



Income and Price Elasticities of Demand for Broad Consumption Items in African Countries

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Abstract

The paper looks at the responses of African households to changes in their incomes and prices of the commodities they consume. It estimates a two stage cross-country-demand system (Florida-PI & Florida-Slutsky models) across 50 countries in Africa by using 2011 ICP Africa data. Study results confirm Engel's law: that when income increases, the budget share of food declines. The decrease is far more pronounced in High Income Countries compared to the Low Income Countries. The results also show that "food & non-alcoholic beverages" and "clothing and footwear" are necessary consumption items for households. In addition, "Bread and Cereals", "Fish", "Oils and fats" and "other food" are expenditure inelastic. In other words, an increase in the prices of these items results in an increase in total expenditure on each of these items. At the same level of income, households reallocate their budgets by reducing the consumption of other consumption categories (including on education and health) in preference for food, non-alcoholic beverages, clothing and footwear. This information can be helpful in informing public policies, especially those aimed at safeguarding the welfare of poor and marginalized households most affected by changes in price and income levels. Ensuring price stability for items that comprise the majority of the poor's consumption baskets could go a long way in enhancing food security and household welfare.

Keywords: ICP; Demand system; Florida PI-model; Conditional Florida PI model.

1. Introduction

Africa's improved economic performance over the past decade or so has resulted in much optimism about the continent's economic outlook and prospects for improving the welfare of its people. In particular, Africa benefited from the commodity booms which were characterized by much improved terms of trade for Africa's key exports of the 2000s - buoyed mostly by increased demand for the key African commodities particularly from China and India. Although the commodity booms have tapered off in recent years, a number of forces have continued to sustain improvements in the African economy, among them better economic management in many African countries coupled with increased investor confidence and a surge in financial flows into the continent, including more robust foreign direct investment, portfolio investments and a surge in remittances. These positive trends for Africa have helped to increase incomes and the size of the middle class although the growth has been characterized by high inequalities and sustained segments of poverty, especially in the lower income countries. To this end, African countries need to find appropriate policy responses to ensure that growth is more encompassing, benefits the majority of Africans and addresses the needs of the poor and marginalized households. Under these circumstances, information on how these households respond to changes in prices of the items they consume and their own income levels is critical for informing policy decisions and ensuring effective targeting of poverty reduction strategies.

This paper attempts to provide some of this critical information to inform policies in this area. It analyzes the demand for a selected number of food and non-food consumption items in 50 African countries using data generated from the 2011 round of the International Comparison Program for Africa (ICP-Africa) managed by the African development Bank (AfDB). The results of the analysis provide information on household consumption patterns in African households and how they tend to react in response to changes in income

and price levels. The information could assist in guiding public policy responses to changes in household incomes and commodity price levels in the economy.

The remainder of this paper is organized as follows: section 2 describes the methodological framework. Section 3 presents the data. Section 4 discusses the budget shares and volume of aggregate categories and food categories. Section 5 focuses on the findings and Section 6 concludes.

2. Methodological Framework

The study utilizes a two-stage cross country demand model to estimate the aggregate demand systems for the broad consumption categories as well as the food sub-category. In the first stage of estimation, an aggregate demand system is generated using the Florida Preference Independence (Florida PI Model) Model which assumes strong preference separability in that consumption of items in other groups does not affect the order of preference among the items in one other particular broad group. For instance, the consumption of education and health services, transport facilities or recreational facilities is not expected to affect one's preference of maize over rice within the food category. In the second stage, the Florida Slutsky Model is used to generate a demand system for the food sub-category, comprising 397 products under 36 main consumption categories named "basic headings". The own price and income elasticities are computed using the Working Preference Independence or Florida Model developed by Theil et al. (1989) and by means of a procedure described by Seale et al. (2003).

2.1 First Stage Estimation of the Demand System

This paper is based on an extension of the Working Model and proposed by Theil et al. (1989). They add a separability property to the basic Working Model as outlined in the Rotterdam Model that uses both Marshallian and Hicksian demand functions (see Barten, 1964; Theil, 1965). The ensuing PI Model developed by Theil et al incorporates prices through the addition of a non-linear substitution term to the basic linear function of the Working Model. This allows for separability in that consumption of items in other consumption categories does not affect the order of preference among the items in a particular individual broad category.

