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Assessment of Household Demand for Livestock and Other Agricultural Products in Kano Metropolis Nigeria using the Almost Ideal Demand Systems (AIDs) Approach

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Abstract: This study investigated household demand for livestock and other agricultural products in Kano metropolis, Nigeria. Proportionate random sampling technique was used to select respondents from the eight LGAs that make up Kano municipality according to the number of households captured in the Kano state ADP household survey as follows: 57, 27, 49, 50, 40, 81, 30 and 50 households to give a total sample size of 384 households used for the study. Data were obtained mainly through oral interview, direct observation and use of well structured questionnaire administered to products consumers. Data were analyzed using the Almost Ideal Demand System (AIDS) Model. Findings showed that the demand for meat, milk and fish appeared to be highly insensitive to changes in price of cereal - a one percent increase in the price of cereal, increased demand for fish by 0.36% and milk by 0.48% but reduced the price of meat by 0.51%. In general, most of the other cross-price elasticities were found to be less than unity with either negative or positive signs, indicating substitution and complementary relationships (respectively) between items concerned.

Key words: Household · Demand · Livestock · Products · AIDs · Agricultural · Metropolis

INTRODUCTION

The consumption pattern of a household is the combination of qualities, quantities, acts and tendencies characterizing a community or a human group's use of resources for survival, comfort and enjoyment. Of course the type of food and non-food items consumed, vary from region to region. Consumption patterns normally contribute greatly to the social and economic policy of the country. In a developing country like Nigeria, the consumption pattern is skewed towards food i.e. food accounts for a higher proportion of the total expenditure, while in developed countries the opposite is the case [1]. Before the 1970's oil boom, agricultural exports were the backbone of the Nigerian economy with livestock products accounting for a significant share of exports. During this period, the country had a well-developed domestic agricultural market. Nigeria is currently witnessing a drastic decline in agricultural production, especially in livestock and meat sectors of the economy.

The abrupt drop in meat imports, coupled with inadequate domestic supply pushed up price of meat and thus depressed domestic demand. For example, per capita meat consumption that had risen from 12.05 kg in 2011 to 13.8 kg in 2013 dropped to 11.6 kg in 2014. Also meat prices rose by 70percent from 2011 to 2013 resulting in a decline in Nigerian per capita meat consumption from z10.5kilograms of meat per year in 2013 to 9.4 kilograms per year in 1999 [2]. Although the federal government of Nigeria has designed various programs to help stabilize meat prices and consumption, the country is still experiencing meat shortage and price fluctuations till date

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[2]. Meat demand in most African countries is very low at a level of 25g and the demand is even lower especially in the southern and eastern parts of Nigeria where production of animal protein has not been high enough to meet the demand of rapid growth in population [3]. Aromolaran (2004), [4], puts Nigerian's total meat production at 810,000 tonnes for a population of about 170 million resulting in a meat production index of 22g per caput per day. Ray, (1982), [5], noted that the unprecedented population growth that has occurred in the last half of the century has created an additional demand for meat and general food in developing countries. Household demand for meat products such as beef, mutton, pork, chevron and chicken is faced with problems which are mostly due to market prices, consumers taste, credit availability and consumers income.

In determining living standards, income and consumption are the most popular approaches. Income refers to earnings from productive activities and current transfers. Measuring consumption over a week or month provides an indication of a household's consumption habits over a year because it has a smooth flow. In order words it is steady. Income however, tends to vary widely from week to week or month to month. Consumption data are much easier to collect than income data, particularly in agricultural communities or with self-employed persons. Consumption is therefore a better indicator of living standards.

The consumption pattern of a country depicts the aggregate demand of goods and services in the country and in most cases it constitutes about 60 percent of the total GDP of the country. Consumption pattern also depicts the level of welfare and poverty that a nation is experiencing.

