

THE IMPACT OF SUGAR TAX ON CARBONATED SOFT DRINKS IN NIGERIA

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Abstract

A sugar tax is a fiscal intervention levied on sugar-sweetened beverages (SSBs) to discourage consumption and improve population health. The over-consumption of SSBs is linked with the prevalence of obesity and diet-related non-communicable diseases (NCDs). Nigeria in the year 2022 introduces a 10 naira per litre excise tax on all non-alcoholic SSBs. This study assessed the impact of a sugar tax on the consumption of carbonated soft drinks in Nigeria. The study explored a mathematical model to estimate the effect of the sugar tax on the consumption of SSBs, three tax scenarios were assessed using Monte-Carlo Simulation. Historical consumption data from the 2018/2019 Nigeria Living Standard Survey was utilised. The outcome of the tax simulation revealed that a 10-naira excise tax on soft drinks is predicted to have a small effect on the price and quantity demanded of SSBs. The overall reduction in quantity demanded of SSB could be negligible if the tax rate does not increase the price by at least 20%. A 50-naira excise tax on soft drinks is anticipated to comply with the World Health Organization's recommendation, which calls for an increase in retail prices by at least 20%.

Keywords: *Sugar-Sweetened Beverages, Sugar-Tax, Obesity, Non-Communicable Diseases, Monte-Carlo Simulation.*

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1. Introduction

There is an increasing trend in research on sugar tax (Wright, et al., 2017). The excessive consumption of added sugar on health is currently an active topic of scientific research and policy debate. Added sugar is sugar that food manufacturers add to their products to add flavour

or extend shelf life, sugar-sweetened beverages (SSB) are a major source of added sugar in the diet (Sanchez-Pimienta, et al., 2016). The effects of the sugar tax on sales, purchase and consumption of SSB remains the subject of growing research (Wright, et., 2017).

In Nigeria, SSBs are non-alcoholic sugar-sweetened beverages such as carbonated soft drinks, malt drinks, fruit juice etc. Empirical research associated frequent consumption of SSB with health problems such as weight gain, obesity and some diet-related non-communicable diseases such as type two diabetes, coronary heart disease and some cancers (Malik, et al., 2010; Malik, et al., 2013; Malik & Hu, 2019; Malik & Hu, 2022; Imamura, et al., 2015; Wang, et al., 2015). Ensuring the health of all citizens is the core responsibility of any country's health system and the imposition of a sugar tax could be beneficial in combatting the rising prevalence of obesity and diet-related non-communicable diseases thereby improving population health (Adedeji, et al., 2022; Papier, et al., 2017; Zhang, et al., 2020).

When the price of harmful products, like SSBs, does not accurately represent the entire social and individual costs associated with their consumption, excise taxes can be employed to address market failures (externalities and internalities) (Thow, et al., 2018). The justification for the fiscal intervention is that the tax alters consumer demand behaviour by increasing the price of the products, which in turn reduces consumption. Indeed, the World Health Organization suggested the use of sugar taxation as one instrument in a package of policy measures to address the prevalence of obesity and non-communicable diseases (WHO, 2016). Governments are progressively implementing SSB taxes and at least 85 countries have introduced some type of SSB tax as at December 2022 (WHO, 2022).

Natural experiments and real-world post-tax studies such as the SSB tax implemented in Mexico, Berkley, Chile and Saudi Arabia indicate that this type of intervention alters beverage consumption patterns (Backholer, et al., 2017; Falbe, et al., 2016; Sánchez-Romero, et al., 2020; Cuadrado, et al., 2020; Jalloun & Qurban, 2022). Also, systematic reviews and meta-analysis studies show that implementation of SSB taxes was associated with a higher price, lower sales and reduced consumption SSBs (Andreyeva, et al., 2022; Escobar, et al., 2013; Fernandez & Raine, 2019; Nakhimovsky, et al., 2016; Teng, et al., 2019; Wright, et., 2017).

