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PERCEIVED QUALITY DIFFERENCES OR HABIT PERSISTENCE?

presented by

HENRY OGADINMA AKAEZE

has been accepted towards fulfillment
of the requirements for the

M.S. degree in AGRICULTURAL, FOOD, AND RESOURCE ECONOMICS

R. J. Myers
Major Professor's Signature

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CONSUMER PREFERENCE FOR IMPORTED RICE IN NIGERIA—PERCEIVED QUALITY DIFFERENCES OR HABIT PERSISTENCE?

By

HENRY OGADINMA AKAEZE

A THESIS

Submitted to
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ABSTRACT

CONSUMER PREFERENCE FOR IMPORTED RICE IN NIGERIA—PERCEIVED QUALITY DIFFERENCES OR HABIT PERSISTENCE?

By

Henry Ogadinma Akaeze

Previous studies on rice in Nigeria have *inter-alia* focused on the constraints to local production and consumption, and the reasons for the growth in imported rice consumption. However, these studies have largely neglected the role of habit persistence and perceived quality differentials in explaining consumer preference for imported rice in Nigeria. Therefore, the goal of this research is to develop a theoretically consistent procedure for identifying and estimating the relative contributions of habit persistence and perceived quality differentials in explaining consumer preference for particular product varieties, and applies this procedure to demand for imported and domestically produced rice in Nigeria. Using annual time series data from 1961 to 2006, results indicate that habit persistence and perceived quality differences both play an important role in explaining consumer preference for imported rice in Nigeria. An important implication is that policies designed to encourage production of relatively high quality local rice, thereby replacing imported rice in consumption baskets, will face considerable inertia due to the persistence of consumer habits and mindset regarding purchase and consumption of imported rice, even if the locally produced rice is of comparable quality. Companion policies designed to shift consumer-buying habits and alter already established cultural mindset via advertising and promotion programs may be required to overcome this consumption inertia.

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To my mother and 'father'— Mrs. Victoria J. A. Akaeze—who gave up life's comfort for my education.

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CHAPTER 1: INTRODUCTION

1.1 Background information

Rice is one of the world's most important food crops and serves as a staple food for a large percentage of the world's population, especially in India, China, other parts of Asia, and Africa. In Nigeria, rice is a vital food consumption staple but has also become an important cash crop where it provides employment for more than 80% of the population in the major producing areas (Okoruwa and Ogundele, 2006). Ayinde et al. (2009), drawing on WARDA (1996), note that Nigeria is both the largest producer and consumer of rice in the West African sub-region. Moreover, Nigeria consumes considerably more rice than it produces (Business Day, 2009), leading to significant imports in recent years (Table 1).

Table 1: Rice production, consumption and imports in Nigeria ('000 MT), 2000-2008

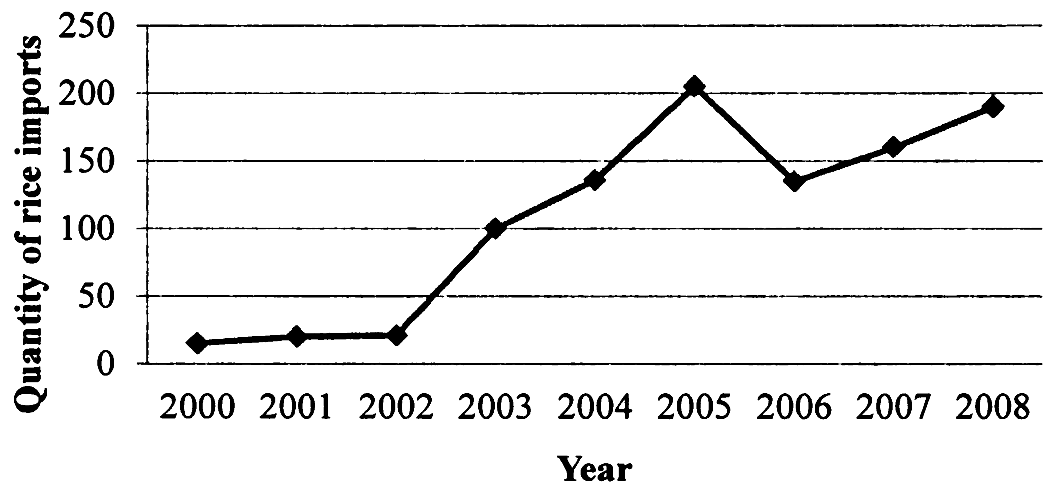
Year	Rice production (Milled rice)	Rice consumption (Milled rice)	Rice Imports (Milled rice)	Rice exports
2000	40	55	15	0
2001	50	70	20	0
2002	54	75	21	0
2003	52	152	100	0
2004	37	148	136	0
2005	51	256	205	0
2006	51	186	135	0
2007	46	206	160	0
2008	51	241	190	0

Source: Index Mundi (2009), adapted from the United States Department of Agriculture http://www.indexmundi.com/agriculture/?country=ng&commodity=milled-rice&graph=ty-exports.

Over the years, several government programs have attempted to stimulate domestic rice production with the goal of addressing the increasing demand-supply gap and making Nigeria more self sufficient in rice. Some of these policies and programs include the Federal Rice Research Station (FRRS), established in 1970; National Accelerated Food Production Project (NAFPP), established in 1972; the National Cereals Research Institute (NCRI), launched in 1974; World Bank-Assisted Development Programs, set up in 1975; Operation Feed the Nation (OFN), started in 1976; the River Basin Development Authorities (RBDs), established in 1977; and Abakaliki Rice Project (ARP), established in 1978. Others include the Back to Land Program (BLP) and the Directorate for Food, Roads and Rural Infrastructures (DFRRI), both introduced in 1988; and the National Land Development Authority (NALDA), dating from 1995 (Imolehin and Wada, 2000; Emodi and Madukwe, 2008). Two of the most recent programs are the Presidential Initiative on Rice (PIR), established in 1999 and the National Program for Food Security (NPFS), the first phase of which was launched in 2001.

Despite these policies, projects and programs, domestic rice consumption has continued to outpace domestic production leading to an ever-increasing role for rice imports. As can be seen from Figure 1, rice imports have been growing steadily in Nigeria and this growth is expected to continue due to increasing demand resulting from growth in incomes, urbanization, and the associated expansion of fast food restaurants (Daramola, 2005).

Figure 1: Milled rice imports (000' MT), 2000-2008



Considerable previous research has focused on identifying the constraints to increasing domestic rice production in Nigeria (Imolehin and Wada, 2000; Ekeleme et al. 2009; IRRI, 2008). Other studies have focused on explaining the growth of rice consumption. Erenstein et al. (2003) note that the persistent increase in per capita rice consumption in Nigeria means that rice has become a structural component in the Nigerian diet and that changes in relative commodity prices have slowed but not reversed the increase in rice consumption. In addition to rapid population growth, Erenstein et al. (2003) conclude that consumption increases were due to increased consumer incomes and changes in tastes and preferences.

This thesis centers on a neglected aspect of rice consumption in Nigeria that may help explain the importance of rice imports in the Nigerian diet. Consumers in Nigeria appear to display a distinct preference for imported rice over domestic rice, which has led to a market price premium for imported rice. There are two major possible explanations for this preference. One is that imported rice is viewed as a better quality than locally produced rice, and that therefore domestic and imported rice are not perfect substitutes. The second explanation is that the long history of consuming imported rice in Nigeria has led to habit persistence and consumption inertia, which makes it more difficult for locally produced rice to compete.

The relative contributions of these two competing explanations is important because if *perceived* quality differentials explain most of the preference for imported rice, this suggests policies will need to focus not only on increasing domestic rice production but also on improving the quality of domestic rice if desired reductions in imports are to be achieved. If, on the other hand, domestic and imported rice are perceived as being of comparable quality, and the preference for imported rice is a result of habit persistence, this suggests policies that overcome inertia and change consumer-buying habits are needed to increase the demand for domestically produced rice. Both policy strategies will be needed if both explanations are supported by empirical evidence from this study.

Specifically, the goal of this research is to develop a procedure for identifying and estimating the relative contribution of perceived quality differentials and habit persistence in explaining consumer preference for particular product varieties, and to apply this procedure to the demand for imported and domestically produced rice in Nigeria.

The organization of the remaining parts of the thesis is as follows. Chapter 2 briefly reviews previous related literature and motivates the contribution of the research reported here. Next, Chapter 3 presents the methodology, data and estimation strategies used in the analysis. This is followed by discussion of results in Chapter 4. The study ends with conclusions and policy implications in Chapter 5.

CHAPTER 2: LITERATURE REVIEW

Over the years, rice in Nigeria has received enormous research attention. For instance, Akpokodje et al. (2003) assess the major supply and demand trends in rice and find that lowland rain-fed rice systems have a higher profitability than upland rice. Erenstein et al. (2003) argue that locally produced rice has the potential to meet food (especially rice) demand of consumers in Nigeria if efficient production practices are employed. Erenstein et al. (2003) also find that the price of imported rice, which is a function of world market price, import duties, transport costs, and a quality premium, puts a cap on the price of local produce.

