ON THE ESTIMATION OF DEMAND SYSTEMS WITH LARGE NUMBER OF GOODS: AN APPLICATION TO SOUTH AFRICA HOUSEHOLD FOOD DEMAND

by

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On the estimation of demand systems with large number of goods: an application to South Africa household food demand*

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Abstract

The estimation of large demand systems to investigate the patterns of consumption of households is notoriously difficult. This study develops a modified Almost Ideal Demand System model based on a flexible two-stage budgeting demand modelling framework to examine the effect of estimation procedures (Bottom-up and Top-down) on South African household food consumption parameters. Household food consumption was divided into seven broad food groups: meat and fish; grains; dairy products; fruits; vegetables; other foods. The demand systems were estimated using data from the 1993 South Africa Integrated Household Survey (SIHS) conducted by the South African Labour and Development Research Unit (SALDRU). Empirical results indicate that the Top-down approach is more suited for estimation of South African household food demand. Results indicate that own-price do play an important role in influencing household food consumption. Results also indicate no presence of gross substitution between and within food groups. Expenditure elasticity estimates indicate that meat and fish, dairy products and fruits are luxury products, while grains, vegetables and other foods are necessities in South African household diet.

***Key words*:** LAIDS model, two-stage budgeting demand model, households, South Africa
JEL Classifications: C21, D12

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1. Introduction

The estimation of large demand systems to investigate the patterns of consumption of households is notoriously difficult. This paper uses disaggregate-level survey data on household food consumption in South Africa to compare two alternative models: Top-down approach and Bottom-up approach to modelling a modified Almost Ideal Demand System. Both of these models involve interactions between socio-economic and demographic characteristics of households and food demand.

Rapid advances in demand analysis have sparked an interest in methods of determining consumer demand. The most commonly used technique is the application of the duality theory in the specification of direct utility functions, indirect utility functions and cost functions. Duality theory allows systems of demand equations to be derived from these dual representations via differentiation, according to Roy's Identity or Sheppard Lemma. Major contributions to the theoretical development of functional forms include Diewert (1974) who specified consumer behaviour to be characterised by a Generalised Leontief functional form, and Christensen *et. al.* (1975) who specified it to be characterised by a Translog functional form. If the demand system is properly specified, the estimated results will generate reliable estimates of own-price and cross-price elasticities and expenditure elasticities that approximate the consumer behaviour and satisfy all the regularity conditions of utility maximisation.

Deaton and Muellbauer's (1980) Almost Ideal Demand System (AIDS) has renewed an interest in demand analysis. The variants of the AIDS model are shown to be consistent with the maximisation of a utility function subject to budget constraints, generating systems of equations satisfying regularity conditions of consumption theory. Since then, a number of studies (Alessie and Kapteyn, 1991; Mergos and Donatos, 1989; Ray, 1983; Blanciforti and Green, 1983) have provided a dynamic generalisation of the Almost Ideal Demand System. These studies concluded that socio-economic and demographic factors are important determinants of consumer behaviour.

The goal of this study is to examine the effect of two approaches, the Top-down approach and Bottom-up approach, on South African household food consumption parameters. A two-stage budgeting model is used to estimate the complete demand system. Estimates of price and expenditure elasticities of broad food groups and individual food commodities are provided. The broad food groups examined are meat and fish, grains, dairy products, fruits, vegetables and other foods. Meat and fish include beef/mutton/pork, chicken, fresh fish and tinned fish. Grains include maize, mealie meal, rice, bread, wheat and breakfast cereals. Dairy products include cheese, butter/ghee/margarine/other fats, fresh dairy/sour dairy/yoghurt and baby formula/dairy powder, and fruits include bananas, apples and citrus fruit. Vegetables include dried peas/lentils/beans, potatoes, tomatoes, sweet potatoes, pumpkin/squash and other vegetables, and other foods are vegetable oil, jam, sugar and soft drinks.

This study utilises cross-sectional data from 1993 South Africa Integrated Household Survey (SIHS) conducted by the Southern Africa Labour and Development Research Unit (SALDRU) as part of the World Bank Living Standard Measurement Surveys (LSMS) to estimate the complete system of budget share equations for household food demand. By incorporating socio-demographic variables in the analysis of household consumption patterns, we provide a means for accounting for differences in the consumption behaviour of households with different characteristics.

The rest of this paper is organised as follows. The model and estimation method is described. In addition, a brief description of the estimation method and the derivation of elasticity estimates is given in Section 2. Section 3 presents a description of data employed in the analyses. The empirical results of the application of the dynamic system to integrated household survey data for South Africa are reported and discussed in Section 4. Section 5 contains some concluding remarks and suggestions for future research.

