Animal Product Differentiation and Demand for Food in Cote d'Ivoire

Wane A., Rich K.M., Bamba Y., N'Goran A.A.J., Fall A.

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Summary

This report presents a demand analysis of primary data collected on 562 households in Abidjan. Findings show that Ivoirian consumers purchase more from traditional retailers where source-differentiated foods are sold in simple or primary forms. There is however an emergence of local and international retail brands (modern butcheries, supermarkets) trading in more specialized or processed food products. Consumers are generally sensitive to expenditure variation in their demand for chicken and fish. The expenditure elasticities of chicken and fish were found to be significant and positive. The elasticity of fish was estimated greater than one, indicating fish as a superior good in the households surveyed. The expenditure elasticity of beef was not significant.

1. Introduction

In Sub-Saharan Africa marked by a context of random supply, efficiency gaps, productivity losses and food security, there has been a clear tendency for livestock sector interventions to focus on production systems and thus support the supply of livestock products. These approaches are justified. However, value chain analysis show countries are strongly constrained by the persistence of a relatively low off-take rate (8-12%) despite many interventions to stimulate offtake. Simulation exercises implemented by Rich and Wane (2021) and Wane and Rich (2019) have preliminary shown that an improvement in animal and herd productivity as well as a development of diversified, alternative, and lucrative markets would be more effective in increasing value chain performances rather than a hypothetical and exhausting increase in herd off-take rates. Then, sector analyses that often focus on supply-side constraints can be usefully combined by end-market analyses to better capture emerging opportunities and threats to inform decision-making process for an effective sectoral development. Therefore, connecting supply and demand of source-differentiated foods (SDF) is critical both at national and regional level.

Very few studies have been carried out on household SDF demand in Cote d'Ivoire. This paper focuses on the meat demand patterns in Abidjan as main end-market in Cote d'Ivoire for cattle imported from Sahelian countries (Mali, Burkina Faso, and Niger). Although there have been numerous debates over the cause and nature of structural shifts in the parameters of beef demand, the presence of diverse animal-source foods and the diversification of supplies intensify the need for further study of the meat consumption patterns in Cote d'Ivoire. Despite its high importance, analysis of the drivers of regional trade in cattle, in particular from Mali, has been relatively neglected by most trade analysts in West Africa. Magnitudes and volumes of exchanges observed between Mali and Cote d'Ivoire make it more than relevant to set up an analysis on this form of economic interconnectivity, focusing on the cattle and beef demand in Cote d'Ivoire to provide insights about how this end-market can play a critical role in the livestock sector in Mali, for example.

This study uses primary data collected on 562 households in Abidjan, main end-market, to examine the response of aggregate SDF demand to variations in price and expenditures. Although pork and wild meats are popular in Cote d'Ivoire, the focus in this study is kept on animal source foods that are more likely to (1) be consumed by all regardless of their religious beliefs i.e., ruminants, chicken, and fish and (2) potential impact on the regional livestock trade. We analyzed meat demand using three forms of Almost Ideal Demand System (AIDS) models (linear, demographic and quadratic) applied to SDF (ruminant, chicken, and fish) consumption preferences. A demographic approach was applied to analysis of demand for beef cuts (meat and offal) as well as chicken and fish.

The study is organized as follows: section 2 briefly introduces the theoretical foundations of the AIDS models commonly used for demand analysis, and the estimation procedure; section 3 provides the data sources and research methodology; section 4 presents and discusses the results; section 5 concludes.

2. Theoretical foundations and estimation procedure

Demand analyses often use partial equilibrium models. These models focus on the levels of demand for current consumer goods by an individual, household or producer, based on the structure of current relative prices, real income, and a set of individual characteristics. Household consumption behavior has always been of major interest to economists and has made important contributions that deserve to be critically analyzed. In terms of consumer theory, a good specification of consumer behavior requires considering both relative incomes and prices. Since Engel's seminal work (1857, pp. 28-29) revealing that "the higher the income, the lower the share of income allocated to food expenditures", more contemporary contributions have verified and even shown what the economic literature calls Engel's law (Houthakker, 1957; Seale and Regmi, 2006; Lewbel, 2008). However, the beginnings of economic modelling applied to demand systems in consumer theory are associated with the work of Stone (1954). Subsequently, other more specific or functional approaches emerged, notably with Deaton and Muellbauer (1980) whose Almost Ideal Demand System (AIDS) model provides a very popular empirical analytical tool in many

countries (Alem, 2011). The most significant contributions to provide demand analysis are the model of Rotterdam (Theil, 1965), translog model (Christensen et al, 1975), Armington (1969) and the almost ideal demand system or AIDS that is a consumer demand model used to study consumer behavior (Deaton and Muellbauer, 1980).

