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COMPLEMENT-SUBSTITUTION NEXUS IN THE NIGERIAN DIET: POLICY GAPS IN NUTRITION

Purpose. *This paper examined urban household food demand patterns in Southwest, Nigeria using complement-substitution relationship.*

Methodology / approach. *Through a multistage sampling technique, the study used cross sectional data of 445 households from two states in Southwest Nigeria which are representative of areas with a rapid rate of urbanisation. Quadratic Almost Ideal Demand System (QUAIDS) modeling framework was used to estimate the demand system for seven food groups considered.*

Results. *The potential nutrition benefits of price and income changes in urban food groups was estimated, which explains the different quantity of food purchased by household as price changes. From the result, the root and tuber group accounted for the largest household food budget share (29.4 %) with the least share found in the legume group (3.3 %). Elasticity estimates revealed that the own-price effect was inelastic for all food groups. The uncompensated cross-price elasticities suggest both substitution and complementary association between groups. More substitution relationships were evident when households' price changes are compensated.*

Originality / scientific novelty. *This paper presents household's responsiveness to food demanded through price effects with possible nutrition gap in urban diet.*

Practical value / implications. *The complement and substitution relationship in household food price changes may be effective in changing urban consumer behavior towards healthier diets. Empirical knowledge of the complement and substitution effects would likely impact policy changes on household nutritional outcome. This is necessary as the scourge of malnutrition is increasing especially in urban areas.*

Key words: *urban households, food expenditure, elasticities, nutrition, Nigeria.*

Introduction and review of literature. Food consumption pattern is changing as a result of rising income, rapid urbanisation and structural modifications in food processing and distribution (Seto and Ramakutty, 2016). These factors are driving up food demand with likely shift in dietary pattern and food landscape (Ikudayisi, 2019; Rupa et al., 2019). However, despite changing demographics and vaunted urban advantage, the triple burden of malnutrition is still rising (Tacoli, 2019). With the continued growth in urban population coupled with the rising food poverty especially in developing countries, there is a concern on household's access to sufficient food needed to maintain a desired dietary level. Therefore, urban food security especially in populated countries has become one of the most critical development challenges (Joshi et al., 2019).

According to United Nations Population Division, urban population growth will be concentrated in Africa and Asia (UN, 2018). Specifically, the largest growth in urban populations will be experienced in India, China and Nigeria which will account

for about thirty-five percent of global urban growth between 2018 and 2050 (UN, 2018). As a result, beyond the main objective of the Nigerian agricultural sector in meeting the increased food production due to population growth, the challenged further lies in a nutritional food system. The question, therefore, remains how agriculture will work for nutrition in developing countries.

In the case of Nigeria, most of the segment of the value chain still remains underdeveloped. Specifically, the mid-stream activities are plagued by inadequate infrastructure such as processing and preservation technology, poor feeder roads and irregular electricity supplies (Mgbenka and Mbah, 2016). Broken food value chains and poor coordination further weaken the rural-urban food distribution. This often holds back progress on food security and nutrition in terms of accessibility and affordability of food for an increasingly urbanised society. In addition, there is a policy mismatch between urban food structure and some of the agricultural and food policies designed to resolve food shortages and improve output quality of food produce. Basically, many of the interventions emphasized increased food production with little attention to value addition enhancement programmes which addresses urban food system. Also, little is known about the manner in which existing food policies vary with changing urban food expenditure and nutrient intake at household level.

To this effect, integration of policies to minimize the disparity in household's food responses requires understanding the food consumption behaviour through the estimation of food expenditure pattern. Ruel et al. (2017) note that the extent to which food is being accessed is fundamental to estimating welfare indicators in the areas of food security, nutrition, health, and poverty. Therefore, expenditure on food, a proxy for food access remains a veritable tool in explaining the extent of household food security status. Knowledge of the complete demand elasticity estimate is most relevant in this direction because it explains urban households behaviour when prices and income changes. Therefore, information on own-price and cross price effects of food will serve as a guide in the design of programs at household level in attaining improved levels of nutritious diet.

