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Introducing Food Safety Labels in Complex Food Supply Chains: Evidence from a Choice Experiment in Nigeria

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Introduction

The public health and economic impacts of poor food safety regulation enforcement are often overlooked in developing countries. These effects are exacerbated when important attributes of food products are unobservable. This is the case with certain highly toxic poisons produced by Aspergillus flavus and Aspergillus parasiticus fungi called aflatoxins. While not always visible to the naked eye, the consumption of aflatoxin-contaminated food has been linked to a host of human and animal health concerns. For humans, aflatoxins cause, for instance, liver cancer (hepatocellular carcinoma, HCC) and has been linked to acute liver toxicity and immunotoxicity (Wu et al., 2014). In chickens, the consumption of aflatoxin contaminated feed affects growth and results in brittle egg shells, and decreased egg production (Bandyopadhyay, 2013).

Nigeria has established standards on the acceptable levels of aflatoxin in maize, however there is limited enforcement of these standards and often no market mechanisms to encourage their enforcement for consumers (SON, 2008). Furthermore, there is limited knowledge among direct maize consumers about aflatoxins and the dangers of consuming aflatoxin contaminated maize products. In a study of consumers in an open market in South West Nigeria, Caputo and Liverpool-Tasie (2018) found that less than 10% of consumers had heard of aflatoxins and only about 5% had some knowledge about what aflatoxins really were. This limited awareness results in the absence of a known premium tied to the supply of aflatoxin-safe maize products. However, certain indirect consumers of maize have a clear preference for high quality maize. For example, industrial food processors and major livestock feed producers are very particular about the quality of their product and hence its inputs (Moser & Hoffmann, 2015). Reasons for this include export considerations as well as traceability and brand reputation (Moser & Hoffmann, 2015).

Key Findings

- Maize traders respond to attributes their buyers care about and will pay a price premium for.
- Wholesalers who sell to buyers (other large traders, large feed mills, food companies) who know or care about aflatoxin exhibit the highest mean WTP for aflatoxin safe certification.
- Traders who sell to consumers consistently have a low WTP for aflatoxin certification; consistent with the fact that they don't know about aflatoxins.
- Traders selling to consumers exhibit the highest WTP for low moisture content, an attribute they are familiar with, but it is an incomplete measure of aflatoxin contamination.
- Nigerian traders trust reputable domestic organizations over foreign ones for aflatoxin certification.

This study capitalizes on the heterogeneous preferences for maize attributes related to food safety (by maize buyers) to explore the potential for a market-based solution to provide aflatoxin-safe maize to Nigerian consumers. It explicitly explores if maize traders are willing to pay a higher price for an aflatoxin-safe product and if this willingness to pay varies with the expected (or known) demand for the same by their buyers. Maize traders in Nigeria provide a unique opportunity to explore this topic because they sell to a wide variety of buyers including wholesalers, maize retailers, food companies, small and large feed mills and household consumers.

We use a discrete choice experiment to estimate maize traders' willingness to pay (WTP) for an aflatoxin-safe product and explore if this willingness to pay varies with the expected (or known) demand for the same by their buyers. Additionally, since low moisture content is often used as an incomplete measure of the absence of aflatoxin

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in most studies, we investigate how the WTPs for aflatoxin safe certification compares to WTP for low moisture content.

Data

The choice experiment was implemented with maize wholesalers in Oyo and Plateau states between February and March 2018. A listing of traders in city and regional markets was conducted in both states. In Oyo state, a listing of the traders in the Ibadan region constitutes the universe included in the sample as there are no regional maize markets. In Plateau state, the listing exercise identified traders in both city and regional markets. A census of all the traders in city markets was conducted. From the top five regional markets in Plateau state, 30 traders were randomly selected. This resulted in a total of 122 traders in Oyo and 193 traders in Plateau state. We conducted a survey that captured the characteristics of the maize being traded, maize traders' demographic characteristics, and their buying and selling behavior throughout the year. The attributes of the product, maize, used in the choice experiment were selected based on interaction with key informants, a thorough review of the literature and a descriptive analysis of a large survey of maize traders conducted in Nigeria between May and June 2017 (see Liverpool-Tasie, Reardon, et al. (2018) for more details on the survey). The set of attributes of the product include color, price, moisture content and aflatoxin-safe label (see Table 1).