Lancon et al. (2003) conduct a survey of imported rice consumer's preferences and suggest that imported rice cleanliness is the overwhelming technical feature explaining the expansion of imported rice consumption in Nigeria at the cost of local rice market development. Next to cleanliness are swelling capacity (mostly preferred by restaurants and fast food joints), taste, availability and grain shape. Other rice studies in Nigeria include research on rice processing (Lancon et al. 2003), improved technologies (Imolehin and Wada, 2000), market supply response and demand for local rice (Rahji and Adewumi, 2008), and rice irrigation (Kebbeh et al. 2003).

Moreover, several studies using stochastic frontier production functions, meta-frontier models, and other production function models have also been used to test for technical efficiency in rice production in Nigeria (See Tijani, 2006; Okoruwa and Ogundele, 2006; Ayinde et al. 2009; Shehu et al. 2007; Moses and Adebayo, 2007).

However, none of these studies has focused on consumer preference and the possible combined effects of habit persistence and perceived quality differences.

In the general demand literature, there are multiple studies that address either habit persistence or preference for quality differences in isolation. For example, Dynan (2000) tests the time separability of preferences (presence of habit formation in consumer preferences) with annual panel data from the U.S. Income Dynamics study and finds no evidence of habit formation. On the other hand, Ferson and Constantinides (1991) find evidence of habit persistence using U.S. monthly, quarterly and annual consumption data from the Center for Research in Security Prices of the University of Chicago and the DRI.

Using the U.S. household level BLS Interview Panel data to test the effects of habit persistence, Heien and Durham (1991) find that habit effects are highly significant but much smaller in cross-sectional data than in time series data. Other studies focus on the implications of habit formation in consumption for monetary-policy models (Fuhrer, 2000), a consumption-based explanation of aggregate stock market behavior and habit (Campbell and Cochrane, 1999), and understanding asset prices under habit formation (Abel, 1990).

Researchers have also done some interesting work on quality variation and its role in consumption behavior. For instance, Nelson (1991) rejects the theoretical arbitrariness of the simple sum of physical quantities used as a measure of demand in the 'quality' literature, and investigates alternative measures of demand derived from restrictions on quality variation, consumer preference, or relative prices. Also, Cox and Wohlgenant

(1986) distinguish quality effects from supply-related price variability to identify cross-sectional demand for disaggregated food commodities.

However, none of these studies on habit and quality has focused on Nigeria, the highest consumer of rice in the West African sub-region. The contribution of the current study, therefore, is that it provides a theoretically consistent way of combining habit persistence *and* preferences for quality differentiated goods in a single consumption model, and applies this framework to investigate preferences for imported rice over locally-produced rice in Nigeria. The resulting empirical model can identify the extent to which consumer demand for imported rice in Nigeria is due to perceived quality differentials versus habit persistence. The generic model developed here can be extended to study the relative importance of habit persistence and perceived quality differences in an entire system of demand equations for both agricultural and non-agricultural quality-differentiated commodities.

CHAPTER 3: METHODOLOGY AND DATA

3.1 Methodology

3.1.1 Effects of perceived quality differences on consumer preferences

Let q_1 and q_2 be the amount consumed of different varieties of the commodity of interest and $\mathbf{x}$ be a vector of other goods consumed. In our case q_1 and q_2 are imported rice and domestically produced rice, respectively. Extension to more than two varieties is straightforward. Assume that utility takes the form $U(q_1 + \alpha q_2, \mathbf{x})$ where α is a measure of the *perceived* quality differentials between q_1 and q_2. If $\alpha = 1$, the varieties are viewed as perfect substitutes, and therefore of equal quality. If $\alpha = 0$, then q_2 is viewed to be of such poor quality that its consumption does not generate utility. If $\alpha \in (0,1)$ any given amount of q_2 generates less utility than the same amount of q_1. Hence, α can be viewed as an index of the perceived quality differential between q_1 and q_2.[1]

The consumer's problem is to:

$$(1) \qquad \max_{q_1, q_2, \mathbf{x}} \{U(q_1 + \alpha q_2, x) : p_1 q_1 + p_2 q_2 + \mathbf{wx} \le y\}$$

where p_i is the price of q_i, $\mathbf{w}$ is a vector of prices for $\mathbf{x}$, and y is consumer income. Assuming both q_1 and q_2 are consumed then necessary conditions for solving (1) include:

$$(2) \qquad U_{q^*} - \lambda p_1 = 0 \text{ and } \alpha U_{q^*} - \lambda p_2 = 0$$

[1] Any two varieties can obviously be reordered if necessary to ensure that $\alpha \in [0,1]$.

where U_{q^*} is the derivative of U with respect to $q^* = q_1 + \alpha q_2$, and λ is the Lagrange multiplier (marginal utility of income). Combining and rearranging (2) gives:

$$p_2 = \alpha p_1 \tag{3}$$

which shows that in order for both varieties to be consumed, their prices must be in fixed proportion given by the quality differential index. Using (3) and the definition of q^* the consumer's problem can therefore be re-written as:

$$\max_{q^*,\mathbf{x}} \left\{ U\left(q^*, \mathbf{x}\right) : p_1 q^* + \mathbf{wx} \leq y \right\} \tag{4}$$

which shows that q^* can be viewed as a composite commodity whose price is p_1 and whose demand function satisfies all of the characteristic properties of conventional consumer demands.

3.1.2 Incorporating habit persistence

So far the model incorporates quality differences between varieties but not habit persistence. To model habit persistence, a time index is added and so (4) is re-specified as:[2]

$$\max_{q_t^*,\mathbf{x}_t} \left\{ U\left(q_t^* - \beta q_{t-1}^*, \mathbf{x}_t\right) : p_{1t} q_t^* + \mathbf{w}_t \mathbf{x}_t \leq y_t \right\} \tag{5}$$

where β is a measure of habit persistence in the consumption of q_t^*. If $\beta = 0$, there is no habit persistence but as $\beta \to 1$ habit persistence plays an increasingly dominant role in consumption behavior. For simplicity, habit persistence has only been modeled in the

[2] This specification restricts the degree of habit persistence to be identical across q_1 and q_2, which seems like a reasonable assumption when looking at different varieties of the same product.

consumption of q_t^* but extending the model to allow habit persistence in $\mathbf{x}$ as well is straightforward. This basic approach to modeling habit persistence has been used previously in the literature (See Dynan, 2000; Naik and Moore, 1996; Fuhrer, 2000).

The budget constraint in (5) can be re-written as:

$$(6) \qquad p_{1t}q_t^* - \beta p_{1t}q_{t-1}^* + \mathbf{w_t x_t} \le y_t - \beta p_{1t}q_{t-1}^*.$$

Then defining $\tilde{q}_t = q_t^* - \beta q_{t-1}^*$ and $\tilde{y}_t = y_t - \beta p_{1t}q_{t-1}^*$, the consumer's problem (5) can be re-written as:

$$(7) \qquad \max_{\tilde{q}_t, \mathbf{x}_t}\{U(\tilde{q}_t, \mathbf{x}_t) : p_{1t}\tilde{q}_t + \mathbf{w}_t\mathbf{x}_t \le \tilde{y}_t\}$$

which shows that $\tilde{q}_t$ can be viewed as a composite commodity whose demand function satisfies all of the characteristic properties of conventional consumer demands given prices $(p_{1t}, \mathbf{w_t})$ and income $\tilde{y}_t$. This implies that any theoretically appropriate functional form can be used to specify and estimate the demand for $\tilde{q}_t$. That is, for any theoretically consistent demand function $\tilde{q}_t = d(p_{1t}, \mathbf{w_t}, \tilde{y}_t)$ an appropriate model for q_{1t} would be (using the definitions of $\tilde{q}_t$ and q_t^*):[3]

$$(8) \qquad q_{1t} = \beta(q_{1t-1} + \alpha q_{2t-1}) - \alpha q_{2t} + d[p_{1t}, \mathbf{w_t}, y_t - \beta p_{1t}(q_{1t-1} + \alpha q_{2t-1})]$$

Note that if $\alpha = \beta = 0$, (no habit persistence but perceived quality dominance of q_1) then consumption of q_2 would be zero and (8) reduces to a standard demand equation in q_1. If $\beta = 0$ and $\alpha = 1$ there is no habit persistence and no perceived quality

[3] Here I focus on demand for the commodity of interest q but the approach is clearly applicable to the entire system of demand equation for both q and $\mathbf{x}$.

differentials, so the demand for both varieties q_1 and q_2 can be aggregated. If $\beta = 0$ and $\alpha \in (0,1)$ there is a perceived quality differential but no habit persistence. If both $\alpha \in (0,1)$ and $\beta \in (0,1)$ then there are both habit persistence and perceived quality differentials with the relative magnitudes of these two parameters indicating the relative importance of the two effects.

