Horn of Africa Journal of Business and Economics (HAJBE), 2022, 5(1), PP: 33–45 ISSN: 2617-0078 (Print), 2617-0086 (Online)

An Analysis on Variation of Consumer Demand and Expenditure Structure of Zambian Residents-Based on Extended Linear Expenditure System Model (ELES)

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Abstract

The purpose of this study is to assess the variations of consumer demand and consumer expenditure structure using the ELES model in Zambia. It evaluates expenditure elasticity, price elasticity and household demand consumption patterns. The study used 2019 household survey data, conducted in two provinces of Zambia, that is, Southern and Northern Provinces. The results indicate that all estimated commodities are price inelastic as the minimum required quantity (q_i^0) *is positive. This entails that the estimated commodities have no effective substitutes. Thus, the rate of variation in the quantity demanded is less than that of a change in the price. The demand for food, health expenses, education, clothes, and housing are relatively inelastic and these commodities are gross complement. Therefore, these commodities are ideal in the consumer's budget share and their consumption is legitimately subtle to income variations. These findings are suitable for developing countries like Zambia in understanding the effect of price and income variations on consumer expenditure structure.*

Keywords: *Consumer, elasticity, price, expenditure, demand, Zambia*

Background of the Study

Statistics from the Organization for Economic Co-operation and

Development (OECD) indicate that personal consumer expenditures account for 56 percent of Gross Domestic Product for all its member countries (OECD, 2019). Generally, households-based in developing countries, like Zambia, suffer from income-generating glitches. This degrades the households into low-income levels coupled with low standards of living, as an immense share of their income is allocated to consumption. To that effect, with an aging population, increasing labor mobility, and widening income inequality becoming critical issues in both low and advanced economies, an analysis that highlights their implication for consumer demand is a major priority. Thus, this paper is segmented as follows; the first unit offers the background of the study; the second unit discusses the ELES model; the third unit demonstrates an overview of data sources and methodology; the fourth unit illustrates our findings, and finally the fifth unit concludes the study.

The term Household-expenditure is often referred to the aggregate share of total consumption costs made by occupant households to meet their daily necessities, such as food, health cost, education, clothing, housing (rent), transport, fuel cost, leisure, and miscellaneous services (OECD, 2015). To that effect, household expenditure in Zambia accounts for 60 percent of Gross Domestic Product (GDP), making it an indispensable variable for economic analysis (OECD, 2019). Household outflows including government transfers (denoted as "actual individual consumption" in the national financial statement) are equivalent to households' consumption expenditure, plus overall government costs such as health care and education. Thus, from the aforementioned distinguished expenditure categories, some households comprise both tangible rent payment (for leaseholders) and credited rent payment (for owner-occupied housing). Aggregate household expenditure is measured in Zambian Kwacha ZMK (1 USD equivalent to 17 Kwacha in current prices and PPPs), as a proportion of GDP, in addition to the annual growth rates. Consequently, we measure Household expenditure together with government transfers as a percentage of GDP. Additionally, we present expenditure in housing as a percentage of household disposable income.

Thus, in 2017, household consumption for Zambia was around K116, 984 million. However, between 1998 and 2017, household consumption in Zambia increased significantly from K5,525 million to K116,984 million growing at a cumulative annual rate that stretched to a maximum of 38.96 percent in 2001 and then dwindled to 11.26 percent in 2017 (Konema, Zambia-Household Consumption,2019). The change in household consumption is due to income variations per household, driven by

economic fluctuations.

Therefore, in both developing and developed countries, economic growth significantly drives change in the social-economic and cultural lives of the households as it influences living conditions both in the short and long-run periods. Hence, microeconomic theories attest that increasing income-generating welfare increases households' purchasing power of goods and services, which has a direct impact on household expenditure (Chihwa et al, 2001). This consumption behavior has a direct effect on the households' expenditure interests as it shifts current expenditure status to financial investment and real assets, thereby, upholding an established standard of living for every household.

Reviewed literatures attest that the best way to calculate the poverty line in a country is by estimating the contemporary currency value of consumer goods and services using the Linear Expenditure System. Chen and Wei (2009) analyzed the variation of consumption expenditure for both rural and urban residents in Ningxia by comparing the average per capita GDP at a national level with residents' consumption expenditure patterns using the Extended Linear Expenditure System (ELES). In Taiwan, Rulof *et al*. (2015) analyzed the pattern of consumer behavior. They attempted to assess a systematic aggregate consumer-demand behavior of Taiwan residents. Thus, they applied econometric modeling using the ELES in estimating the expenditure elasticity using the time series budget survey data spanning from 1951-1990.

