Feed the Future Innovation Lab for Food Security Policy

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# Demand for Imported-Frozen versus Domestic-Traditionally Processed Fish in Africa: Panel Data Evidence from Nigeria

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## Introduction

We present empirical results on fish demand in Nigeria by form of fish and income groups, comparing North and South Nigeria. Our study tests two hypotheses. (1) That fish demand is price and income elastic, and thus considered a luxury by consumers; (2) that the poor in general and those in rural areas in particular, tend to buy more of the traditional form (dry/smoked), while wealthier urban consumers prefer the frozen imported fish. The study is innovative through its use of panel data and its distinction between different forms of fish in Nigeria. The form in which the fish is sold is important because frozen fish is largely all imported and there is a debate about the extent and determinants of fish imports that compete with domestic fish production and capture.

## Data

The study uses data from the three rounds of the Nigeria Living Standard Measurement Study-Integrated Survey on Agriculture (LSMS-ISA), namely 2010/11, 2011/12, and 2015/16. Fish expenditure is disaggregated into five categories: fresh, frozen, dried, smoked, and other fish (e.g., fresh or frozen shrimp, snails, crab, lobster, canned fish and canned seafood). Price indices were computed for each of the fish categories as a weighted average of transaction-derived prices. All nominal prices and values were converted into real values using the consumer price index (CPI) at the national level for 2010, 2012, and 2015 with 2010 being the base year. Lastly, all fish quantities are expressed in wet kilogram weight equivalents.

## Analysis

Our analysis combines descriptive statistics with an empirical analysis of fish consumption patterns using panel data methods. Using non-parametric local polynomial regressions to model the relationship between the fish budget shares and the natural log of fish expenditure, we find that budget shares for most fish forms (and for fish and seafood generally) are not linear in expenditure. Consequently, we use the "Quadratic Almost Ideal Demand System (QUAIDS) model of Banks et al. (1997) applied within a panel framework. We implement a modified routine of the QUAIDS model based on Poi (2012) that enables us to include demographic variables. This enables us control for factors such as gender, education, residing in a rural or urban area, North vs. South, and ownership of a refrigerator: all likely to affect the amount and form of fish demand. Furthermore, the method of Poi (2012) satisfies the additivity, homogeneity, and Slustky symmetry properties of the estimated parameters as required by demand theory. See Box 1 for more details on the empirical estimation.

### Highlights

- Fish consumption in Nigeria is higher in the richer South than the poorer North.
- Fish consumption is surprisingly similar in urban and rural areas, controlling for the region. Rural fish consumption (as well as that of the North in general) is heavily skewed toward traditional forms (dried, smoked) and somewhat less frozen/imported.
- Fish consumption is found to be relatively expenditure inelastic (compared with poultry and milk), thus signaling "perception as necessity" by consumers.
- Among fish forms, traditional forms such as dried and smoked fish tend to be income inelastic while the modern frozen fish form is income elastic
- Currently imported frozen fish prices are much higher than fresh domestic fish or the fresh-equivalent price of dried fish. This creates opportunities for domestic fish production to compete with imports

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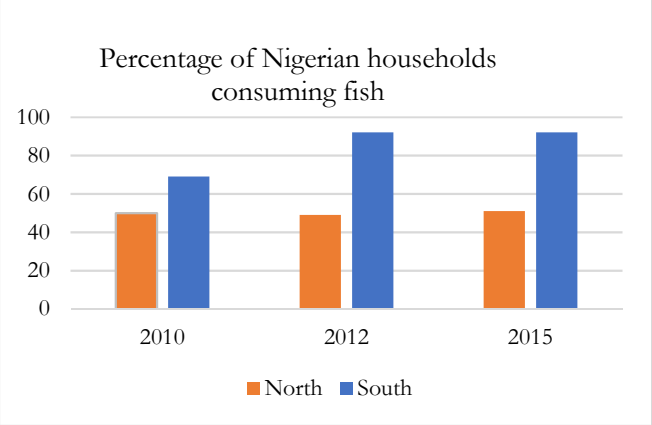
## Key Findings

Fish consumption growth in Nigeria was higher than the African average over the last four decades. Average fish consumption doubled from about 7.6 kg per capita between 1999 -2001 (according to the National Oceanic and Atmospheric Administration) to 14.2kg in 2015, according to the LSMS-ISA data. However, there is significant variation between the North and South as shown in Figure 1. On average over the three survey years, 70% of Nigerians eat fish. While almost all households in the South consume fish and fish products (around 92%), only 51% consumed fish and fish products in the North in 2015. The North consumes less fish because of lower incomes and higher fish prices in the North (than in the South). Moreover, the regional difference in fish consumption extends to fish expenditure shares in total food expenditure (Figure 2). While fish expenditures in the South in 2015 are 12% of total food expenditures, the budget share in the North is but 5% in any year.