Given a specification for $d(\cdot)$, equation (8) can be estimated to provide inferences on α and β. Of course, estimation of (8) may be complicated by nonlinearity and the likely endogeneity of q_{2t}. However, estimation strategies will be discussed in more detail below.

3.2 Functional forms

In this section I provide details of the model for four possible choices of $d(\cdot)$. The first example is based on a simple linear specification, followed by a linear expenditure system (LES), an almost ideal demand model specification (AI), and a log-linear model specification (LL).

3.2.1 The simple linear specification

A simple linear specification follows the form:

$$\tilde{q}_t = \gamma + \delta_q p_{1t} + \sum_{j=1}^{n} \delta_j w_{jt} + \xi \tilde{y}_t$$

where n is the dimension of $\mathbf{x}$ (and $\mathbf{w}$). The corresponding version of (8) is then:

$$\text{(9)} \qquad q_{1t} = \gamma + \beta(q_{1t-1} + \alpha q_{2t-1}) - \alpha q_{2t} + \delta_q p_{1t} + \sum_{j=1}^{n} \delta_j w_{jt} + \xi[y_t - \beta p_{1t}(q_{1t-1} + \alpha q_{2t-1})]$$

which can be estimated using procedures discussed below. Note that if $\alpha = \beta = 0$ then (9) reduces to a standard linear demand equation for q_1, and if $\alpha = 1$ and $\beta = 0$ then (9) is a single equation representing aggregate demand for q_1 and q_2 (which are perceived to be of comparable quality).

3.2.2 The linear expenditure system (LES)

The second example is based on the linear expenditure system (LES) which has been used extensively to investigate habit persistence in consumption choice (see Pollak and Wales, 1992; Welsch, 1989). The LES model for $\tilde{q}_t$ is:

$$\tilde{q}_t = \gamma_q + \delta\left[\frac{\tilde{y}_t - \gamma_q p_{1t} - \sum_{j=1}^{n} \gamma_j w_{jt}}{p_{1t}}\right].$$

The corresponding version of (8) is then:

$$(10) \qquad q_{1t} = \gamma_q + \beta\left(q_{1t-1} + \alpha q_{2t-1}\right) - \alpha q_{2t}$$

$$+\frac{\delta}{p_{1t}}\left[y_t - \beta p_{1t}\left(q_{1t-1} + \alpha q_{2t-1}\right) - \gamma_q p_{1t} - \sum_{j=1}^{n} \gamma_j w_{jt}\right]$$

which can be estimated using procedures discussed below. Note again that if $\alpha = \beta = 0$ then (10) reduces to a standard LES equation for q_1.

3.2.3 The almost ideal demand model (AI)

The third example is based on the almost ideal demand model (AI). The AI model for $\tilde{q}_t$ is

$$\tilde{q}_t = \left(\tilde{y}_t \big/ p_{1t}\right)\left[\gamma + \delta_q \ln(p_{1t}) + \sum_{j=1}^{n} \delta_j \ln(w_{jt}) + \xi \ln\left(\tilde{y}_t \big/ P_t\right)\right]$$

where P_t is the conventional AI price index defined over $(p_{1t}, \mathbf{w}_t)$. The corresponding version of (8) is then:

$$(11) \qquad q_{1t} = \gamma + \beta(q_{1t-1} + \alpha q_{2t-1}) - \alpha q_{2t} + \left[\frac{y_t - \beta p_{1t}(q_{1t-1} + \alpha q_{2t-1})}{p_{1t}}\right]$$

$$\times \left\{\gamma + \delta_q \ln(p_{1t}) + \sum_{j=1}^{n} \delta_j \ln(w_{jt}) + \xi \ln\left[\frac{y_t - \beta p_{1t}(q_{1t-1} + \alpha q_{2t-1})}{P_t}\right]\right\}$$

which can be estimated using procedures discussed below. Again, if $\alpha = \beta = 0$ then (11) reduces to a standard AI model for q_1.

3.2.4 The log-linear specification (LLS)

The log-linear model for $\tilde{q}_t$ is

$$\ln\tilde{q}_t = \gamma + \delta_q \ln p_{1t} + \sum_{j=1}^{n} \delta_j \ln w_{jt} + \xi \ln\tilde{y}_t$$

Again, using the definitions of $\tilde{q}_t = q_t^* - \beta q_{t-1}^*, \tilde{y}_t = y_t - \beta p_{1t} q_{t-1}^*$, and $q^* = q_1 + \alpha q_2$ the corresponding version of (8) is

$$(12) \qquad q_{1t} = \beta(q_{1t-1} + \alpha q_{2t-1}) - \alpha q_{2t}$$

$$+ \exp\left(\gamma + \delta_q \ln p_{1t} + \sum_{j=1}^{n} \delta_j \ln w_{jt} + \xi \ln[y_t - \beta p_{1t}(q_{1t-1} + \alpha q_{2t-1})]\right)$$

If $\alpha = 1$ and $\beta = 0$[4], and if the natural logarithm of (12) is taken, then (12) reduces to

---

[4] Notice that if $\alpha = \beta = 0$, then (12) reduces to a standard log-linear demand for imported rice. That is,

$$\ln q_{1t} = \gamma + \delta_q \ln p_{1t} + \sum_{j=1}^{n} \delta_j \ln w_{jt} + \xi \ln(y_t)$$

$$(13) \qquad \ln q_t^* = \gamma + \delta_q \ln p_{1t} + \sum_{j=1}^{n} \delta_j \ln w_{jt} + \xi \ln(y_t)$$

where $q_t^* = q_{1t} + q_{2t}$. Equation (13) is the standard log-linear demand equation for q_t^*, which is the total demand for rice aggregated across imported and locally produced rice.

3.3 Estimation

The quantity of imported rice consumed in Nigeria was used as the dependent variable while the price of imported rice, prices of other competing commodities, proxied by the Consumer Price Index (CPI), one-period lags of the quantities of domestically produced and imported rice, quantity of domestically produced rice, and income are the explanatory variables. Equations (9), (10), (11) and (12) were estimated with nonlinear least squares using instrumental variables for the endogeneous q_{2t}.[5]

3.3.1 Endogeneity and instrumental variable choice

In this study, local rice consumption q_{2t} is hypothesized to be endogenous because quantities of locally produced and imported rice are likely to be jointly determined. In demand studies using aggregate data, as are used here, price variables (here price of imported rice, p_{1t}) may also be endogenous because there may be feedback from aggregate consumption choices to equilibrium prices. Other variables in the model (income and lagged quantities) can more reasonably be assumed exogenous. If endogeneity is found then the nonlinear least squares estimators in equations (9) to (12)

[5] Even (9) is nonlinear in parameters because of nonlinear parametric restrictions.

will be biased and inconsistent and an instrumental variables (IV) approach will be required to correct for endogeneity.

To illustrate the instrumental variable approach, consider a structural equation:

(14) $$y_1 = \varsigma_0 + \varsigma_1 y_2 + \varsigma_2 z_1 + u_1$$

Assume z_1 is uncorrelated with u_1 and so exogenous but it is suspected that y_2 is correlated with u_1. Wooldridge (2009) recommends the use of other exogenous variable(s) uncorrelated with u_1 that do not explicitly appear in the structural equation, as well as possibly z_1, as instruments. Define a vector of these external variables as $\mathbf{z}$. The basic assumptions here are that z_1 and $\mathbf{z}$ are both uncorrelated with u_1, and that u_1 has a mean of zero. That is,

$$E(u_1) = 0,\ Cov(z_1, u_1) = 0 \text{ and } Cov(\mathbf{z}, u_1) = 0.$$

Instrumental variables need to satisfy the *exogeneity* condition and the *relevance* condition. The exogeneity condition requires that the instrumental variable must be uncorrelated with the error term in the demand model, while the *relevance* condition requires that the instrumental variable must exibit some *partial* correlation with the endogenous explanatory variable. The latter condition is testable by doing an F test on $\mathbf{z}$ in the following equation and testing $\boldsymbol{\rho} = 0$ (Wooldridge 2009),

$$y_2 = \varphi_0 + \varphi_1 z_1 + \mathbf{z}\boldsymbol{\rho} + v_2.$$

If $\boldsymbol{\rho} \neq 0$, then the chosen instrumental variables (IVs) are correlated with local rice consumption and thus meet the relevance condition. Results of this test including the test for endogeneity of p_{1t} are presented in section 4.1.

3.4 Data

Aggregate annual time series data from 1961-2006 were collected on the quantity of domestically produced rice consumed in Nigeria, imported rice consumed in Nigeria, price of imported rice, prices of substitute and complementary goods as measured by the consumer price index (CPI), Gross Domestic Product (GDP) as a measure of consumer income, and the Nigerian population. Data on locally produced rice consumption, imported rice consumption, and the CIF price of imported rice were obtained from the International Rice Research Institute (IRRI), while the GDP and population data were obtained from the *World Development Indicators, 2007* (World Bank, 2010). Nigerian CPI data were obtained from NationMaster.com.