The analysis of demand systems has known a rapid theoretical and empirical development in recent decades. Studies have developed the AIDS model using panel data which leads to convergent estimators with the increase in the number of observations. This approach also makes it possible to take account of consumption behavior through its individual and temporal dimensions and to highlight the influence of individual and aggregate factors on this behavior (Sevestre, 2002). Other studies have attempted to work with households organized into subgroups that are homogeneous in terms of household size (Banks et al., 1997; Calvet and Comon, 2000; Khed, 2018). However, as Deaton and Muellbauer (1980) pointed out, the criterion of homogeneity depends not only on household size but also on household composition. Indeed, two households with the same number of individuals but composed differently certainly do not have the same demand for food. Moreover, demand can also depend on consumption habits (Calvet and Comon, 2000), so that there is an inelasticity of demand for certain goods, which are often considered non-priority in certain situations. Indeed, a household can be satisfied with the same quantity of products demanded regardless of its size and composition. Banks et al. (1997) have amply demonstrated the relativity of the notion of income elasticity.

As with most consumer goods, AIDS approaches and its variants have been applied to the meat sector. In sub-Saharan Africa, many studies have applied variants of AIDS approaches to analyze meat demand/consumption in middle-income countries (e.g., Ojogho and Eqware, 2015; Shibia, Rahman and Chidmi, 2017). However, it should be noted from the outset that the application of AIDS approaches must take account of certain specificities such as the lack of statistical data, the dual nature of economies, the limited opportunity for substitution between broad categories of goods, the distortion created by market subsidies, and the possible primacy of demographic variables over other standard variables such as prices and income (Goaïed, 1991). For all these reasons, it is strongly recommended to use the AIDS approach developed by Deaton and Muellbauer (1980) while integrating demographic aspects.

The AIDS model was implemented for the case of Abidjan using a three-step estimation procedure (not shown) in which (1) households allocate expenditures between several categories of goods and services, (2) expenditure on food includes the purchase of SDF, and (3) expenditure on SDF is allocated to the purchases of beef, mutton, goat meat, pork, bush meat, poultry, fish, and shellfish.

3. Data sources and quantitative research methodology

Secondary data

This study used secondary data collected from various sources. The viewpoints of officials from the Ministry of Animal and Fisheries Resources (MIRAH) in Côte d'Ivoire were collected through in-depth interviews. A meeting organized on March 28, 2019 on the premises of the Ministry allowed the authors to share the research design, discuss sector policies with decision-makers, and gather data additional data on the livestock sector. The research team also met on May 22, 2019 with experts from the Bureau National d'Études Techniques et de Développement (BNETD), a center of expertise for global and sectoral strategy and development that supports the Ivoirian government in the implementation of large-scale development projects including the livestock sector. These meetings facilitated the gathering of relevant information on the livestock and meat supply chain in the country. Finally, we triangulate information on cattle and beef trade by using International Trade Statistics and Import/Export Data (UN Comtrade, Faostat).

Primary data

To answer the question on the current consumption patterns of SDF and beef cuts in Abidjan, primary quantitative data was collected and used. The viewpoints of the consumers were collected through in-depth interviews of respondents randomly distributed within the ten communes of the district of Abidjan. The data collection work is based on one survey conducted between March and May 2019 on 562 households in the city of Abidjan as an administrative entity composed of two parts (Abidjan north and Abidjan south) and ten communes on either shore of the Ebrié lagoon. Out of a sample of 562 people, the largest number of respondents resided in the populous commune of Yopougon where 171 households were interviewed (31% of the sample) while the smallest was in the commune of Plateau; a commune housing many office buildings (1% of the sample).

The data collection tool was built on semi-structured questionnaires related to respondent's socio-demographics characteristics, purchase of SDF and consumption habits, beef purchase and consumption habits as well as offal purchase and consumption habits. The questionnaire included general questions related to proportion of monthly expenditures used for family food, purchase of meat and cuts, monthly expenditures on food and non-food items. Given the heterogeneous distribution, the AIDS analysis of SDF demand in Abidjan focused on the most consumed products declared by the respondents specifically cattle meat (consumed by 97% of the sample), chicken meat by (89%) and fish (88%).

A first level of data elucidation identified the main sources of animal proteins (excluding pork and wild meat). In a second level, beef demand was disaggregated by beef products of different cuts.