Thus in the PI Model for n goods, $i = 1, \dots, n$

$$w_{ic} = \alpha_i + \beta_i q_c + (\alpha_i + \beta_i q_c) \left(\log \frac{P_{ic}}{P_i} - \sum_{j=1}^n (\alpha_j + \beta_j q_c) \log \frac{P_{jc}}{P_j} \right) + \varphi (\alpha_i + \beta_i q_c^*) \left(\log \frac{P_{ic}}{P_i} - \sum_{j=1}^n (\alpha_j + \beta_j q_c^*) \log \frac{P_{jc}}{P_j} \right) + \varepsilon_{ic} \quad (1)$$

where w_{ic} is the budget share of good i in country c , q_c is the natural logarithm of Q_c the measure of total real per capita income, $q_c^* = (1 + q_c)$, P_i is the geometric mean price of P_i for all the N countries, φ represents the income flexibility i.e. the inverse of the income elasticity of the marginal utility of income and it is assumed to be constant in this model, and ε_{ic} is the error term.

The model specified can be divided into linear, quadratic, and cubic components (RHS of in equation (1)). The linear term in the model is the real income term representing the effect of a change in real income, i.e., the volume of total expenditure, on the budget share. Since the quadratic and cubic terms vanish at geometric mean prices, the linear term is also the budget share at geometric mean prices. The quadratic term is the pure-price term showing how the increase in price results in a higher budget share on good i , even if the volume of expenditures goes down or stays the same. The cubic term is the substitution effect term reflecting how higher prices may cause lower budget shares for good i due to substitution of good i for other goods.

Three types of own-price elasticities can be calculated from the parameter estimates¹. The first of these is the Frisch-deflated own-price elasticity generated when own-price changes and income is compensated to keep the marginal utility of income constant. The Slutsky (compensated) own-price elasticity measures the change in demand for good i when the price of i changes, while real income remains unchanged. The Cournot (uncompensated) own-price elasticity refers to the situation when own-price changes while nominal income

¹See Seale et al. (2003) for the formulas of the elasticities.

remains constant but real income changes.

2.2 Second Stage Estimation of the Demand System

The second stage estimation of the demand system incorporates a weak separability preference property such that consumption of one item within the food sub-category does affect the order of preference for other food items. The estimation is done using conditional Florida-Slutsky Model, which like the PI Model has three components but in the form of a linear real income term; a quadratic pure price term and a linear substitution term in place of cubic term used in the PI Model:

$$w_{ic}^* = \alpha_i^* + \beta_i^* q_{gc} + (\alpha_i^* + \beta_i^* q_{gc}) \left(\log \frac{P_{ic}}{P_i} - \sum_{j \in S_g} (\alpha_j^* + \beta_j^* q_{gc}) \log \frac{P_{jc}}{P_j} \right) + \sum_{j \in S_g} \pi_{ij}^* \log \frac{P_{jc}}{P_j} + \varepsilon_{ic} \quad (2)$$

where $w_{ic}^* = w_{ic}/W_{gc}$, w_{ic} is the unconditional budget share of good $i \in S_g$, W_{gc} is the budget share of category S_g in country c and the α^* , β^* , and π^* s are vector of conditional parameters to be estimated. In particular, the π_{ij}^* s are the conditional Slutsky (compensated) price parameters.

The conditioning implies that the demand for a particular consumption item in a given category is conditional on the total expenditure allocated for that particular consumption category. Income and price elasticities estimated from the conditional Florida-Slutsky Model are conditional on given food expenditures. The unconditional demand elasticities can then be obtained using the parameters estimated in the first stage of the analysis (See Seale et al., 2003).

3. Data for the Estimation Models: Survey Data from the International Comparison Program for Africa (ICP-Africa)

Data used for the models are obtained from price survey data collected by the Statistics Department of the African Development Bank under its International Comparison Program for Africa (ICP-Africa) conducted monthly in 50 African countries over the period January 2011 to March 2012. The ICP-Africa price collections were conducted monthly in parallel with existing consumer price index (CPI) collection activities regularly conducted by African countries as part of their macroeconomic management systems. The ICP coverage in terms of products and outlets was larger than the CPI coverage to reflect the specific requirements of the ICP program.