Adusumalli *et al*. (2012) carried out an analysis of expenditure patterns of rural consumers and examined different types of rural households' cost patterns using the ELES model in India. Chihwa et al. (2001) steered research on simulated maximum probability estimation of the ELES with obligatory non-negativity constraints. Deaton and Muellbauer (1980) conducted a municipal linear disbursement system and applied the ELES using Constant Elasticity of Substitution (CES) and Klein and Rubin's function as a precise form of the expenditure technique. Furthermore, Sary *et al*. (2018) examined the household demand consumption in rural Cambodia using the ELES demand function and their estimates confirm that as income rises, demand growth for industrial commodities slows and eventually plateaus

It is against this background that this study endeavors to apply Linear Engel curves as curtailed forms of the ELES model in assessing consumer

demand and expenditure structures in Zambia. Thus, the study evaluates the parameters of the ELES function which encompasses expenditure, own-price, and cross-price elasticity

Model

Theoretical Background

In production theory, Cobb-Douglas (1928) developed a production and utility function with a purely technical relation that connects factor inputs and output. It shows the maximum amount of outputs from any special set of inputs, given the existing technology (Cobb-Douglas, 1928). The major weakness of the Cobb-Douglas production function is its flexibility of the unit cost for the linear curve to be straight through the origin. Thus, Tinbergen (1942) proposed a general feature of the Cobb-Douglas production function, illustrating the minimum quantity of capital and labor force. During the postwar period, the concept was integrated as a profound economic theory and coined as the Stone-Geary utility function derived as follows:

$$\cup(x) = \prod_{j=1}^{n}(x_i - \gamma_i)^{\alpha_i} \quad \textbf{[1]}$$

Where,x_i is the demand for a product (i=1, 2, 3...n),γ_i denotes the utility function constraints. Additionally,$x_i > \gamma_i$ and $0<\alpha_i<1$ which is the marginal expenditure share, with $\sum_{i=1}^{n}\alpha_1 = 1$ certifies that the preference structure inferred by equation (1) is well behaved. Furthermore, ∪ denotes the utility associated with the consumption share$x^{'}(x_1 \dots x_n)$.

Linear Expenditure System (LES)

The total expenditure, which is also the budget constraint, is derived as follows:

$$\sum_{i=1}^{n} p_i q_i = M \quad \textbf{[2]}$$

Where,

p_i is the the price of the i^{th} good, qi is the quantity of the i^{th} good, and M= total expenditure on $n$goods. The benefit of using the LES is that it provides an intuitive economic interpretation, despite its strong discrete assumption. The distinguishable assumption is not overly restrictive for such commodities as food, housing, or clothing. Thus, the ELES function form is illustrated as:

$$p_i q_i = p_i q_i^0 + \beta_i(M - \sum_{j=1}^{n} p_j q_j^0) \quad \textbf{[3]}$$

Taking i= 1, 2, 3 ...n

Where,p_iq_i ($p_i and\ q_i$ represent the indices for aggregate price and quantity for commodities within-group (i) is the expenditure allocated to group *i*. *M* denotes the household total expenditure, while q_i^0 and β_i are estimated parameters. As indicated in the derivation below, the consumer purchases the minimum required quantities of each commodity group q_i^0, costing $p_iq_i^0$. The consumer then distributes the remaining expenditure $(M-\sum_{j=1}^{n}p_jq_j^0)$overall commodities in fixed proportions, β_i (marginal budget share of commodity group (i). Hence, p_iq_i and $(M-\sum_{j=1}^{n}p_jq_j^0)$ can be interpreted as subsistence and supernumerary expenditure, respectively.