Several studies stressed the importance of the impact of food prices on welfare particularly the rising obesity and non-communicable diseases (Powell and Chaloupka, 2009; Andreyeva et al., 2010; Osei-Asare and Eghan, 2013; Cornelsen et al., 2015; Paraje, 2016). Most of these reviews, however, did not consider the cross-price elasticities that explain substitution and complementarity effects which provides more understanding on shifting dietary pattern. However, literature emphasized the relevance of cross-price effects in policy issues (Dharmasena and Capps, 2012; Zhen et al., 2014; Cornelson et al., 2018). For instance, Quirmbach et al. (2018), in their cross-price elasticities reported a differential effect such that taxing soft-drinks may reduce their purchase, but assessing the impact on health demands require wider consideration on other alternative beverage choices which contain similar or greater amounts of sugar than soft-drinks. In a study by Guerrero-López et al. (2017), the demand of soft drinks was price sensitive compared to other sugar-sweetened

beverages and energy dense foods among Chilean households. The cross-price effect of food and beverages behave as substitutes for soft drinks such that subsidies to non-sweetened beverages and tax to soft drinks lead to increases in the substitutions for other healthier beverages. Likewise, Clements and Si (2016), estimated the uncompensated and compensated price elasticity of food consumption such that the income effect was removed from the elasticities to recover the compensated elasticities response when consumers' real income remains unchanged. From this, the underlying uncertainty of behaviour, provided a range of possible consumer responses when modelling the impact of food taxes/subsidies. Miao et al. (2012) examined the effect of substitution within 25 food groups from high-fat to low-fat products and high-sugar to low-sugar products. Results showed that, without accounting for substitution, a tax on fats is more efficient than a tax on added sugar, but if substitution is accounted for, the opposite holds. Some of these studies focused on substitution and complementary patterns within a specific foods groups rather than across the whole diet. However, this paper contributes to literature by estimating cross-price effect on whole diet specifically for urban households with its implication on nutrition. The Hicksian (compensated) price elasticities shows change in quantity demanded relative to other prices. It also measures only the price and welfare effect through compensation variation which is useful for better policy measure. The evidence on cross-price effects across the food consumed might help identify a consumer's food consumption basket relevant in addressing malnutrition issues. Understanding food demand patterns through elasticities outcome is an important prerequisite for designing food and agricultural policies and for predicting policy impacts on the nutritional food consumption.

The purpose of the article. This paper examined urban household food demand patterns in Southwest, Nigeria using complement-substitution relationship.

Methodology. This paper focused on intra-household food demand pattern which involves households' response to price and income changes on food purchased within urban locations. Through a multistage sampling procedure, the study used cross sectional data of 445 households from two states in Southwest Nigeria. They are representative of areas with a rapid rate of urbanisation in southwest zone of the country. Afterwards, most urban location within each of the sampled states was purposively selected on the basis of administrative criteria and level of urbanisation. From these locations, households were selected through Enumeration Areas map from National Population Commission. Information sourced from sampled 445 households were households' socioeconomic characteristics, physical quantities and expenditures of food using a seven-day recall. This paper considered only food source from purchase based on the assumption that urban households are net food buyers as they purchase almost 90 per cent of their food (Matushke and Kohler, 2014). We employed a utility-based structural model, the Quadratic Almost Ideal Demand System introduced by Banks et al. (1997). The model is a generalization of AIDS model due to the inclusion of the square of the logarithm of expenditure. This allows any given good to be a luxury at one level of expenditure and a necessity at

another. This flexible Engle curve characteristic makes it well suited for household food demand with varying income level (Van Oordt, 2016; Ikudayisi et al., 2019). It allows for post-estimation analysis which enables the computation of budget share, price and expenditure elasticities with demographic estimates that affect food expenditure pattern. Thus, satisfying adding up restrictions, while its elasticities satisfy the homogeneity and symmetry conditions.

The model is expressed as:

$$w_i = \alpha_i + \sum_{j=1}^n \gamma_{ij} \ln p_i + \beta_i \ln \left[\frac{m}{a(p)} \right] + \frac{\lambda_i}{b(p)} \left\{ \ln \left[\frac{m}{a(p)} \right] \right\}^2 + \sum_{s=1}^n \delta_{is} Z_s + \varepsilon_i \quad (1)$$

where w_i = expenditure share for each i th food group,

p_i = the price of i th food group,

m = total food expenditure,

Parameters to be estimated are α , β , γ , λ , and δ

α_i = the average value of budget share without price and income effects.