2. The Model

2.1 *Separability and demand System*

For empirical estimation of large demand systems restrictions need to be imposed on the structure of consumer preferences. The seminal article by Gorman (1959) has shown that a simplified two-stage budgeting process is possible under two alternative conditions: homothetic weak separability of the direct utility function and strong separability of the direct utility function with group subutility functions. The study by Blackorby *et al*. (1978), where they propose a separable structure for consumer preferences of large demand systems, provides a promising approach to explaining South African household food consumption.

To recap, following Moschini *et al.*, (1994), let $q = (q_1, \ldots, q_n)$ denote the vector of consumer goods, $p = (p_1, \ldots, p_n)$ denote the corresponding price vector and y denote total expenditures on the n goods. Now, assume the set of indices of the n goods to be

$I = \{1,\ldots,n\}$, such that the goods consumed can be ordered in S separable groups defined by the mutually exclusive partition $\hat{I} = \{I^1,\ldots,I^N\}$ of the set *I*. Now, if the utility function $U(q)$ is separable in partition *I*, then the utility function can be written, following Moschini *et al*. (1994), as

$$U(q) = U^0\left[U^1\left(q^1\right), U^2\left(q^2\right),\ldots,U^S\left(q^S\right)\right] \qquad (1)$$

where $U^s(.)$ is a set of sub-utility functions that depend on a subset q^s of goods whose indices are $I_s\,(s = 1,\ldots,S)$, and where $U^s(.)$ satisfies the conditions of a utility function, that is, strong monotonicity, strict quasi-concavity and differentiability. This structure on the utility function is sufficient to guarantee the existence of conditional demand functions of the form

$$\tilde{x}_i\left(p^r \big/ y_r\right), \forall i \in I^r, r = 1,\ldots,N \qquad (2)$$

where p^r is the vector of prices of partition $I^r, p = \left(p^1,\ldots,p^N\right)$ and y_r is the optimal allocation of expenditure to the goods in the r^{th} group.

The optimal expenditure on goods to any one particular partition (y_r) however depends on the set of all prices and total expenditures so that $y_r = y_r\left(p \big/ y\right), r = 1,2,\ldots,N$ and therefore the unconditional demand functions satisfy

$$q_i\left(p \big/ y\right) \equiv \tilde{x}_i\left(p^r \Big/ y_r\left(p \big/ y\right)\right) \qquad (3)$$

So to be able to say anything meaningful about the responsiveness of demand to a particular price change, one needs to know how the optimal allocations $y_r(p/y)$ are affected by such a change. This essentially implies that we need to estimate the first stage expenditure allocations as well.

The task at hand is to estimate the unconditional demand functions in (3). To do that we need therefore to estimate: (1) the first stage expenditure allocations; and (2) conditional on the first stage optimal allocations, the (conditional) demand functions. One could use two possible approaches and in the absence of any better terminology we will call them “Bottom-up” and “Top-down” approaches.

2.2 *Bottom-up approach*

Let $V(p/y)$ denote the indirect utility function which is assumed to be continuous, quasi-convex in (p/y), non-increasing, homogenous in degree zero in p and y. Then if preferences are indirectly weakly separable then $V(p/y)$ can be written as:

$$V\left(p/y\right) = V^0\left[V^1\left(p^1/y\right), \ldots, V^N\left(p^N/y\right)\right] \tag{4}$$

where once again $p^r, r = 1,\ldots,N$ are the group price vectors, $V^r(p^r/y)$ are indices that depend only on group prices and total expenditures and $V^0[.]$ is assumed to have the standard properties of any indirect utility function . This indirect separability allows a recursive characterisation of the consumer's budgeting problem. Using Roy's identity, the indirect utility function defined in equation (4) gives us the unconditional demand functions as:

$$q_i\left(p/y\right) = -\frac{\dfrac{\partial V^0[.]}{\partial V^r}\dfrac{\partial V^r}{\partial p_i}}{\sum_{s=1}^{N}\dfrac{\partial V^0[.]}{\partial V^s}\dfrac{\partial V^s}{\partial y}}; i \in I^r \tag{5}$$

Then under indirect weak separability, the expenditure allocation to goods in any one partition $y_r(p/y)$ must satisfy the following condition:

$$y_r\left(p/y\right) \equiv \sum_{i \in I^r} p_i q_i\left(p/y\right) = -\frac{p_i \dfrac{\partial V^0[.]}{\partial V^r}\sum_{i \in I^r}\dfrac{\partial V^r}{\partial p_i}}{\sum_{s=1}^{N}\dfrac{\partial V^0[.]}{\partial V^s}\dfrac{\partial V^s}{\partial y}}; r = 1,\ldots,N \tag{6}$$