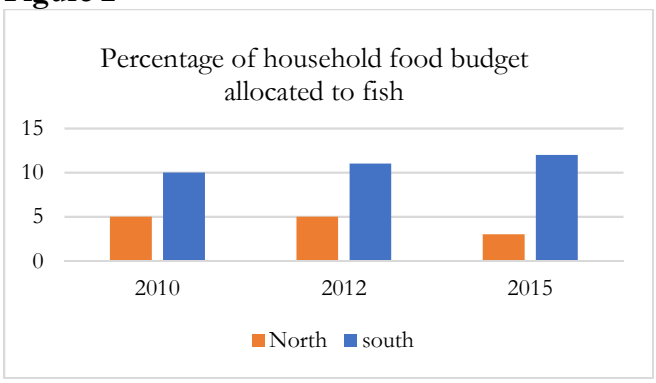
**Figure 1**




Source: Authors' estimations from the LSMS-ISA data

In terms of expenditure elasticities, fish is much more of a necessity (with elasticity less than 1) compared to poultry and dairy (with elasticities around 1.1). Equally surprising is the finding that this is true for both the richer South and the poorer North. Thus with the findings on the important share of fish in diets of Nigerians, we confirm that fish is basically an essential staple. Among different fish forms, traditional dried and smoked fish are expenditure inelastic while the modern frozen/imported fish is more responsive to income. Nigeria is a middle-income country with a growing middle class. These households are increasingly diversifying their diet to include animal proteins; as expected by virtue of Bennett's Law.

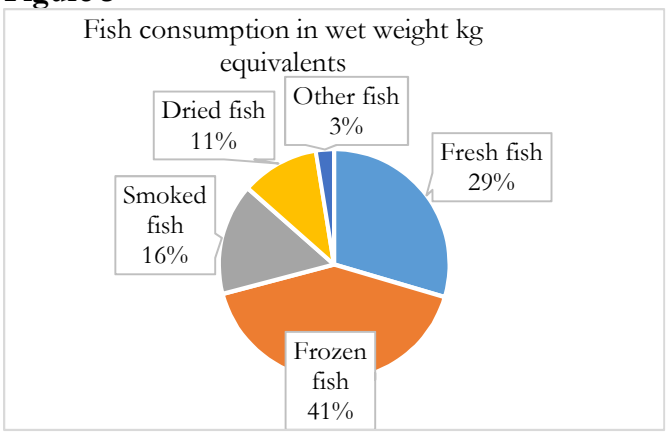
**Figure 2**




Source: Authors' estimations from the LSMS-ISA data

Frozen fish dominates other fish forms in total "wet equivalent" of fish consumption in Nigeria (Figure 3). This obtains in rural and urban areas but is more striking in urban areas. This is fascinating because buying frozen fish (basically imports), while not having a significant fish freezing industry domestically indicates that Nigeria is "leap-frogging" a consumption shift that was gradual in the US and Europe and then became fast; a phenomenon which is recent in Asia. The rise of an increasingly urban middle class in Nigeria is a key driver of the vast increase in frozen fish, and thus the change in fish consumption habits at the relative expense of the local fish sold dried/smoked.

**Figure 3**




Source: Authors' estimations from the LSMS-ISA data.

A key policy implication is that as incomes increase in Nigeria, the demand for frozen and fresh fish will increase more than proportionately. Currently, the high cost of imported products appears to have created a greater opportunity for domestic fish production to compete with imported fish. Yet even then, imported fish are fully 40% of national fish consumption, driven particularly by the rise of the urban middle class. Successfully competing with imported frozen fish in Nigeria requires prompt attention (of research and policy) to domestic fish production.

**Key Reference**

Liverpool-Tasie, L. S.O, Sanou, A. & Reardon, T. 2017. Demand for Imported-Frozen versus Domestic-Traditionally Processed Fish in Africa: Panel Data Evidence from Nigeria. MSU Staff Paper 2017-09. December.

## Box 1: QUAIDS estimation with panel data

Following Banks et al. (1997), we assume that the amount, $m$ a household spends on fish is chosen using a two-stage budgeting process. In the first stage, households allocate their food budget to fish and to non-fish food (cereals, fruits, vegetables, meat, etc.) conditional on prices, income, and household characteristics. In the second stage, the household allocates fish expenditure among different forms of fish.