β_i = parameter that determines the expenditure elasticity

γ_{ij} = effects of cross price elasticity

λ_i = the parameter that determines effects of quadratic term, and

δ_{is} = vector of explanatory variables

Z_s = socioeconomic and demographic variables such as age of household head, sex, occupational status, income, household size etc.

ε_i = error term.

Furthermore, when the model for the budget share of food group is differentiated with respect to $\ln m$ and $\ln p_i$, elasticities of demand are obtained and expressed as:

$$\mu_i = \frac{\partial w_i}{\partial \ln m} = \beta_i + \frac{2\lambda_i}{b(p)} \left\{ \ln \left[\frac{m}{a(p)} \right] \right\} \quad (2)$$

$$\mu_{ij} \equiv \frac{\partial w_i}{\partial \ln p_j} = \gamma_{ij} - \mu_i \left(\alpha_j + \sum_k \gamma_{jk} \ln p_k \right) - \frac{\lambda_i \beta_i}{b(p)} \left\{ \ln \left[\frac{m}{a(p)} \right] \right\}^2 \quad (3)$$

Expenditure elasticity measure the change in quantity demanded as income changes. Further estimation generates the expenditure elasticity which determines the nature of goods (normal or luxuries) at all expenditure levels. It is expressed as:

$$\ell_i = 1 + \frac{\mu_i}{w_i} \quad (4)$$

Price elasticity on the other hand explains own price and cross price effects. The own price effect describes the elastic or inelastic effect of quantity demanded of a commodity while the magnitude and patterns of cross-price elasticity is explained by the substitution and complementary effect from both Marshallian and Hicksian demand equation (Van Oordt, 2016).

Conversely, the uncompensated or Marshallian price elasticity indicates relative changes in the quantity demanded as prices change. It is given by:

$$\ell_{ij}^u = \frac{\mu_{ij}}{w_i} - \phi_{ij} \quad (5)$$

where ϕ_{ij} is the Kronecker delta equaling one when $i=j$, and zero otherwise. That is, it takes the value of one for own-price elasticity and zero for cross-price elasticity.

The compensated or Hicksian price elasticities show changes in quantity demanded relative to other prices. It is expressed as:

$$\ell_{ij}^c = \ell_{ij}^u + w_j \ell_i \quad (6)$$

These elasticities provide information on the sensitivity of urban households to price and income changes.

Weak separability assumption was employed in grouping food commodities in accordance with consumer preferences (Zheng and Henneberry, 2009; Van Oordt, 2016). This is based on the assumption that sub-utility functions can be defined for each group of commodities. From Okrent and Alston (2011), non-parametric measure which aggregates large food items was applied in this paper for the issue of zero expenditure. This approach seems reasonable, since it could be expected that a household has some expenditures during the survey period. Further, this was shown to be acceptable by Blundell and Robin (2000), as certain weakly separable groups of commodities which contained observed zero expenditures were grouped together. Following these assumptions, about eighty-nine (89) food items were grouped into seven (7) food categories based on nutritional capacities. These include root and tuber, cereals, legumes, meat and its products, fruits and vegetables, fat and oil and miscellaneous food groups (sweeteners, beverages, alcoholic and non-alcoholic drinks, snacks, pasta, can foods and condiments). Purchased quantities and expenditures on each food items are aggregated on a weekly basis for each household.

Results and discussion. Distribution of Household Heads Characteristics as presented in Table 1 shows that about 68.5 % of households are male-headed with over 70 % of household heads being married. Age difference within a family structure could influence the nature of household food consumption patterns. It was also observed within the age bracket that more population were in 41–60 range and lesser population in 60 and above. Family structure often influences varieties of food demanded by different members of household with the largest percentage (67.4 %) of households found in the range 5–7. Over three quarters (78.7 %) of household heads had formal education beyond primary and secondary level and a little percentage with no formal education. More than 80 % of household heads engaged in one income earning activities, but the occupational structure revealed that about 35.5 % of household heads engaged in the government services while 31.1 % were in the private sector. Furthermore, household heads associated towards social capital as about three quarters of them belonged to a membership of social group. Household income affects the type and quantity of foods consumed in most food consumption practices. Result showed that average monthly income category of ~~N40001–N60000~~

had the highest percentage of household heads.

