury goods have elastic demand. Since food is regarded as an essential good, human beings need food in order to live. Once we have enough food to satisfy our needs, we do not generally buy more food. So, consumers demand for food is income-elastic (Akinleye, 2007).

As consumers' incomes increase, household spend their money on luxuries (such as holidays, manufactured goods, etc.). The producers of these products that as the output, or supply of a product increases, its price falls. As the price of a product falls, normally consumers demand more of it. But the demand for food is price inelastic. No matter how far price falls, if we already have enough food, we are unlikely to buy more, but consumers will possibly substitute better quality food for inferior products as real income will have increased. In fact, any fall in the price of food effectively increases consumers' real disposable income, and they are likely to spend that money on more luxuries.

3. Research methodology

3.1 Study area

South West Nigeria represents an agricultural zone spreading between Lat. 5° and 9°N and has a land area of 114, 271 km^2 representing 12% of the country's land mass. The agricultural South West Nigeria zone comprises of 8 States namely Delta, Edo, Ekiti, Lagos, Ogun, Ondo, Osun, and Oyo States (State Agricultural Zones) (Agricultural Research Council of Nigeria[1]; Research Extension

1. www.arcnigeria.org

Farmers Input Linkage System Workshop Report, 2016). The zone has a total population of about 35,877,260 (NBS, 2018). The zone is characterized by a typical equatorial climate with distinct dry and wet seasons. The main growing season lasts up to 9 months with two peaks of rainfall in July and September. Rainfall ranges between 1200 mm in the northern areas of Ondo, Oyo and Osun States to nearly 2600 mm in the coastal areas of Lagos and Ogun States. Average zonal rainfall is 1480 mm with monthly temperature range of 18° – 24°C during the rainy season and 30° – 35°C during the dry season.

3.2 Source of data collection

Primary data were used for this study. They were collected through the use of a structured questionnaire with the support of the extension agents who recorded purchases ahead of the date questionnaire was administered. Data collected include households' expenditure on sellected food items, socioeconomic characteristics, price (market price was adjusted for getting the perceived price farmers would have paid for a particular food item) and income of crop farmers. The major foods items consumed in Nigeria include maize, rice, beans, cassava, yam, plantain, vegetable/oil and meat/fish. However, information on the number of different food groups consumed was gathered rather than the number of of four different food groups implies that their diets offer some diversity in both macro- and micronutrients. This is a more meaningful indicator than knowing that households consume four different foods, which might all be cereals. The U.N. Food and Agriculture Organization (FAO) classification as adapted by Obayelu (2008), Mbwana et al., (2016) and the modified classification was used in the study (Table 1).

Table 1. Components of each of the Selected Food Group

Food group	Composition
Tuber and root crops	Cassava tuber and other products (cassava flour, chips and Gari), yam tuber and other products (flour and chips), sweet potato, Irish potato, cocoyam
Cereal	Fresh maize, dry maize grain, maize flour, sorghum, rice, wheat grain and flour
Legume	Beans, soybean, groundnut
Fruit and vegetable	Banana, plantain, orange, mango, pawpaw, pineapple, apple, coconut, guava, chochorous, bitter leaf, pepper, onion, okro, tomato and egg plant
Animal protein	Beef, mutton, goat meat, pork, bush meat, chicken, fish (dry, fresh), crayfish, turkey and snail
Fats and oil	Palm oil and groundnut oil

Source: Adapted from Obayelu (2008), Mbwana et al., (2016). Modified by Egbetokun (2018).

Sample size and sampling procedure

The total sample size of respondents interviewed is given by Bowley's (1977) proportion sample formula:

$$S_{\text{total}} = \frac{N}{1 + N\,(e^2)}$$

Where:
S_{total} = Total sample size of all respondents
N = Total population of farming household in Southwest Agricultural Zone
e = Level of significance (Confidence Interval that is 95%)

The total farming household in Southwestern Nigeria is estimated as 1,788,384 (REFILS Workshop Report, 2016). Assuming a 95% confidence interval, equation (13) gives a total sample size of

400 for the study that is

$$\frac{1,788,384}{1+1,788,384(0.05)^2} = 400$$

The sample size in each of the States is however determined by probability proportional to size given by:

$$S_{\text{state}} = \frac{P_i}{P_t} n$$

Where: S_{State} = Sample size for a State i
P_i = Population of farming households in State i
P_t = Total population of farming households in the selected States
n = the total sample size for the study obtained above

In view of the objectives of the study, household level data were collected from a survey of South West agricultural zones of Nigeria. A multi-stage sampling technique was employed in the study. The first stage was the simple random sampling of three States in South West Nigeria. Here, Edo, Ondo and Oyo States were selected. The second stage was random sampling of six Local Government Areas (LGAs) that are agricultural from the selected states. Third and last stage was proportionate to size sampling of households in the selected LGA. In all, a total number of 400 households were selected and questionnaires were administered, however, due to inadequate information given by the respondents 342 were found useful for analysis. Households were sampled from selected households using probability proportionate to size of the population.