Research Methodology

The Almost Ideal Demand System (AIDS) Model: The Almost Ideal Demand System (AIDS) modelling approach is a method for estimating demand systems. In 1980, Deaton and Muellbauer suggested the AIDS model as a particular representation of price-independent generalised logarithmic (PILOG) preferences. As Chalfant *et al*. [6], noted, the AIDS model is consistent with the aggregation of individual preferences. The Linear Approximation of the Almost Ideal Demand System (LA/AIDS) employed in this study was chosen to estimate the parameters of Kano Metropolis household demand system. The LA/AIDS model is flexible, consistent with the aggregation of individual preferences and provides an arbitrary first-order approximation of the demand system that satisfies the axioms of choice exactly [7]. In addition, the LA/AIDS technique is employed in the analysis because of the relative ease of imposition of the theoretical restrictions of homogeneity, Slutsky symmetry and adding-up in the estimation of the Kano demand system.

Following Deaton and Muellbauer (1980), [7], the budgetary share (W) allocated to the i-th commodity in the Almost Ideal Demand System (AIDS) is

$$W_i = \alpha_i + \sum_{j=1}^{n} y_{ij} \ln p_j + \beta_i \ln\left(\frac{x}{p}\right) \quad (1)$$

where wi is budget share of the i-th good; X is total expenditure on all goods; Pj is the price of the j-th good in the group; and P is the price index defined by

$$\ln P = \alpha_i + \Sigma \alpha_I \ln P_i + \frac{1}{2}\sum_{j=1}^{n}\sum_{j=1}^{n} y_{ij} \ln P_i \ln P_j \quad (2)$$

where α_0, α_i, β_i and y_{ij} are parameters to be estimated; and n=1,…, 8.

Deaton and Muellbauer [7], suggest replacing the expression in (2) with a Stone's geometric index defined by

$$\ln P = \sum_{j=1}^{nj=1} w_k \log P_k \quad (3)$$

where w_k is the mean of the budget share in periods t and t -1.

Substituting (3) in (1) gives an expression of budget shares in terms of the Stone geometric index as

$$w_i = \alpha_i + \sum_{i=1}^{n} y_{ij} \ln P_i + \beta_i \ln\left(\frac{x}{p^*}\right) \quad (4)$$

The budget share equation in (4) is referred to in the econometric literature as the linear approximate of the almost ideal demand system (LA/AIDS) because the model yields a system linear in parameters.

To ensure that the LA/AIDS model provides a satisfactory approximation of the true demand system that is consistent with the underlying utility maximisation it is important to impose the basic demand restrictions of adding-up, homogeneity and symmetry. The demand restrictions are expressed in terms of the model coefficients as follows:

$$\sum_{i=1}^{n}\alpha_I = 1; \quad \sum_{i=1}^{n}y_{ij} = 0; \quad \sum_{i=1}^{n}\beta_i = 0 \quad \text{(Adding-up)} \tag{5}$$

$$\sum_{i=1}^{n}y_{ij} = 0; \quad \text{(Homogeneity)} \tag{6}$$

$$y_{ij} = y_{ji} \quad \text{(Symmetry)} \tag{7}$$

The adding-up restriction ensures that the sum of individual expenditure is equal to total expenditure. The homogeneity restriction ensures that the demand equation is homogenous of degree zero in incomes and prices. The Slutsky symmetry assures consistency of choice on the part of the consumer. Assume that the group prices are fixed, the Marshallian or uncompensated measures of own-price and cross-price elasticities are computed from the estimated parameters of the LA/AIDS model in (4), following [8], as

$$\varepsilon_{ii} = 1 + \frac{y_{ij}}{w_i} - \beta_i \tag{8}$$

$$\varepsilon_{ii} = \frac{y_{ij}}{w_i} - \beta_i \left(\frac{W_j}{W_i}\right) \tag{9}$$

where Σ denotes the uncompensated price elasticity measure.

The expenditure elasticity measure is given by:

$$\eta_{ii} = 1 + \left(\frac{\beta_i}{W_i}\right) \tag{10}$$

where the variables are as defined above.

Where Wi is the average expenditures share, βi and yij are parameter estimates. The own – price elasticity measures the change in quantity demanded given a one percent change in the own price of the product. Normal goods are expected to have negative own price elasticity. Relation between foods as shown in the cross – price elasticity shows the competitive or complementary relations amongst products. Substitute product can be indicated by positive cross – price elasticity, while negative cross price elasticity represented complementary products.

Expenditure elasticity measures the expected change in quantity demanded of a specific product, as the expenditure on livestock product is increased. If the calculated expenditure elasticity is positive and greater than one, the product is classified as a luxury product. A positive expenditure elasticity ranging between zero and one indicates a normal product, whereas negative expenditure elasticity is indicative of an inferior product.