Table 1

Socioeconomic Distribution of Household Heads

Variables	Percentage (%)
Sex	
Male	68.54
Female	31.46
Age in years	
≤40	29.66
41–60	58.88
>60	11.46
Marital status	
Married	74.83
Single	15.06
Divorced	3.15
Widowed	6.97
Household size in number	
≤4	23.15
5–7	67.42
>8	9.44
Educational status	
No formal	1.12
Primary education	1.57
Secondary education	18.65
Tertiary education	78.65
Occupational status	
Government jobs	35.51
Private organization	31.24
Trader/Artisan	17.53
Agricultural-based	5.62
Others	10.11
Engaged in employment activities	
Yes	88.76
No	11.24
Membership of social group	
Yes	77.67
No	22.33
Average monthly income in Naira	
<40,000	31.94
40001–60,000	39.95
60,001–80,000	20.57
>80,000	7.54

Source: field survey, 2018.

The result of household budget share by food groups is shown by the radar chart in Figure 1. It revealed that roots and tuber had the highest (29.4 %) budget share of food expenditure while legume had the least share of about 3.3 %. The cereal group also recorded a high food share of about 22.7 %. The high budget shares for

root/tuber and cereal groups suggest they are staple foods from which major calorie needs in urban diets are met. This finding agrees with most food demand studies in Nigeria especially Kuku-Shittu et al. (2013) such that most urban households sourced their calorie need from staples which are often affordable and accessible. Also, households' expended more on high value food commodities such as meat (16.6 %) and fruits and vegetables (19.8 %) attracting over a quarter of total food expenditure. This could imply a dietary shift towards more macro- and micro-nutrients consumption.

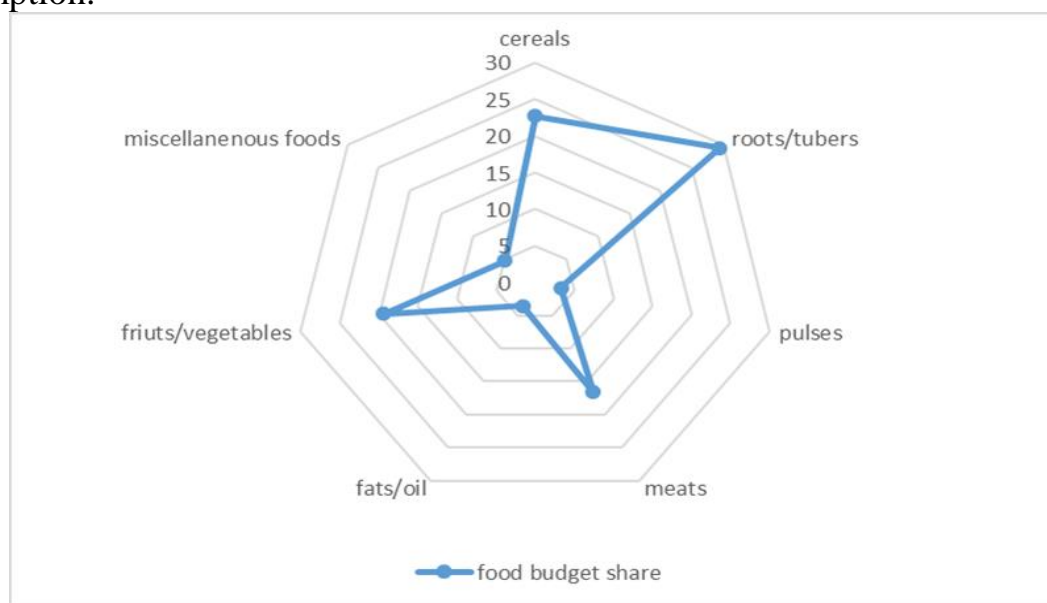


Fig. 1. Radar chart showing the distribution of food group share

Source: calculation from QUAIDS analysis.

The expenditure estimates explain how food group are demanded for in the event of income changes. From Table 2, the expenditure elasticities vary substantially ranging from 0.47 for root/tuber to 2.47 for cereal group (see Table 2).

With the exception of root/tuber and miscellaneous food groups, the food groups values are above unity which suggest increased demand as income improves. For example, high value foods such as meat and fruits and vegetables, with elasticities above one suggests improvement in consumption of diverse diets as income takes off. This agrees with Adetunji and Rauf (2012) findings for meats among urban households in Nigeria.