3.3 Substitution Elasticity Demand System (SEDS) Model

Substitution Elasticity Demand System (SEDS) is a system whose coefficients are the own-price Marshallian demand elasticities and the elasticities of substitution between goods. The functional form of the model is given as:

$$\ln Q_i = \alpha_i + \eta_{ii} \cdot \left[\ln P_i - \frac{\ln Y - \sum_{j \neq i} S_j \cdot \ln P_j}{S_i}\right] + \sum_{j \neq i} \sigma_{ij} \cdot S_j \cdot \left[\ln P_j - \frac{\ln Y - \sum_{j \neq i} S_j \cdot \ln P_j}{S_i}\right].$$

Where: Q_i = quantity of demand of *goodi*
Y = income of respondents
P_j = price of *goodj*
S_j = market share of commodity j
η_{ii} = income elasticity of commodity i
S_i = market share of commodity i
σ_{ij} = elasticity of substitution

African Review of Economics and Finance Since the price elasticities of substitution are symmetric (that is $\sigma_{ij} = \sigma_{ij}$), this model displays the symmetry property, together with the homogeneity property. The homogeneity property is given by

$$\eta_{iY} = -\eta_{ii} - \sum_{j \neq i} \eta_{ij}$$

Where: η_{iY} = income elasticity η_{ii} = income elasticity of commodity i η_{ij} = income elasticity of commodity j The inclusion of the homogeneity and symmetry restrictions in the model reduces the number of elasticity coefficients from $N(N+1)$ to $N+N(N-1)/2$. Adding-up restriction of consumer theory is also incorporated into the model. In order to do this, restrictions are written in a way that relates Marshallian own-price elasticities and cross-price elasticities. The main advantage of SEDS over other models of demand system such as the ranked-three demand model QUAIDS proposed by Banks et al. (1997); and ranked-two demand model AIDS of Deaton and Muellbauer (1980), is the fact that the main coefficients are direct estimates of different elasticity concepts (own-price and substitution elasticities). This allows for straight forward interpretation of its results, which does not occur when using other models (Coloma, 2007).

4. Results and discussion

4.1 Socio-economic characteristics of the respondents

Appendix 1 shows that larger percentage of the head of farming households was male (78.95%). This shows male farmers are still dominating the production activities on the farm. The mean age was 50.8 ± 16.8 years and 69.01% of the respondents fell within the age bracket of 41–50 years. This shows that the majority of farmers are at the peak of their productive years. The result also reveals that 88.89% of the respondents were married. The average household size in the study area was 7.0 ± 2.78 while larger proportion (76.6%) of the respondents has household size of between 4 and 9 members. This implies that more members of the household could serve as family labour as household size increases. In line with the result of this study, Cazzuffi et al., (2010) found out in their study that 89% of the agrarian household has a large household size. Moreover, many (38.3%) of the respondents had primary school education while 31.29% had secondary school education. The average farm size in the study area is 1.8 ± 1.72 ha. This shows that food production in Nigeria is still in the hands of small-scale farmers. The farmers in the area cultivate small farm sizes as 56.43% of the respondents have farm size between 0.5 and 1.4 hectares which represents the highest followed by farm sizes between 1.5 and 2.4 hectares. Farmers who are members of farmers' group or association make up 54.5% of the farming population, while a significant proportion of the respondents (75.7%) has access to extension services. This implies that extension workers have a significant impact in improving expenditure on food of farming households through dissemination of best consumption pattern. The total income per annum is $N73,637.13 \pm 14.6$, which indicates that returns per annum are low. This, in turn, implies if farmers do not engage in off farm work, what they get in a cropping season is not an adequate income. The distance to the nearest market is 7.7 ± 9.1. This means that farmers would need to cover a long distance which implies an additional cost to food bought for consumption in the market.

4.2 Analysis and description of substitution among food groups in the study area

Substitution elasticity demand system (SEDS) whose coefficients are own-price Marshallian elasticities and elasticities of substitution between goods was used in this study. The model satisfies the homogeneity, symmetry and adding-up restrictions implied by consumer theory.