Let us now define

$$\tilde{x}_i\left(p^r/y\right) = -\frac{\dfrac{\partial V^r}{\partial p_i}}{\dfrac{\partial V^r}{\partial y}}; i \in I^r \tag{7}$$

Then the unconditional demand functions can be expressed in terms of the first stage expenditure allocations $y_r(p/y)$ and of the second stage conditional demand functions $\tilde{x}_i(p^r/y)$ so that

$$q_i\left(p/y\right) = \frac{y_r\left(p/y\right)}{y}\tilde{x}_i\left(p^r/y\right); r \in I^r \tag{8}$$

Therefore given an expenditure allocation to group r, optimal within group allocation is possible given the knowledge only of group prices and total expenditure.

As a specific example, we consider the translog demand system of Christensen, Jorgenson & Lau (1975). We write the indirect utility function as:

$$\log V^r\left(p^r/y\right) = b_0^r + \sum_{i\in I^r} b_i \log\left(p_i/y\right) + \frac{1}{2}\sum_{i\in I^r}\sum_{j\in I^r} b_{ij}\log\left(p_i/y\right)\log\left(p_j/y\right) \tag{9}$$

and the aggregator function $V^0(.)$ as:

$$V^0(.) = -\left[g_0 + \sum_{r=1}^{N} g_r \log V^r(.) + \frac{1}{2}\sum_{r=1}^{N}\sum_{s=1}^{N} g_{rs}\log V^r(.)\log V^s(.)\right] \tag{10}$$

Symmetry requires: $b_{ij} = b_{ji}; \forall(i,j)$ and $g_{rs} = g_{sr}; \forall(r,s)$. Also we set:

$$\begin{aligned}
&b_0^r = 1; r = 1,\ldots,N\\
&g_0 = 1\\
&\sum_{i\in I^r} b_i = 1; r = 1,\ldots,N\\
&\sum_{r=1}^{N} g_r = 1; r = 1,\ldots,N\\
&\sum_{s=1}^{N} g_{rs} = 1; r = 1,\ldots,N
\end{aligned} \tag{11}$$

The unconditional share equations can be written as:

$$w_i = \frac{\left[g_r + \sum_{s=1}^{N} g_{rs}\log V^s\left(p^s/y\right)\right]\left[b_i + \sum_{j\in I^r} b_{ij}\log\left(p_j/y\right)\right]}{\sum_{g=1}^{N} B^g\left(p^g/y\right)\left[g_g + \sum_{s=1}^{N} g_{gs}\log V^s\left(p^s/y\right)\right]}; i\in I^r \tag{12}$$

where $w_i \equiv p_i\tilde{x}_i/y$ is the unconditional share of the ith good; $V^s\left(p^s/y\right)$ is the indirect utility function and the function $B^g\left(p^g/y\right)$ is defined as:

$$B^g\left(p^g/y\right) = 1 + \sum_{j\in I^g}\sum_{i\in I^g} b_{ij}\log\left(p_j/y\right); g = 1,\ldots,N \tag{13}$$

For estimation purposes, it is easier to consider a two-step (recursive) estimation procedure. Define $w_i^r \equiv p_i x_i/y_r$ as the conditional (within group) share of commodity i and $w^r \equiv y_r/y$ as the group share. Given an expenditure allocation to the group $\left(y_r\right)$ the optimal within group allocation is possible given knowledge only of group prices $\left(p^r\right)$ and total expenditure $\left(y\right)$ (Equation 8) so that

$$w_i^r = \frac{b_i^r + \sum_{j\in I^r} b_{ij}^r \log\left(p_j/y\right)}{1+\sum_{k\in I^r}\sum_{j\in I^r} b_{kj}^r \log\left(p_j/y\right)}; \forall i \in I^r \tag{14}$$

Using the translog specification, the group share equations can be written as:

$$w^r = \frac{B^r\left(p^r/y\right)\left[g_g + \sum_{s=1}^{N} g_{rs} \log V^s\left(p^s/y\right)\right]}{\sum_{g=1}^{N} B^g\left(p^g/y\right)\left[g_g + \sum_{s=1}^{N} g_{gs} \log V^s\left(p^s/y\right)\right]}; r = 1,\ldots,N \tag{15}$$

So the estimation methodology is:

1. Estimate the within group share systems independently for each of the N groups (equation (14)).
2. Taking the estimated $\left(b_i, b_{ij}\right)$ as given we compute the indices $\log V^r$ and B^g and estimate the $\left(N-1\right)$ group share equations conditional on these shares (equation (15)).

