Choosing between the AIDS and Rotterdam models: A meat demand analysis case study

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Abstract

Due to the inability of economic theory to choose ex ante between the Almost Ideal Demand System (AIDS) and the Rotterdam model, a non-nested test was used. The results of the non-nested test points to the Linearized-AIDS model applied to 31 years of meat consumption data in South Africa. When comparing the estimated demand relations of the two models, the LA/AIDS model also proved to be a better fit for South African meat demand.

1. Introduction

Functional form is an important issue in empirical production and consumption studies. Dameus *et al* (2002) indicate that different functional forms often result in very different elasticity estimates and that most researchers often arbitrarily select one or the other model in advance.

Alston and Chalfant (1993) state that two demand systems have gained prominence in demand analysis: the Almost Ideal Demand System (AIDS) and the Rotterdam model. Economic theory does not provide a basis of choosing *ex ante* between the two models, and merely provides a limited basis for *ex post* discrimination (such as when one model violates the law of demand or another strong prior belief). Authors like Alston and Chalfant (1991) and Bester and Wohlgenant (1991) show the importance of selecting the appropriate model, as the two models may lead to different results in some applications.

Taljaard (2003) applies two different but related models to the meat industry in South Africa, i.e. the Linearized AIDS (LA/AIDS) and the Rotterdam models. In this article, a non-nested test selects the superior model, based on the estimated results of these two models.

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2. Problem statement and historical background

Red meat constitutes one of the most important agricultural products, both worldwide and in South Africa. This applies to its contribution to the total gross value of production of agricultural commodities, and also to its value in the value adding system of other commodities and products.

Over the last 30 years, the relative consumption share of the various meat products in Rand value terms has changed significantly. Since 1970, the share of beef, pork and mutton has decreased by 43.7%, 10.4% and 44.4% respectively. In the case of chicken, an increase of more than 46.2% compared to the total expenditure on the other three commodities has been recorded. Hancock *et al* (1984) state that, in spite of this threat to red meat producers, insufficient research has been conducted on the demand for red meat in South Africa.

When comparing demand relations of red meat in South Africa as estimated by various studies in the past, significant differences are revealed. According to Lubbe (1992), these differences can be ascribed to four main factors. A first reason can be real price movements in the time periods covered by the studies. Secondly, the market level, wholesale or retail, at which the elasticities were estimated, could differ. In the third place, the time period, long or short term, over which the elasticities were estimated, can also influence the value of the elasticity significantly. A fourth, and surely one of the most important reasons why estimated demand relationships for red meat in South Africa are not directly comparable, is the different methodologies that have been used in the estimation process.

3. Overview of previous South African meat demand studies

As mentioned above, using different methodological frameworks in demand analysis is largely the reason for differences in estimated demand relations. Table 1 provides a summary of most quoted South African studies that estimated demand relations for livestock/meat.

In an econometric analysis of the demand for and the supply of red meat in South Africa, Du Toit (1982) estimated both long and short-term price elasticities at retail level for the period 1959 to 1978. Du Toit (1982) found that, at retail level, the short-term own price elasticity of beef is higher than in the long term, with the opposite being true in the case of mutton.

Table 1: Summary of previously estimated demand relations for meat in South Africa

Author and year published	Time span of study	Functional form/ model used	Commodities included in study
Du Toit (1982)	59/60 – 78/79	Ordinary Least Squares (OLS)	Beef, mutton, pork and chicken
Hancock *et al* (1984)	1962 – 1981	Single and simultaneous OLS equations	Beef, mutton, pork and chicken
Loubser (1990)	Unknown	OLS	Various categories of beef, mutton, pork, chicken and other
Badurally-Adam (1998)	1971 – 1996	Rotterdam model	Beef, mutton, pork and chicken

Source: Liebenberg and Groenewald (1997) and Badurally-Adam (1998).

Hancock *et al* (1984) regarded the own price elasticities of beef (-0.96), mutton (-1.93), pork (-1.86) and poultry (-1.66) as relatively high. Except for beef in the poultry demand equation, all other coefficients behaved according to economic expectations. Hancock *et al* (1984) assigned little importance to calculated income elasticities, due to the fact that the elasticities were derived from time series data and that it might include dynamic effects such as changes in income distribution, urbanization, and the structure of the population over time. Flexibilities, calculated from inverse demand functions, were also calculated for the same period and appeared to be more stable than the quantity-dependent equations.