An interest in this study was to assess the effect of quality and safety perceptions on the demand for dairy products and meat. Inclusion of such a demand shifter in the AIDS model was considered useful by Alston [9]. Piggott and Marsh (2004), [10], accommodated three indices accounting for beef safety, pork safety and poultry safety. In this study, perception on quality and safety as reflected in the preference rankings for different dairy products and meat according to their various attributes which was regarded as a household characteristic that affected purchase and consumption behaviour like any other demographic characteristic was adopted.

Estimation of demand elasticities

The LA/AIDS model was estimated using the iterative seemingly unrelated regression procedure in STATA (Version 9.0) econometric package [11], which converges to the maximum likelihood estimator. Because food and non-food expenditure shares sum to one, a demand system composed of 13 individual expenditure share equations would be singular. Therefore, one of the equations must be omitted to estimate the equations as a system. The other foods equation was chosen for deletion in this study. The final model estimated consisted of 12 budget share equations of cereal, Legumes, vegetables, fruit, edible oil, spices, sugar, tea, eggs, meat, fish, milk and other foods. The model was estimated, with restrictions in 3 to 6. imposed and using 377 effective observations (13 equations and 29 observations). The system approach was adopted in preference to single equation estimation because it accounted for the relationship between different goods and accommodated the presence of contemporaneous correlation between error terms of the different equations within the system. The systems approach permits the imposition of demand theory restrictions and provides a more-efficient parameter estimates than single OLS estimation of each equation [12]. The usefulness of the system approach is that it yields maximum likelihood estimates that are invariant to the equation deleted in the final model estimation [13].

The Linear Approximate AIDS (LA/AIDS) of [7], that uses Stone (expenditure) share weighted price instead of the nonlinear general price index of full AIDS model was

used to estimate the demand system. The price and expenditure elasticities were derived from parameter estimates of the model using the following formulae:

$$\text{Own-price elasticity} = -1 + \frac{\alpha i1}{wi} - Bi \quad (11)$$

Where
$\alpha i1$ = Expenditure coefficient of the ith commodity
wi = Geometric mean of the budget share (dependent variable)
wj = Geometric mean of price of the other meat types
Bi = Coefficient of household expenditure,

$$\text{Cross-price elasticities} = \frac{\alpha ij}{wi} - Bi\frac{wj}{wi} \quad (12)$$

where
aij = Expenditure coefficient of ijth commodity,
wi = Geometric mean of the budget share (dependent variable),
wj = Geometric mean of price of each of the other food item and
Bi = Coefficient of household expenditure

The price and expenditure elasticities wee derived from parameter estimates of the model using the following formulate:

$$\text{Expenditure elasticity} = 1 + \frac{Bi}{Wi} \quad (13)$$

where,
Bi = Coefficient of household expenditure
wj = Geometric mean of price of each of the other food item

RESULT AND DISCUSSION

Total Household Expenditure on Livestock and Other Agricultural Products: In order to put the demand (expenditure) for animal products within the context of overall household budget or expenditure, respondents reported actual or estimated expenditure on all livestock agricultural products during the 30 days prior to the survey. The result of the study showed that food expenditure accounted for 58% of overall household expenditure for the entire sample. For low, medium and high income household groups, shares of food expenditure in total household expenditure were respectively, 93.3%, 69.7% and 23.6%.

The sample average can be compared with the national household expenditure report 2012 which showed that the total expenditure on food and non-food for 2009/2010 was N24, 253, 670, 127, 758.80 (Twenty-four trillion, two hundred and fifty-three billion, six hundred and seventy million, one hundred and twenty-seven thousand, seven hundred and fifty-eight Naira, Eighty Kobo). About 64.68% of the total household expenditure in 2009/2010 was spent on food, with the balance of about 35.32% spent on non-food items. Tubers and plantain were responsible for the largest proportion of household expenditure representing 14.6 percent of total household expenditure. This group was followed by rent, vegetables, other cereals and beans & peas each taking up 12.1, 9.9, 6.7 and 6.2%, respectively, of the total household consumption.