Now, lets derive the elasticities for the Bottom-up approach. The Marshallian (or uncompensated) elasticities must satisfy the following conditions:

$$\begin{aligned} e_{ij} &= \frac{1}{w_i}\frac{\partial w_i}{\partial \log\left(p_j\right)} - d_{ij} \\ e_i &= \frac{1}{w_i}\frac{\partial w_i}{\partial \log\left(y\right)} \end{aligned} \tag{16}$$

Here d_{ij} is the Kronecker delta with $d_{ij} = 1$ if $i = j,$ and 0 otherwise. Then using the translog specification (Equation 8):

$$\begin{aligned} e_{ij} &= \frac{1}{D}\left[\frac{\Gamma^r b_{ij} + g_{rr}B_iB_j}{w_i} - \sum_{g=1}^{N} g_{gr}B_jB^g - \Gamma^r\left\{\sum_{m\in I^r} b_{jm}\right\}\right] - d_{ij}; (i,j)\in I^r \\ e_{ik} &= \frac{1}{D}\left[\frac{g_{rs}B_kB_i}{w_i} - \sum_{g=1}^{N} g_{gr}B_kB^g - \Gamma^s\left\{\sum_{m\in I^r} b_{jm}\right\}\right]; i\in I^r, k\in I^s \\ e_i &= 1 - \frac{1}{D}\left[\begin{array}{l} \dfrac{\Gamma^r\left(\sum_{j\in I^r} b_{ij}\right) + B_i\sum_{s=1}^{N} g_{sr}B^s}{w_i} - \sum_{g=1}^{N}\sum_{s=1}^{N} g_{sg}B^sB^g - \\ -\sum_{s=1}^{N}\Gamma^s\left(\sum_{k\in I^s}\sum_{m\in I^s} b_{km}\right) \end{array}\right]; i\in I^r \end{aligned} \tag{17}$$

where

$$D = \sum_{g=1}^{N} B^g \left(p^g / y \right) \left[g_g + \sum_{s=1}^{N} g_{gs} \log V^s \left(p^s / y \right) \right] \tag{18}$$

B^g is defined in equation (12) and B_i and Γ^r are defined as follows:

$$\begin{aligned} B_i &= b_i + \sum_{j \in I^r} b_{ij} \log \left(p_j / y \right); i \in I^r \\ \Gamma^r &= g_r + \sum_{s=1}^{N} g_{rs} \log V^s \end{aligned} \tag{19}$$

The Hicksian (compensated) elasticities can be obtained as:

$$h_{ij} = e_{ij} + w_j e_i \tag{20}$$

where e_{ij} and e_i are defined in equation (15).

2.3 *Top-down approach*

Let us instead assume that the first stage comprises of groups of goods $r = 1, \ldots, N$ and in the second stage the r^{th} group consists of goods $i = 1, \ldots, m_r$. Once again assume consumer preferences to be weakly separable so that they can be represented as in equation (1):

$$U(q) = U^0 \left[U^1 \left(q^1 \right), U^2 \left(q^2 \right), \ldots, U^N \left(q^N \right) \right] \tag{21}$$

Now given an allocation of expenditures between the broad groups (Stage 1), the second stage of the two-stage budgeting process follows all the rules of standard demand analysis but with total expenditure (y) replaced by group expenditure (y_r). Then the Marshallian demand function for good *i* in the r^{th} group $\left(q_i^r; r = 1, \ldots, N; i \in I^r \right)$ can be written as:

$$q_i^r = q_i^r \left(p_r, y_r \right); r = 1, \ldots, N; i \in I^r \tag{22}$$

Here p_r denotes the price vector of the r^{th} group.

Define w_r as the share of the r^{th} group in total expenditure. Therefore

$$w^r = w^r \left(\left\{ P^r \right\}_{r=1}^{N}, y \right) + u^r \tag{23}$$

So the expenditure share of the r^{th} group depends on the index of prices of each of the r groups $\left(\left\{ P_r \right\}_{r=1}^{N} \right)$, total expenditure (y) and an error term u_r. Now P_r is the price index for group *r* and can be computed as the Stone Price Index. Equation (22) can be estimated as a system of $N - 1$ equations.