Studies that explored demand models revealed that the demand for sugar-sweetened beverages is price elastic, as such fiscal measures such as taxing SSBs may lower SSB consumption, which in turn lowers total calorie intake and reduces population weight (Nor, et al., 2021; Caro,

et al., 2017; Paraje, 2016; Pereda & Garcia, 2020; Segovia, et al., 2020; Zhen, et al., 2014) Furthermore, rich literature simulating the likely effect of an SSB tax has shown that it could reduce consumption of SSBs, reduce obesity, lower diabetes and avert a substantial number of deaths (Briggs, et al., 2013; Collins, et al., 2015; Hangoma, et al., 2020; Kao, et., 2020; Manyema, et al., 2014; Schwendicke & Stolpe, 2017)

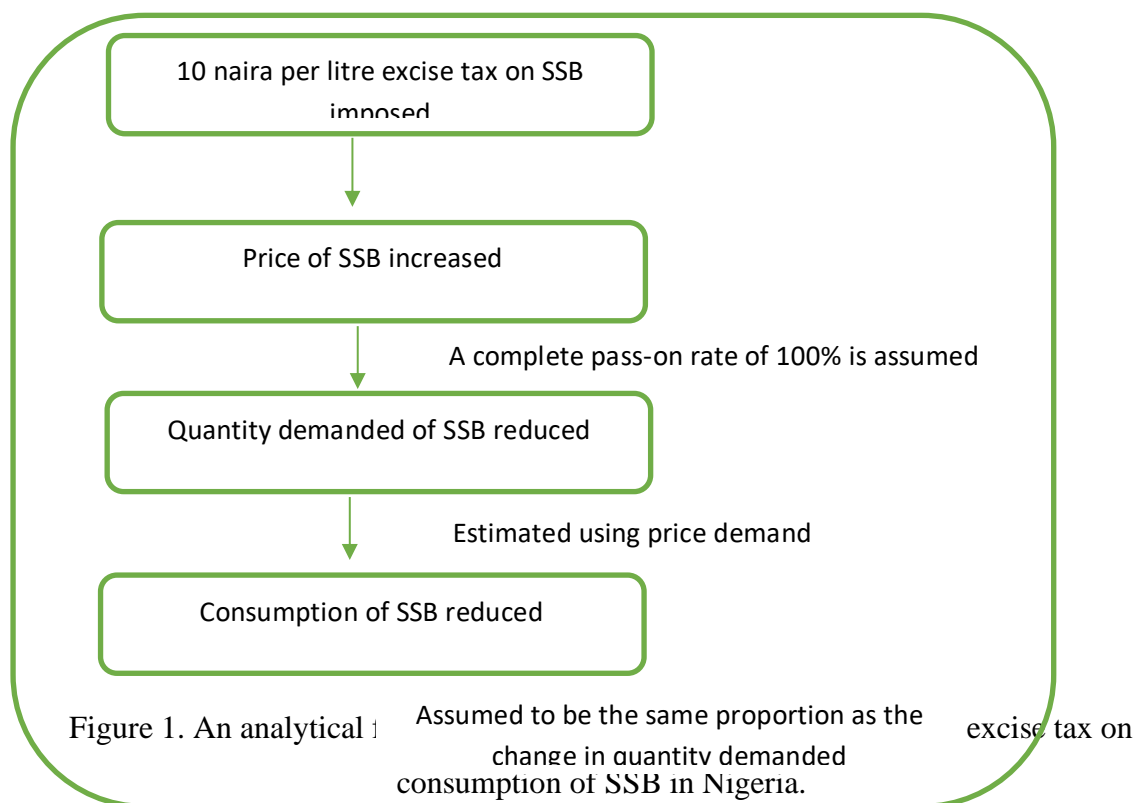
Despite the abundance of literature on the effects of SSB taxation on consumption and health, these studies mainly focused on high-income and middle-income countries. There is not much information available about how an SSB tax may affect sub-Saharan Africa. A few research examined the impact of a sugar tax on the African population, and the results have been mixed due to the variation in taxation design among countries see (Hangoma, et al., 2020; Manyema, et al., 2014). This study aimed to simulate the impact of the 10-naira per litre excise tax on the consumption of carbonated soft drinks in Nigeria. This will contribute to the body of knowledge on the impact of SSB taxes on Sub-Saharan African populations.

Evaluating the effect of Nigeria's sugar tax on consumption is important to ascertain the efficacy of the tax in influencing consumer behaviour. The research will make available evidence on the potential impact of the sugar tax on the consumption of carbonated soft drinks in Nigeria, this will support the refinement of the tax policy and inform the development of new policies elsewhere in Sub-Saharan Africa.