Further analysis of food expenditure by households in 2009/2010 revealed that total cereals (adding maize, rice and other cereals categories) and tubers and plantain accounted for a combined 46.7% of total household expenditure on food and 30.2% of total household expenditure. Household expenditure on non-food items were directed as aforementioned mostly at rent, clothing & footwear and 'other services' (which included information technology and communication equipment as well as things like insurance, domestic help and so on) and fuel and light, each representing 34.3%, 13.5%, 12.7% and 12.5%, respectively of total nonfood expenditure and 12.1%, 4.79%, 4.5% and 4.43%, of total household expenditure, respectively.

Aromolaran [4], studied intra-household redistribution of income and calories consumption in south western Nigeria. His study investigated how per capita calorie in low income households of rural south western Nigeria responded to changes in total household income and women's share of household income. The results showed that calorie income elasticity was small and close to zero implying that income policies might not be the most effective way to achieve substantial improvements in calorie consumption. Moreover, increases in women's share of household income were likely to result in marginal declines in per capita food calorie intake. This implied that income redistribution from men to women would not increase per capita food energy intake in these households.

Parameter Estimate of the LA/AIDS Model for Food and Non-Food Items: The linear approximation of almost ideal demand systems (LA/AIDS) in the model was estimated using the iterative seemingly unrelated regression procedure in STATA (Version 9.0) econometric package,

which converges to the maximum likelihood estimator. Because food and non-food expenditure shares sum to one, a demand system composed of 13 individual expenditure share equations would be singular. Therefore, one of the equations must be omitted to estimate the equations as a system. The other food equation was chosen for deletion in this study. The final model estimated consisted of 12 budget share equations of cereal, legumes, vegetables, fruit, edible oil, spices, sugar, tea, eggs, meat, fish, milk and other foods. The model was estimated, with restrictions in 5 to 7 imposed and using 377 effective observations (13 equations and 29 observations). The system approach was adopted in preference to single equation estimation because it accounted for the relationship between different goods and accommodated the presence of contemporaneous correlation among error terms of the different equations within the system. The systems approach permits the imposition of demand theory restrictions and provides a more-efficient parameter estimates than single OLS estimation of each equation. The usefulness of the system approach is that it yields maximum likelihood estimates that are invariant to the equation deleted in the final model estimation.

The estimated coefficients of the 12 equation system of food and non-food expenditure shares are presented in Table 1. Nearly half of the estimated parameters were significant at the 1% level. The parameters of the omitted equation (other foods equation) were derived using the adding up restrictions. The diagnostic statistics of the goodness-of-fit of the estimated equations are presented in Table 2. The estimated R^2-value was at 0.95. The R^2-value indicated that the model explained well the budget shares of food products in the household budget. Monotonicity condition is satisfied if the predicted budget shares are all between 0 and 1. All the predicted budget shares were between 0 and 1, implying that the monotonicity condition was satisfied. This ensured that the predicted quantities consumed were positive.

Table 1: Parameter Estimate of the LA/AIDS Model for livestock and agricultural products

