

CONSUMER DEMAND ANALYSIS OF SUGAR-SWEETENED BEVERAGES IN NIGERIA

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Abstract

Sugar-sweetened beverages (SSB) represent a leading public health concern worldwide and the World Health Organization recommends for fiscal approach, by raising prices through taxation to discourage the consumption of SSB. This study was conducted to explain the consumer demand for sugar-sweetened beverages in Nigeria. The key objective of the study is to estimate expenditure and price elasticity of demand as a first and necessary step to assess the impact of the sugar tax. Data from the 2018-2019 National Living Standard Survey (NLSS), which contains detailed information on household food and beverage consumption as well as socio-economic variables was used. The Quadratic Almost Ideal Demand System was employed for estimation. The expenditure elasticity results revealed all non-alcoholic beverages to be normal goods, sachet water is categorised as a necessity, while bottled water and all sugary drinks were revealed to be luxury beverages. Own-price elasticity for all beverages was revealed to be greater than a unit (in absolute terms), implying that the beverages are price elastic. For SSB, malt drinks and soft drinks had higher elasticity estimates of -3.21 and -2.10 respectively. Also, substitutability was observed between SSBs and sachet water. These results show that demand for SSB is price-sensitive and the effective implementation SSB- tax has the potential to discouraging consumption of SSB in Nigeria.

Keywords: *Sugar-Sweetened Beverages, Public Health, Demand Elasticity, Quadratic Almost Ideal Demand System, Fiscal Policy.*

DOI: 10.58934/jgeb.v4i15.212

1. INTRODUCTION

Reducing the consumption of Sugar-Sweetened Beverages (SSBs) remains a crucial step in improving diet quality, which could have a quantifiable influence on weight control and global health, given the high intake levels around the world (Malik & Hu, 2022). Sugar-sweetened beverages (SSBs) are non-alcoholic beverages containing free sugars, such as carbonated drinks, soft drinks, energy and sports drinks, fruit or vegetable juices with added sugar, ready-to-drink teas and coffees, sweetened waters, and milk-based drinks.

The trend in the consumption of SSB in low-and middle-income countries (LIMC) is driven by several factors; on one hand by an increase in consumer income, catchy-advertisement to safeguard the presence of their product and continued popularity by the big players in the industry, and as the business has grown more competitive over time, SSBs have become more accessible and affordable. The consumption of SSBs is on the rise in Nigeria, with a high prevalence of consumption among adolescents (Ansa et al., 2008).

The rising trend in SSB consumption continues to spark public health and policy challenges (Vartanian et al., 2007). Several studies have linked sugar-sweetened beverage use to higher energy intake and body weight, nutrient displacement, and an increased risk of diet-related chronic diseases (Imamura et al., 2015; Malik et al., 2013; Malik et al., 2006; Rhee et al., 2012; Vartanian et al., 2007). Popkin (2012). As the link between obesity, diet-related non-communicable diseases (NCDs) and an unhealthy diet are largely recognized, the role of price in the choice of food consumption continues to gain more recognition (Cuadrado et al., 2020). Price plays a significant role in the choice of food consumed by a consumer, hence the growing interest in the importance of price in controlling the consumption of SSB. From a public health viewpoint, taxing SSBs is internationally recommended as an important component of the all-inclusive approach to preventing and controlling obesity and diet-related NCD.

Over 50 countries have introduced sugar tax to discourage the consumption of SSB (Royo-Bordonada et al., 2022). In Nigeria, the tax on SSBs was enacted as part of the Finance Act of 2021. It increases the price of sugar-sweetened beverages by 10 Naira (N) per litre (US\$0.02 /litre). This is following the World Health Organization's (WHO) recommendation to reduce the health effects of NCDs and enhance population health (WHO, 2016). The justification for fiscal measures includes the externality in the form of increased health care cost linked to the consumption of SSB; information asymmetry in advertisement and use of excise revenue for

health-related government outcomes. There is currently no evidence that the SSB tax has any influence on the consumption of such beverages. To determine the impact of a tax on SSB consumption in Nigeria, the first and most important step will be to determine the elasticity of demand for the beverages. Estimating demand and expenditure elasticity is crucial because the effect of a policy aimed at influencing consumer behaviour is informed by how responsive customers are to changes in factors that affect demand such as price and income.