Now to the second stage of the Top-down approach. Define w_i^r as the expenditure share of the i^{th} commodity in the r^{th} group. If w_i^r depends on the prices of each of the commodities in the group, and given the total expenditure on group r and an error term u_i^r, then:

$$w_i^r = w_i^r\left(\{p_i\}_{i\in I^r}, y_r\right) + e_i^r; r = 1,\ldots, N, i \in I^r \tag{24}$$

The problem with equation (23) is that y_r is likely to be endogenous. To correct for this (potential) endogeneity we use the predicted value of y_r from the first stage as the relevant instrument and $\tilde{y}_r = \tilde{w}_r\, y$. We can write the second stage estimating equations as:

$$w_i^r = w_i^r\left(\{p_i\}_{i\in I^r}, \hat{y}_r\right) + e_i^r; r = 1,\ldots, N, i \in I^r \tag{25}$$

Equation (25) can be estimated as a system of equations for each group.

In our actual estimation we will estimate linear versions of equations (23) and (25). The estimating equation characterising the group expenditures (first stage equation), is given by:

$$w^r = g_0^r + \sum_{r=1}^{N}\sum_{s=1}^{N} g_1^{rs} \log P^r + g_2^r \log y + u^r \tag{26}$$

and the second stage equation is given by:

$$w_i^r = g_{0i}^r + \sum_{i\in I^r}\sum_{j\in I^r} g_{1ij}^r \log p_i^r + g_{2i}^r \log \hat{y}_r + u_i^r; r = 1,\ldots, N \tag{27}$$

Now, let us derive the elasticities for the Top-down approach. Let us denote the within group expenditure elasticity for the i^{th} good within the r^{th} group as e_i^r, the group expenditure elasticity for the r^{th} group as e^r and the total expenditure elasticity of the i^{th} good within the r^{th} group as e_i. Similarly denote the within group elasticity between the i^{th} and the j^{th} good within the r^{th} group as e_{ij}^r, the group elasticities as e^{rs} and the total price elasticities as e_{ij}. Note that it is assumed that the group expenditure is unchanged even if prices change. Then we can define:

$$\begin{aligned} e_i &= e^r e_i^r \\ e_{ij} &= d_{rs} e_{ij}^r + e_i^r w_j^s \left(d_{rs} + e^{rs}\right) \end{aligned} \tag{28}$$

Note here d_{rs} is the Kronecker delta with d_{rs}=1 for r=s and 0 otherwise. Also w_i^r is as defined above: the expenditure share for the i^{th} good within the r^{th} group. Finally, the compensated elasticities can be written as:

$$h_{ij} = e_{ij} + w_j e_i = d_{rs} h_{ij}^{r} + e_i^{r} w_j^{s} h^{rs} \tag{29}$$

Therefore for two goods within the same group the total price elasticity (e_{ij}) is the sum of the within group direct price elasticity (e_{ii}^{r}) and an indirect term. The indirect term essentially measures how much the change in the price of an individual commodity affects the allocation of expenditure between the groups. This is obtained as the product of three terms: the relative change in the group price index caused by a change in the price of the j^{th} good $(1+e^{rs})$; the effect the change in price has on group expenditure (w_j^{s}); and finally the effect this change in within group expenditure has on the consumption of the i^{th} good (e_i^{r}).

3. Application to South Africa household food demand

The primary task is to analyse South African household food demand. We have data on 28 food items and the issue of multistage estimation arises because it is difficult to obtain sensible parameter estimates and elasticities for the full set of 28 items. The food items are divided into six broad food groups: Meat and fish, Grains, Dairy products, Fruits, Vegetables, Other foods. Table 1 presents the details of the categorisation.

The data used in the study are household expenditure, consumption and prices of food items obtained from the 1993 South Africa Integrated Household Survey (SIHS) data set collected by the South African Labour and Development Research Unit (SALDRU) as part of World bank's Living Standard Measurement Surveys (LSMS). The survey was conducted in the nine months prior to the country's first democratic election in 1994. The data set is unique in that it is the first that covers the entire South African population, including those residing in the former *homelands*. More on the survey and the data set may be obtained from SALDRU (1994). While the survey involved nearly 8000 households we deleted households with a monthly food expenditure of less than 50 Rands. Also we deleted households where the household head was less than 16 years of age and those households without any member more than 17 years. This left us with a sample of 6960 households that were used in the estimation. The final data employed in the analyses are still characteristic of South African population distribution. The average share of food in total household expenditure is 45% - suggesting that food comprises of the major share of total household expenditure.

The LA/AIDS models were estimated using the seemingly unrelated regression (SUR) technique developed by Zellner (1962) and available in Stata Version 10.0, which converges to the maximum likelihood estimator. Since the system is expressed in budget-share form (summing to unity), the specification of demand system composed of N share equations would be singular. As a result, one equation has to be deleted. Therefore, we estimate $n_r - 1$ conditional share equations for each food group and $N - 1$ share equations for the broad food groups. For the purpose of this study, for borad food groups, other foods equation was deleted. As Barten (1969) has shown the maximum likelihood estimates are invariant to which equation is dropped. For the demand system to be consistent with consumption theory, restrictions need to be imposed on the parameters of the system; that is, adding-up, homogeneity and symmetry. As Wu and Wu (1997) note, excluding one equation automatically implies the adding-up restriction is satisfied. The homogeneity and symmetry restrictions were imposed on the estimated model.