Model Derivation

The extended Linear Expenditure System of demand function is derived based on the utility function as follows;

$$p_iq_i = p_iq_i^0 + b_iM - b_i\sum_{j=1}^{n}p_jq_i^0$$

$$p_iq_i = \left[p_iq_i^0 - b_i\sum_{j=1}^{n}p_jq_j^0\right] + b_iM$$

$$p_iq_i = [\alpha_i] + b_iM \qquad \textbf{[4]}$$

Where,p_iq_i = Dependent variables

Thus, when calculating the Marginal Budget Share, $p_iq_i^0$ is denoted as Basic Consumption. Therefore, in finding the constant $[\alpha_i]$ and $[b_i]$, regress expenditure against income as illustrated below:

$$\alpha_i = p_iq_i^0 - b_i\sum_{j=1}^{n}p_jq_j^0 \qquad \textbf{[5]}$$

$$\alpha_1 = p_1q_1^0 - b_1[p_1q_1^0 + p_2q_2^0 + \ldots + p_nq_n^0]$$

$$\alpha_2 = p_2q_2^0 - b_2[p_1q_1^0 + p_2q_2^0 + \ldots + p_nq_n^0]$$

$$\alpha_n = p_nq_n^0 - b_n[p_iq_i^0 + p_2q_2^0 + \ldots + p_nq_n^0]$$

Thus, the sum of $\alpha_1 + \alpha_2 + \ldots \alpha_n$ is denoted as $\sum_{i=1}^{n}\alpha_i$derived as shown below.

$$\sum_{i=1}^{n}\alpha_i = \sum_{i=1}^{n}p_iq_i^0 - b_i\sum_{j=1}^{n}p_jq_j^0$$

$$\sum_{i=1}^{n}p_iq_i^0\left(1-\sum_{i=1}^{n}b_i\right)$$

$$\sum_{i=1}^{n} p_i q_i^0 = \frac{\sum \alpha_i}{1 - \sum b_i}$$

$$p_i q_i^0 = p_i q_i - b_i M + b_i \sum_{i=1}^{n} p_i q_i^0$$

$$p_i q_i^0 = p_i q_i - b_i M + b_i \frac{\sum \alpha_i}{1 - \sum b_i} \quad \textbf{[6]}$$

Income Elasticity and Price elasticity

The uncompensated own-price elasticity is formulated as follows:

$$\eta_{ii} = \frac{(1-\beta_i) p_i q_i^0}{(p_i q_i) - 1} \quad \textbf{[7]}$$

The cross-price elasticity is denoted as:

$$\eta_{ij} = -\beta_i \frac{p_j q_j}{p_i q_i} \quad \textbf{[8]}$$

Thus, we derive the expenditure/ income elasticity as illustrated below:

$$\varepsilon_i = \frac{\partial q_i}{q_i} \div \frac{\partial Y}{Y}$$

$$= \frac{\partial q_i}{q_i} \times \frac{Y}{\partial Y}$$

$$= \frac{\partial q_i}{\partial Y} \times \frac{Y}{q_i}$$

$$= \frac{\partial q_i}{\partial Y} \times \frac{P_i}{P_i} \times \frac{Y}{q_i}$$

$$= \frac{\partial p_i q_i}{\partial Y} \times \frac{1}{P_i} \times \frac{Y}{q_i}$$

$$\varepsilon_i = \frac{\beta_1 Y}{p_i q_i} \quad \textbf{[9]}$$

Data Description

The study utilizes price and income data collected from the 2019 household survey in two provinces of Zambia namely; Southern and Northern Provinces. The survey covered a wide range of aspects on living conditions such as income, food, health, housing expenditure as well as goods consumption. The study applied a stratified random sampling method to select at least 25% of the total number of respondents.

Approximately 80 households were captured for interviews on agriculture production, consumption, and trade from 5 districts, and 16 villages within the study area. The data assortment procedure encompassed face-to-face interview with household farmers. Thus, Table 1 below illustrates the summary of prominent statistics on household expenditure.

Table 1: Summary Statistics of Household Expenditure (In 1000 ZMK/per year)

Variable	Observation	Mean	Standard Deviation	Minimum	Maximum
Expenditure _Food	80	45 62.5	5594.264	1000	50000
Expenditure _Health	80	1240.625	722.6049	400	3500
Expenditure _Education	80	4656.25	3653.535	0	15000
Expenditure _Cloths	80	1563.75	961.6697	100	6000
Expenditure _Living	80	3326.875	2132.048	400	15000
Expenditure _Transport	80	1397.5	883.6382	450	6000
Expenditure _Fuel	80	970	666.9693	0	3000
Expenditure _Equipment	80	2409.438	1565.698	400	12005

Source: Author's Calibration

In attempting to conduct an economic analysis on household expenditure, Richard Strait in 1954 formulated a model which he coined as a linear expenditure system function. Later on in the 1960s, Stone-Geary reviewed the model by deriving it from the Kilin-Rubin expenditure index. The linear expenditure system is erratic for specific values and the estimated cost of income, which is projected to be negative. Though theoretically indistinct, this system may still be beneficial in numerous spheres of analysis. Thus, the above model defines eight major categories of expenditure suitable for meeting the basic need of the majority of Zambians.

