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Estimation of Food Demand Patterns in South Africa Based on a Survey of Households

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South Africa is emerging as a major player in the world agricultural products market. This study investigates aggregate food demand patterns in South Africa using a linear approximate almost ideal demand system (LA/AIDS) modeling framework. Data from a 1993 integrated national household survey are employed in the analysis. Empirical results show that demand for meat and fish, grains, dairy products, fruits, vegetables, and other foods are generally price elastic. The expenditure elasticities imply that meat and fish and grains are luxury products, whereas dairy products, fruits, vegetables, and other foods are necessities in the household diet. The results also indicate that if income of households increases food expenditure on meat and fish and grains would increase, whereas that on dairy products, fruits, vegetables, and other foods would decrease. Race, age, and gender of household head, urbanization, and family size affect food demand in South Africa.

Key Words: household food demand, LA/AIDS model, South Africa

JEL Classifications: C21, D12

South Africa is an upper-middle-income country. Despite its wealth, the experience of the majority of South African households is either one of outright poverty or of continued vulnerability to becoming poor (May). Over the years, South Africa's agricultural policy has been aimed at achieving self-sufficiency in food production. Despite the success made by the government in achieving this goal, there are still large inequities, inefficient food distribution networks, and high levels of malnutrition in South Africa (van Zyl and Kirsten). Since the return to democracy in 1994, South Africa has undergone a dramatic economic, social, and political transition. The government of South Africa has implemented market-oriented food policies and has liberalized trade. The importance of reducing poverty and inequality has been on the forefront of policies implemented by the new government. The global trade agreements, to which South Africa is a signatory, have led to a reduction in tariffs and nontariff barriers, and this has spurred growth in trade in agricultural products. These reforms have resulted in structural shifts in many parts of the South African economy, and this is likely to impact on food consumption. Given the government's gradual and continuing progression toward a liberalized economy, there is a need to characterize household demand for food.

Although there has been much empirical work on the impact or potential impact of government policy on agricultural production and

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productivity, there have been few estimates of own-price and expenditure elasticities for broad food groups in South Africa. These analyses include those of Bowmaker and Nieuwoudt; Hancock; Hancock, Nieuwoudt, and Lyne; and Poonyth, Hassan, and Kirsten. However, these studies have employed the traditional demand models without examining the impact of socioeconomic and demographic factors on household food demand. Further, these studies do not attempt to quantify a food demand model that satisfies the axioms of choice exactly.

This study builds on the growing empirical literature on food demand in South Africa by incorporating household socioeconomic and demographic characteristics into a linear approximate almost ideal demand system (LA/AIDS) modeling framework. This approach is useful as it provides an arbitrary first-order approximation to any demand system and satisfies the axioms of choice (Hayes, Wahl, and Williams). Further, the LA/AIDS model permits the exploration of interdependence among products (Byrne, Capps, and Saha), thereby allowing consistent aggregation of microlevel demands up to a market demand function. The primary focus of this analysis is to examine the factors influencing South African household food demand. The analysis is based on a nationwide household survey conducted in South Africa in 1993. Although limited to the period before major reforms, this study will provide a glimpse into nationwide food demand patterns in South Africa.

The paper is organized as follows. The next section introduces the methodology and discusses the estimation problems, followed by a description of the data employed in the analysis. Next, the empirical results are presented. The final section contains a brief summary and concluding remarks.

Model

For the purposes of this paper, an LA/AIDS model is employed based on Deaton and Muellbauer's methodology. The derivation of the LA/AIDS model starts with the specification of a cost function (or expenditure function) consistent with the Price Independent Generalized Logarithmic (PILOG) preferences. The LA/AIDS model is given by

$$(1) \qquad w_i = \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_i \log\left(\frac{x}{P}\right),$$

where w_i is the budget share of good i, p_j is the price of good j, x is total expenditure within the system, and P is a price index approximated by a weighted (geometric) price index, following Stone, as

$$(2) \qquad \log P = \sum_i^n w_i \log p_i,$$

where the variables are as defined above.