4.3 Food demand elasticities among farming households in Southwest Nigeria

The Marshallian elasticities of food groups obtained in this study have the correct signs and are consistent with past studies (Wang and Zivkovic, 2018; Coloma, 2007). All own price elasticities were less than 1 except root and tuber, and fat and oil as shown in Table 3. This indicated that all foods were price inelastic (necessity) except root and tuber and, fat and oil.

The result was slightly different from the findings of Obayelu (2008) whereby own price of only root and tuber were elastic. The own price elasticity of animal protein was the smallest in absolute terms, indicating that animal protein was the least sensitive to changes in its own price. This is due to the fact that animal protein is not always consumed by households in the study area. On the other hand, any increase in household's total expenditure would be accompanied by an increase in expenditure on root and tuber, and fat and oil with a higher than proportionate increase in total

Table 2. SEDS Estimation Results

Food groups	Coefficient	Std error	T-statistic	Probability
Own price elasticities				
Root and tuber (η_{rt})	–1.3613***	0.1493	–9.11	0.000
Cereals (η_c)	–0.7135***	0.1207	–5.91	0.000
Legumes (η_l)	–0.6616***	0.1653	–4.00	0.000
Fruits and vegetables $\left(\eta_f\right)$	–0.5390***	0.0597	–9.03	0.000
Animal protein $\left(\eta_{ap}\right)$	–0.4712***	0.0661	–7.13	0.000
Fats and oil $\left(\eta_{fat}\right)$	–1.2406***	0.3643	–3.41	0.003
Substitution elasticities				
R&tuber/cereals (σ_{rtfc})	0.1742***	0.0459	3.79	0.000
R&tuber/legumes (σ_{rtf})	0.0531	0.0643	0.78	0.434
R&tuber/fruits (σ_{trff})	0.4338***	0.0505	8.58	0.000
R&tuber/animal protein $\left(\sigma_{\text{rtfap}}\right)$	0.3340***	0.0589	5.67	0.000
R&tuber/fats (σ_{rtffat})	–0.2097***	0.0567	–3.69	0.000
Cereals/r&tuber (σ_{crt})	0.3234***	0.8531	3.79	0.000
Cereals/legumes (σ_{cl})	–0.0568	0.8844	–0.064	0.052
Cereals/fruits (σ_{cff})	0.3379***	0.0745	4.53	0.000
Cereals/animal protein (σ_{clap})	0.4721***	0.0814	5.80	0.000
Cereals/fats (σ_{cfft})	–0.2295***	0.0774	–2.96	0.003
Legumes/r&tuber (σ_{yrt})	0.0522	0.6681	0.78	0.434
Legumes/cereals (σ_{Vc_c})	-0.0318	0.0494	-0.64	0.520
Legumes/fruits $\left(\sigma_{\text{yf}}\right)$	0.1652	0.0567	2.91	0.004
Legumes/animal protein (σ_{yap})	0.2650***	0.0612	4.32	0.000
Legumes/fats $\left(\sigma_{\text{yfat}}\right)$	-0.4134***	0.0522	7.91	0.000
Fruits / &tuber (σ_{fftt})	0.5725 * * *	0.0667	8.58	0.000
Fruits/cereals (σ_{ffc})	0.2403***	0.0530	4.53	0.000
Fruits/legumes (σ_{ff})	0.2099***	0.0721	2.91	0.004
Fruits/animal protein $\left(\sigma_{\text{ffap}}\right)$	-0.0141	0.0715	-0.20	0.843
Fruits/fats (σ_{fffat})	0.2812***	0.0630	4.46	0.000
Animal protein/r&tuber ($\sigma_{\text{ap/tt}}$)	0.3597 * * *	0.0635	5.67	0.000
Animal protein/cereals ($\sigma_{\text{ap/c}}$)	0.2740***	0.0472	5.80	0.000
Animal protein/legumes (σ_{apl})	0.2748***	0.0635	4.32	0.000
Animal protein/fruits $\left(\sigma_{\text{ap/f}}\right)$	-0.0115	0.0583	-0.20	0.843
Animal protein/fats $\left(\sigma_{\text{ap/fat}}\right)$	0.3169***	0.0554	5.72	0.000
Fats / r&tuber (σ_{fatrft})	-2811***	0.0760	-3.69	0.000
Fats / cereals (σ_{fatcc})	-1658***	0.0559	-2.96	0.003
Fats / legumes (σ_{fat})	0.5336***	0.0675	7.91	0.000
Fats/fruits (σ_{fatff})	0.2857 * * *	0.0640	4.46	0.000
Fats/animal protein (σ_{fotlon})	0.3944***	0.0690	5.72	0.000

Note: *** Significant at 1% level. Source: Data analysis, 2018.

expenditure. This implies that an increase in average total household expenditure would lead to an increase in demand for root and tuber, and fat and oil by higher extent.