In order to control the effects of population on aggregate demand, consumption of local and imported rice as well as GDP were put in per capita terms by dividing by population. Summary statistics of all the variables used in this analysis, including various transformations are presented in Table 2. Consumption of rice imports has a low minimum value of 0.005 because it was put in per capita terms. The AI price index variable was constructed as the price of imported rice and prices of other competing staples weighted by their shares of expenditure in income per capita.

Table 2: Summary statistics for dependent and explanatory variables

n = 46				
Variable	**Mean**	**Std. Dev.**	**Min**	**Max**
Imported rice per capita (kg/person)	3602.699	3369.716	4.280	12541.45
Consumer price index	28.759	52.445	0.240	207.398
GDP per capita (10,000 USD)	34.493	20.845	10.161	90.343
Log of CPI	1.186	2.285	-1.427	5.335
Log of consumers' income (10,000USD)	3.362	0.617	2.319	4.504
Price of imported rice (1000$/ton)	0.326	0.139	0.109	0.708
Log of price of imported rice (millions USD)	-1.195	0.419	-2.228	0.345
Log of quantity of imported rice per capita (tons/person)	-0.187	2.596	-5.356	2.627
Price index for AI model	8.637	17.351	0.234	78.701

CHAPTER 4: RESULTS

The first part of this chapter presents results of the endogeneity test for local rice consumption and price of imported rice, and for the test for the validity of the instrumental variable choice. This is then followed by presentation of the major results of the study.

4.1 Results of endogeneity tests on local rice consumption and price of imported rice

Following Wooldridge (2009), the test for endogeneity proceeded in two stages. First, the hypothesized endogenous explanatory variable was regressed against all the exogenous variables in the demand model, including the instrumental variables, to obtain the IV residual, $\hat{v}_t$. Second, this residual was then added to the original model including the endogenous explanatory variable and a heteroskedasticity-robust t test of the coefficient on $\hat{v}$ was used to determine the endogeneity of the variable in question.

Results presented in Table 3 show no evidence of endogeneity of price of imported rice. However results in Table 4 show that the null hypothesis of no endogeneity in the quantity of locally produced rice is strongly rejected, implying that local rice consumption is endogenous and NLS estimators of equations (9), (10), (11) and (12) would be biased and inconsistent, requiring an instrumental variable for q_{2t}.

Table 3: Second stage results of the robust test for endogeneity of price of imported rice

$n = 46$		
Variables	**Coef.**	**P-value**
Constant	7.506	0.007
One-period lag of imported rice consumption, q_{1t-1}	0.511	0.006
One-period lag of local rice consumption, q_{2t-1}	0.023	0.502
Consumer price index, w_{jt}	0.057	0.039
Consumers' income per capita, y_t	0.074	0.094
Price of imported rice, p_{1t}	-2.966	0.518
Local rice consumption, q_{2t}	-0.616	0.037
Residual, $\hat{v}$	-3.495	0.754
Adj. R-squared	0.817	

Table 4: Second stage results of the robust test for endogeneity of local rice consumption

$n = 46$		
Variables	**Coef.**	**P-value**
Constant	-2.485	0.020
One-period lag of imported rice consumption, q_{1t-1}	0.508	0.002
One-period lag of local rice consumption, q_{2t-1}	-0.846	0.006
Consumer price index, w_{jt}	-0.010	0.284
Consumers' income per capita, y_t	0.004	0.857
Price of imported rice, p_{1t}	1.223	0.696
Local rice consumption, q_{2t}	1.070	0.003
Residual, $\hat{v}$	-0.945	0.011
Adj. R-squared	0.793	

The instrumental variable regression for testing endogeneity of price of imported rice was specified as levels and squares of the exogenous variables. For the endogeneity test of local rice consumption, the instrumental variable regression was originally specified as levels, cross products and squares of the model independent variables, but due to model over-parameterization, there was need for excluding some of these variables. Therefore, on the basis of empirical testing and consistency with demand theory, squares of Consumer Price Index and the price of imported rice were the instrumental variables used in the later test. The choice of squares of the IVs was further supported by the nonlinear nature of the estimated models.

These IVs were hypothesized to be correlated with q_{2t} but not with the error term in the demand equation. This conjecture is supported by the validity test in Table 5. Formally, an OLS regression of q_{2t} on all the explanatory variables including the IVs was done, and the validity of the IVs was determined using an F test.

As Table 5 clearly shows, the coefficient on squared CPI is statistically different from zero. Though the square of the price of imported rice appear to be statistically insignificant, results of an F test for joint significance show that F(2, 40) = 3.232 with a computed F value of 21. Thess results provide evidence of partial correlation between the IV's and local rice consumption, indicating that the squares of CPI and price of imported rice are valid IVs.

Table 5: Results of the robust test for the validity of the instrumental variable choice

Variables	Coef.	P-value
Constant	2.090	0.467
One-period lag of imported rice consumption, q_{1t-1}	-0.002	0.994
One-period lag of local rice consumption, q_{2t-1}	0.814	0.000
Consumer price index, w_{jt}	0.063	0.056
Consumers' income per capita, y_t	0.066	0.251
Price of imported rice, p_{1t}	-5.235	0.760
Squared Consumer Price Index, w_{jt}^2	-0.0003	0.097
Squared price of imported rice, p_{1t}^2	1.385	0.952

4.2 Major results of the study

The generic model:

$$q_{1t} = \beta(q_{1t-1} + \alpha q_{2t-1}) - \alpha q_{2t} + d[p_{1t}, \mathbf{w_t}, y_t - \beta p_{1t}(q_{1t-1} + \alpha q_{2t-1})]$$

was estimated using all the model specifications (9) to (12) as a possible choice for $d(\cdot)$. However, results for the log-linear model are reported here because this specification is simple to estimate, easy to interpret, and provides results that are more consistent with demand theory and a better fit than other model alternatives.

In reporting the results particular attention is paid to the effects of habit persistence and perceived quality differences on rice consumption in Nigeria by testing parametric restrictions on α and β.

4.2.1 *Conventional determinants of demand*

The static demand models presented in Table 6 assume no effects of habit persistence and perceived quality differentials, that is, the restrictions $\alpha = 1$ and $\beta = 0$ are imposed. Results are consistent with *a priori* expectations concerning the signs of the determinants of a conventional demand model with income and price of other goods having positive effects on the aggregate quantity of rice consumed in Nigeria while price has a negative effect. All the determinants of demand are statistically significant at the 1% level.

The coefficients of the log-linear model have a direct interpretation as elasticities. Thus, results indicate that a 1% increase in own-price decreases rice consumption by 0.23%. Conversely, as the CPI and consumers' income increase by 1%, aggregate rice consumption increases by 0.08% and 0.33%, respectively, *ceteris paribus*. This indicates that rice is both a substitute for other consumption goods and a normal good in Nigeria.

Table 6: Conventional specification of demand in the log-linear demand model

Parameters	Symbol	Coef.	P-value
Constant	γ	1.385	0.000
Own-price	δ_q	-0.231	0.004
Cross price	δ_j	0.079	0.000
Income	ξ	0.331	0.000
n		46	
R-squared		0.821	
Lung Box Q. Stat.		0.000	

The goodness of fit is reasonably high, indicating that about 82% of the variation in the aggregate demand for rice in Nigeria is explained by the model. The Ljung Box statistic shows evidence of autocorrelation in the residuals, but this will be discussed in the next section.

Results from estimating this conventional demand model would suggest own price, incomes and changes in the general price level are the main determinants of rice consumption. However, this model does not account explicitly for perceived quality differentials and habit persistence and so may misrepresent actual determinants of the growth of imported rice consumption.

4.2.2 *Effects of habit persistence and perceived quality differentials on imported rice consumption in Nigeria*

Table 7 presents results of the endogeneity-adjusted log-linear demand model with perceived quality differentials and habit persistence. The effects of both quality differentials and habit persistence are important and statistically significant. With habit persistence and perceived quality differentials, the conventional determinants of demand still maintain their expected signs. Unlike in the conventional demand model results, the own-price parameter estimate is not statistically significant. This indicates that there is no significant responsiveness of demand for imported rice to changes in price due to habit persistence and perceived quality differences. While the positive income effect is statistically different from zero below the 1% level, the cross price effects are statistically significant at the 10% level.