For the LA/AIDS model to be consistent with the theory of consumer demand, the conditions of adding-up, homogeneity, and symmetry must be satisfied. The adding-up conditions imposed on the estimated model are given by

$$(3a) \qquad \sum_i^n \alpha_i = 1 \qquad \sum_i^n \gamma_{ij} = 0 \qquad \sum_i^n \beta_i = 0,$$

whereas homogeneity requires that

$$(3b) \qquad \sum_j^n \gamma_{ij} = 0.$$

In addition, symmetry requires that

$$(3c) \qquad \gamma_{ij} = \gamma_{ji}.$$

Next, we introduce socioeconomic and demographic factors into the model. Following Ray, socioeconomic and demographic variables are characterized as intercept shifters of the linear demand function. If the socioeconomic and demographic factors are denoted by z, the "socio-demographically flexible" LA/AIDS can be written as

$$(4) \qquad w_i = \alpha_0 + \sum_j \gamma_{ij} \log p_j + \beta_i \log\left(\frac{x}{P}\right) + \delta z,$$

where the other variables and parameters are as defined above.

The problems associated with calculating elasticities from LA/AIDS models is fully discussed in Alston, Foster, and Green and Buse and therefore not discussed here. In the context of the LA/AIDS modeling framework, the expenditure elasticity is derived, following Chalfant, as

$$(5) \qquad E_i = 1 + \frac{\beta_i}{w_i}.$$

The Marshallian (or uncompensated) elasticity of good i with respect to the price of good j is given by

$$(6) \qquad e_{ij} = \frac{\gamma_{ij} - \beta_i w_j}{w_i} - \delta_{ij}.$$

The Hicksian (or compensated) elasticity of good i with respect to the price of good j is given by

$$(7) \qquad e_{ij} = \frac{\gamma_{ij}}{w_i} + w_j - \delta_{ij},$$

where δ_{ij} is the Kronecker delta and where δ_{ij} is 1 for own-price elasticity and 0 for cross-price elasticity.

Data Sources and Description

The data used in this study are part of a nationwide survey, the Project for Statistics on Living Standards and Development (PSLSD), conducted by the Southern Africa Labour and Development Research Unit (SALDRU) at the School of Economics, University of Cape Town, South Africa (SALDRU). The survey was carried out in the 9 months prior to the country's first democratic election in April 1994. Out of 9,000 households surveyed, a sample of 4,353 observations was used in the final analysis. It is important to note here that these observations are still representative of the total South African population distribution (see Statistics South Africa).

Seventy-two percent of the respondents were of black origin, 17% were white, and the remaining 11% were of other ethnic origin. Forty-four percent of households interviewed lived in urban areas, 24% in peri-urban areas, and 32% of respondents lived in rural areas. Average monthly income of household head was R1282.60. The average age of household head was 47 years, whereas the average household size was 4.47. Most household heads interviewed were men (71%). The average number of years of education of respondents was 5.33, implying that household heads generally have a primary level of education.

The budget shares employed in the study are based on broad food groups of meat and fish, grains, dairy products, fruits, vegetables, and other foods. The explanatory variables included in the model are household expenditure and price data on food items and variables capturing household sociodemographic characteristics (age, gender, race and education of household head, family size, and urbanization). The provincial effects on food consumption are modeled by incorporating discrete 0–1 variables for the provinces into the model.

There are difficulties associated with estimating demand systems with missing prices. This study adopts the approach proposed by Cox and Wohlgenant whereby the cluster price of the food item is substituted for the missing price. This implies that nonconsuming households or households with no price for a food item are assumed to face average commodity price for that cluster. Another problem relates to endogeneity of prices in complete demand systems. In developing countries, most governments regulate food prices. In South Africa, as van Zyl and Kirsten note, the agricultural marketing system and specifically the marketing of staple foods are generally characterized by statutory controls and one-channel marketing. The marketing boards, with the approval of the Ministry of Agriculture, set the producer and selling prices of staple foods, for example maize and wheat. Therefore, domestic food prices are assumed to be exogenous in the demand system.