Table 3 further revealed that root and tuber only complement fat and oil (-0.21) but substituted for cereals (0.17), fruits/vegetables (0.43) and animal protein (0.33). Cereals complemented with fat and oil (-0.23) but substituted for fruits/ vegetables (0.34) and animal protein (0.47). Legume complemented with cereals (-0.03) and fat and oil (-0.41) but substituted for fruit and vegetable (0.17) and animal protein (0.27). It is also revealed that fruit and vegetable substituted for root and tuber (0.57), cereals (0.24), legumes (0.21) and fat and oil (0.28). Also, animal protein substituted for root and tuber (0.36), cereals (0.27), legumes (0.27) and fat and oil (0.32). In addition, fat and oil complemented with root and tuber (-0.28) and cereals (-0.17) but substituted for legumes (0.53), fruit and vegetable (0.29) and animal protein (0.39).

5. Conclusion

This study applied SEDS in estimating food demand among farming households in Nigeria and found the results to conform with the theory of demand as claimed by Coloma (2007). It is therefore concluded that SEDS could be used to estimate demand systems. Estimated results of the households' food demand and substitution in the study area using SEDS model shows that cereals (-0.71), legume (-0.66), fruit and vegetables (-0.54), animal protein (-0.47) were price inelastic and root and tuber (-1.36), fat and oil (-1.24) were price elastic. This is because in absolute terms, the values of root and tuber, and fat and oil are greater than 1. Own-price elasticities show that all food items are price inelastic except root and tuber and, fat and oil. Cereals, legume, fruit and vegetables, animal protein were price inelastic indicating that they are all necessity while on the contrary root and tuber, and fat and oil were price elastic for which they could be considered as a luxury. The food sector production policy should therefore be based on the demandsupply balance in the market. The substitution effects of price were quite strong, therefore government policy interventions should be on price regulation to avert considerable price repercussions in the economy.

Biographical notes

Olugbenga Aderemi Egbetokun is a Post Doctoral Fellow in the Department of Economics and Economic History at Rhodes University, Grahamstown, South Africa. His research interests are particularly anchored on Micro Economics, household and consumer behaviour and time series econometric methods.

Gavin Fraser is an Emeritus Professor and coordinator of the ENREFA Programme in the Department of Economics and Economic History at Rhodes University, Grahamstown, South Africa. Fraser's area of focus is on Environmental and Resource Economics, Agricultural Economics, Institutional Economics and Sports Economics.

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Conflict of interest

The authors declare no conflict of interest.

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Table 3. Appendix Socio-economic characteristics of the respondents

Variables		Frequency	Percentage
Gender	Male	270	78.95
	Female	72	21.05
Age	< 30	7	2.05
	31 – 40	45	13.15
	41 – 50	236	69.01
	51 – 60	47	13.74
Household size	61 and above	7	2.05
	Mean (50.8 ± 16.8)	17	
	1 – 3 members	152	4.98
	4 – 6 members	110	44.44
	7 – 9 members	49	32.16
	10 – 12 members	14	14.33
	12 and above		4.09
	Mean (7 ± 2.78)		
Level of education	No formal edu.	49	14.33
Pri. sch.	131	38.30	
	Sec. sch.	107	31.29
	Tertiary	55	16.08
Marital status	Single	8	2.34
	Married	304	88.89
	Widow	22	6.43
	Divorced/sep.	8	2.34
Farm size 0.5-1.4	193	56.43	
	1.5-2.4	77	22.51
	2.5-3.4	45	13.16
	Above 3.5	27	7.89
	Mean (1.8 ± 1.72)		
Membership of farmers' group	Yes	184	54.45
	No	154	45.55
Access to extension service	Yes	259	75.73
	No	83	24.27
Total income	<30000	82	24.0
	31000 - 60000	136	39.8
	61000 – 90000	27	7.9
	91000 and above	97	28.4
	Mean (73637.13 ± 14.57)		
Distance to market	<2		35.7
	2.1 – 4		20.8
	4.1 – 6		22.2
	6.1 and above		21.3
	Mean (7.68 ± 6.63)		

Source: Data analysis, 2018.