	Cereal	Legumes	Vegetable	Fruit	Oil	Spices	Sugar	Tea	Eggs	Meat	Fish	Milk
Constant	0.0013	0.0005	0.0000	0.0001	-0.0002	0.0000	-0.0057	-0.0057	0.0003	0.0001	0.0006	0.0001
	(0.0082)	(0.0017)	(0.0012)	(0.0011)	(0.0013)	(0.0008)	(0.0012)	(0.0009)	(0.0009)	(0.0038)	(0.0087)	(0.0013)
Cereal	0.3058											
	(0.0105)											
Legumes	0.7425	0.0308										
	(0.2543)	(0.0105)										
Vegetables	-0.2932	0.4492										
	(0.3640)	(0.0701)										
Fruit	0.7281	0.0069	0.2660									
	(0.3947)	(0.0805)	(0.0551)									
Edible oil	0.5148	0.2171	0.1885	0.0534								
	(0.3193)	(0.0640)	(0.0448)	(0.0421)								
Spices	0.9185	0.0906	0.3731	0.1551	0.1237							
	(0.5010)	(0.1038)	(0.0708)	(0.0669)	(0.0832)							
Sugar	0.2992	0.0944	-1860	-0.0915	0.4601	0.3035						
	(0.3599)	(0.0729)	(0.0507)	(0.0472)	(0.0535)	(0.0351)						
Tea	0.9735	0.2431	0.2575	0.1292	-0.1893	0.2148	0.2745					
	(0.4909)	(0.0993)	(0.0694)	(0.0646)	(0.0798	(0.0490)	(0.0701)					
Egg	1.0363	0.1139	0.0314	0.1789	0.0772	-0.0564	0.0752	0.1714				
	(0.4467)	(0.0911)	(0.0645)	(0.0585)	(0.0732	0.0458)	(0.0651)	(0.0467)				
Meat	-0.0896	0.0711	0.0397	0.0044	0.1140	0.0129	-0.0156	-0.0215	0.0159			
	(0.1127)	(0.0226	(0.0160)	(0.0148)	(0.0174	0.0115)	(-0.0163)	(0.0119)	(0.0131)			
Fish	0.4163	0.0772	0.0893	0.2485	0.0475	-0.0732	0.0257	0.0078	0.0994	0.7003		
	(0.3343)	(0.0679)	(0.0478)	(0.0422)	(0.0545)	(0.0339)	(0.0485)	(0.0354)	(0.0385)	(0.1507)		
Milk	0.6110	0.1741	0.0045	-0.0838	0.3003	0.0019	0.0652	-0.0723	0.2167	0.4210	0.1373	
	(0.3186)	(0.0643)	(0.0459)	(0.0419)	(0.0498)	(0.0326)	(0.0463)	(0.0337)	(0.0353)	(0.1466)	(0.0494)	
R	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
F-Value	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95

Figures in the parenthesis are standard errors

Source: Field survey

Estimation of Demand Elasticities: LA/AIDS model was used to calculate the elasticities and coefficients of agricultural products consumed

Table 2: Estimated own and cross price elasticities of different food items from LA/AIDS model

	CER	LEG	VEG	FRUIT	OIL	SPICE	SUGAR	TEA	EGG	MEAT	FISH	MILK
CER	**0.868**	0.443	-70.6	0.143	-0.764	-0.576	0.481	0.835	0.293	0.982	0.368	0.824
LEG	0.092	**0.563**	-0.38	0.632	-0.227	0.383	0.506	0.171	0.116	0.294	0.669	0.542
VEG	-0.18	-0.605	**-0.66**	0.447	-0.112	0.961	0.225	0.259	0.133	-0.16	-0.02	0.296
FRUIT	0.742	-0.632	0.654	**-66.79**	0.9789	0.215	10.29	-0.891	0.225	0.391	0.613	34.61
OIL	-0.38	0.52	-0.11	0.979	**-0.343**	0.485	0.531	0.782	-0.049	-0.58	0.89	0.879
SPICE	-141	0.282	-0.85	0.522	-0.457	**-0.046**	0.872	0.923	0.685	-0.37	-0.028	0.196
SUGAR	0.348	0.506	0.642	0.293	0.5853	0.872	**-0.165**	0.188	0.891	0.649	-0.022	0.496
TEA	0.284	0.171	-0.59	0.925	0.8782	0.923	-0.772	**-0.478**	-0.613	0.816	0.351	-0.01
EGG	0.523	0.164	0.324	-0.251	-0.21	0.685	-0.969	0.222	**-345.8**	0.302	0.454	0.572
MEAT	-0.51	0.294	-0.35	0.904	-0.824	0.728	-0.649	0.816	0.31	**-55.6**	0.743	0.529
FISH	0.36	-0.669	0.114	-0.256	0.0299	0.028	-0.223	0.675	0.265	-0.96	**-656.1**	8.053
MILK	0.482	0.542	0.637	0.609	81.988	9.575	0.496	-0.727	-0.572	-0.45	0.053	**-22.5**

Table 2 presented the estimated price elasticity of food group items in Kano Metropolis. The bold figures in the diagonal are own price elasticities which measure the change in demand for a product in response to relative price changes of that product. As expected, other things remaining the same, price rise for a particular item is associated with decrease in demand for that item. The elasticity estimates were calculated at the mean budget shares observed in the sample. The demands for egg, meat, fish, milk and fruit were highly price elastic.