Results

The LA/AIDS model was estimated by the seemingly unrelated regression technique in the SHAZAM version 8.0 econometric pack-

Table 1. Parameter Estimates of LA/AIDS Model for South Africa

	Budget Share of					
Explanatory Variable	MF Estimate	GRA Estimate	DP Estimate	FRU Estimate	VEG Estimate	OF Estimate
Constant	0.482	0.300	0.281	0.267	0.364	0.361
	(5.97)[a]	(4.01)	(3.90)	(3.76)	(5.06)	(5.05)
Price of meat and fish	−0.087	0.134	0.005	−0.044	−0.019	−0.055
	(−3.75)	(8.45)	(0.63)	(−5.06)	(−2.03)	(−1.50)
Price of grains	0.134	−0.178	0.022	0.006	0.030	0.100
	(8.45)	(−8.50)	(3.12)	(0.61)	(3.08)	(3.87)
Price of dairy products	0.005	0.022	−0.021	−0.011	0.001	−0.038
	(0.63)	(3.12)	(−4.58)	(−2.79)	(0.23)	(−2.31)
Price of fruits	−0.044	0.006	−0.011	0.038	0.001	−0.020
	(−5.06)	(0.61)	(−2.79)	(4.77)	(0.11)	(−1.31)
Price of vegetables	−0.019	0.030	0.001	0.001	−0.042	−0.024
	(−2.03)	(3.08)	(0.23)	(0.11)	(−4.27)	(−1.56)
Price of other foods	−0.055	0.100	−0.038	−0.020	−0.024	0.030
	(−1.50)	(3.87)	(−2.31)	(−1.31)	(−1.56)	(2.20)
Expenditure	0.009	0.067	−0.009	−0.015	−0.012	−0.041
	(0.80)	(7.83)	(−1.98)	(−3.44)	(−2.41)	(−8.35)
Socioeconomic and demographic characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.26	0.54	0.24	0.16	0.09	0.09

Notes: LA/AIDS is linear approximate almost ideal demand system; MF is meat and fish, GRA is grains, DP is dairy products, FRU is fruits, VEG is vegetables, and OF is other foods.

[a] Values in parentheses are *t*-ratios.

age. Since the system is expressed in budget-share form (summing to unity), the estimation requires deleting one equation. Barten showed that maximum likelihood estimates are invariant to which equation is dropped. In this study, the other foods equation was dropped. Table 1 reports the estimated regression coefficients of the model. Most of the parameters are significant at a 10% level. The estimated R^2 (goodness-of-fit) measures range from 0.09 for the vegetables and other foods equations to 0.54 for the grains equation. Log-likelihood ratio test was performed to test the joint null hypothesis that all slope coefficients of the socioeconomic and demographic variables are equal to zero (Theil). For the food demand system, the test statistic was 2440.68, which is much greater than the critical value of 43.77 at a 5% significance level and 30 df. Based on this result, the null hypotheses of no socioeconomic and demographic effects on food consumption is rejected at a 5% level, demonstrating the importance of these factors in influencing South African household food demand. Hence the LA/AIDS model with socioeconomic and demographic factors is accepted as the preferred model for discussion.

Table 2 reports the estimated Marshallian (or uncompensated) and Hicksian (or compensated) own-price and expenditure elasticities, evaluated at the sample means, of the household food demand system. All own-price elasticities have correct signs (negative) and are statistically significant at a 10% level. The estimated Marshallian own-price elasticities of demand for food groups range from −1.73 for grains to −0.26 for fruits, whereas the Hicksian own-price elasticities of demand for food groups range from −1.39 for grains to −0.23 for fruits. The Marshallian own-price elasticities of demand for meat and fish, grains, dairy products, and vegetables are >1, implying that a change in the own-price would lead to a more than proportionate response in the de-

Table 2. Estimated Own-price and Expenditure Elasticities, Marginal Expenditure Shares, and Effect of Socioeconomic and Demographic Characteristics on South Africa Household Food Consumption