A common problem associated with complete demand systems is the endogeneity of prices. The endogeneity of price arises from demand systems derived from simultaneous supply and demand models. In developing countries, most governments regulate food prices. South Africa is no exception where the government intervenes in the foreign exchange market to stabilise exchange rate variability, which in turn influences domestic food prices. Furthermore, the government sets minimum support prices for agricultural products at a premium to world prices in order to achieve sufficiency in major agricultural products. The liberalised South African economy allows domestic food prices to be influenced by world market prices. In this study therefore domestic food prices are assumed to be exogenous in the demand system. Another problem relates to estimating demand systems with missing prices. Two popular and computationally simple solutions to this problem are: (a) to discard all incomplete observations and estimate population parameters using the remaining observations; and (b) to use zero-order methods which substitute 'appropriate' sample means for the missing values (Cox & Wohlgenant, 1986). This study adopts the second approach whereby the missing prices were substituted for by cluster prices of the food item. The use of the cluster prices implies that non-consuming households or households with no prices for a commodity face average commodity price for that cluster.

4. Results and Discussion

4.1 *Broad food group elasticities*

As already mentioned, we consider two alternative estimation techniques – the *Bottom-up* and the *Top-down* approaches. Table 2 reports the estimated expenditure elasticities of the two approaches. All the expenditure elasticities are positive and of similar magnitudes. The positive sign of the expenditure elasticities indicate that an increase in expenditure to total food would lead to an increased consumption of all food items. The expenditure elasticity estimates are greater than unity for meat and fish, dairy products and fruits, indicating that these broad food groups are luxury products. Grains, vegetables and other foods are necessities in South African household diet.

We now turn to own-price and cross-price elasticities of broad food groups. Table 3 reports the Marshallian (or uncompensated) and Hicksian (or compensated) own-price and cross-price elasticities of broad food groups, respectively. The uncompensated and compensated own-price elasticities of the bottom-up and top-down approaches are similar in magnitude and sign, except for dairy products and fruits of the bottom-up approach, where demand is unresponsive to changes in own-price. With the exception of dairy products and fruits of the bottom-up approach, the own-price elasticities of demand for broad food groups are negative and statistically significant at a 10% level. For the top-down approach, the demand for broad food groups are elastic, except for dairy products, which is also close to unity. This indicates that price is an important factor influencing consumption of broad food groups. For the Top-down approach, the uncompensated elasticity estimates indicate that dairy products is the most inelastic of the food groups (-0.958) and meat and fish are the most price-elastic food group (-1.309). For the compensated elasticity estimates, dairy products is still the most inelastic food group (-0.874) and other foods are the most price-elastic food group (-1.135). Overall, the demand for broad food groups of the top-down approach are more elastic than those obtained from the bottom-up approach. The cross-price elasticities of broad food groups are generally statistically non-significant at a 10% level for both estimation procedures. The results suggest that no substitution exists between the broad food groups.

4.2 *Within food group elasticities*

Table 4 reports the estimated within group expenditure elasticities of the broad food groups. All the expenditure elasticities of the Top-down approach are positive as expected. The signs of the expenditure elasticities of the Bottom-up approach are mixed. For the Bottom-up approach, the within group expenditure elasticities of meat and fish, dairy products, vegetables and other foods are all negative. This is contrary to that expected.

Hence, the discussion here focuses on expenditure elasticity estimates of the Top-down approach.