It is interesting to note that own-price and cross-price parameter estimates are approximately similar in the generalized and conventional demand results, while income effects increased from 0.331 to 0.585 in the generalized model. This implies that the importance of income growth as a partial explanation for the expansion of demand for rice increases when perceived quality differentials and habit persistence are incorporated into the demand model.[6]

The significance of habit persistence and quality differentials indicates that they both play an important role in the demand for imported rice in Nigeria. For the perceived quality differential parameter, the estimate of 0.18 indicates an extremely large effect of consumers'

Table 7: Results of non-linear least square estimation of endogeneity-adjusted log-linear model

Variable	Symbol	Coef.	P-value
Constant	γ	-1.178	0.166
Effects of *perceived* quality differential	α	0.176	0.054
Effects of habit persistence	β	0.491	0.002
Own-price	δ_q	-0.243	0.354
Cross-price	δ_j	0.077	0.089
Income	ξ	0.585	0.001
n		46	
R-squared		0.887	
Ljung Box Q stat.		0.778	

perception of differences in quality on the consumption choice for imported rice in Nigeria (i.e., it is much closer to zero than to one). This is because a coefficient of 1 indicates no perceived quality differentials and thus the two goods can be considered as perfect substitutes while zero indicates a large perceived quality dominance of imported rice such that the consumption of domestic rice generates no utility.

[6] For future research, it will be interesting to understand and estimate the effects of different income levels or income distribution on demand for imported rice in a generalized demand framework that incorporates perceived quality differentials and habit persistence.

Further, while it is important to test if α is significantly different from zero indicating that the consumption of local rice does not generate utility, it is more interesting to test the substitutability effects of imported and domestically produced rice by testing whether α is significantly different from one. Though not presented, this test shows that F(1, 40) = 86.79 with a P-value of 0.000, indicating that the hypothesis of perfect substitutability between imported and locally produced rice is strongly rejected below the 1% level. This means that locally produced rice is not perceived to be of comparable quality with imported rice and therefore, one variety cannot be easily substituted for the other.

The magnitude of parameter estimate of habit persistence has an opposite interpretation because as $\beta \to 1$, habit persistence plays an increasingly dominant role in consumption behavior. Therefore, a parameter estimate of 0.50 indicates a moderate effect of habit persistence on consumer preference for imported rice.

Moreover, the model fits well with an R-squared of 89%. The Ljung Box Q-statistic shows that there is no evidence of autocorrelation in the residuals, unlike in the simple static specification. Thus the generalized models are more robust in controlling autocorrelation in the residuals.

4.2.3 Elasticity estimates in the conventional and generalized demand models

For the log-linear specification in (12) given as:

$$q_{1t} = \beta\left(q_{1t-1} + \alpha q_{2t-1}\right) - \alpha q_{2t}$$
$$+ \exp\left(\gamma + \delta_q \ln p_{1t} + \sum_{j=1}^{n} \delta_j \ln w_{jt} + \xi \ln\left[y_t - \beta p_{1t}\left(q_{1t-1} + \alpha q_{2t-1}\right)\right]\right),$$

the elasticity estimates for the conventional demand models are obtained by estimating equation (13), which is

$$\ln q_t^* = \gamma + \delta_q \ln p_{1t} + \sum_{j=1}^{n} \delta_j \ln w_{jt} + \xi \ln(y_t).$$

Thus, the coefficients of p_{1t}, w_t and y_t are own-price ζ, cross-price ζ_j, and income η elasticity estimates, respectively.

In the generalized demand models, however, the coefficients of own-price, cross-price and income are not elasticity estimates with respect to imported rice consumption but with respect to $\tilde{q}_t$, which, itself, is a function of imported rice consumption, one-period lags of imported and local rice consumption, local rice consumption, and the coefficients α and β.

For the own-price, cross-price and income elasticity estimates, therefore, I take the derivative of (12) with respect to p_{1t}, w_t and y_t, respectively. These are converted to elasticities by multiplying the outcome of these derivatives by the ratios of p_{1t}, w_t and y_t to q_{1t} accordingly. Thus the formulas for the own-price, ζ, cross-price, ζ_j and income, η elasticities are:

(15) $$\zeta = \frac{1}{q_{1t}}\left[\delta_q - \frac{\xi \beta p_{1t} \phi}{\pi}\right]\psi$$

(16) $$\zeta_j = \frac{\psi}{q_{1t}}\left[\sum_{j=1}^{n} \delta_j\right]$$

(17) $$\eta = \frac{y_t}{q_{1t}}\left[\frac{\xi}{\pi}\right]\psi$$

where $\psi = \exp\left(\gamma + \delta_q \ln p_{1t} + \sum_{j=1}^{n} \delta_j \ln w_{jt} + \xi \ln(\pi)\right)$, $\pi = y_t - \beta p_{1t}\phi$ and

$\phi = q_{1t-1} + \alpha q_{2t-1}$. For the elasticity formulas of other endogeneity-adjusted alternative model specifications, see Appendix.

Table 8 presents endogeneity-adjusted elasticity estimates[7] for the generalized and also the static log-linear demand models. These estimates were computed at the mean values of data. As discussed earlier, in the conventional model all parameter estimates have the expected signs and are statistically significant at the 1% level. When the effects of habit persistence and perceived quality differentials are incorporated, the own price and cross-price elasticity estimates are not statistically different from zero, though they maintain their expected signs. However, income elasticity is statistically significant at the 10% level but the magnitude of this estimate increased from 0.331 to 0.560.

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[7] The result presented here and in the Tables of all the major results reported in this study met the homogeneity restriction imposed by demand functions—Marshallian demand functions are homogeneous of degree zero in all prices and income:

$$\frac{1}{q_{1t}}\left[\delta_q - \frac{\xi\beta\phi p_{1t}}{\pi}\right]\psi + \frac{\psi}{q_{1t}}\left[\sum_{j=1}^{n}\delta_j\right] + \frac{y_t}{q_{1t}}\left[\frac{\xi}{\pi}\right]\psi = 0,$$

which would imply that the sum of all prices and income elasticities of demand must equal zero. This equation was evaluated at the mean values as a non-linear combination of parameter estimates in the unconventional (dynamic) demand framework. Result shows that $F(1, 40) = 1.69$ and Prob. > F = 0.2010, thus we fail to reject the null hypothesis of homogeneity of degree zero in all prices and income at any reasonable significance level. Therefore, the log-linear demand model is homogeneous of degree zero in all prices and income.

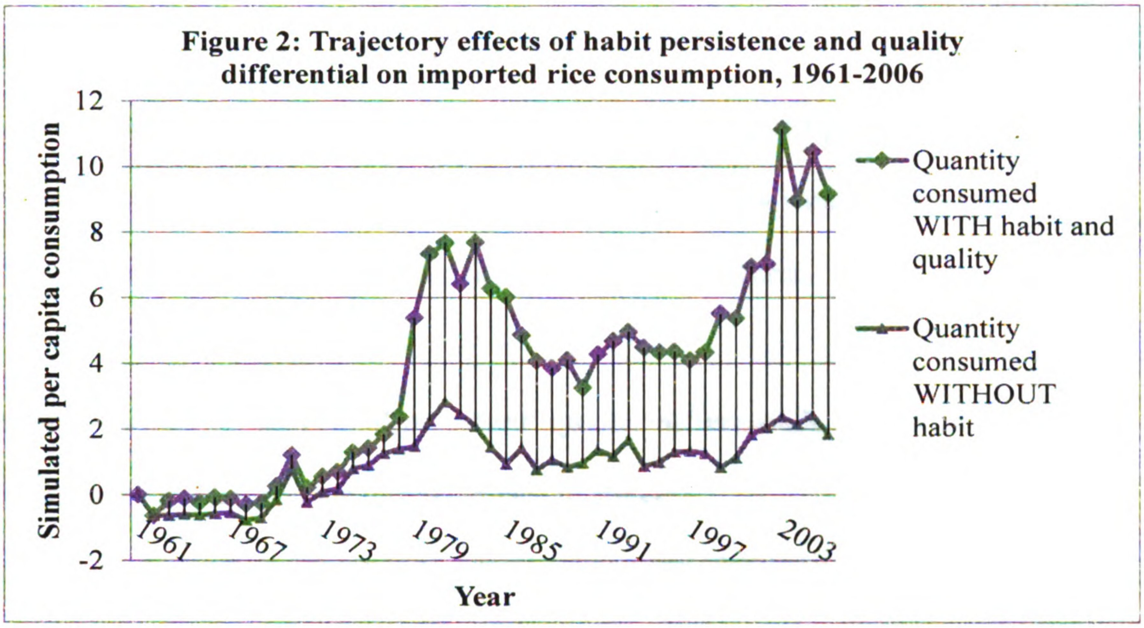
Table 8: Marshallian elasticity estimates from the endogeneity-adjusted conventional and generalized demand models