Short-run term price elasticities using quarterly wholesale data were also estimated by means of simultaneous equation techniques. The reason given by Hancock *et al* (1984) for the high own price elasticity coefficients is similar to that offered by Liebenberg and Groenewald (1997), namely that the elasticities are based on quarterly data (short-term data).

Laubscher and Kotze (1984) found significant differences in income elasticities among the different population groups. According to Laubscher and Kotze (1984) these income elasticities suggest that non-whites in general and blacks in particular will spend a greater proportion of any increase in their real per capita income on meat and meat products than whites.

In a research report of the Bureau of Market Research, Loubser (1990) provided estimated income elastisities for small categories, for example bulk beef, fresh beef, beef mince and beef bones. The income elasticities were aggregated (weighted) using expenditure data to obtain the income elasticities for different population groups: Asians, blacks, rural blacks, coloureds and whites. Estimated income elasticities for bulk beef were found to be the highest for single black households (1.67), followed by multiple black households (1.15), asians (0.65), whites (0.32) and lastly coloureds (0.16). In the case of bulk mutton, the estimated income elasticities with respect to bulk mutton were the highest for asians (1.9), followed by single black households (1.35), multiple black households (1.28), whites (0.22) and lastly coloureds (0.17). In the case of poultry, income elasticities for asians (1.11) were again found to be the highest, followed by single black households (0.69), multiple black households (0.64), whites (0.26) and lastly coloureds (-0.21).

Badurally-Adam (1998) used the Rotterdam model to estimate the demand for South African meat (beef, chicken, mutton and pork) for the period 1971 to 1995. He further analyzed the possible impacts of a Free Trade Agreement (FTA) between South Africa and the European Union. The results indicate that a 1% change in beef price, following a FTA between SA and the EU, would have a relatively greater impact on the consumption of other meats than would a 1% change in chicken, mutton or pork prices. For example, a 1% fall in the beef price would cause chicken consumption to fall by 0.43%, while a 1% fall in chicken price would reduce beef consumption by only 0.14% (Badurally-Adam, 1998).

It is clear that more recent research in the field of meat demand could make a valuable contribution to improving the accuracy of demand change predictions. This is especially important, because, firstly, since the start of the deregulation process of the agricultural sector in 1994, role players have faced more volatile market prices, and thus rely on their own analyses and interpretations of these markets for decision-making. Various authors have estimated demand relations of red meat products in the past. However, with the exception of Badurally-Adam (1998), most of these estimations date back to before 1994, with the bulk dating as far back as the late 1970s and mid 1980s. These elasticities cannot be used for predictions since many structural changes have occurred in South Africa since that time. These changes have surely had an impact on the demand relations of red meat products.

A second reason for concern with regard to the existing demand relations is that the focus of consumption analysis moved to a system- wide approach during the last two decades. The elasticities that currently exist for red meat products in South Africa were estimated by means of more traditional techniques, e.g. single or double log equations. These single equation techniques do not adhere to all the restrictions implied by macroeconomic demand theory, and therefore cannot be used for predictions, as the mentioned restrictions can influence the magnitudes of the estimated elasticities.

The methodological framework discussed in the next section is used to choose between two system-wide demand models that basically address the two concerns mentioned above.

4. Methodological framework

The Rotterdam and LA/AIDS models exhibit many similarities. They both have locally flexible functional forms, they have the same data requirements, they are equally parsimonious with respect to number of parameters, and both are linear in parameters. Alston and Chalfant (1991) point out that, since these two models share these characteristics, and most alternatives do not, these two models are likely to continue to be selected more often than other models.

The respective assumptions used to parameterize the AIDS and Rotterdam systems have different implications. One implication is that the marginal expenditure shares and Slutsky terms are assumed to be constant in the Rotterdam model, while they are assumed to be functions of the budget shares in the AIDS model (Lee *et al,* 1994).

The theoretical specification of the non-nested test used in this study was obtained largely from Pesaran and Pesaran (1997), Greene (2000) and Johnston and Dinardo (1997).