For meat and fish, the expenditure elasticities of beef/mutton/pork, eggs and fresh fish are greater than unity, implying that these food items are luxury products. The expenditure elasticities of chicken and tinned fish are less than one, implying that these food items are necessities in South African household diet. The within group expenditure elasticity estimates suggests that as the expenditure on meat and fish increases, the shares on beef/mutton/pork, eggs and fresh fish would rise while expenditure on chicken and tinned fish would fall. The within group expenditure elasticities of grains are all less than one, implying that all food items within the grains group are necessities in household diet. This suggests that as the expenditure increases for food, the shares of individual food items within the grains group would remain constant. This is consistent with the findings that the expenditure elasticity of grains, under broad food groups, is less than one. For dairy products, with the exception of baby formula/dairy powder, all other food items are luxury products since the expenditure elasticities are greater than one. The results suggests that an increase in expenditure on dairy products will lead to an increase in the shares of butter/ghee/margarine, cheese and fresh dairy/sour dairy/yoghurt, but a decrease in the share of baby formula/dairy powder. For fruits, banana and apples are luxury products while citrus fruits are necessities in household diet. An increase in the expenditure on fruits would lead to an increase in the share of banana and apples and a decrease in the share of citrus fruits. For vegetables and other foods groups, all food items are necessities in household diet because all the expenditure elasticities are less than one. This suggests that an increase in expenditure on broad food groups would have little impact on the consumption of individual food items within the vegetables and other foods groups. However, it should be noted that the expenditure elasticity estimates of soft drink, dry peas/lentils/beans, sweet potatoes, pumpkin/squash, and other vegetables are greater than 0.9, suggesting that these products may be near luxury products. These findings are consistent that the expenditure elasticities of broad food groups where the expenditure elasticities of vegetables and other foods were less than one.

Next, we look at the Marshallian (uncompensated) and Hicksian (compensated) own-price elasticities of the Bottom-up approach and Top-down approach, evaluated at the sample means of the household food demand system. This is reported in Table 4. The own-price elasticities of the Bottom-up approach are not discussed here due to the inconsistent estimates of the expenditure elasiticies. It is important to note however that the Marshallian and Hicksian own-price elasticities reported for the Bottom-up approach are similar. The estimated Marshallian and Hicksian own-price elasticities of the Top-down approach are all statistically significant at a 10% level. The estimated Marshallian and Hicksian own-price elasticities of demand for individual commodities within the food groups are of similar magnitudes, but the own-price elasticity estimates of the Top-down approach appear to be larger than that of the Bottom-up approach. With the exception of tinned fish, mealie meal, bread, baby formula/dairy powder, individual commodities have own-price elasticities less than one, implying that an increase in own-price would lead to a less than proportionate change in the demand for individual commodities in South African household diet. The cross-price elasticity estimates are generally non-significant at a 10% level, suggesting that there exists no gross substitution among commodities within food groups. Generally, the cross-price elasticity estimates have lower values than those of the own-price estimates implying that South African households are in general more sensitive to changes in own-prices of broad food groups and individual commodities. Most of the cross-price elasticity estimates are also statistically non-significant at a 10% level, suggesting no presence of gross substitution among commodities within broad food groups.

5. Conclusion

Two sets of LA/AIDS modelling approaches are developed and estimated: one is the Bottom-up approach and the other is Top-down approach. The Top-down approach gave reasonable elasticity estimates, while the Bottom-up approach gave questionable expenditure and own-price elasticity estimates. For the South African food demand, the Top-down approach is considered the preferred model. For the top-down approach, the own-price elasticities of broad food groups are generally greater than one or close to unity, suggesting that prices do play an important role in determining household food consumption patterns in South Africa. We find that the choice of approach has an influence on the elasticity estimates, especially at the within group level where we find the elasticity estimates of the Bottom-up to be contrary to expectations. The finding that the own-price elasticities are significant for broad food groups and individual commodities indicates that producers and exporters must be conscious of their pricing decisions. The expenditure elasticity estimates for broad food groups, for the top-down approach, are all positive implying that an increase in income of household would lead to an increase in consumption of food, particularly meat and fish, fruits and vegetables in South Africa.

Table 1: Classification of Food items into Food Groups

	Food group					
	Meat and fish	**Grains**	**Dairy products**	**Fruits**	**Vegetables**	**Other foods**
Food items	Beef/Mutton/ Pork	Maize	Butter/Ghee/ Margarine	Banana	Dry peas/Lentils/ Beans	Vegetable oil
	Chicken	Mealie meal	Cheese	Apples	Potatoes	Jam
	Eggs	Rice	Fresh dairy/Sour dairy/Yogurt	Citrus fruits	Tomatoes	Sugar
	Fresh fish	Bread	Baby formula/ Milk powder		Sweet Potatoes	Soft drink
	Tinned fish	Wheat			Pumpkin/Squash	
		Breakfast cereal			Other vegetables	

Table 2: Expenditure elasticities of broad food groups

	Estimation method	
Broad food group	**Bottom-up approach**	**Top-down approach**
Meat and fish	1.413 (0.691)[a]	1.389 (0.650)
Grains	0.767 (0.417)	0.762 (0.427)
Dairy products	1.277 (0.582)	1.331 (0.696)
Fruits	1.008 (0.011)	1.123 (0.179)
Vegetables	0.872 (0.160)	0.853 (0.183)
Other foods	0.689 (0.309)	0.699 (0.299)

[a]Values in parenthesis are standard errors.