The own-price and cross-price elasticities estimated using QUAIDS model for seven food groups is presented in Table 2. From the elasticity matrix, the diagonal entries are the own-price elasticities which are negative as expected. However, the inelastic uncompensated own-price elasticities ranged from -0.11 for legume to -0.88 for root/tuber, except for root/tuber group, which is slightly elastic (-1.02) at the compensated matrix. This is consistent with literature, as others studies found the demand for food may be inelastic due to food preferences and/or socioeconomic factors (Andreyeva et al., 2010; Olorunfemi, 2013; Rono et al., 2016). If price rise at the same level, more quantity of food to be purchased among the food groups in ascending order will be roots/tuber (0.88), meat (-0.46), fat/oil (-0.45), fruit/vegetable

(-0.33), cereal (-0.30), miscellaneous food (-0.30) and legume (-0.11).

Table 2

Expenditure and (Un) Compensated Price Elasticities Estimates of Households

Expenditure							
Food group	Cereal	Root/ tuber	Legume	Meat	Fat/ oil	Fruits/ vegetable	Other food
	2.48	0.48	2.20	1.27	1.30	1.14	0.49
Uncompensated							
Change in price							
Change in quantity	Cereal	Root/ tuber	Legume	Meat	Fat/oil	Fruits/ vegetable	Other food
Cereal	-0.2992	0.7192	-0.2618	-0.9541	-0.2438	-1.2031	-0.2554
Roots and tuber	-0.1113	-0.8787	0.1134	0.5126	0.1325	0.5940	0.1248
Legumes	-0.4270	-0.0742	-0.1094	-0.6386	-0.1016	-0.7254	-0.1340
Meat and its products	-0.2203	-0.3327	-0.0354	-0.4654	-0.0302	-0.1519	-0.0316
Fat and oil	-0.2663	-0.3861	0.0158	-0.1324	-0.4536	-0.0740	-0.0054
Fruits and vegetable	-0.2752	-0.4572	-0.0099	-0.0569	0.0029	-0.3304	-0.0124
Other food	-0.2482	-0.7746	0.0904	0.2926	0.0969	0.3624	-0.2975
Compensated							
Change in quantity	Cereal	Root/ tuber	Legume	Meat	Fat/ oil	Fruits/ vegetable	Other food
Cereal	0.2628	1.4474	-0.1810	-0.5435	-0.1554	-0.7126	-0.1372
Roots and tuber	-0.2190	-1.0181	0.0979	0.4340	0.1156	0.5000	0.1021
Legumes	0.0722	0.5724	-0.0377	-0.2738	-0.0232	-0.2898	-0.0290
Meat and its products	0.0672	0.0398	0.0060	-0.2553	0.0150	0.0990	0.0289
Fat and oil	0.0293	-0.0033	0.0583	0.0835	-0.4071	0.1839	0.0568
Fruits and vegetable	-0.0164	-0.1219	0.0272	0.1323	0.0436	-0.1046	0.0421
Other food	-0.1377	-0.6315	0.1063	0.3733	0.1143	0.4589	-0.2742

Source: output from QUAIDS analysis.

Contrariwise, in the compensated own-price, the increase in price at the same rate will change the quantity demanded across food groups in this order: root/tuber (-1.02), fat/oil (-0.41), miscellaneous food (-0.27), meat (-0.26), fruit/vegetable (-0.11) and legume (-0.04). The difference in the pattern of quantity demanded of food could be as a result of income effect in the uncompensated and the pure price effect in the compensated when consumers' money income is held constant. This own-price effect pattern elaborates on the rising malnutrition and diet-related diseases as shown by the monotonous diets through higher demand for roots/tuber and processed foods which are prevalent in Nigerian cities (Olawuyi and Adeoye, 2018). Further, increase in food prices pushes out consumption of high value foods (meat, fruits and vegetables, legumes) as major source of micronutrients and low fiber. The price sensitive nature of these foods might be responsible for the poor access to nutritious food furthering urban food insecurity in Nigeria (Iorlamen et al., 2014; Babalola and Isitor, 2014). Also, Cornelsen et al. (2014) identified price of food as a crucial factor in issues related to both under-nutrition and over-nutrition and subsequent reduction in overall food intake.