The survey tool was designed on ODK (Open Data Kit) and transferred to Samsung tablets for electronic capture. In each commune, field enumerators were recruited and trained to administer the questionnaires. The team leader of the field activities oversaw data cleaning and quality assurance every day after the enumerators returned from the field. Data was then uploaded to the server and downloaded in Excel and statistical files for further cleaning. Analysis was mostly done using Stata software.

4. Results and discussions

Allocation of household expenditures

The demand level for food and non-food consumption varied in accordance with socio-economics characteristics of the study households. Overall, households were found to allocate 40% of their expenditures to food purchases.

Findings from secondary data

The meat consumed in Côte d'Ivoire comes from national production, imports of live cattle from Sahelian countries (Mali, Burkina Faso, Niger) and frozen meat from Asia, Latin America, and Europe. Côte d'Ivoire imports the bulk of its meat of cattle and small ruminants, some of which originates from live animal imports from the Sahelian countries. According to the United Nations database UN Comtrade, three categories of frozen beef are imported into Côte d'Ivoire: carcasses, frozen meat cuts with bone (excluding carcasses and half-carcasses), and frozen boneless meat. According to the published data, imports of frozen meat declined from 1,539 tons in 2014 to 408 tons in 2017. The decrease was more pronounced for frozen bone-in cut meat (except for carcasses and half carcasses). The country also imported fresh or chilled beef following broadly the same trends as frozen meat for the period from 2014 (26.8 tons) to 2017 (22.7 tons).

Socio-demographic analysis

Small-size households (less than 5 people) are relatively important in our sample (33%), while large-size households (9 or more people) account for nearly one-fifth of the households surveyed (19%). Most of the households surveyed had between 5 to 8 family members. Almost all heads of households are male (88%). Females interviewed account for almost one in nine (13%). The structure of the population by major age groups is characterized by a significant proportion of the number of people aged between 21 and 50 years old (89%) as active household respondent, with a dominance in this category of the 31-40 years old age group (46%). As might be expected, very few respondents are under 20 years old (1%) or over 60 years old (2%). For the level of education of the active head of household surveyed, we simplified by considering 5 categories: those who have no formal education in the official language (French), those who have reached primary, secondary and university levels and those who report other forms of education. The level of education of the household heads surveyed is relatively average, with 52% having at least a secondary level. Some of them (23%) reported having attained a higher or university level, while 24% reported a primary level. It should be noted that 24% declared that they had not received formal education in French. Most of the heads of households interviewed are married (63%). It also emerges a small proportion of the heads of households interviewed are not of Ivorian nationality (11%). 11% of respondents indicated not having a job, the majority (46%) reported being farmers and workers, 14% were self-employed and 28% executives (**Table 1**).

Table 1- Summary statistics of qualitative variables included in the analysis

Parameters	Description	N	Frequency per category	Relative frequency (%)
Gender of interviewee	0 = male	562	488	87
	1 = female		74	13
Age	1 = under 20 years old	562	8	1
	2 = 21 - 30 years old		137	24
	3 = 31 - 40 years old		259	46
	4 = 41 - 50 years old		105	19
	5 = 51 - 60 years old		39	7
	6 = over 60 years old		14	2
Education	0 = other	562	136	24
	1 = primary		136	24
	2 = secondary		159	29
	3 = university		131	23
Marital status	0 = other	562	208	37
	1 = married		354	63
Citizenship	0 = other	562	62	11
	1 = Ivoirian		500	89
Profession	0 = no employment	562	72	13
	1 = farmers & workers		257	46
	2 = independents		76	14
	3 = executives		157	28

Descriptive statistics on SDF consumption

Table 2 summarizes other fitted variables of the AIDS model. These variables are related to consumption frequencies, quantities, prices, and purchases of all SDF categories. Prices were generated while other variables were collected through intensive one-on-one interviews with 562 respondents. It should be mentioned that there are some missing data so that the basis of analysis differs depending on the commodities and variables targeted. On average, the price of beef, chicken, fish, and offal are 2,300; 3,100; 1,800 and 1,825 XOF, respectively. However, depending on the place of purchase (markets, supermarkets, rotisseries, etc.), prices can vary greatly, as illustrated by the standard deviation values.