To the best of my knowledge, there are no previous study on consumer demand analysis of SSB, specifically, the estimations of expenditure elasticity of demand and price elasticity of demand of SSB using Quadratic Almost Ideal Demand System (QUAIDS) demand model. The specific objectives of this study were to estimate the expenditure and price elasticity of non-alcoholic beverages (bottled water, sachet water, malt drink, soft drink, fruit juice and other drinks). Analysing how consumers respond to price changes in sugar-sweetened beverages provides information for evaluating the likely direction and impact of sugar tax to reduce SSB consumption. This research fills a gap in the literature on SSB consumption in Nigeria. It also advanced the frontiers of knowledge on the use of a quadratic almost ideal demand system (QUAIDS) to estimate demand elasticities in Nigeria. Furthermore, the analysis employed the most recent historical data available for Nigeria and offered demand elasticity for non-alcoholic beverages at the national level, as well as a split between urban and rural areas to investigate the heterogeneity in demand for non-alcoholic beverages demand in Nigeria.

2. METHODS

2.1. Data sets

The analysis employed household micro-data from the consumption expenditure pattern in Nigeria which is based on the 2018/2019 National Living Standard Survey (NLSS) conducted by the National Bureau of Statistics (NBS). The survey increased the accuracy and cost-effectiveness of acquiring food expenditures data by using a seven-day recall food consumption module instead of a month-long diary (as was done in the previous survey). Extra effort was made to measure food quantities where households used non-standard units of measurement, resulting in a better quantification of food consumption (NBS, 2019). The consumption expenditure pattern on food items was organized into 15 major categories based on the Nigerian food basket, including baked and processed products; starchy roots, tuber and plantain; pulses, nuts and seeds; oil and fats; fruits; vegetable; poultry and poultry products; meat; fish and

seafood; milk and milk products; coffee, tea, cocoa and similar beverages; sugar, sweets and confectionery; other miscellaneous fodder (NBS, 2019)

The budget shares of non-alcoholic beverages were derived from the food spending pattern. Bottled water, sachet water, malt drinks, soft drinks, fruit juice, and other drinks (Kunu/zobo) are among the six beverage categories studied. As a proxy for prices, the unit value was utilized. The unit values were calculated using daily household spending and the quantity purchased in litres. Demographic data are also incorporated in the model, allowing for the modelling of heterogeneity and a better understanding of non-alcoholic beverage demand in Nigeria. The model accounts for household size, education level, marital status, age, sex, and income level. The total number of households in the sample is 10145.

2.2 Variables

For this study, the demand elasticity for non-alcoholic beverage food categories was estimated. These include bottled water, sachet water, malt drinks, soft drinks, fruit juice and other juice. Bottled water and sachet water are non-sugary drinks while malt drinks, soft drinks, fruit juice and other juice represent beverages with added sugar, be it sugar-free or artificial sweeteners. Beverage expenditure shares for each beverage category were calculated for the six beverage categories. Total non-alcoholic beverage represents 2.42 per cent of the total food expenditure, and this drinks category excludes food away from home. Unit values were used as a proxy for the price, derived as the ratio of expenditure by quantity for each beverage group. In households that had no record for consumption of certain beverages, which is likely attributed to non-consumption, and as a result zero expenditure, the missing unit value for the household was replaced by the average household unit values within the enumerated area (EA), Local Government Areas (LGA), state or zone. All data are expressed in absolute value.

2.3 Quadratic Almost Ideal Demand System (QUAIDS) Model Specification

The study estimates a demand system for non-alcoholic beverages using the Quadratic Almost Ideal Demand System (QUAIDS). The Quadratic Almost Ideal Demand System (QUAIDS) is an extension of the Almost Ideal Demand System (AIDS) developed by Banks, Blundell & Lewbel (1997). QUAIDS model has the advantage of flexibility over income-expenditure (Engel) curves. Following the work of Poi (2012), demand systems are typically specified with expenditure shares as the dependent variables. According to the author, the specification of the QUAIDS budget share equation is given as:

$$w_i = \alpha_i + \sum_{j=1}^k \gamma_{ij} \ln P_j + \beta_1 \ln \left[\frac{m}{P(p)} \right] + \frac{\lambda_i}{b(p)} \left[\ln \left[\frac{m}{P(p)} \right] \right]^2 + U_t \quad (2.1)$$

From equation (2.1) $\ln(p)$ is the price index which is defined as

$$\ln P(p) \equiv \alpha_0 + \sum_{i=1}^k \alpha_i \ln p_i + \frac{1}{2} \sum_{i=1}^k \sum_{j=1}^k \gamma_{ij} \ln p_i \ln p_j \quad (2.2)$$

where w_i , p_i and m are budget share, and price of the non-alcoholic beverage item group i , and the total non-alcoholic beverage expenditure per household, respectively.