The demand for cereal, vegetable and legumes appeared to be inelastic with respect to their own price. This meant that, other things being equal, the consumption changes were not in direct proportion to the price changes. Normally cereals and vegetables are expected to be inelastic. Equally the demand for edible oil, spices, sugar and tea were highly price inelastic.

The cross- price elasticity of an item measures the change in demand for that item in response to relative price changes of another product. As expected, other things remaining the same, price rise for a particular item is associated with decrease or increase in demand for other item (s) in varying degrees.

The demand for meat, milk and fish appeared to be highly insensitive to changes in prices of cereal a one percent increase in the price of cereal, increased demand for fish by 0.36% and demand for milk by 0.48%, respectively. While the demand for meat appeared to be highly sensitive to the change in prices of cereal, a one percent increase in the price of cereals decreased demand for meat by 0.51%. Thus, given the low average income in Kano Metropolis households and the budget constraint, a rise in the staple price induced a decrease in the demand for protein commodities. In general, most of the other cross- price elasticities were found to be less than unity with either negative or positive signs, indicating substitution and complementary relationships (respectively) between items concerned. In a few cases, the values were close to zero implying no demand relationship between the two products.

These results could be compared with findings from other studies in Nigeria and elsewhere in the developing countries. Oloyede [14], studied food demand among Nigerian households. Since food calorie has been found to have a strong empirical linkage with both human health and productivity, they therefore, determined the probable influence of price and income changes on the availability of nutrients to the Nigerian households. Their findings showed that guinea corn was the food that would have the greatest implication for the nutrient status of low income status: while millet, guinea corn, maize, rice, beans and maize were the major food items for the household whose heads earned average and above incomes. Moreover, Adejobi (2004), [15], studied the demand structure of rural household food pattern in relationship with poverty. In his study, the analysis of food demand revealed that 72.0% of household expenditure was on food. Out of this, 56.0% was cereals, while 22.0%, 7.0%, 5.0%, 5.0%, 4.0% and 1.0%, respectively, were on animal protein, fruits, vegetables, legumes, roots and tubers, fats and oils seed items.

Hossain and Bose [16], estimated the income elasticity of demand for milk in Bangladesh in 1995–96 as 1.62 compared to 1.19 for meat and eggs and these were projected to be 0.65 and 0.63, respectively, in 2020. Based on national level aggregate data for 64 developing countries for the period 1970–95, Delgado and Courbois (1998), [17], found expenditure elasticity of 1.36 for milk, 0.65 and 0.27, respectively, for beef and chicken meat and 1.10 for pork and mutton. In a more recent study in China, Sener. (1977) and Ma and Rae (2003), [18], found expenditure elasticity for ruminant meat ranging from 1.10 for low income urban group to 0.71 for high income urban group, which are closer to the estimates in Kano Metropolis.

Delgado and Courbois [[17], found own price elasticity of –0.86 for milk, which was close to the estimate for milk in this study, but they found –0.14 to –0.39 for different types of meat, which were quite the opposite compared to the estimates in this study. However, differences in the nature of sample units and data—national aggregate in Delgado–Courbois case and individual urban households in the current study—and the difference in the reference period and location (in some countries meat features more importantly in the diet than others) may partly explain these differences in the estimates.

Taljaard and VanSchalkwyk, [19], used the Linear Approximate of Almost Ideal Demand System (LA/AIDS) model to estimate the demand for meat in South Africa. The LA/AIDS was first employed to analyze the demand relations for meat which comprises of beef, chicken, pork and mutton from 1970-2000. Two test for weak separability including an F and likely hood ratio version, failed to reject the null hypothesis of weak separability, confirming that four meat products are separable and should be modeled together. Hausman exogeneity test show that, the expensive term in the South African meat demand model, is exogenous. As a result, a Restricted Seemingly Unrelated Regression (RSUR) was used to estimate the model, after the estimated parameters were used to estimate compensated, uncompensated and e

CONCLUSION

Demand for food and non-food items in Kano Metropolis follows patterns familiar to Nigeria and many developing countries in that it employs informal markets, has an income – sensitive character and varies by location (urban and rural). Its characteristics with reference to food quality and safety and familiar from studies of developed countries as well, in that consumers seek out, can identify and are willing to pay for quality and safety expenditure elasticities.

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