Consider the following two models:

LA/AIDS: $f(y) = X\beta_1 + u_1 \qquad u_1 \approx N(0, \sigma_1^2 I)$ (1)

Rotterdam: $g(y) = Z\beta_2 + u_2 \qquad u_2 \approx N(0, \sigma_2^2 I)$ (2)

where X is a n × k vector and Z is a n × l vector.

Generally the two distinct models may have some explanatory variables in common, so that:

$$X = [X_1 X_*] \qquad Z = [X_1 Z_*] \quad (3)$$

Testing is accomplished by setting up a composite or artificial model within which both models are nested. This composite model can be written as:

$$Composite: y = (1-\alpha)X\beta + \partial\alpha(Z\gamma) + u \quad (4)$$

where α is a scalar parameter.

When α = 0, the composite model reduces to the LA/AIDS model, and conversely, when α = 1, the composite model reduces to the Rotterdam model. Davidson and MacKinnon (1981) suggest that, in order to test for the LA/AIDS (Equation 1), the unknown γ vector in Equation 4 can be replaced by its OLS regression estimate from the Rotterdam model (Equation 2). The following hypotheses can then be tested:

H_0: α = 0
H_a: α ≠ 0

If H_0 is accepted; then the LA/AIDS (Equation 1) is the superior model; conversely if H_0 is rejected it implies the selection of the Rotterdam model (Equation 2). The following test statistics may be used to test the hypotheses: The P_E test statistic, the Bera-McAlees (BM) test statistic, the double-length (DL) regression test statistic, and the Cox's non-nested statistic computed by simulation. These test statistics can be explained by:

The PE statistic, when testing LA/AIDS against Rotterdam, uses the t-ratio of α(LA/AIDS) in the following auxiliary regression:

$$f(y) = Xb + \alpha_f [Z\hat{B}_2 - g(f^{-1}\{X\hat{B}_1)\}] + Error \qquad (5)$$

Similarly, the PE statistic for testing the Rotterdam model against LA/AIDS is given by the t-ratio α (Rotterdam) in the auxiliary regression:

$$g(y) = Zd + \alpha_g [X\hat{B}_1 - f(g^{-1}\{Z\hat{B}_2)\}] + Error \qquad (6)$$

where $\hat{B}_1$ and $\hat{B}_2$ represents the OLS estimators of β1 and β2 under LA/AIDS and Rotterdam respectively. This statistic was first proposed by Davidson and MacKinnon (1981).

The BM statistic is used for testing the linear against the log-linear model. It can however be readily extended to general known one-to-one transformations of the dependent variable of interest (Pesaran & Pesaran, 1997). In order to calculate the BM statistic to test LA/AIDS against Rotterdam, the residual $\hat{\eta}_g$ is first calculated from the regression of,

$$g[f^{-1}(X\hat{\beta}_1)] \qquad (7)$$

on Z. Then the BM statistic for the test of LA/AIDS against Rotterdam, on the one hand, is calculated as the t-ratio of θf in the auxiliary regression:

$$f(y) = Xb + \theta_f \hat{\eta}_g + Error \tag{8}$$

On the other hand, to test for Rotterdam against LA/AIDS the BM statistic is given by the t-ratio of θ_g in the following auxiliary regression:

$$g(y) = Zd + \theta_g \hat{\eta}_f + Error \tag{9}$$

where $\hat{\eta}_f$ is the residual vector of the regression of

$$f[g^{-1}(Z\hat{\beta}_2)] \tag{10}$$

on X.

The double-length (DL) regression statistic is used to test for LA/AIDS and Rotterdam and can be given by the Equation 11:

$$DL_f = 2n - SSR_f \tag{11}$$

SSR_f represents the sums of squares of residuals of the DL regression. For a more detailed description of the DL regression, the reader is referred to Pesaran and Pesaran (1997).

Three alternative versions of the Cox statistic are considered. Similar to the BM test, the interested reader is referred to Pesaran and Pesaran (1997) for a detailed description of the Cox statistic.