Findings and Discussions

In calibration process of consumer behavior and income elasticity, the study applied the Extended Linear Expenditure System. Thus, in evaluating the sensitivity of the marginal income utility, the study applies the marginal budget share ($\beta_1 The$), the parameter is also known as the money flexibility which institutes a correlation between own-price and income elasticity. Table 1 above is an assessment of eight commodities.

According to Table 2, it is evident that the minimum required value (q_i) for all commodities is positive, indicating that all commodities are price inelastic. For many households the biggest share of their expenditure goes to education, accounting for a minimum expenditure of 4656.25 ZMK, these results concur with the findings of Rulof et al. (2015) who analyzed the pattern of consumer behavior in Taiwan. Food expenses ranked second with a minimum required expenditure of 4562.5 ZMK per household. These findings correspond with the results of Chen and Wei (2009) in their analysis on the variation of consumption expenditure for both rural and urban residents in Ningxia by comparing the average per capita GDP at a national level with residents' consumption expenditure patterns. Furthermore, housing (living), equipment, clothes, transport, and health had a minimum required expenditure of 3326.88, 2409.44, 1563.75, 1397.5, and 1240.63 ZMK in that order. On the contrary, the majority of households spent less on fuel. This is partly due to the high cost of the commodity and lack of government subsidies.

Table 2: Parameter Estimation for Eight Commodities

	Parameters	
	Marginal Budget Share (βi)	**Minimum Required Quantities (q_i^0)**
Food	0.2649	4562.5
Health	0.0206	1240.63
Education	0.1736	4656.25
Cloths	0.0375	1563.75
Living	0.0822	3326.88
Transport	0.0145	1397.5
Fuel	0.0136	970
Equipment	0.0307	2409.44

Source: Authors Calibration

As shown in Table 2, the parameter β_i indicates that the food commodity has a high estimated marginal budget share of 0.2649 followed by education with a marginal budget share of 0.1736. While housing (living), clothes, equipment, health, and transport having a marginal budget share of 0.0822, 0.0375, 0.0307, 0.0206, and 0.0145, respectively. Additionally, fuel recorded the lowest marginal budget share of 0.0136. The main reason for having a low marginal budget share for transport and fuel is due to the high cost of the commodities, as a result, people opt for the substation method of the aforementioned commodities. These results harmonize with the outcomes of Adusumalli et al. (2012) in their analysis on expenditure patterns of rural consumers in India. They examined

different types of rural household cost patterns using the ELES model. Based on the estimated parameters from Table 2, using the ELES model we derive some elasticity estimation for own-price, cross-price, and income pliability in Zambia as indicated below in Table 3.

Table 3: Own-Price, Cross-Price and Income elasticity of Eight Commodities

Food	**Health**		**Education**	**Cloths**	**Living**	**Transport**	**Fuel**	**Equipment**
Own-Price elasticity η_{ii}								
	-0.8515	-0.3573	-0.8115	-0.5154	-0.5517	-0.2262	-0.2999	-0.2866
Cross-Price elasticity η_{ij}								
Food	-0.8515	-0.0473	-0.0617	-0.0457	0.0944	-0.0637	-0.0400	-0.1030
Health	-0.0153	-0.3573	-0.0176	-0.0131	-0.0270	-0.0182	-0.0114	-0.0294
Education	-0.0344	-0.0304	-0.8115	-0.0294	-0.0606	-0.0409	-0.0257	-0.0661
Cloths	-0.0221	-0.0195	-0.0255	-0.5154	-0.0390	-0.0263	-0.0165	-0.0425
Living	-0.0228	-0.0201	-0.0262	-0.0195	-0.5517	-0.0271	-0.0170	-0.0438
Transport	-0.0096	-0.0084	-0.0110	-0.0082	-0.0169	-0.2262	-0.0071	-0.0184
Fuel	-0.0129	-0.0114	-0.0149	-0.0110	-0.0228	-0.0154	-0.2999	-0.0249
Equipment	-0.0117	-0.0104	-0.0135	-0.0100	-0.0207	-0.0140	-0.0088	-0.2866
Income elasticity ε_i								
0.6044	0.4588		0.3025	0.6627	0.6828	0.2867	0.3874	0.3521