Banks et al. (1997) derive the QUAIDS model by approximating the indirect utility function

$$\ln V(\mathbf{p}, m) = \left[\left\{\frac{\ln m - \ln a(\mathbf{p})}{b(\mathbf{p})}\right\}^{-1} + \lambda(\mathbf{p})\right]^{-1} \quad (1)$$

where $\ln a(\mathbf{p})$ is the transcendental logarithm function

$$\ln a(\mathbf{p}) = \alpha_0 + \sum_{i=1}^{k} \alpha_i \ln p_i + \frac{1}{2}\sum_{i=1}^{k}\sum_{j=1}^{k} \gamma_{ij} \ln p_i \ln p_k \quad (2)$$

$p_i$ is the price of fish $i$ for $i = 1, \ldots k$
$b(\mathbf{p})$ is the Cobb-Douglas price aggregator and
$b(\mathbf{p}) = \prod_{i=1}^{k} p_i^{\beta_i}$ and $\lambda(\mathbf{p}) = \sum_{i=1}^{k} \lambda_i \ln p_i$.
All Greek letters except $\alpha_0$ are parameters to be estimated and $\alpha_0$ is chosen to be slightly less than the lowest value of $\ln m$ in the data (Poi, 2012).

Fitting the QUAIDS model within a panel framework, we implement a modified routine of Poi (2012). Poi (2012) enables us to add demographic variables to the model using the method of (Ray, 1983), and compute expenditure and price elasticities. Furthermore, the method of Poi (2012) satisfies the additivity, homogeneity, and Slustky symmetry properties of the estimated parameters as required by demand theory. However, the standard routine does not control for zero expenditures or selection problems, and unobserved heterogeneity, which are inherent in demand systems estimations.

To address the unobserved heterogeneity problem, the modified routine we assume that the time-invariant unobserved characteristics ($c_i$) are correlated with some of the observed variables included as explanatory variables in our model. A fixed effects (FE) estimation method, or a Correlated Random Effects (CRE) estimation method, can be used to correct for endogeneity introduced by the time invariant characteristics (Wooldridge, 2010). However, since we are in the non-linear environment with the QUAIDS model, the CRE is appropriate (Meyerhoefer, Ranney, & Sahn, 2005). As such, we add means of time-varying variables as additional explanatory variables in the second stage of the estimation of the system.

The literature identifies three main reasons for zero expenditures in household level data. First, households can be at a corner solution meaning that they never consume the commodity of interest. Second, limited survey periods can record zero consumption of the commodity among some households. Third, some households may not report consuming the commodity because it is not an optimal decision at a particular time subject to the set of prices they face and income (Meyerhoefer et al., 2005; Tafere, Taffesse, Tamru, Tefera, & Paulos, 2011).

The LSMS-ISA data exhibit the zero expenditures problem with 41%, 30%, and 29% of the households reporting not allocating any budget to any one of the five fish forms in 2010, 2012, and 2015 respectively. Consequently, we follow the approach of (Shonkwiler & Yen, 1999) for dealing with a censored dependent variable when estimating a system of equations (Magrini, Balie, & Morales-Opazo, 2017; Tafere et al., 2011; Tefera, Mulat, Shahidur, & Kayitare, 2015). In the first stage we estimate a Correlated Random Effects Probit model for each fish form. Next, we compute the normal cumulative distribution ($\Phi(z_{ih}'\hat{\theta}_1)$) and normal probability density functions ($\phi(z_{ih}'\hat{\theta}_1)$) which are used with the system of fish budget shares $w_i$ to generate new fish budget shares $w_i^*$ to be estimated:

$$w_i^* = \Phi(z_{ih}'\hat{\theta}_1)w_i + \delta_i\phi(z_{ih}'\hat{\theta}_1) + \xi_{ih} \quad (3)$$

where $\xi_{ih}$ are error terms. One challenge with this transformation is that the new fish budget shares $w_i^*$ no longer satisfy the additivity condition as required by demand theory. Most studies address this issue by treating the $k^{th}$ good as a residual category with no specific demand. This means imposing the identity:

$$w_k^* = 1 - \sum_{i=1}^{k-1} w_i^* \quad (4)$$

where $w_{kt}^*$ is the budget share of the residual good or "all other" category of the good being studied. In contrast, we opt for a reweighing of the transformed shares (Steele & Weatherspoon, 2016) to obtain $w_i^{**}$ such as

$$w_i^{**} = w_i^* / \sum_{i=1}^{k} w_i^* \quad (5)$$

This approach has two advantages. First, we do not have to arbitrarily choose any of the fish groups as the residual category with no specific demand. Second, it avoids the issue of obtaining negative expenditure shares for the good since it is possible that the sum of the other goods is greater than one when one imposes the identity above.

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