It is instructive to note that unequal distribution in the age, sex, education of the respondents and the household size of consumers in Nigeria can to a large extent determine their expenditure pattern, it is necessary to capture those demographic variables by incorporating them into the QAIDS model. Hence, equation (2.1) can be modified as follows:

$$w_i = \alpha_i + \sum_{j=1}^k \gamma_{ij} \ln P_j + \beta_1 \ln \left[\frac{m}{P(p)} \right] + \frac{\lambda_i}{b(p)} \left[\ln \left[\frac{m}{P(p)} \right] \right]^2 + \sum_{s=1}^l \delta_s Z_s + U_t \quad (2.3)$$

Z_i is a set of sociodemographic factors which allows for household variability.

The restrictions on the demand functions can be deduced from the cost function since it is well known from duality theory that if the cost function is linear homogeneous and strictly increasing in prices. Therefore, the following restrictions were imposed on the estimation of the constrained model:

$$\sum_{i=1}^k \alpha_i = 1 \quad (2.4); \quad \sum_{i=1}^k \beta_i = 0 \quad (2.5)$$

$$\sum_{i=1}^k \lambda_i = 0 \quad (2.6); \quad \sum_{i=1}^k \gamma_{ij} = 0 \quad (2.7)$$

From the above equations, equation (2.4) represents the adding up condition. This restriction is necessary for the QAIDS model to hold. The restriction implies that the budget share allocated to each non-alcoholic beverage selected must be equal to unity. Equation (2.5) and (2.6) represents the homogeneity conditions for income and prices respectively. The homogeneity condition ensures that the demand functions are homogeneous of degree zero in

income and prices. This implies that the Marshallian demand function used in this study for each household is homogeneous of degree 0 in price and income. If income and price rise in the same proportion, demand for the selected beverages (sachet water, bottled water, malt drinks, soft drinks and fruit juice) will not be affected. This is necessary to obtain reliable elasticity estimates for the model. Finally, equation (2.7) represents the Slutsky symmetry condition. Generally speaking, the symmetry of a Slutsky matrix means that the substitution effect of an increase in the price of commodity j on the demand for commodity i is identical to the substitution effect of an increase in the price of good i on the demand for good j .

3. RESULTS

A description of the consumption expenditure pattern of sugar-sweetened beverages is presented in Table 1. The beverages in this category are bottled water, sachet water, malt drinks, soft drinks, fruit juice and other juice. The lowest expenditure share was on other drinks and which accounted for about 0.41 per cent of the total expenditure share of non-alcoholic beverages. Whereas, sachet water was observed to take the largest expenditure shares of about 33 per cent. However, re-grouping the beverages into non-sugary and sugar-sweetened beverages, the expenditure share of water accounted for about 40 per cent, while that of sugary beverages put together accounted for about 60 per cent of the total budget shares of non-alcoholic beverages.

Table 1 Expenditure share of consumers on drinks

Category	Variable	Share expenditure	of Percentage (%)
National level	Bottled water	0.07	7.34
	Sachet water	0.33	33.32
	Malt drinks	0.28	28.43
	Soft drinks	0.27	27.40
	Fruit juice	0.03	3.09
	Other juice	0.0041	0.41

Author's regression output – Microsoft Excel

Oftentimes, emphasis is placed more on the price elasticity parameters rather than on the estimated coefficient (Poi, 2012). For all estimated equations, it is dependably observed that all expenditure parameters are statistically significant at a 5% level of significance. It was also

observed that most of the coefficients of both own-price and cross-price parameters are statistically significant at a 5% level of significance.