The main surveys conducted included the principal household consumption items: food and non-alcoholic beverages; alcoholic beverages, tobacco and narcotics; clothing and footwear; housing, water, electricity, gas and other fuels; furnishings, household equipment and routine household maintenance; health; transport; communication; recreation and culture; education; restaurants and hotels; miscellaneous goods and services and net purchases abroad. As indicated in Table 1, over a thousand products were grouped into 110 basic headings and defined for subsequent pricing. Given the diversity of the continent, there was some variation in the geographic representativity of individual products, but, taken as a whole, the selection was deemed to adequately represent the consumption patterns of all 50 participating countries.

Table 1: Number of Basic Headings and Products for the 2011 ICP-Africa Update

Category	Number of Basic Headings	Number of Products
Food and non-alcoholic beverages	29	356
Alcoholic beverages, tobacco and narcotics	5	41
Clothing and footwear	5	128
Housing, water, electricity, gas and other fuels	7	12
Furnishings, household equipment and maintenance	13	124
Health	7	158
Transport	13	55
Communication	3	19
Recreation and culture	13	49
Education	1	9
Restaurants and hotels	2	51
Miscellaneous goods & services & net purchases abroad	12	34
Total Household Final Consumption Expenditure	110	1,036

Source : AfDB.

The surveys were designed to provide national coverage and included both urban and rural areas. Most countries used a stratification based on administrative areas. Outlets were selected through a two-stage purposive

sampling approach. First, the administrative center of an administrative area and - when feasible - one or more adjacent rural areas were chosen as primary sampling units. Second, outlets were selected within each primary sampling unit on the basis of a pre-survey.

4. Budget Shares and Volumes of Aggregate Categories and Food Categories

For the this study, the 50 African countries that participated in the 2011 ICP round are divided into two groups: (i) the low and middle income countries with per capita income levels below US\$3,115 that are classified as "low income countries" (LICs) or "ADF countries" for the purposes of this study; and (ii) and the other group of higher income countries or "ADB countries" (HICs) with per capita income levels above US\$3,115. The average budget shares for the aggregate consumption categories and each of the two country groups are presented in table 2. The two main consumption categories of the two country groups are food (food and non-alcoholic beverage) and housing (housing, water, electricity, gas and other fuel). These two categories account for 45.01% and 42.95% of the average expenditure share of respectively LICs and HICs, respectively. Overall, HICs spend less in on Food food and housing than LICs. The lower income countries spend almost the a third (32.52%) of their budget to on food and non-alcoholic beverages while the higher income countries spend less than a quarter (25%). The budget share for health expenditure in HICs is almost double the size of that of LICs. This is also true for household expenditure on communication services whose budget shares vary from 1.3 in LICs and to 2.52 percent for HICs. Similarly, budget shares for recreation activities, Transportation transportation and other luxury goods budget share are much higher in HICs while the LICs allocate much higher budget shares to clothing and furnishing. On the other hand, budget allocations for education are almost the same in both country categories.

Table 2: ICP-Africa Average Expenditure Shares for Broad Consumption Categories (%)

	ADB Countries	ADF Countries*
Food & Non Alcoholic Beverages	24.10	32.52
Alcoholic Beverages & Tobacco	2.79	2.19
Clothing & Footwear	4.56	10.05
Housing, Water, Electricity, Gas & other Fuels	18.85	12.49
Furnishings Household Equipment and Operation	4.92	8.14
Health	10.86	6.15
Transport	9.83	6.54
Communication	2.52	1.30
Recreation & Culture	3.30	1.85
Education	11.60	11.39
Others**	11.76	7.43

* include Nigeria in this category

** include Restaurant & Hotels, Misc. Goods & Services, Net Purchases Abroad

Source : AfDB & Authors' calculations.

5. Results

The two models were estimated by the Maximum Likelihood (ML) method using a procedure described by Seale et al. (2003).

5.1 Aggregate Model Estimates and Elasticities

Table 3 below presents the estimated parameters for the first stage (aggregate categories). The negative beta estimated for "food & non-alcoholic beverages" and "clothing and footwear" indicate that these consumption categories are necessities for African households. All other consumption categories, including expenditure on health and education, are shown as luxuries. "Alcoholic Beverages & Tobacco" and "others" have near-zero estimates which means that the income elasticity for these categories is close to unity i.e. reflecting unitary elasticity. The β estimate for food and non-alcoholic beverages is the largest in absolute value at -0.064.