Table 1. Attributes and attribute levels of maize in the choice experiments

Attributes	Description	Attribute levels
Price*	Purchase price (in Naira/100 Kg)	Plateau state: ₦ 7,800, ₦ 8,800, ₦ 9,800 Oyo state: ₦ 10,500, ₦ 11,500, ₦ 12,500
Certification	Aflatoxin safe maize	Maize is certified to have below 4ppb** for total aflatoxin, not certified
Moisture level	The acceptable level of moisture content to avoid fungal growth is 13%	Low (<13%), medium (14-15%), high (17-19%)
Color	Yellow maize is for human and feed consumption while white maize is typically for human consumption only	Yellow, White

* The price attribute has different values for Oyo and Plateau state because they reflect differences in actual market prices. ** 4 ppb (4 parts per billion) of total aflatoxin is the allowable level set by the Standards Organization of Nigeria (SON)

Key Results

Traders will purchase aflatoxin-safe maize if they know or believe that there is a market for it.

We find that traders who sell to buyers who know and care about aflatoxin exhibit a high WTP for aflatoxin safe maize. In both study states, we find consistent evidence that traders selling to other traders, large feed mills, food companies and retailers exhibit a higher WTP for certification compared to those who sell to small feed mills and consumers. In addition to actual sales, we also categorize traders based on their perceptions about their customers. Traders who believed that other traders, retailers, large feed mills and food companies would be willing to pay a price premium for aflatoxin-safe maize exhibited a higher WTP for aflatoxin-safe maize compared to others who did not share these beliefs. Consequently, our findings consistently reveal that traders will purchase aflatoxin-safe maize if they know or believe that there is a market for it.

Traders who sell to consumers exhibit the highest WTP for low moisture maize

Though traders who sell primarily to consumers do not exhibit high WTP for aflatoxin free maize, they have the highest WTP for maize with low moisture content. This is likely because moisture content is one of the main proxies used by consumers to determine maize quality. Maize traders selling primarily to consumers, other traders and the food industry care the most about moisture content while large feed mills and retailers care the least. This might be because large feed millers and retailers have their own ways of drying maize. The observed differences (across traders) in the WTP for certification and low moisture depending on who their main buyers are suggest that the knowledge level of the final buyers is a key driver of the market-based incentive. In addition, the fact that traders who sell primarily to consumers have low WTP for aflatoxin certification but high WTP for low moisture content (which consumers care a lot about) reveals that maize traders respond to the preferences of their consumers.

A certification scheme implemented by a domestic agency would be more credible than one established by a foreign organization.

Traders in Oyo state revealed that they are more likely to trust a certification scheme implemented by the National Agency for Food & Drug Administration & Control (NAFDAC) by itself or NAFDAC together with a university based in Nigeria. In Plateau state, traders are more likely to trust an aflatoxin-safe label certified by NAFDAC, NAFDAC and a university in Nigeria, or a research institute in Nigeria by itself. Conversations with traders in Plateau state during field work are aligned with these findings as many shared that they do not believe a foreign certifying agency would care about their health as much as a Nigerian one.

Policy implications

These findings have important policy implications for Nigeria and the functioning of maize markets in the country. From a public health safety point of view, the use of moisture content labels as a proxy for aflatoxin contamination is not ideal. Consumers already value moisture level in their buying decisions but that does not protect them from buying aflatoxin-contaminated maize. They are still exposed to the negative health impacts that are associated with the consumption of aflatoxin-contaminated maize.