2. Methodology and Data Collection

Overview of model

This study used simulation model to predict the impact of the sugar tax on the quantity demanded of SSB utilising price elasticity coefficient. Previously published price elasticity estimates from (Darsamo, 2022) was used to calculate the effect of excise tax on the quantity demanded of SSB. A similar approach has been used to estimate the effects of a sugar tax on the consumption of SSB (Briggs, et al., 2013; Hangoma, et al., 2020; Collins, et al., 2015; Manyema, et al., 2014). Figure 1 shows the hypothesised relationship, which has been adapted from works done by (Briggs, et al., 2013) and (Hangoma, et al., 2020). The assumptions are indicated in the text that appears outside of the text fields. The pathway's advancement from one step to the next is shown by the arrows.



Data and assumptions

Price elasticity estimates are sourced from demand modelling studies of sugar-sweetened beverages in Nigeria (Darsamo, 2022). Price elasticity measures the degree of responsiveness to the quantity demanded of a commodity given a change in the price of the commodity, the own price elasticity measures the change in quantity demanded when the price of the commodity changes. According to Darsamo (2022), the elasticity estimates ranged from -0.8 to -1.8 for carbonated soft drinks. Darsamo utilised Nigeria Household survey Panel (2013 and 2016) data using the Almost Ideal Demand System (AIDS) for analysis. The own-price elasticity of -0.8 was observed for carbonated soft drinks, indicating an inelastic demand. In 2016, carbonated drinks were found to be relatively elastic with own-price elasticity estimates of -1.8 (Darsamo, 2022). This study adopts the 2016 elasticity estimates of -1.8 for the simulation of price change in the quantity demanded of carbonated soft drinks.

Sugar tax may be a shift in full, under-shifted or over-shifted to the consumers. Berardi, et al., (2016) found that the pass-on rate was heterogeneous across brands and retail groups in France. The pass-through rate was over-shifted to consumers (Bonnet & Réquillart, 2013). A modelling study by Brigg et al assumed a pass-on rate of 90% (80 to 100%). Other studies assumed and

adopted a conservative rate of 100% (Hangoma, et al., 2020). Pass-on rate of 100% (80 to 120%) was adopted for the study.

Consumption estimates were sourced from the 2018-2019 Nigerian Living Standard Survey (NLSS) (NBS, 2019). The survey was a nationwide activity, covering all 36 States of the Federation and the Federal Capital Territory (FCT). The NLSS 2018-2019 is the government's recognised baseline data set for Nigeria's living standards survey system (NBS, 2019); it is the first large-scale household survey in ten years, focused on measuring the living conditions of the population. The NLSS data set gathered an extensive and varied collection of socioeconomic and demographic data relevant to the fundamental requirements and circumstances that households live in daily.

The survey utilised a seven-day recall food consumption module to gather information on food consumption, and households that employed non-standard units of measurement, and additional effort was made to quantify food quantities, which led to a better quantification of food intake. SSB in Nigeria is classified as a non-alcoholic drink with added sugar such as soft drinks (carbonated drinks, fizzy drinks), malt drinks, fruit juice and other drinks (zobo/kunu). However, the study only simulated the impact of the sugar tax on soft drinks. The elasticity estimates of malt drinks and fruit juice could not be estimated due to a lack of adequate data and low consumption reported by households (Darsamo, 2022). Likewise, price data was obtained from the NLSS 2018-2019. The average price of soft drinks per litre cost about N233.49 per litre.

Modelling

The 10-naira excise tax combined with the pass-on rate of 100% was used to estimate the price effect. The price effect is combined with the own-price elasticity estimate of soft drinks to estimate the percentage change in quantity demanded of SSBs. The percentage change quantity consumed was applied to the average weekly per capita consumption to estimate change consumption. By integrating the various baseline consumptions by zones with the percentage change in consumption, multiple absolute estimates for the change in volume consumed by zones are generated. A counterfactual reference population and a hypothetical intervention population, where changes in SSB price correspond to changes in SSB consumption, are compared in the model

Uncertainty analysis

Using Microsoft Excel (2016) Monte Carlo simulation for uncertainty analysis was conducted to account for uncertainty resulting from stochastic variance in estimated model parameters. The 95% confidence intervals around estimates of changes in the quantity consumed of SSB were derived from 1,000 iterations of a Monte Carlo analysis. Each simulation uses a set of parameters that are all taken from an inverse normal distribution with means that correspond to the estimates of the parameters indicated before. The primary scenario modelled was a 10-naira excise tax. The model was re-run for the key results assuming a 50-naira and 100-naira per litre excise tax assuming a 100% pass-through rate.