5. Empirical results

In order to reach a conclusion, the Saragan's and the Vuong's likelihood criteria for LA/AIDS model (M1) versus the Rotterdam model (M2) are used. Tables 2 to 5 list the non-nested test results for all four-share equations (beef, chicken, pork and mutton). In the case of all four-share equations, the Saragan's and Vuong's likelihood criteria favour the M1, i.e. the LA/AIDS model.

Table 2: Non-nested tests by simulation of the beef share equation

Dependent variable in model M1 is BW-BW(-1)
Dependent variable in model M2 is ((BW+BW(-1))/2)*DLOGQB
29 observations used from 1972 to 2000. Number of replications 100

Estimates of parameters of M1			Estimates of parameters of M2		
	Under M1	Under M2		Under M2	Under M1
Constant	-.013949	.21086	C	-.011804	-.011808
Price of beef	.15374	1.2096	Price of chicken	.018506	.019066
Price of chicken	-.10824	-2.6271	Price of beef	-.098365	-.098855
Price of pork	-.055965	-2.9370	Price of pork	-.0098775	-.010129
Price of mutton	.045759	-.97997	Price of mutton	.097079	.095418
Real expenditure	.17902	-1.7588	Real expenditure	.59160	.58916
Standard Error	.017615	4.6328	Standard Error	.017729	.017620
Adjusted Log-L	78.9819	-74.6793	Adjusted Log-L	-34.9094	-34.7294
Non-Nested Test Statistics and Choice Criteria					
Test Statistic		**M1 against M2**		**M2 against M1**	
S-Test 100 replications		.45890[.646]		-30.7833[.000]	
PE-Test		-12.8442[.000]		.63555[.525]	
BM-Test		-12.8442[.000]		.63555[.525]	
DL-Test		6.5472[.000]		.96039[.337]	

Notes: Sargan's Likelihood Criterion for M1 versus M2= 113.8913 **favours M1**
Vuong's Likelihood Criterion for M1 versus M2= 116.0892[.000] **favours M1**
S-Test is the SC_c test proposed by Pesaran and Pesaran (1997) and is the simple version of the simulated Cox test statistic.
PE-Test is the PE test due to MacKinnon, White and Davidson.
BM-Test is due to Bera and McAleer.
DL-Test is the double-length regression test statistic due to Davidson and MacKinnon.

Table 3: Non-Nested Tests by Simulation of the chicken share equation

Dependent variable in model M1 is CW-CW(-1)
Dependent variable in model M2 is ((CW+CW(-1))/2)*DLOGQC
29 observations used from 1972 to 2000. Number of replications 100

Estimates of parameters of M1			Estimates of parameters of M2		
	Under M1	Under M2		Under M2	Under M1
Constant	.0071398	2460137	C	.0052036	.0048621
Price of beef	-.10649	4934417	Price of chicken	.0032221	.0050067
Price of chicken	.21843	-9837163	Price of beef	.029152	.029051
Price of pork	-.018818	-9593487	Price of pork	-.015425	-.015759
Price of mutton	-.036574	2144697	Price of mutton	.043807	.043215
Real expenditure	-.12886	-5832681	Real expenditure	.18580	.18418
Standard Error	.015889	8366474	Standard Error	.013929	.013463
Adjusted Log-L	81.9717	-483.4638	Adjusted Log-L	-41.0529	-40.0627
Non-Nested Test Statistics and Choice Criteria					
Test Statistic		**M1 against M2**		**M2 against M1**	
S-Test 100 replications		.17455[.861]		-30.6494[.000]	
PE-Test		-13.4141[.000]		1.1528[.249]	
BM-Test		-13.4141[.000]		1.1528[.249]	
DL-Test		6.5223[.000]		1.2207[.222]	

Notes: Sargan's Likelihood Criterion for M1 versus M2= 123.0246 **favours M1**
Vuong's Likelihood Criterion for M1 versus M2= 35.9656[.000] **favours M1**
S-Test is the SC_c test proposed by Pesaran and Pesaran (1997) and is the simple version of the simulated Cox test statistic.
PE-Test is the PE test due to MacKinnon, White and Davidson.
BM-Test is due to Bera and McAleer.
DL-Test is the double-length regression test statistic due to Davidson and MacKinnon.