Table 2 presents the expenditure elasticity estimates at the national level, as well as, the urban and rural sectors. Overall, all expenditure elasticity was observed to be greater than zero, which implies that all non-alcoholic beverages are normal goods. For sachet water, the expenditure elasticity is less than a unit and greater than a unit for other beverages. The indication is that a percentage increase in the expenditure of the consumer will result in a less than proportionate increase in the demand on sachet water and a more than the proportionate increase in the demand on other beverages in the category. A comparison between the expenditure elasticity estimates of both the urban and rural consumers revealed that the expenditure elasticity of demand for all sugar-sweetened beverages is higher among the urban households except for soft drinks expenditure elasticity which was observed to be 1.3 for both urban and rural households.

Table 2 Expenditure elasticity of demand for Non-SSB and SSBs in Nigeria

Beverages	National	Urban	Rural
Bottled water	1.54	1.70	1.68
Sachet water	0.52	0.62	0.48
Malt drinks	1.78	1.74	1.67
Soft drinks	1.36	1.33	1.33
Fruit Juice	1.98	2.10	2.07
Other Juice	1.39	1.58	1.05

Author’s regression output – Stata 13.0

Table 3 presents the estimated own price and cross elasticity of the six non-alcoholic beverages. The own-price elasticity is shown along the major diagonal of the price elasticity matrix. All own-price elasticity parameters had expected negative signs and are all statistically significant at a 5 per cent level of significance except for other drinks. Overall, all sugar-sweetened beverages are revealed to be price elastic. The own-price elasticity parameter for the beverage category ranged from (-1.1 to -3.2). This implies a percentage increase in the price of sugar-sweetened beverages will result in a more than proportionate decrease in the demand of the beverages. Bottled was observed to have the highest elasticity of the non-sugary beverages with price elasticity estimates of -3.04. Whereas malt drinks have the highest elasticity estimate (-3.21) and the lowest was fruit juice (-1.1) for the sugar-sweetened beverages category. Most of the cross-price elasticity estimates were also observed to be statistically

significant at a 5% level of significance, both negative and positive cross-price elasticities were observed between the beverages.

Table 3 Uncompensated (Marshallian) Price Elasticity Matrix

Beverages	Bottled Water	Sachet water	Malt drinks	Soft drinks	Fruit Juice	Other Drinks
Bottled Water	-3.04	.576	1.56	-.457	-.161	-.025
Sachet Water	.065	-.1.74	.592	.514	.036	.0131
Malt drinks	.296	1.14	-3.21	.090	-.081	-.018
Soft drinks	-.052	.667	.135	-2.10	-.004	-.015
Fruit juice	-.512	1.18	-1.42	-.297	-1.10	.170
Other drinks	-.283	1.94	-1.00	-1.30	.631	-1.32

Author’s regression output – Stata 13.0

Table 4. presents the estimated own-price elasticity of non-alcoholic beverages for rural and urban households. The demand for malt drinks and soft drinks are more elastic for the urban consumers, while the demand for bottled water, sachet water, fruit juice and other drinks is more price elastic for the rural consumers.

Table 4. Uncompensated (Marshallian) Price Elasticity Matrix for Urban and Rural Sector

Beverages	Bottled water	Sachet water	Malt drinks	Soft drinks	Fruit Juice	Other drinks
Urban	-2.79	-1.70	-3.13	-2.17	-1.19	-0.68
Rural	-3.55	-1.82	-3.03	-2.13	-1.64	-1.83

Author’s regression output – Stata 13.0

4. DISCUSSION

In an attempt to reduce the consumption of sugar-sweetened beverages, the Nigerian government introduced a pro-health tax (10-naira excise per litre) to discourage the demand for these beverages as a result of a price increase. Although the debate on the sugar tax is not new globally, Nigeria recent introduced the tax, hence are no estimates about the potential impact of the tax on the consumption of sugary drinks. This study provides expenditure and price elasticity estimates as a first and necessary step for the assessment of the pro-health tax.

The study estimated system a demand system for non-alcoholic beverages and derived the expenditure elasticity and price elasticity of demand for each beverage category. All

expenditure elasticity was found to be greater than zero, implying that all non-alcoholic beverages are considered normal commodities. In a comparable study conducted for Ecuadorian homes, Paraje found similar results (Paraje, 2016). At the national level, in the urban and rural sectors, the expenditure elasticity estimates of sachet water are revealed to be a necessity. Whereas, all other non-alcoholic beverages were found to be luxury goods. Furthermore, it was observed that the urban consumer had higher expenditure elasticity compared to their rural counterparts, this reflects a lower willingness to raise the expenditure on these beverages by the rural consumers.