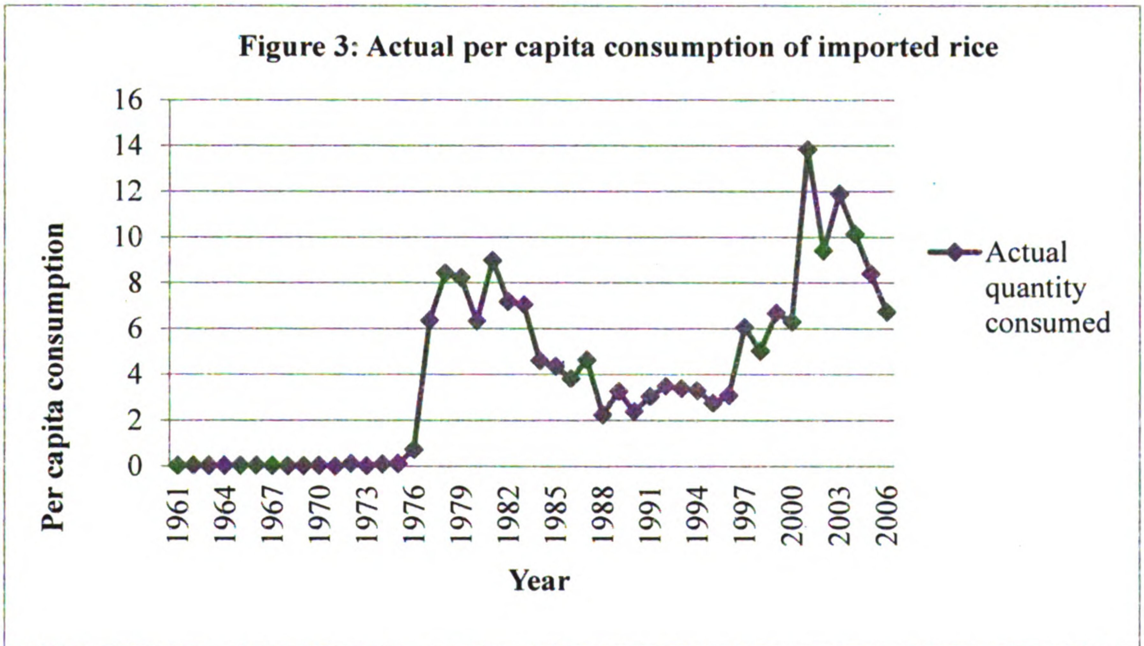
Parameters	Conventional Demand Model (α = 1, β = 0)			Generalized Demand Model	
	Symbol	Coef.	P-value	Coef.	P-value
Own-price	ζ	-0. 231	0.000	-0. 242	0.408
Cross-price	ζ_j	0.079	0.004	0.072	0.144
Income	η	0.331	0.000	0.560	0.063

4.3 Tracing the effects of habit persistence and perceived quality differentials on imported rice consumption pattern over time

Figure 2 presents a graphical representation of the effects of habit persistence and perceived quality differentials on imported rice consumption in Nigeria using simulated data from 1961 to 2006, while Figure 3 presents the consumption pattern of imported rice using actual data for the same time period. The simulated imported rice consumption data were computed recursively. First, one-period lag of the variables and the parameters estimated from the model were used to compute the simulated quantity of imported rice consumption at time t = 1. Next, the simulated values at time t = 2 were computed using the computed values from the first time period. In the third period, computed values from the second period were used with the model's parameter estimates and so on.

In order to trace the joint effects of habit persistence and perceived quality differentials on consumption, α and β were set to their estimated values as shown by the upper line in Figure 2. The lower line in Figure 2 shows the effects of perceived quality differentials on imported rice consumption. This was obtained by setting β = 0 while α was set to its estimated value. It is shown that between 1961 and 1969 the simulated per capita consumption was close to zero while a gradual increase in the importation of foreign rice due to increase in demand was observed in the 1970s. In all, the quantity consumed resulting from the effects of habit persistence and perceived quality differences grew higher than that without habit effects.





What is interesting enough to be highlighted is that the graph of the joint effects of habit persistence and perceived quality differentials in Figure 2 and the graph of the actual per capita consumption of imported rice in Figure 3 follow a similar pattern. This implies that the joint effects of habit persistence and perceived quality differentials truly represent the consumption pattern of imported rice in Nigeria, *ceteris paribus*. Therefore, any omission of such important determining factors that explain preference for imported rice as habit persistence and perceived quality differentials would misrepresent actual determinants of growth of imported rice consumption in Nigeria.

4.4 Implications of the role of *perceived*[8] quality differentials and habit persistence on consumer preference for imported rice in Nigeria

The parameter estimate of perceived quality differentials has an interesting consumer utility implication. For example, the 0.176 estimate implies that any given amount of locally produced rice is viewed to be of such poor quality that its consumption only generates about *one-fifth* as much utility as the same amount of imported rice. Secondly, it suggests a high degree of perceived quality differentials between foreign rice and domestically produced rice and thus one variety cannot be easily substituted.

However, given the important effects of perceived quality differentials on consumption preferences, another important implication can be traced to the role habit persistence plays in explaining the growth of imported rice consumption in Nigeria. In

[8] It is important to emphasize that the empirical notion of quality in this thesis is essentially that of *perceived* quality differences. This raises the question of what forms perception about quality. To the extent to which such perception could be explained by real quality differentials between imported and locally produced rice, or by other factors that impact on perception such as mindset, this measure may reflect something more complex.

other words, while it has been established that rice consumers place high importance to quality, this study shows that consumer habit is also an important contributing factor in explaining consumer preference for foreign rice in Nigeria.

An important implication of habit persistence is that even if locally produced rice is of comparable quality and thus "competitive", its consumption will face considerable inertia due to persistence of consumer habits for imported rice. Another implication of the role of habit persistence in the consumers' preference for imported rice is its effects on the local rice market. In summary, though not equally as important as the effects of quality perception, habit persistence plays a significant role in explaining consumer preference for imported rice in Nigeria.

4.5 Sensitivity of accounting for endogeneity and of habit persistence and perceived quality differentials to alternative model specifications

4.5.1 Sensitivity of controlling for the endogeneity of local rice consumption to alternative model specifications

The purpose of this section is to discuss the effects of controlling for endogeneity on estimation results and its sensitivity to alternative model specifications. To do this, estimations with and without controlling for endogeneity were done. As clearly shown in the upper section of Table 9, though habit and perceived quality differential effects are statistically significant, quality differential has a negative effect on imported rice consumption in all the model specifications. Indeed, this makes no economic sense because it contradicts *a priori* expectations. This is because it violates equation (3) which would imply that local rice consumption generates negative utility.

Another counter-intuitive implication of a negative perceived quality effect is that the demand for imported rice will be positively related to the demand for local rice. In other words, an increase in the consumption of local rice will also mean an increase in the consumption of imported rice, *ceteris paribus*.

The lower section of Table 9 presents the results of well–behaved generalized demand models. What quickly stands out from the Table is the switch in sign of the quality parameter estimate in all the demand models. Notice that except in the AI model own-price, cross price and income effects now have the correct signs for a normal good in addition to positive quality effects consistent with demand theory. All parameter estimates are consistent with *a priori* expectation. In the log-linear model, for example, the magnitude of quality effects (α) changed from -0.231 to 0.176, own-price (δ_q) from 1.726 to -0.243, and cross-price (δ_j) from -0.313 to 0.077.

Moreover, estimation results were sensitive to alternative instrumental variable choice. For example, use of levels, squares and cross products of the model exogenous variables as instruments produced results that were inconsistent with demand theory due to over parameterization and extremely high explanatory power of the first stage instrumental variable regression.

4.5.2 *Sensitivity of habit persistence and perceived quality differentials to alternative model specifications*

This section presents the sensitivity of perceived quality differentials (α) and habit persistence (β) to alternative model specifications. As can be seen from Table 10, the estimate of perceived quality differentials is roughly 0.10 except in the SLS model where it is 0.43 and is marginally significant below the 5% level in the log-linear specification, and at the 5% level in the SLS model.

Though the perceived quality differential effect is not statistically different from zero in the LES and the AI models, a separate test showed that it is statistically different from one. This is presented in the lower section of Table 10, where it is shown that perceived quality differential is statistically different from one below 1% level in all the model specifications. This is more interesting because, as discussed earlier, it tests the substitutability effects between imported and locally produced rice rather than just testing perceived quality dominance of imported rice. The parameter estimates of habit persistence are statistically different from zero below the 5% level in all the alternative model specifications.