Table 4: Non-Nested Tests by Simulation of the pork share equation

Dependent variable in model M1 is PW-PW(-1)
Dependent variable in model M2 is ((PW+PW(-1))/2)*DLOGQP
29 observations used from 1972 to 2000. Number of replications 100

Estimates of parameters of M1			Estimates of parameters of M2		
	Under M1	**Under M2**		**Under M2**	**Under M1**
Constant	-.6115E-3	-.24815	C	-.4864E-3	.0017608
Price of beef	-.010339	.44298	Price of chicken	-.0027707	-.0072178
Price of chicken	-.022905	.11695	Price of beef	.020705	.015087
Price of pork	.047834	.28704	Price of pork	-.015871	-.014968
Price of mutton	-.0089259	.15440	Price of mutton	.0023089	.0015230
Real expenditure	-.0018580	1.9350	Real expenditure	.053466	.011019
Standard Error	.0041970	.37344	Standard Error	.0039739	.0045362
Adjusted Log-L	120.5791	-7.6026	Adjusted Log-L	12.4084	8.5723

Non-Nested Test Statistics and Choice Criteria		
Test Statistic	**M1 against M2**	**M2 against M1**
S-Test 100 replications	-.34413[.731]	-28.7390[.000]
PE-Test	-6.4764[.000]	-.11860[.906]
BM-Test	-6.4764[.000]	-.11860[.906]
DL-Test	6.9612[.000]	.91127[.362]

Notes: Sargan's Likelihood Criterion for M1 versus M2= 108.1708 **favours M1**
Vuong's Likelihood Criterion for M1 versus M2= 144.2963[.000] **favours M1**
S-Test is the SC_c test proposed by Pesaran and Pesaran (1997) and is the simple version of the simulated Cox test statistic.
PE-Test is the PE test due to MacKinnon, White and Davidson.
BM-Test is due to Bera and McAleer.
DL-Test is the double-length regression test statistic due to Davidson and MacKinnon.

Table 5: Non-Nested Tests by Simulation of the mutton share equation

Dependent variable in model M1 is MW-MW(-1)
Dependent variable in model M2 is ((MW+MW(-1))/2)*DLOGQM
29 observations used from 1972 to 2000. Number of replications 100

Estimates of parameters of M1			Estimates of parameters of M2		
	Under M1	**Under M2**		**Under M2**	**Under M1**
Constant	.0074205	.14971	C	.0074942	.0077880
Price of beef	-.036913	1.7821	Price of chicken	-.045361	-.048168
Price of chicken	-.087280	.22816	Price of beef	.035415	.037533
Price of pork	.026949	-.87112	Price of pork	.040304	.041649
Price of mutton	-.2593E-3	-2.0579	Price of mutton	-.12769	-.13196
Real expenditure	-.048304	-5.1458	Real expenditure	.092857	.089198
Standard Error	.0091423	1.0780	Standard Error	.0095984	.0099646
Adjusted Log-L	98.0012	-36.0623	Adjusted Log-L	-7.3212	-8.4017

Non-Nested Test Statistics and Choice Criteria		
Test Statistic	**M1 against M2**	**M2 against M1**
S-Test 100 replications	.24490[.807]	-25.8300[.000]
PE-Test	-20.4992[.000]	-1.5457[.122]
BM-Test	-20.4992[.000]	-1.5457[.122]
DL-Test	6.9042[.000]	1.1616[.245]

Notes: Sargan's Likelihood Criterion for M1 versus M2= 105.3224 **favours M1**
Vuong's Likelihood Criterion for M1 versus M2= 121.6122[.000] **favours M1**
S-Test is the SC_c test proposed by Pesaran and Pesaran (1997) and is the simple version of the simulated Cox test statistic.
PE-Test is the PE test due to MacKinnon, White and Davidson.
BM-Test is due to Bera and McAleer.
DL-Test is the double-length regression test statistic due to Davidson and MacKinnon.

A similar conclusion can be reached by comparing the estimated elasticities (see Tables 6 to 11) and the statistical significance of the two models directly. The compensated own price and cross-price elasticities for the LA/AIDS and Rotterdam models are reported in Tables 6 and 9 respectively. Except for the two cross-price elasticities of pork for chicken and vice versa, the rest of the LA/AIDS compensated price elasticities show the typical assumed signs and are statistically significant at the 5% level of confidence. The LA/AIDS models' compensated own price elasticities of all four meat products are relatively inelastic and carry negative signs as expected *a priori*, and are statistically significant at the 5 per cent level.