Source: Author's Calibration

According to Table 3, calibration of own-price elasticity indicates that the demand for all commodities is relatively inelastic as their elasticity quotient is less than 1signifying that all goods are essential and that the demand for the aforementioned commodities is static when its price or other factors changes. Therefore, when the price increases or decreases, consumers will not change their purchasing behaviors. Nonetheless, although many elastic goods have substitutes, the opposite is the truth for inelastic goods. Thus, according to the above findings the most common commodities with inelastic demand are food, education, health, clothes, and housing costs with 0.8515, 0.8115, 0.3573, 0.5154, and 0.5517, respectively. This implies that the consumption of these commodities is more subtle to price variations. Additionally, the own-price elasticity of transport, fuel, and equipment are low with an average elasticity of 0.2708. This confirms Engle's Law which affirms the principle of decreasing the share of food expenditure when an individual's income

increases. These results correspond with the findings of Chihwa et al. (2001) in their research on simulated maximum probability estimation of the ELES with obligatory non-negativity constraints.

Conversely, these results indicate that housing (living) has the highest income elasticity of 0.6828, followed by clothes with an elasticity of 0.6627, while food commodity is ranked the third with an income elasticity of 0.6044. Transport commodity indicated the lowest income elasticity of 0.2867; this implies that in Zambia all the eight commodities are of great value in the allocation of the budget share per household. These results suggest that the aforementioned commodities are among the most preferred items in the consumer's budget and their consumption is fairly sensitive to change in income. This is in tandem with Ernst Engel Law that as the household income increases the budget share allocated to food expenditure decreases. This is mainly due to an increase in the proportion of expenditure on luxurious goods as excess income lures the consumer to upsurge their standard of living both in developed and developing economies like Zambia. These results agree with the findings of Sary et al. (2018), in their assessment of the household demand consumption in rural Cambodia using the ELES demand function and their findings indicate that the commodity's demand increases in tandem with income in Cambodia.Additionally, Table 3 presents our findings on cross-price elasticityη_{ij}concerning the price of each commodity. To that effect, the positive statistics of cross-price elasticity imply that all goods are net substitutes. While the negative statistics indicate that income outcomes trade substitution result so that all goods are gross complement. Accordingly, our findings show that all cross-price elasticity of all commodities are negative, signifying that they are gross complement commodities.

Conclusion and Recommendations

The study has analyzed the expenditure structure of eight commodities vis-à-vis the income of the sampled Zambian residents using the ELES model. The results indicate that all commodities are price inelastic as the minimum required quantity q_i^0 is positive. This entails that there are no close or effective substitutes for these commodities. In this case, the rate of variation in the quantity demanded turns out to be less than that of a change in the price. The demand for food, health expenses, education clothes, and housing is relatively inelastic. Based on the assessed data, the elasticity of demand is less than one (negative) or unity (but greater than zero). The same principle applies to the estimation of own-price and

cross-price elasticity and that these commodities are gross complements. Therefore, these commodities are ideal items in the consumer's budget share and their consumption is legitimately subtle to changes in income. These findings are suitable for developing countries like Zambia in understanding the impact of price and income on the expenditure structure of each household.

Thus, our findings illustrate great significance to policymakers and planners, as they indicate a strong relationship between household expenditure and income. This offers a deep analysis on the variation of consumers' demand and consumer expenditure structure among Zambian residents. The atrociousness of estimating cross-price elasticity is that its constraint is usually lower than that of own-price elasticity suggesting that policies that drive the growth of income in Zambia (income injecting policies) are less effective in comparison to price regulation policies influencing consumption patterns.

In addition, the lower expenditure on the marginal budget share on both fuel and transport commodities are an intriguing and critical issue for policymakers to adhere to. This is because fuel and generally transportation cost is one of the major drivers of the economy which directly or indirectly affect the consumption pattern with trickled down effects to income-generating capabilities of the consumers. The estimated income elasticity on both fuel and transport cost spans from 0.2867 to 0.3874, respectively. These results indicate that these commodities' demand increases with increasing income, meaning that for a household to cope up with the escalating fuel and transportation challenges in Zambia, they ought to upsurge their income-generating spots.

Consequently, these finding signals a pivotal inference on government production strategies relating to price stability, timely injection of subsidy policies in strategic sectors of the economy as well as promotion of judicious standards of social welfare. Therefore, it is more justifiable for the government to adopt cost-effective food policies by intensifying production chambers in all sectors, for the benefit of consumers and the national economic growth at large.

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