Sensitivity analyses

The sensitivity analysis was carried out to examine how altering one or more parameters might impact the simulation's outcomes. The impacts of altering the tax and pass-on rates on the price effect of the sugar tax were examined in the deterministic sensitivity analysis. The tax rate varied between 10 naira per litre excise tax and 100 naira per litre excise tax, while the pass-on rate varied between 80% and 120%. Following Hangoma et al, these parameters were targeted given their uncertainty and lack of country-specific evidence of their values (Hangoma, et al., 2020).

3. Results

The simulated increases in price and reduction of quantity consumed of the beverages were observed to vary in the three different scenarios as seen in Table 1. In scenario 1, an excise tax of 10 naira per litre with a full tax shifting assumption led to a 4% price rise and an 8% decrease in quantity demanded. In scenario 2, an excise tax of 50 naira per litre is predicted to increase the cost of carbonated soft drinks by 21% with a corresponding decrease in quantity demanded of 39%. In scenario 3, an excise tax of 100 naira per litre is predicted to increase prices by 44% with a corresponding decrease in quantity demanded of 77%.

Table 1. Estimated price and quantity effect post-tax intervention.

Scenarios	Average price (baseline)	After-tax-price (intervention)	Estimated percentage change in Price	PED	Estimated percentage change in Quantity SSB
Scenario 1	233.49	243.49	0.04	-1.8	-0.08
Scenario 2	233.49	283.49	0.21	-1.8	-0.39
Scenario 3	233.49	333.49	0.43	-1.8	-0.77

Scenario 1 is a 10-naira per litre excise tax, scenario 2, is a 50-naira per litre excise tax and scenario 3 100-naira per litre excise tax, price and quantity effect of tax are estimated. The price elasticity of the demand coefficient was obtained (Darsamo, 2022)

Effects on SSB consumption

The simulated average weekly consumption of carbonated soft drinks was divided up among Nigeria's several geopolitical zones. At the national level, the baseline counterfactual means average weekly intake of carbonated soft drinks was observed to be 0.29 litres overall at the national level (95% CI 0.27 - 0.31). In scenario 1, a price rise of 4% and a decrease in demand of 8% correspond to mean weekly consumption of 0.25 litres of soft drinks in the (95% CI 0.23 - 0.27). In scenario 2, an excise tax of 50 naira per litre leads to a price effect of a 21% price increase and a 39% decrease in quantity demanded. With a 95% confidence interval of 0.15 to 0.18, this translates to an estimated average weekly per capita consumption of 0.16 litres. Finally, it was found that scenario 3 led to a 77% decrease in quantity demanded and a price effect of 43%. This is equivalent to an observed 0.07-litre average weekly intake (95% CI 0.07 - 0.07).

On a zonal scale, the southwestern households had the greatest average weekly consumption of carbonated soft drinks, at 0.33 litres (95% CI 0.30 to 0.36) according to the zonal categorization of average weekly consumption. While the average weekly per capita consumption is observed to be 0.22 litres (95% CI 0.20 - 0.24) in the north-central consumer.

For the three distinct scenarios, Figure 2 shows the baseline counterfactual and post-tax invention average weekly consumption of carbonated soft drinks by zones and national.