Table 6: LA/AIDS model compensated price elasticities of South African meat products (1970–2000)

	Beef	Chicken	Pork	Mutton
Beef	**-0.161*** *(-9.99)*	0.139* *(8.75)*	0.375* *(17.63)*	0.060*
Chicken	0.087* *(8.75)*	**-0.193*** *(-12.43)*	-0.172* *(-10.17)*	0.173*
Pork	0.053* *(17.63)*	-0.039* *(-10.17)*	**-0.305*** *(-19.65)*	0.043*
Mutton	0.020* *(2.00)*	0.094* *(7.01)*	0.103* *(4.75)*	**-0.277**

*Indicates significance at the 5% level; t-ratios are in parentheses.

Table 7: LA/AIDS model uncompensated elasticities of South African meat products (1970–2000)

	Beef	Chicken	Pork	Mutton
Beef	**-0.750*** *(-33.87)*	-0.11* *(-4.72)*	-0.074* *(-2.49)*	-0.5*
Chicken	-0.282* *(-20.46)*	**-0.35*** *(-18.5)*	-0.454* *(-21.24)*	-0.178
Pork	-0.030* *(-8.18)*	-0.074* *(-16.39)*	**-0.37*** *(-23.33)*	-0.036*
Mutton	-0.18* *(-15.58)*	0.009 *(0.63)*	-0.05* *(-2.17)*	**-0.468**

*Indicates significance at the 5% level; t-ratios are in parentheses.

Table 8: LA/AIDS model expenditure elasticities of South African meat products (1970– 2000)

	Beef	Chicken	Pork	Mutton
Expenditure	1.243* *(38.60)*	0.526* *(14.56)*	0.948* *(21.6)*	1.182

*Indicates significance at the 5% level; t-ratios are in parentheses.

Table 9: Rotterdam model compensated elasticities of South African meat products (1970–2000)

	Beef	Chicken	Pork	Mutton
Beef	**-0.256*** *(-12.82)*	0.153* *(9.31)*	0.315* *(15.16)*	0.340*
Chicken	0.096* *(9.31)*	**-0.116*** *(-7.60)*	-0.104* *(-6.03)*	-0.026
Pork	0.045* *(15.17)*	-0.024* *(-6.03)*	**-0.260*** *(-16.92)*	0.021*
Mutton	0.116* *(7.06)*	-0.014 *(-0.94)*	0.049* *(2.09)*	**-0.335**

*Indicates significance at the 5% level; t-ratios are in parentheses.

Table 10: Rotterdam, model uncompensated elasticities of South African meat products (1970–2000)

	Beef	Chicken	Pork	Mutton
Beef	**-0.544*** *(-22.26)*	0.128* *(6.278)*	0.308* *(11.98)*	-1.386
Chicken	-0.084* *(-6.22)*	**-0.131*** *(-7.72)*	-0.109* *(-5.52)*	-1.109
Pork	0.004 *(1.09)*	-0.027* *(6.34)*	**-0.261*** *(-16.83)*	-0.225*
Mutton	0.018 *(1.04)*	-0.022 *(1.46)*	0.047* *(1.94)*	**-0.923**

*Indicates significance at the 5% level; t-ratios are in parentheses.

Table 11: Rotterdam model expenditure elasticities of South African meat products (1970–2000)

	Beef	Chicken	Pork	Mutton
Expenditure	0.607* *(20.35)*	0.053* *(2.051)*	0.015 *(0.48)*	3.642

*Indicates significance at the 5% level; t-ratios are in parentheses.

Similar to the own price elasticities, the cross-price elasticities are all statistically significant at the 5 per cent level. In the case of the Rotterdam model, 4 of the 16 estimated elasticities have uncharacteristic signs and 1 is not statistically significant at the 5% level of confidence.