Table 9: Effects of endogeneity on parameter estimates

Parameter		Simple Linear Specification (9)		Linear Expenditure System (10)		Almost Ideal Demand System (11)		Log-Linear Specification (12)	
Endogeneity-unadjusted models, n = 46									
	Symbol	Coef.	P-value	Coef.	P-value	Coef.	P-value	Coef.	P-value
Own-price	δ_q	2.252	0.498	-0.002	0.339	-0.001	0.411	1.726	0.730
Cross-price	δ_j	0.004	0.646	0.999	---	0.013	0.080	-0.313	0.883
Income	ξ	0.009	0.743	---	---	0.018	0.082	1.803	0.629
Habit persistence	β	0.642	0.000	0.714	0.000	0.591	0.000	0.673	0.000
Perceived quality differentials	α	-0.216	0.021	-0.203	0.033	-0.221	0.006	-0.231	0.000
Adj. R-squared		0.765		0.767		0.893		0.889	

Parameters		Simple Linear Specification (9)		Linear Expenditure System (10)		Almost Ideal Demand System (11)		Log-Linear Specification (12)	
Endogeneity-adjusted models, n = 46									
	Symbol	Coef.	P-value	Coef.	P-value	Coef.	P-value	Coef.	P-value
Own-price	δ_q	-2.845	0.451	-0.004	0.081	0.001	0.871	-0.243	0.354
Cross-price	δ_j	0.036	0.037	0.996	---	0.003	0.721	0.077	0.089
Income	ξ	0.079	0.026	---	---	0.004	0.736	0.585	0.001
Habit persistence	β	0.315	0.017	0.725	0.000	0.657	0.000	0.490	0.002
Perceived quality Differentials	α	0.436	0.026	0.089	0.168	0.090	0.334	0.176	0.054
Adj. R-squared		0.770		0.754		0.878		0.887	

---LES-imposed restrictions

Table 10: Sensitivity of habit persistence and perceived quality differentials to the well-behaved alternative model specifications

	$(\alpha = \beta = 0)$								
Parameters		**Simple Linear Specification (9)**		**Linear Expenditure System (10)**		**Almost Ideal Demand System (11)**		**Log-Linear Specification (12)**	
	Symbol	Coef.	P-value	Coef.	P-value	Coef.	P-value	Coef.	P-value
Habit persistence	β	0.315	0.017	0.725	0.000	0.657	0.000	0.491	0.002
Perceived quality differentials	α	0.436	0.026	0.089	0.168	0.090	0.334	0.176	0.054
	$(\alpha = 1, \beta = 0)$								
Parameters		**Simple Linear Specification (9)**		**Linear Expenditure System (10)**		**Almost Ideal Demand System (11)**		**Log-Linear Specification (12)**	
	Symbol	Coef.	P-value	Coef.	P-value	Coef.	P-value	Coef.	P-value
Habit persistence	β	0.315	0.017	0.725	0.000	0.657	0.000	0.491	0.002
Perceived quality differentials	α	0.436	0.000	0.089	0.000	0.090	0.000	0.176	0.000

CHAPTER 5: CONCLUSION AND POLICY IMPLICATIONS

Previous studies have focused on the constraints to local rice production and consumption and the reasons for growth in aggregate rice consumption in Nigeria. However, these studies have ignored an important aspect of rice consumption preference in Nigeria—the role of habit persistence and *perceived* quality differentials in explaining the increase in imported rice consumption relative to domestically produced rice.

Therefore, this research extends previous studies by developing a procedure for understanding, identifying, and estimating the relative contribution of habit persistence and perceived quality differentials in explaining consumer preference for imported rice in Nigeria. The generic model developed in this study can be extended to study the relative importance of habit persistence and perception of quality differences in an entire system of demand equations for both agricultural and non-agricultural quality-differentiated commodities.

Results show that habit persistence and consumers' perception of quality differences are both significant and important in explaining consumer preference for imported rice in Nigeria. The magnitudes of habit persistence and perceived quality differentials were estimated to be 0.491 and 0.176, respectively. Thus, any given amount of locally consumed rice only generates about *one-fifth* as much utility as the same amount of imported rice. The resulting strong preference for imported rice may have resulted from a cultural mindset that foreign products are of higher quality than domestic products, rather than actual quality differences between the products. This is because the model estimated here only measures demand response to perceived quality differences, not to actual differences that can be measured in some objective way.

Because habit persistence also plays an important role in explaining the relative preference for imported rice in Nigeria, it is concluded that policies designed to encourage production of relatively high quality local rice that will help replace imported rice in consumption baskets will face considerable inertia due to the persistence of consumer habits regarding purchase and consumption of imported rice, even if the locally produced rice is of comparable quality. This will require companion policies that will shift consumer-buying away from established, habitual patterns.

In general, the major findings of this study are:

1. Habit persistence and perceived quality differentials both play an important role in explaining consumer preference for imported rice in Nigeria;
2. The strong preference for imported rice may be due to a cultural mindset that foreign products are generally of better quality than domestic products rather than the actual quality differences between them;
3. Consumption of any given amount of local rice generates about *one-fifth* as much utility as the same amount of imported rice;
4. Imported rice in Nigeria is a normal food commodity and is income inelastic;
5. The *importance* of income growth as a partial explanation for the growth of demand for imported rice in Nigeria increases when the effects of perceived quality differentials and habit persistence are included; and
6. Imported rice is a substitute for other competing consumption goods but not a perfect substitute for locally produced rice.

Finally, it is concluded that while it is important to pursue policies that will encourage production of relatively high quality local rice, such policies will face considerable inertia if such issues as effects of perceived quality differences and persistence of habit in purchase and consumption of imported rice are not tackled. Therefore, companion policies designed to shift consumer-buying habits and alter cultural mindset via advertising and promotion programs to benchmark any aggressive quality improvement may be required to overcome this consumption inertia.

APPENDIX

APPENDIX

Elasticity formulas for alternative model specifications in the conventional and generalized demand models

The own-price, cross-price and income elasticity formulas for the generalized models were derived by taking the first derivative of q_{1t} in equations (9) to (12) with respect to p_{1t}, w_t and y_t, respectively, and converted to elasticity by multiplying these by the rations of p_{1t}, w_t and y_t to q_{1t}. A similar approach is taken for the conventional models as discussed below. An exception is that in the conventional log-linear model specification coefficients are elasticity estimates.

I. Conventional model specifications

The elasticity formulas for testing no habit persistence but perceived quality dominance of q_1 are computed by imposing $\alpha = \beta = 0$. However, in the conventional demand models, $\alpha = 1$ and $\beta = 0$. This restriction tests no habit persistence and no perceived quality differentials. Thus, q_t^* (see definition below) is replaced with q_{1t}.

I-1: Simple linear specification (SLS)

The SLS model is generally given as:

$$q_{1t} = \gamma + \beta(q_{1t-1} + \alpha q_{2t-1}) - \alpha q_{2t} + \delta_q p_{1t} + \sum_{j=1}^{n} \delta_j w_{jt} + \xi[y_t - \beta p_{1t}(q_{1t-1} + \alpha q_{2t-1})]$$

For the conventional SLS where the restrictions $\alpha = 1$ and $\beta = 0$ are imposed, we have

$$q_t^* = \gamma + \delta_q p_{1t} + \sum_{j=1}^{n} \delta_j w_{jt} + \xi(y_t), \quad \text{where } q_t^* = q_{1t} + q_{2t}$$

(i) Own-price elasticity

$$\frac{\partial q_t^*}{\partial p_{1t}}\frac{p_{1t}}{q_t^*} = \zeta = \frac{p_{1t}}{q_t^*}\delta_q,$$

(ii) Cross-price elasticity

$$\frac{\partial q_t^*}{\partial w_{1t}}\frac{w_{1t}}{q_t^*} = \zeta_j = \frac{1}{q_t^*}\sum_{j=1}^{n}\delta_j w_{jt}$$

(iii) Income elasticity

$$\frac{\partial q_t^*}{\partial y_t}\frac{y_t}{q_t^*} = \eta = \frac{y_t}{q_t^*}\xi$$

I-2: Linear expenditure system (LES)

The LES model is given as:

$$q_{1t} = \gamma_q + \beta(q_{1t-1} + \alpha q_{2t-1}) - \alpha q_{2t} + \frac{\delta}{p_{1t}}\left[y_t - \beta p_{1t}(q_{1t-1} + \alpha q_{2t-1}) - \gamma_q p_{1t} - \sum_{j=1}^{n}\gamma_j w_{jt}\right]$$

Again, the conventional LES model is:

$$q_t^* = \gamma_q + \frac{\delta}{p_{1t}}\left[y_t - \gamma_q p_{1t} - \sum_{j=1}^{n}\gamma_j w_{jt}\right]$$

Thus,

(i) Own-price elasticity

$$\frac{\partial q_t^*}{\partial p_{1t}}\frac{p_{1t}}{q_t^*} = \zeta = -\frac{\delta}{p_{1t}q_t^*}\left(y_t - \sum_{j=1}^{n}\gamma_j w_{jt}\right)$$

(ii) Cross-price elasticity

$$\frac{\partial q_t^*}{\partial w_{1t}}\frac{w_{1t}}{q_t^*} = \zeta_j = -\frac{\delta}{p_{1t}q_t^*}\sum_{j=1}^{n}\gamma_j w_{jt}$$

(iii) Income elasticity

$$\frac{\partial q_t^*}{\partial y_t}\frac{y_t}{q_t^*} = \eta = \frac{y_t}{p_{1t}q_t^*}\delta$$

I-3: Almost ideal demand system (AI)

The AI is given as:

$$q_{1t} = \gamma + \beta(q_{1t-1} + \alpha q_{2t-1}) - \alpha q_{2t} + \left[\frac{y_t - \beta p_{1t}(q_{1t-1} + \alpha q_{2t-1})}{p_{1t}}\right]$$

$$\times\left\{\gamma + \delta_q \ln(p_{1t}) + \sum_{j=1}^{n} \delta_j \ln(w_{jt}) + \xi \ln\left[\frac{y_t - \beta p_{1t}(q_{1t-1} + \alpha q_{2t-1})}{P_t}\right]\right\}$$

Similarly, the conventional AI model is given as:

$$q_t^* = \gamma + \left[\frac{y_t}{p_{1t}}\right] \times \left\{\gamma + \delta_q \ln(p_{1t}) + \sum_{j=1}^{n} \delta_j \ln(w_{jt}) + \xi \ln\left[\frac{y_t}{P_t}\right]\right\}$$

where P_t is the conventional AI price index defined over $(p_{1t}, \mathbf{w_t})$. Notice that the left-hand side of the AI model is not shares but aggregated quantities of q_1 and q_2.