	Food Item					
	MF	GRA	DP	FRU	VEG	OF
Marshallian elasticity	−1.266	−1.730	−1.237	−0.263	−1.312	−0.923
	(−18.39)[a]	(−22.13)	(−23.40)	(−1.74)	(−17.28)	(−56.73)
Hicksian elasticity	−0.919	−1.394	−1.160	−0.225	−1.195	−0.583
	(−13.39)	(−17.87)	(−21.57)	(−1.49)	(−15.75)	(−4.76)
Expenditure elasticity	1.027	1.250	0.896	0.717	0.910	0.670
	(29.90)	(39.09)	(16.99)	(8.72)	(24.21)	(15.67)
Expenditure share	34.0	27.0	9.0	5.0	13.0	12.0
Marginal expenditure share	34.9	33.8	8.1	3.6	11.8	8.0
	Effect of SED Characteristics					
Education	+	−	+	+	−	−
Urbanization	+	−	+	−	−	ns−
Age	−	+	−	+	+	−
Gender	ns−	+	−	ns−	+	ns−
Race	+	−	+	+	+	−
Family size	−	+	+	−	ns−	+

Notes: MF is meat and fish, GRA is grains, DP is dairy products, FRU is fruits, VEG is vegetables, and OF is other foods. SED is socioeconomic and demographic factors. For SED effects, + is significant at the 0.1 level and positive; − is significant at the 0.1 level and negative; ns+ is nonsignificant at the 0.1 level but exhibits a positive trend; ns− is nonsignificant at the 0.1 level but exhibits a negative trend.

[a] Values in parentheses are *t*-ratios.

mand for these food products. Conversely, the Marshallian own-price elasticity of demand for fruits and other foods are <1, suggesting that a change in own-price would lead to a less than proportionate response in demand for fruits and other foods. The Hicksian own-price elasticities for food items are similar in magnitude to those of the Marshallian elasticities, except for meat and fish for which the Hicksian own-price elasticity is <1. The high own-price elasticity of demand for grains is probably due to the inclusion of expenditure on breakfast cereal in the grains expenditure estimate, which is regarded as a luxury food item in the South African household diet.

The cross-elasticity estimates indicate that meat and fish and fruits, dairy products and fruits, and dairy products and other foods are complementary products. For Marshallian cross-elasticity estimates, the positive cross-price effects in the grains model indicate that—with the exception of fruits—grains and all other food products (meat and fish, dairy products, vegetables, and other foods) are substitutes. For Hicksian cross-elasticity estimates, grains are substitutes for all other foods (meat and fish, dairy products, fruits, vegetables, and other foods), and dairy products are substitutes for both meat and fish and vegetables.

The estimated expenditure elasticities are also reported in Table 2. The estimated expenditure elasticities are all positive and statistically significant at the 1% level. The expenditure elasticities range from 0.67 for other foods to 1.25 for grains. The expenditure elasticities of meat and fish and grains are >1, implying that these foods are luxury products in the household diet. The expenditure elasticities for dairy products, fruits, vegetables, and other foods are <1, implying that these food products are necessities in the South African household diet.

In order to determine the impact of changes in income on future household expenditures on food, the marginal expenditure shares are

derived following the approach proposed by Powell. The marginal expenditure share is estimated as the product of expenditure elasticity and the expenditure shares for that food group. The estimated marginal expenditure shares reported in Table 2 indicate that, for an increase in future incomes, households would allocate proportionately more of their income on meat and fish and grains and less on dairy products, vegetables, and other foods. The result also indicates that any change in future household income would have a very little impact on expenditures on fruits.

Table 2 also reports the effect of socioeconomic and demographic characteristics on household food consumption in South Africa. Many of the parameters of the socioeconomic and demographic characteristics are significant at a 10% level. Table 2 indicates that educated household heads are likely to consume more meat and fish, dairy products, and fruits and less of grains, vegetables, and other foods. Male-headed households are likely to consume more of grains and vegetables and less of dairy products than female-headed households. Gender of household head has no statistically significant effect on the consumption of meat and fish, fruits and other foods, although they are all negative. A large family size has a positive effect on the consumption of grains, dairy products, and other foods, but has a negative effect on the consumption of meat and fish and fruits. Family size, however, has no statistically significant effect on the consumption of vegetables. The results reported in Table 2 suggest that whites are more likely, relative to blacks, to consume less grains and other foods and more of meat and fish, dairy products, fruits, and vegetables.