Tables 7 and 10, in turn, report on the uncompensated own price and cross price elasticities for the LA/AIDS and Rotterdam models respectively. In the case of the uncompensated own and cross price elasticities, for the LA/AIDS model, 11 have the unexpected signs and two were not statistically significant at the 5% level of confidence. In the case of the Rotterdam model, seven out of the 16 estimated elasticities have the wrong signs and five were not statistically significant. In the case of the LA/AIDS model, the uncompensated own price elasticities of beef (-0.75), chicken (-0.35), pork (-0.37) and mutton (-0.47) are significantly lower than some previous estimates for meat in South Africa. Hancock *et al* (1984) also estimated price elasticities, though for the time period 1962 to 1981, and found significantly higher figures for some products, than those mentioned above. The own price elasticities they reported, for example, were beef (-0.96), poultry (-1.66), pork (-1.86) and mutton (-1.93).

Badurally-Adam and Darroch (1997) report on Slutsky (compensated) price elasticities estimated by means of a Rotterdam model, which are more elastic than the estimates of this study. Interesting to note is that both Badurally-Adam and Darroch (1997) and Taljaard (2003) found the cross price elasticity between chicken and pork and vice versa to be negative, as in both the cases of the LA/AIDS model and the Rotterdam model in the present study. In addition, the cross-price elasticity of chicken for mutton calculated by means of the Rotterdam model in both studies, were also found to be negative, i.e. complements.

When calculating uncompensated elasticities for Korea, Jung (2000) found some of the calculated uncompensated cross-price elasticities to be negative. Products for which Jung (2000) found unexpected signs include the cross-price elasticity of imported beef for chicken, imported beef for crustacean (a fish group), pork for Hanwoo beef, pork for imported beef, pork for chicken, pork for crustacean, chicken for imported beef, chicken for pork, chicken for crustacean, fish for pork, fish for chicken, crustacean for imported beef, crustacean for pork, crustacean for chicken, mollusc for beef and mollusc for chicken. Most of the elasticities mentioned were found to be statistically insignificant, therefore no further explanations were given with regard to the negative signs in the particular study.

The expenditure elasticities for the two respective models are provided in Tables 8 and 11. The expenditure elasticities of both models carry the expected positive signs and all are statistically significant at the 5% level of confidence, except for the expenditure elasticity of pork in the Rotterdam model. Corresponding to these expenditure elasticities are the conditional income elasticities estimated by Badurally-Adam and Darroch (1997), who also classified beef and mutton as luxury products, whereas pork and chicken were found to be normal goods.

6. Conclusions

This article presents the results of a non-nested test for choosing between the Rotterdam and the LA/AIDS model to estimate South African meat demand. Like the estimation of other direct comparisons, i.e. *a priori* expectations or a comparison of the statistical significance between the estimated results of the two models, the non-nested test also favours the LA/AIDS model. This result coincides with that of a similar study conducted on the demand for meat and fish in Korea (Jung, 2000). Jung also found that the LA/AIDS model fits the meat and fish data in Korea better than the Rotterdam model.

Most of the compensated own and cross-price elasticities calculated, as well as the expenditure elasticities of all four meat products, were found to be statistically significant at the 10% level of significance. Not all the cross-price elasticities (compensated and uncompensated) carry positive signs. In the case of the compensated cross-price elasticities, only two (pork for chicken and vice versa) are negative.

A possible explanation for unexpected signs in the case of the uncompensated elasticities is that, when consumers experience a change in their relative disposable income (DI), whether positive or negative, most households first decide what percentage of income to save and spend. Consumers will probably first decide on the amount to be saved. The remainder of the DI, once the decision has been made about savings, leaves consumers with a certain amount to be spent on a conglomeration of goods and services, of which meat products form part. With meat being considered a normal product or, in some cases, a luxury product by a large part of the South African population, a rise in disposable income will lead to an increase in the consumption of meat (positive income elasticity).

Considering the income effect as the difference between compensated and uncompensated cross-price elasticities, a further explanation for the unexpected signs is that South African consumers tend to prefer specific meats. In the case of the uncompensated cross-price elasticities, where the income effect is also captured in the elasticity, some of the meat products tend to be classified as complements (negative cross-price elasticity). This implies that, as the DI of consumers increase, consumers tend to consume different meat products altogether, as well as some other complementary products.

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