Marginal shares: The computed marginal shares (figure 1) show that the two groups of countries analyzed in this study display almost the same household behaviors. They allocate a greater portion of an additional unit of income to food but the proportion is much higher in low income countries than in higher income countries. For instance, the results show that a dollar increase in household income would result in an increase in expenditure on food by 36.65 cents in the Democratic Republic of Congo but by only 13.98 cents in Seychelles. Besides expenditure on food, households in both country categories tend to allocate the rest of the additional income to "Housing, Water, Electricity, Gas & other Fuels", "Education" and "Others" in that order. Expenditure on communications shows the least increase in both groups of countries in response

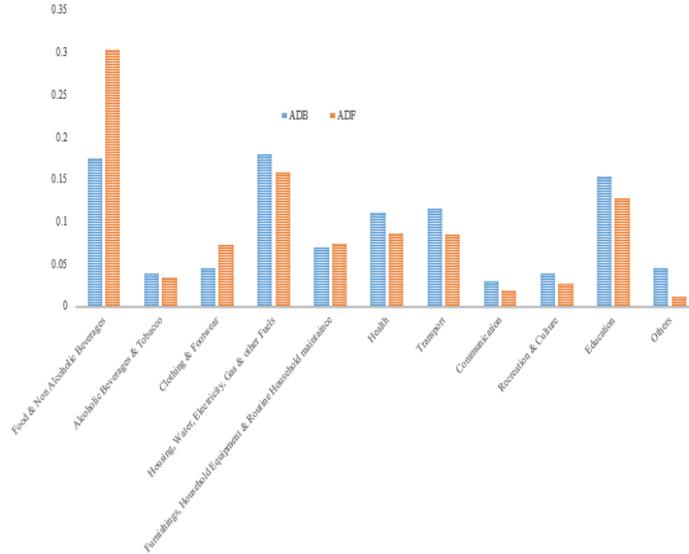
Table 3: Estimation of aggregate model, 50 countries, 2011

	Parameter	Standard error	Parameter	Standard error
Income flexibility (φ)	-1.5556	0.0919	-	-
	Beta (β)		Alpha (α)	
Food & Non Alcoholic Beverages	-0.064	0.0013	0.3492	0.0126
Alcoholic Beverages & Tobacco	0.002	0.0004	0.0326	0.0031
Clothing & Footwear	-0.007	0.0006	0.0643	0.0051
Housing, Water, Electricity, Gas & other Fuels	0.004	0.001	0.1496	0.0089
Furnishings, Household Equipment & Routine Household maintenance	0.004	0.0004	0.0613	0.004
Health	0.013	0.0007	0.0701	0.0062
Transport	0.016	0.0005	0.0643	0.0044
Communication	0.004	0.0002	0.0149	0.0015
Recreation & Culture	0.004	0.0002	0.0226	0.0019
Education	0.024	0.0007	0.0911	0.0064
Others	0.002	0.0006	0.0801	0.007

Source : Authors' estimates using 2011 ICP data.

to an increase in income levels.

Figure 1: Estimated marginal shares



Source : Authors' estimates using 2011 ICP data.

Income Elasticities The analysis shows that only the two categories of "food and non-alcoholic beverages" and "clothing and footwear" with income elasticities of less than one, are necessities in both low and higher income countries. The rest of the consumer goods and services are deemed luxuries with income elasticities greater than one. The income elasticities vary across African countries and are highest in LICs for both necessities and luxury goods and services. The income elasticity for the "food and non-alcoholic beverages" category is the lowest among all consumer goods and services implying that when incomes increase, households will make marginal increases in budgetary shares for food items, preferring to allocate greater portions of their budgets to other categories of goods and services, such as housing, communication and recreation. The elasticities vary from 0.8510 for Democratic Republic of Congo among the low income categories to 0.6855 in Seychelles among the HICs. Whereas both categories of countries show an increase in demand for food items arising from an increase in household income, the magnitude is higher in low income countries. For example, the results show that a one percent increase in incomes in the Democratic Republic of Congo (and Seychelles) is expected to generate an increase in food consumption of about 0.85% (and 0.68% respectively). In other words, the proportion of expenditure (budget share) for food declines as household incomes

increase even though overall expenditure on food goes up. This is in line with Engel's law in economics. On the other hand, households in both low and higher income countries allocate a greater proportion of their incomes on other consumer items deemed luxuries as their incomes go up. In the case of DRC and Seychelles, for example, a one percent increase in incomes is expected to increase consumption of a luxury such as communication by 1.34% and 1.15%, respectively.