From the elasticity matrix (Table 2), about seventy-five percent (37 out of 49) of the uncompensated cross-price elasticities had negative values which suggest

complementary mix among the food categories. Of such combination was in the quantity demanded of legume (-0.43) and cereal prices which exhibited a bi-complement relationship. For example, rice and beans are often consumed together in typical Nigerian household diets. Also, legume and meat and legume and fruit/vegetables further showed bi-complementary relationships. However, the cross-price elasticity of root/tuber (-0.11) with respect to cereal prices is complementary, but only in one direction. The findings from uncompensated results showed to a greater extent food combination patterns within urban consumption basket. The compensated elasticities revealed mostly substitution relationships with a few exceptions. There was a strong uni-directional substitution between quantity demanded of cereal (0.26) and prices of root/tuber; roots/tuber and fruits/vegetables. However, the substitution effect of root/tuber and meat was bi-directional. These observed relationships suggest that urban households' might exchange diets within staple and high value food commodities (Erhabor and Ojogho, 2011). The meat group showed substitution relationship with other food groups, however, the effect was lower compared to cross price effects of other food groups. For instance, a one percent increase in prices of other food groups resulted in an increase in quantity demanded of meat which ranges between 0.01 (legume) to 0.1 (cereal and fruits/vegetables). The pure price effect which was most sensitive in the meat category which explains their substitution between other food products when prices are compensated. Therefore, rising prices may contribute to switching to low-quality, cheaper, staple foods and decrease in the consumption of nutrient rich non-staples.

In both matrixes, cross price effect of cereal and root and tuber are substitutes. For every 1 % increase in the price of root/tuber, the quantity demanded of cereal increases by 0.72 % which indicates some substitution between the two food groups. A similar trend was observed in the compensated matrix but the effect was more elastic (1.45). It is reasonable to assume cereal and root and tuber groups act as substitutes for one another because they are components of staple foods with related purposes for calorie sources for household. In addition, most households still rely more on cereal group for calorie intake based on their availability as grain crops with longer shelf life. Relevance of this finding to policy makers about Nigerian diets are the very elastic elasticities of demand for cereal with respect to the price of root/tuber, the primary starchy staples, which are heavily influenced by market prices. Also, the positive expenditure elasticities of meat, legume and fruit/vegetable suggest their relevance in urban diets as income changes.

Conclusions. High expenditure elasticity of food groups estimates suggest greater changes in household purchases as income shifts especially with respect to increased consumption of meat, legume fruits and vegetables. The own-price demand for food was relatively inelastic, while the variations in price changes specifically the most responsive food groups provided more understanding to their nutritional effects on households' welfare. The uncompensated cross-price elasticities had negative values which suggest complementary mix among the food categories. The compensated effects showed that the cross-price elasticities between all food types

are almost positive, which suggests substitution effects between food groups. The complement-substitution estimates present different pattern of household responsiveness to food price changes which require different types of policy interventions most especially in Nigeria. This evidence suggests that these relationships may have the characteristics suitable for a cost-effective food programs towards increase consumption of nutritious diets. This imply that market-based strategies that will facilitate households' access at all time to healthy foods of their choice should be given priority. This intervention might increase household opportunity to benefit from greater varieties of food items offered by the market towards nutrition sensitive diets. Given the relative magnitude of food price elasticities especially the observed substitutions and complementary associations may be a considerable value to policymakers in understanding consumer response to price changes. Also, in predicting the impact of specific public nutrition/health policies on farmer and food subsidies aimed at improving diets and reducing the burden of malnutrition.

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How to cite this article? Як цитувати цю статтю?

Стиль – ДСТУ:

Ikudayisi A. A., Omotola A. M. Complement-substitution nexus in the Nigerian diet: policy gaps in nutrition. *Agricultural and Resource Economics*. 2020. Vol. 6. No. 1. Pp. 37–49. URL: <http://are-journal.com>.

Style – Harvard:

Ikudayisi, A. A. and Omotola, A. M. (2020), Complement-substitution nexus in the Nigerian diet: policy gaps in nutrition. *Agricultural and Resource Economics*, vol. 6, no. 1, pp. 37–49, available at: <http://are-journal.com>.