Thus:

(i) Own-price elasticity

$$\frac{\partial q_t^*}{\partial p_{1t}}\frac{p_{1t}}{q_t^*} = \zeta = \frac{y_t}{p_{1t}q_t^*}\left\{\delta_q - \left[\gamma + \delta_q \ln p_{1t} + \sum_{j=1}^{n} \delta_j \ln w_{jt} + \xi \ln(y_t / P_t)\right]\right\}$$

(ii) Cross-price elasticity

$$\frac{\partial q_t^*}{\partial w_{1t}}\frac{w_{1t}}{q_t^*} = \zeta_j = \frac{\delta_j y_t}{p_{1t}q_t^*}$$

(iii) Income elasticity

$$\frac{\partial q_t^*}{\partial y_t}\frac{y_t}{q_t^*} = \eta = \frac{y_t}{p_{1t}q_t^*}\left\{\gamma + \delta_q \ln p_{1t} + \sum_{j=1}^{n} \delta_j \ln w_{jt} + \xi \ln(y_t / P_t) + \xi\right\}$$

I-4: Log-linear specification

For the log-linear specification given as:

$$q_{1t} = \beta(q_{1t-1} + \alpha q_{2t-1}) - \alpha q_{2t}$$

$$+\exp\left(\gamma + \delta_q \ln p_{1t} + \sum_{j=1}^{n} \delta_j \ln w_{jt} + \xi \ln[y_t - \beta p_{1t}(q_{1t-1} + \alpha q_{2t-1})]\right)$$

the resultant conventional demand equation becomes:

$$\ln q_t^* = \gamma + \delta_q \ln p_{1t} + \sum_{j=1}^{n} \delta_j \ln w_{jt} + \xi \ln y_t.$$

Thus, the coefficients of p_{1t}, w_t and y_t are the own-price, ζ, cross-price, ζ_j and income, η elasticity estimates, respectively.

(i) Own-price elasticity

$$\frac{\partial \ln q_t^*}{\partial \ln p_{1t}} = \zeta = \delta_q$$

(ii) Cross-price elasticity

$$\frac{\partial \ln q_t^*}{\partial \ln w_{jt}} = \zeta_j = \delta_j$$

(iii) Income elasticity

$$\frac{\partial \ln q_t^*}{\partial \ln y_t} = \eta = \xi$$

II. Generalized model specifications

II-1: Simple linear specification (SLS)

The SLS model is given as:

$$q_{1t} = \gamma + \beta(q_{1t-1} + \alpha q_{2t-1}) - \alpha q_{2t} + \delta_q p_{1t} + \sum_{j=1}^{n} \delta_j w_{jt} + \xi[y_t - \beta p_{1t}(q_{1t-1} + \alpha q_{2t-1})]$$

(i) Own-price elasticity

$$\frac{\partial q_{1t}}{\partial p_{1t}} \frac{p_{1t}}{q_{1t}} = \zeta = \frac{p_{1t}}{q_{1t}} [\delta_q - \xi\beta\phi], \text{ where } \phi = q_{1t-1} + \alpha q_{2t-1}.$$

(ii) Cross-price elasticity

$$\frac{\partial q_{1t}}{\partial w_{1t}} \frac{w_{1t}}{q_{1t}} = \zeta_j = \frac{w_{1t}}{q_{1t}} \sum_{j=1}^{n} \delta_j$$

(iii) Income elasticity

$$\frac{\partial q_{1t}}{\partial y_t} \frac{y_t}{q_{1t}} = \eta = \frac{y_t}{q_{1t}} \xi$$

Notice that the elasticity formulas for cross-price and income are the same with the conventional SLS. This is because in the generalized SLS, cross-price and income elasticities are not directly affected by the effects of habit and perceived quality differentials. However, the parameter estimates could be different because they are indirectly affected through the dependent variable.

II-2: Linear expenditure system (LES)

The LES model is given as:

$$q_{1t} = \gamma_q + \beta(q_{1t-1} + \alpha q_{2t-1}) - \alpha q_{2t} + \frac{\delta}{p_{1t}} \left[y_t - \beta p_{1t}(q_{1t-1} + \alpha q_{2t-1}) - \gamma_q p_{1t} - \sum_{j=1}^{n} \gamma_j w_{jt} \right]$$

(i) Own-price elasticity

$$\frac{\partial q_{1t}}{\partial p_{1t}}\frac{p_{1t}}{q_{1t}} = \zeta = -\frac{\delta}{p_{1t}q_{1t}}\left(y_t - \sum_{j=1}^{n} \gamma_j w_{jt}\right)$$

(ii) Cross-price elasticity

$$\frac{\partial q_{1t}}{\partial w_{1t}}\frac{w_{1t}}{q_{1t}} = \zeta_j = -\frac{\delta}{p_{1t}q_{1t}}\sum_{j=1}^{n} \gamma_j w_{jt}$$

(iii) Income elasticity

$$\frac{\partial q_{1t}}{\partial y_t}\frac{y_t}{q_{1t}} = \eta = \frac{y_t}{p_{1t}q_{1t}}\delta$$

II-3: Almost ideal demand system (AI)

The AI is given as:

$$q_{1t} = \gamma + \beta(q_{1t-1} + \alpha q_{2t-1}) - \alpha q_{2t} + \left[\frac{y_t - \beta p_{1t}(q_{1t-1} + \alpha q_{2t-1})}{p_{1t}}\right]$$

$$\times\left\{\gamma + \delta_q \ln(p_{1t}) + \sum_{j=1}^{n} \delta_j \ln(w_{jt}) + \xi \ln\left[\frac{y_t - \beta p_{1t}(q_{1t-1} + \alpha q_{2t-1})}{P_t}\right]\right\}$$

(i) Own-price elasticity

$$\frac{\partial q_{1t}}{\partial p_{1t}}\frac{p_{1t}}{q_{1t}} = \zeta = \frac{1}{p_{1t}q_{1t}}\left\{\delta_q y_t - \beta p_{1t}\phi(\delta_q + \xi) - y_t\left[\gamma + \delta_q \ln p_{1t} + \sum_{j=1}^{n} \delta_j \ln w_{jt} + \xi \ln\left(\frac{\pi}{P_t}\right)\right]\right\}$$

where $\pi = y_t - \beta p_{1t}\phi$, $\phi = q_{1t-1} + \alpha q_{2t-1}$

(ii) Cross-price elasticity

$$\frac{\partial q_{1t}}{\partial w_{1t}} \frac{w_{1t}}{q_{1t}} = \zeta_j = \frac{\pi}{p_{1t} q_{1t}} \sum_{j=1}^{n} \delta_j$$

(iii) Income elasticity

$$\frac{\partial q_{1t}}{\partial y_t} \frac{y_t}{q_{1t}} = \eta = \frac{y_t}{p_{1t} q_{1t}} \left\{ \gamma + \delta_q \ln p_{1t} + \sum_{j=1}^{n} \delta_j \ln w_{jt} + \xi \ln\left(\frac{\pi}{P_t}\right) + \xi \right\}$$

II-4: Log-linear specification

This is given as:

$$q_{1t} = \beta(q_{1t-1} + \alpha q_{2t-1}) - \alpha q_{2t}$$

$$+ \exp\left(\gamma + \delta_q \ln p_{1t} + \sum_{j=1}^{n} \delta_j \ln w_{jt} + \xi \ln[y_t - \beta p_{1t}(q_{1t-1} + \alpha q_{2t-1})] \right)$$

Using the differentiation rule: $\frac{\partial e^{f(p_{1t})}}{\partial p_{1t}} = f'(p_{1t}) e^{f(p_{1t})}$

(i) Own-price elasticity

$$\zeta = \frac{1}{q_{1t}} \left[\delta_q - \frac{\xi \beta \phi}{\pi} \right] \psi$$

(ii) Cross-price elasticity

$$\zeta_j = \frac{\psi}{q_{1t}} \left[\sum_{j=1}^{n} \delta_j \right]$$

(iii) Income elasticity

$\eta = \frac{y_t}{q_{1t}} \left[\frac{\xi}{\pi} \right] \psi$, where $\psi = \exp\left(\gamma + \delta_q \ln p_{1t} + \sum_{j=1}^{n} \delta_j \ln w_{jt} + \xi \ln[\pi] \right)$, ϕ and π as defined earlier.

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