When total expenditures on all consumption categories increase by 1%, households tend to decrease their overall budget shares for food by 0.0178 basis points in low income countries and 0.256 basis points in higher income countries, on average. The decrease is lower for "clothing & footwear" (0.104 in LICs and 0.126 in HICs).

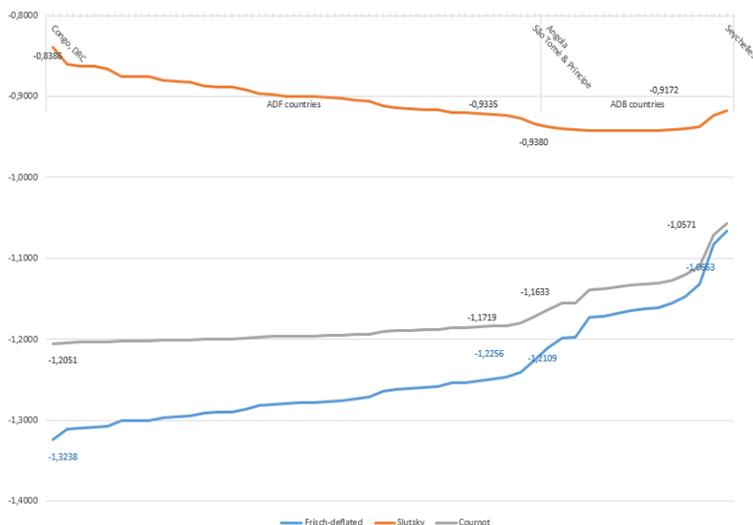
Own-Price elasticities: In addition to income elasticities, we compute three types of own-price elasticities of demand for the categories of goods and services. Except for Slutsky own-price elasticities, the results are in conformity Timmer's proposition on the demand for food that: *own-price elasticities of demand are larger in absolute value for low-income countries than for high-income countries* (Timmer, 1981). Our results are, however, in line with those obtained by Seale et al. (2003) and Muhammad et al. (2011).

The estimated Cournot and Frisch own-price elasticities for food are all larger (in absolute value) than the corresponding Slutsky elasticities. Figure 2 below shows the evolution of the three own-price elasticities for the food category for low and higher income countries. The Cournot and Frisch own-price elasticities rise gradually from -1.2051 and -1.3238, respectively to -1.1719 and -1.2256, respectively in LICs. Similarly for higher income countries, the Cournot and Frisch own-price elasticities rise from -1.1633 and -1.2109, respectively to -1.0571 and -1.0663, respectively in HICs.

As mentioned earlier, only the Slutsky own-price elasticities for food seem not to strictly conform with Timmer's proposition. As the graph shows, instead of increasing, the Slutsky own-price elasticities for "Food & Non Alcoholic Beverages" decline from -0.8386 for Democratic Republic of Congo to -1.0571 for Seychelles. In fact, because β_i is negative for "Food & Non Alcoholic Beverages" category then the logarithm derivative of the Slutsky own-price is positive. The Slutsky own-price elasticity therefore decreases with Q (see Seale et al., 2003).

Nonetheless, the Slutsky elasticities also show that consumption of food and non-food beverages is relatively price inelastic compared with all other categories of goods and services.

Figure 2: Frisch, Cournot and Slutsky own-price elasticities



Source : Authors' estimates using 2011 ICP data.

5.2 Food Sub-groups: Second-stage Estimates and Elasticities

Table 4 presents the estimated parameters for the food subgroups (second-stage model). In this model, parameters are estimated conditional on total per capita food expenditures and not total per capita expen-

ditures on all categories. When β is negative, then a good is expenditure inelastic. It is expenditure elastic otherwise. The results of this study show that four food subcategories are expenditure inelastic. These are "bread and cereals", "fish", "oils and fats" and "other food". The negative elements of the Slutsky price matrix are in conformity with the basic law of demand in economics which states that all else being equal, the demand for a product will decline as its price increases.