Table 22- Statistics summary of fitted quantitative variables

Variables	Description	N	Minimum	Maximum	Mean	Standard deviation	Standard error
HH size		562	1	55	6	4	0
Expenditures (XOF)	Beef	288	500	36,500	4,358	5,215	307
	Offal	504	300	78,000	7,421	9,445	421
	Chicken	498	500	60,000	6,319	7,824	351
	Fish	492	100	60,000	2,856	5,818	262
Prices (XOF)	Beef	287	2,000	3,500	2,329	191	11
	Offal	471	500	5,230	1,825	409	19
	Chicken	496	1,750	12,500	3,203	944	42
	Fish	489	165	4,000	1,779	226	10
Monthly expenditures (XOF)	Food	550	15,000	750,000	87,069	56,020	2,389
	Non-food	530	5,000	700,000	125,803	92,251	4,007
	Total	528	15,000	1,160,000	213,798	122,131	5,315

[a] West African CFA franc – XOF (Exchange rate in April 2019 was 1 United States' dollar = XOF 579.59).

Source: Authors' computation from Field Survey, 2019

Econometric estimates

For all SDF, three AIDS models were tested to determine the most appropriate model with respect to the estimating the elasticities:

- a Linear Expenditure System (LES) as reference model and that is a demand system in expenditure relative to price, which often fulfills the regularity conditions of demand theory;
- a demographic version of the Almost Ideal Demand System (AIDS) that basically fits to consumer expenditure theory and provides new insights relative to that provided by the traditional single equation approach;
- a demographic version of the Quadratic Almost Ideal Demand System (QUAIDS) as an extension of the demographic version of the AIDS to overcome the limitation of the flexibility in expenditure.

The two demographic models with and without a quadratic term produced near identical estimates except that the model with quadratic term had a higher value of log-livelihood. For parsimony, only the QUAIDS is presented below in contrast with the LES.

Source-differentiated food

The header of the **Table 3** indicates the type of model fit, the number of observations and demographic variables, the value of alpha_0 used, and the maximized value of the log-likelihood function. The table of estimated parameters is divided into groups representing each vector or matrix that appears in the demand system.

According to the **Table 3,** all autonomous values of the budget coefficients represented by α ($\alpha_1, \alpha_2, \alpha_3$) in each equation are significant at level 1% whatever the model used. Moreover, in the absence of expenditure and price variations, expenditure on beef represents 32% of total expenditure in the linear model but stabilizes at 27% in the demographic model and the demographic model with quadratic term; expenditure on fish represents 29% in the linear model and stabilizes at 34% in the other models; expenditure on chicken remains almost stable at 39% regardless of the model considered.

An income variation may lead to a significant and negative variation at 1% in demand for chicken and a significant and positive variation at 1% in demand for fish in the linear model. However, with the introduction of demographic parameters, only the variation in the demand for fish remains significant and positive at 5%.

Cross term analysis indicates that all 3 coefficients are still significant while keeping the same signs. The results are very close to the former for both the cross terms and the direct price effects.

Table 3- Estimation results of different AIDS model for SDF demand in Abidjan

Linear Expenditure System (LES)		*Demographic QAIDS*	
Number of observations	=	*Number of observations*	
445		*= 445*	
Number of demographics	=	*Number of demographics*	
0		*= 1*	
Alpha_0	=	*Alpha_0*	=
0		*0*	
Log-likelihood	=	*Log-likelihood*	=
1089		*1110*	

Variables	***Coefficient***	***Variables***	***Coefficient***
Alpha^{rc}		**Alpha^{rc}**	
α_{Cattle}	0.32***	α_{Cattle}	0.275***
$\alpha_{Chicken}$	0.39 ***	$\alpha_{Chicken}$	0.386***
α_{Fish}	0.29***	α_{Fish}	0.340***
Beta^{rc}		**Beta^{rc}**	
β_{Cattle}	-0.00	β_{Cattle}	0.051
$\beta_{Chicken}$	-.018***	$\beta_{Chicken}$	-0.019
β_{Fish}	0.021***	β_{Fish}	0.032**
Gamma^{rc}		**Gamma^{rc}**	
γ_{Cattle}	0.111***	γ_{Cattle}	0.109***
$\gamma_{\text{Chicken\_Cattle}}$	0.045***	$\gamma_{\text{Chicken\_Cattle}}$	0.045***
$\gamma_{\text{Fish\_Cattle}}$	-0.157***	$\gamma_{\text{Fish\_Cattle}}$	-0.154***
γ_{Chicken}	-0.169***	γ_{Chicken}	-0.170***
$\gamma_{\text{Fish\_Chicken}}$	0.125***	$\gamma_{\text{Fish\_Chicken}}$	0.124***
γ_{Fish}	0.032**	γ_{Fish}	0.030**

	Lambda^{rc}	
	λ_{Cattle}	-0.010
	$\lambda_{Chicken}$	-0.002
	λ_{Fish}	0.012***
	Eta^{rc}	
	η_{Cattle}	-0.001
	$\eta_{Chicken}$	0.001**
	η_{Fish}	-0.000
	Rho^{rc}	
	ρ_t	0.026

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Source: Authors' computation from Field Survey, 2019

Moreover, the demographic variable represented by the Eta parameter, which reflects the effect of household size on their demand for meat and fish, is significant only for chicken demand meaning that demand for beef and fish is neutral to household size that, however, positively influences the demand for chicken.