Table 3: Uncompensated and compensated own-price elasticities for broad food groups

Broad food groups	Uncompensated elasticity		Compensated elasticity	
	Bottom-up approach	**Top-down approach**	**Bottom-up approach**	**Top-down approach**
Meat and fish	-0.894	-1.309	-0.530	-0.949
	(0.292)[a]	(0.410)	(0.273)	(0.510)
Grains	-1.334	-1.258	-1.045	-0.970
	(0.677)	(0.543)	(0.783)	(0.654)
Dairy products	-0.633	-0.958	-0.550	-0.874
	(0.790)	(0.110)	(0.774)	(0.114)
Fruits	0.279	-1.061	0.318	-1.019
	(1.871)	(0.086)	(1.862)	(0.109)
Vegetables	-0.926	-1.123	-0.808	-1.007
	(0.079)	(0.169)	(0.081)	(0.216)
Other foods	-1.088	-1.238	-0.986	-1.135
	(0.115)	(0.263)	(0.169)	(0.311)

[a]Values in parenthesis are standard errors.

Table 4: Expenditure elasticities for individual commodities within broad food groups

Food item	Bottom-up approach	Top-down approach
Meat and fish		
Beef/Mutton/Pork	-0.94	1.75
Chicken	-1.92	0.88
Eggs	-0.96	1.63
Fresh fish	-0.12	1.44
Tinned fish	-2.97	0.90
Grains		
Maize	0.55	0.80
Mealie meal	0.49	0.65
Rice	0.57	0.81
Bread	0.65	0.81
Wheat	0.46	0.78
Breakfast cereal	0.40	0.79
Dairy products		
Butter/Ghee/Margarine	-2.40	1.09
Cheese	-0.40	1.41
Fresh dairy/Sour dairy/Yogurt	-1.08	1.45
Baby formula/milk powder	-8.32	0.99
Fruits		
Banana	0.39	1.02
Apples	0.41	1.26
Citrus fruits	0.34	0.79
Vegetables		
Dry Peas/Lentils/Beans	-0.53	0.91
Potatoes	-1.35	0.84
Tomatoes	-1.48	0.70
Sweet Potatoes	-0.26	0.91
Pumpkin/Squash	-0.41	0.90
Other vegetables	-2.44	0.91
Other foods		
Vegetable oil	-1.30	0.47
Jam	-0.30	0.71
Sugar	-1.02	0.56
Soft drink	-26.21	0.96

Table 5: Uncompensated and compensated own-price elasticities for individual commodities

Food item	Uncompensated elasticity		Compensated elasticity	
	Bottom-up approach	**Top-down approach**	**Bottom-up approach**	**Top-down approach**
Beef/Mutton/Pork	-1.14	0.21	-1.16	0.39
Chicken	-0.79	-0.08	-0.85	-0.01
Eggs	-1.58	0.09	-1.58	0.28
Fresh fish	-1.15	-0.03	-1.14	-0.02
Tinned fish	0.01	2.61	-0.02	2.63
Maize	-0.96	-0.44	-0.93	-0.41
Mealie meal	-0.49	-1.80	-0.39	-1.57
Rice	-0.87	0.00	-0.85	0.04
Bread	-0.83	-1.31	-0.78	-1.25
Wheat	-0.93	-0.06	-0.89	-0.03
Breakfast cereal	-0.93	-0.09	-0.92	-0.09
Butter/Ghee/Margarine	-0.44	0.23	-0.46	0.26
Cheese	-0.80	0.10	-0.79	0.12
Fresh dairy/Sour dairy/Yogurt	-0.74	0.46	-0.74	0.56
Baby formula/milk powder	-0.12	1.00	-0.19	1.02
Banana	-1.11	0.57	-1.10	0.59
Apples	-1.15	0.31	-1.14	0.37
Citrus fruits	-1.62	-0.23	-1.61	-0.21
Dry peas/Lentils/Beans	-2.06	-0.53	-2.05	-0.51
Potatoes	-1.12	-0.14	-1.13	-0.08
Tomatoes	-1.13	-0.04	-1.14	-0.02
Sweet Potatoes	-1.25	-0.08	-1.25	-0.07
Pumpkin/Squash	-0.94	0.05	-0.94	0.06
Other vegetables	-1.16	0.10	-1.20	0.14
Vegetable oil	-1.36	-0.17	-1.37	-0.15
Jam	-1.42	-0.16	-1.42	-0.15
Sugar	0.76	-0.37	0.75	-0.30
Soft drink	53.82	-0.15	53.27	-0.11