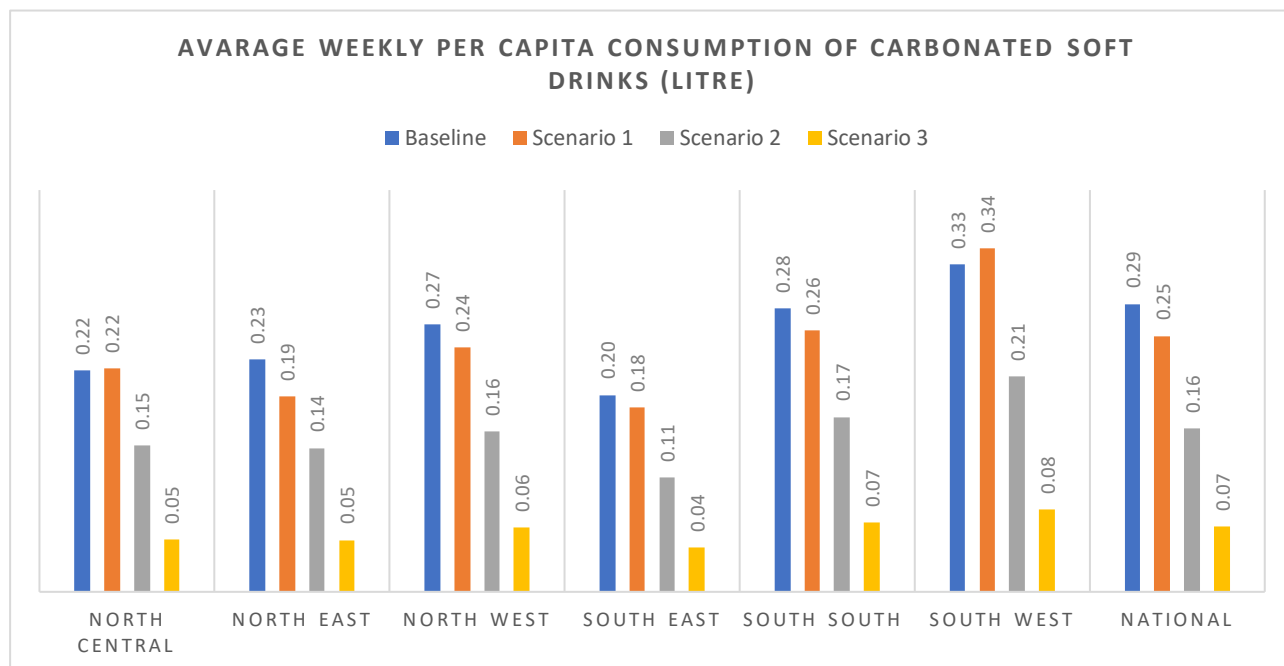


Figure 2 Estimated baseline and a post-tax weekly per capita beverage consumption by zones

Sensitivity Analysis

Table 2 depicts the sensitivity analysis of the price effect. As expected, the greatest price rise is associated with higher tax rates and pass-on rates. A combination of tax rate and pass-on rate of (10-naira per litre excise and 80%) would raise the price effect by about 3.46%, 100-naira per litre excise and 100% pass-on-rate would raise the price effect by about 21% and lastly, 100 per litre excise and 120 pass-on-rate results in 51% increase in price. Furthermore, the result revealed that price effects are more responsive to changes in tax rates than tax pass-through rates.

Table 2 Effect of varying tax and pass-on rates on price effects

		Tax rate		
		N10 per litre	N50 per litre	N100 per litre
Soft drinks				
Pass-on rate	80%	3.43	17.13	34.26
	100%	4.28	21.41	42.83
	120%	5.14	25.70	51.39

4. Discussion

This study simulated the impact of the 10 Naira per litre excise tax, in addition to two counterfactual tax rates of 50 naira and 100 naira per litre excise tax on the consumption of carbonated soft drinks in Nigeria. Because of the elastic nature of carbonated soft drinks demand, the simulation result demonstrates that the sugar tax is effective at influencing consumer demand behaviour in Nigeria. In addition, the two-way deterministic sensitivity analysis revealed that the price effect is greatest at higher tax and pass-on rates. In comparison with other studies, overall, the results are supportively similar to those found in other studies concluding the efficacy of sugar tax in reducing the consumption of SSB see (Collins, et al., 2015; Hangoma, et al., 2020; Manyema, et al., 2014; Nakhimovsky, et al., 2016; Nor, et al., 2021; Royo Bordonada, et al., 2022). However, the magnitude of the impact on consumption varies across different countries and regions. An explanation for this could be the difference in policy design (tax design and tax rates), market structure, the elasticity of demand and the difference in baseline consumption and substitution pattern.

The results presented are not without certain limitations, SSB intake away from home was not included in the model; food and beverages away from home expenditure constitute about 20.19% of the total household consumption expenditure survey (NBS, 2019). Consequently, the historical data utilised only takes into account household consumption. Out-of-home

consumption is not captured in the calculation of the baseline consumption, hence, the average weekly per-capita consumption might be under-estimated. This out-of-home beverage consumption was not included in the model due to a lack of sufficient data to separate the food and beverages data set.

5. Conclusion

This study is the first to examine the effect of the 10-naira excise tax imposed on drinks with added sugar in Nigeria. Varying price and quantity effect was observed in the different tax scenarios simulated. The result suggests that the 10-naira excise tax will create a negligible effect on the price and quantity demanded of soft drinks. Overall, the study revealed that the influence of sugar tax on consumption significantly depends on the price of SSB, the elasticity of the demand coefficient, the tax rate, the pass-on rate and baseline consumption. The World Health Organization (WHO) has recommended a 20% rise in the price of SSB, therefore adopting higher tax rates in Nigeria, such as an excise tax of 50 naira per litre, will be in line with the recommendation.

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