With the quadratic term, only the lambda coefficient for fish is significant. When expenditure reaches a very high level, its variation positively impacts the demand for fish only.

Model results on expenditure and price elasticities are summarizedin Table 4 and Table 5 below. Determining price and expenditure elasticities is central to the development of AIDS model. To do so, we applied a technical adjustment to avoid the overvaluation of elasticities in particular for households that do not declare consuming a particular good (budget coefficient close to 0). Zero observations are commonly found in consumption and expenditure data and should be excluded in demand system analysis. Therefore, we removed from the analysis households with coefficients equal to 0, leaving a sample of 202 observations of an initial 445. Despite the loss in precision, the approach yields useful elasticities.

Table 3- Expenditure elasticities of SDF

Expenditure elasticities	Average values	Confidence intervals	
Beef	1.005	-1.130	1.209
Chicken	0.956**	0.678	1.044
Fish	1.189**	0.889	7.795

Source: Authors' computation from Field Survey, 2019

The expenditure elasticities of chicken and fish are significant and positive. The elasticity of fish was estimated greater than 1, indicating fish as a superior good in the households surveyed. The expenditure elasticity of beef was not significant. When expenditure increases by 1%, the demand for chicken increases by 0.96% while the demand for fish increases by 1.2%. The expenditure elasticity of beef is positive but not significant, meaning that the increase in expenditure has no effect on the demand for beef.

The (compensated) price elasticities are reported in Table 5.

Table 4- Compensated price elasticities (Hicksian Elasticity's)

Animal-source food	Beef	Chicken	Fish

Beef	-0.334	0.628	-0.294
Chicken	0.406	-0.863	0.457
Fish	-0.461	1.109	-0.647

Source: Authors' computation from Field Survey, 2019

Table 5 shows all direct price elasticities to be negative, meaning that all goods seem to follow the patterns for normal goods. A 1% increase in beef price leads to a 0.33% decrease in beef demand. This result confirms the descriptive analysis which shows that 63% of households wish to reduce their consumption of beef following a price increase. On the other hand, a 1% beef price increase causes a 0.63% increase in chicken demand. Chicken meat and beef meat are thus found to be substitutable as mentioned above. In addition, a 1% increase in beef price leads to a 0.29% decrease in fish demand, indicating beef and fish could be substitutable goods.

Results from the demand analysis of specific meat cuts indicated cuts are responsive to expenditure variation assuming ceteris paribus. The expenditure-related coefficients were significant in all demand equations, meaning that changes in expenditure lead to changes in the demand for beef, offal, chicken, and fish. An expenditure increase causes an increase of offal and fish demands so that they can be considered as normal goods. While beef and chicken responded negatively to expenditure changes, i.e., characterizing them as inferior goods, expenditure elasticities were positive for all products, indicating them as normal goods (contrary to the results of the AIDS model).

5. Conclusion

The objective of this paper was to provide an empirical exploration of Ivorian households' demand reactions to price and expenditure variations for SDF and meat cuts through the specification and estimation of comparable demand models. From primary data collected between March and May 2019 on 562 households in the 10 communes of Abidjan, capital city of Cote d'Ivoire and main meat end-market, price and expenditure elasticities for SDF (cattle, chicken and fish) as well as for cuts (beef, chicken and fish meat and beef offal).

For SDF and beef cuts, the demographic AIDS model, compared to linear and quadratic models, proved to be more relevant in analyzing households' demands.

Some shortcomings of the analysis are worth mentioning. First, to circumvent the problem of zero purchases, the aggregation of purchases for each commodity might have led to some loss of information. Second, our study focused on the most consumed meats as reported by respondents, so there were few responses regarding pork. The lack of declarations concerning pork may be due to religious reasons with the presence of a large Muslim community, estimated at 43% of the population in Côte d'Ivoire. However, by excluding pork, some substitution effects may be misjudged. Many factors, in addition to price and expenditure, can influence decisions to consume meat. Thirdly, for methodological convenience, the sustainability of consumption patterns has not been addressed in this article, even though the sustainability of food systems is a major food security and economic policy issue. Therefore, future studies could provide more information by estimating the parameter of sustainability in a demand system.

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