Few studies have reported own-price and expenditure elasticities of food groups for South Africa. The own-price elasticities for meat and fish reported in this study are higher than the −0.41 and −0.94 reported by Poonyth, Hassan, and Kirsten for South African red meat and white meat demand, respectively. The own-price elasticities of demand for meat and fish and fruits reported in this study are less than the −1.60 (average estimate) reported for meat by Hancock, Nieuwoudt, and Lyne and the −2.17 reported for fruits by Hancock, respectively.

Summary and Conclusions

This paper applies an LA/AIDS model to examine food demand patterns in South Africa based on a survey of households. The empirical method used to measure food demand is flexible because it incorporates household socioeconomic and demographic characteristics in the analysis, which provides a means for accounting for differences in the consumption behavior of households.

The empirical results are summarized. First, the estimated Marshallian own-price elasticities range from −1.73 for grains to −0.26 for fruits, whereas the Hicksian own-price elasticities range from −1.39 for grains to −0.23 for fruits. The demand for meat and fish, grains, dairy products, and vegetables is price-elastic, implying that if the price of these food products are reduced, total revenue will increase because the quantity sold will increase by a larger percentage than the decrease in price. For fruits and other foods, the demand is price-inelastic, indicating that a fall in price of these food items will cause a smaller percentage change in the quantity demanded. The implication is that the revenue derived from the sale of fruits and other foods could decrease given that the quantity sold increases by a smaller percentage than the fall in price. Second, the estimated expenditure elasticities range from 0.67 for other foods to 1.25 for grains. The results indicate that meat and fish and grains are luxury products, whereas dairy products, fruits, vegetables, and other foods are necessities in the household diet. Third, the results indicate that an increase in household income could cause food expenditure on meat and fish and grains to rise while decreasing expenditure on dairy products, fruits, vegetables, and other foods. Fourth, socioeconomic and demographic characteristics of age, race, and gender of household head; urbanization; and family size are important determinants of South African household food consumption.

Evidence of the impact of household socioeconomic and demographic characteristics on

food consumption has implications for policy. The findings are important in the context of the ongoing policy reform in South Africa with regard to alleviating poverty and inequality. In terms of different characteristics of households, there is the need for the government to continue to pursue this policy. This is because household composition varies and consumption patterns are aligned with socioeconomic and demographic characteristics such that if growth impacts unequally, household inequalities could increase. It is pertinent that the government is cognizant of this problem, because an improvement in the welfare of households could lead to an increase in food consumption and hence better nutrition.

The analysis presented in this paper also contributes to the debate centered on the abolition of production subsidies to farmers as a means of reforming the agricultural sector. Maintaining the strong assumption that production subsidies lead to inefficient resource allocation and distort price, this suggests that the South African government's policy of removing production subsidies to farmers is appropriate. This is because the policy could lead to the efficient use of resources and consequently an increase in domestic production of agricultural products to meet the expected increase in food demand. This proposal, however, presents an interesting issue. On the one hand, a cut in production subsidies may push some farmers in marginally solvent or vulnerable categories out of the agricultural sector, and for South Africa, this could mean failure to achieve increased agricultural production. On the other hand, the provision of production subsidies, such as a cut in tax on inputs used in the agricultural sector, could stimulate growth in domestic production of agricultural products. Given that this could affect producers differently at the subsector level, it is important that the impact of removal of production subsidies is well understood before the government embarks further on such a policy. To meet increased demand for food, the South African government needs to address some of the constraints facing the agricultural sector by providing adequate infrastructure through increased government expenditure on postharvest infrastructure, such as storage and packaging facilities and roads, as well as improving food distribution networks.

Looking to the future, the implication of the analysis is that household food consumption is likely to change as incomes rise in the climate of a growing economy. The results suggest that with an increase in incomes the demand for meat and fish and grains could rise, whereas the demand for dairy products, fruits, vegetables, and other foods are likely to fall. It is pertinent that this basic fact be integrated into any assessment of government policy in South Africa.

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