The study results indicate that the introduction of an aflatoxin certification scheme could be implemented in Nigeria. However, given the low level of awareness about aflatoxin and its health effects in the general populace, such a policy should be preceded or accompanied by an information campaign highlighting the negative health impacts of the toxin. This would increase awareness among different categories of buyers and ultimately influence the characteristics that matter to them when purchasing maize. This claim is predicated on the study findings that if the trader knows that a buyer cares enough to pay a price premium for aflatoxin-safe maize then the trader will be willing to provide it. Some of the details of implementing such a policy including the ideal nature and process for getting the maize tested require further research and discussions among key players in the policy development and implementation arena in Nigeria.

Key references

1. Liverpool-Tasie, L. S. O., Reardon, T., Sanou, A., Ogunleye, W., Iredele, O., & Omonona, B. (2018). *The Transformation of Value Chains in Africa: Evidence from the First Large Survey of Maize Traders in Nigeria*. Retrieved https://www.canr.msu.edu/resources/the-transformation-of-value-chains-in-africa-evidence-from-the-first-large-survey-of-maize-traders-in-nigeria
2. Train, K. E. (2009). *Discrete choice methods with simulation*: Cambridge university press.

Box 1: Estimation approach

The econometric model is based on McFadden's random utility theory, which describes discrete choices in a utility maximizing framework (McFadden, 1974). Let U_{njs} denote the latent indirect utility that trader n will derive from alternative j (one of the three alternatives in each choice task) and in choice situation s (one of the six choice tasks presented to the trader). This utility may be partitioned in an observed or modelled component, V_{njs}, and an unknown stochastic component, ϵ_{njs}, such that:

$$U_{njs} = V_{njs} + \epsilon_{njs} \tag{1}$$

Assuming V_{njs} is linear in parameters, the functional form of the utility function for alternative *j* can be expressed as:

$$V_{njs} = \boldsymbol{\beta X}_{njs} \tag{2}$$

where $\boldsymbol{X}_{njs}$ is a vector of observable attributes and attribute levels, and $\boldsymbol{\beta}$ is the corresponding vector of parameters to be estimated; ϵ_{njs} is an unobserved error term, which is assumed to be independent and identically distributed (iid) extreme value type I. In this study, V_{njs} can be expressed as follows:

$$V_{njs} = ASC + \beta_1 Price + \beta_2 Price * Oyo + \beta_3 Color + \beta_4 Low\ Moisture + \beta_5 High\ Moisture \tag{3}$$

where *price* indicates the maize price in Plateau state; *Price*Oyo* is an interaction term between the price and a dummy variable equal to 1 if the survey took place in Oyo; Color is a dummy variable equal to one if the maize is yellow and zero otherwise; *Low Moisture* and *High Moisture* are dummy variables equal to one if the moisture level is low and high respectively (medium moisture is the base).

In this study, the analysis was conducted using the mixed logit (MXL) model (or random parameter logit model (RPL)) (Train, 2009). The MXL allows us to account for random taste variation among the traders, and correlation patterns. It also relaxes the IIA assumption which is defined below. Formally, mixed logit models allow a continuous representation of heterogeneity whereby the utility parameters vary randomly over individuals (Adamowicz & Swait, 2011). Following Train (2009), the conditional probability of choice in the MXL model for each time period $\mathbf{i} = \{i_1, \ldots, i_T\}$ is given by the product of logit formulas:

$$\boldsymbol{L}_{n\mathbf{i}}(\beta) = \prod_{t=1}^{T} \left[\frac{\exp(\beta'_n x_{nit})}{\sum_{j=1}^{J} exp(\beta'_n x_{njt})} \right] \tag{4}$$

Since we do not observe β_n but know the density $f(\beta_n|\theta)$, following Train (2009) we can derive the unconditional probability that the individual chooses an alternative as the integrals of standard logit probabilities as below:

$$P(y_n|\theta) = \int P(y_n|\beta_n) f(\beta_n|\theta)\ d\beta_n \tag{5}$$

In the mixed logit model the distribution of β is specified to be continuous. The choice probabilities therefore depend on θ and not the values of β. It is common to specify the integral of $f(\beta_n|\theta)$ (and not closed form) to have a normal or lognormal distribution and use simulations to estimate the model.

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