The result revealed that the own-price elasticity of demand for non-alcoholic beverages is greater than a unit in absolute at the national level (-1.10 to -3.21) implying that non-alcoholic beverages are price elastic. The demand for malt drinks and soft drinks is more elastic for urban consumers compared to their rural counterparts. Whereas, the demand for fruit juice and other drinks is more elastic among households living in the rural areas. The fact that the beverages are price elastic indicates that the demand for sugar-sweetened beverages will be significantly reduced given a price increase (*ceteris paribus*). Greater reductions are anticipated for malt drinks and soft drinks which are both carbonates and assumed to include added sugar compared to fruit juice. The result of own-price elasticity corroborates with other studies that non-alcoholic beverages are price elastic see (Segovia et al., 2020;Caro et al., 2017; Colchero et al.,2015); and). Our estimates are higher compared with the estimates compared to the findings of Nakhimovsky et al., for Middle-Income Countries which is within the range (-0.6 to -1.2) (Nakhimovsky et al., 2016). The difference in elasticities estimates is associated with the type of data and modelling framework (Andreyeva et al., 2011).

Cross price elasticity revealed substitutability and complementarity within the beverage group. Sachet water was revealed to be a substitute for all non-alcoholic beverage groups. Colchero et al., (2015), found similar substitution effects for Mexico see (Colchero, Salgado, Unar-Munguía, & Hernández-Ávila, 2015). Also, malt drinks and soft drinks were revealed to be substitutes, as well as, fruit juice and other drinks. An explanation for the substitutability between soft drinks and malt drinks is that both drinks are carbonated, in addition, soft drinks are an affordable substitute for malt drinks. For fruit juice and other drinks, an explanation for the substitutability can be linked to the characteristics of higher nutrient as compared to carbonated drinks. The substitution pattern observed between sachet water and other beverages is desirable because water does not contain calories.

Bottled water and soft drinks, as well as, bottled water and fruit juice were found to be complementary beverages. Likewise, Fruit juice and malt drinks, fruit juice and soft drinks were revealed to be complements. Bottled water is pricier than sachet water, hence, not an affordable substitute for sugar-sweetened beverages. In the same vein, fruit juice is more expensive than carbonated drinks (malt drinks and soft drinks), hence, also not an affordable substitute for other SSB in the beverage group, Colchero et al., found a similar pattern in their study see (Colchero et al., 2015). Another possible explanation for the observed complementarity is cultural consumption patterns; a considerable percentage of the complementarity seen might be attributable to cultural consumption and purchase patterns as a variety of drinks are served together at occasions and during festive periods in Nigeria.

The study results presented are with certain limitations. Household beverage expenditure in the 2018/2019 national living standard survey may be under-reported for many reasons. The study only included households that consumed at least one of the several types of non-alcoholic beverages; houses that did not consume any of the non-alcoholic beverages were excluded. To avoid losing a major portion of the sample size due to a household's non-consumption of other beverages, the amount consumed was set to zero, and the unit value (price) was interpolated using the price reported for the EA, LGA, Zone, or State. Furthermore, because the head of the family fills the survey, household non-alcoholic beverage expenditures may be under-reported, and individual consumption away from home is likely not reported. Also, food and beverage away from home expenditures were not included in the model, food and beverages away from home expenditure constitute about 20.19 per cent of total household expenditure. This expenditure was not included in the model due to a lack of sufficient data to separate food from beverages.

Lastly, as Colchero et al. (2015) we acknowledge a potential source of endogeneity in the model; measurement error in prices. The measurement error could arise as unit values were used as a proxy for prices and were derived from the quantity of beverage expenditure reported by the household.

5. CONCLUSION

Improving a county's diet is a multifaceted task, the World Health Organization recommends fiscal measures be adopted. Given the increasing demand for sugar-sweetened beverages and the high rates of diet-related non-communicable diseases in Nigeria (29% of death in 2018)

SSB tax has the potential to reduce consumption and have a positive effect on health because of the price elastic nature of SSBs in Nigeria. Also, if the demand for SSB decreases as a result of the pro-health sugar tax introduced in Nigeria and later has an impact on diet-related non-communicable diseases, we may anticipate a reduction in health expenditure on diet-related NCDs nationwide.

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