From the model, we compute expenditure and price unconditional elasticities. The unconditional expenditure elasticities measure the percentage change in demand arising from a percentage change in total expenditure; whereas the unconditional Frisch own-price elasticities measure changes in demand arising from changes in the price of the product. The results show that the unconditional income elasticities for "Bread & Cereals", "Fish", "Oils and fats", "Fruits, vegetables, & potatoes" and "other food" are all less than 1 but greater than zero, implying that they are necessities for households in both low and higher income African countries. These food subcategories account for more than three quarters of the total expenditure on food. The expenditure elasticities for the "milk, cheese & eggs" and "meat" food subcategories are either greater than or close to one. They could therefore be considered as luxury goods for most African households. According to the results generated, when incomes increase African households tend to allocate a greater portion of their budgets on items like meat, milk, cheese and eggs. Similarly, they reduce the budgetary share of food items like cereals in response to increases in income.

Table 4: Estimation of the food sub-group model, 50 countries, 2011

	Parameter	Standard error	Parameter	Standard error	Parameter	Standard error
	Beta (β)		Alpha (α)		Diagonal of Slutsky Matrix	
Bread and cereals	-0.053	0.0043	0.3040	0.0169	π_{11}^*	-0.787
Meat	0.032	0.0032	0.1453	0.0138	π_{22}^*	-0.242
Fish	-0.002	0.0021	0.0969	0.0088	π_{33}^*	-0.307
Milk, cheese and eggs	0.017	0.0011	0.0526	0.0041	π_{44}^*	-0.141
Oils and fats	-0.002	0.0014	0.0484	0.0056	π_{55}^*	-0.125
Fruits, vegetables, potatoes	0.016	0.0036	0.2549	0.0166	π_{66}^*	-0.592
Other food	-0.007	0.0027	0.0978	0.0097	π_{77}^*	-0.21

Source : ICP 2011 & Authors' estimations.

The estimated Frisch own-price elasticities for the food subcategories vary according to economic theory: consumers in HICs are less responsive to price changes than those in LICs; these elasticities in HICs are less (in absolute value) than those in LICs and almost close to one. For instance, the value for "breads and cereals" varies from -1.1098 (Liberia) to -0.8964 (Comoros).

6. Conclusion

This paper estimates a two stage cross-country-demand system across 50 countries in Africa by using 2011 ICP Africa data. Specifically, we fit a two-stage-demand system with the Florida-PI and Florida-Slutsky models for twelve broad categories and seven food sub-categories. Study results confirm Engel's law: that when income increases, the budget share of food declines. The decrease is far more pronounced in High Income African Countries compared to the Low Income Countries. The results also show that "food & non-alcoholic beverages" and "clothing and footwear" are necessary goods and that all other consumption categories are luxuries including education.

The results have implications for public policy measures aimed at ensuring household food security and overall welfare in many African countries, especially for the 40 percent plus of African living under absolute poverty conditions. In particular, the results are critical for informing policy measures to ensure price stability for items such as food that comprise a major component of the consumption basket of poor households. More so since these items have been shown to be expenditure inelastic. As prices of these items go down, this provides households more disposable income to spend on other items, including the "luxury" items like education and health. On the other hand, increases in the prices of these essential and expenditure inelastic items results in a decrease in disposable income available to households and a reallocation of the household budget away from items considered as luxurious. In such cases, expenditure on items such as education and health tend to be among the first to be curtailed by poor households in preference for food. This worsens an already bad situation for poor households since education and health are critical for enhancing human capital and improving access to and prospects for income generating opportunities and improved household welfare.

Identifying households that susceptible to such predicament would go a long way in strengthening targeting

mechanisms for public social program and safety nets for poor households. The sensitivity analysis arising from this study could therefore be helpful in helping to identify items that are particularly critical for poor households and ensuring that price fluctuations for these items are minimized to safeguard the food security and welfare of poor households. This assumes greater criticality in lower income African countries where the proportion of poor households is much larger than in higher income countries.

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