DEMAND RELATIONS OF OILSEED PRODUCTS IN SOUTH AFRICA

by

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ABSTRACT

In this study demand relations for primary oilseeds in South Africa is estimated and interpreted with the use of econometric models. Two different models, namely the Linear Approximate Almost Ideal Demand System (LA/AIDS) and the two-step Error Correction Model (ECM), were applied to annual oilseed data for the years 1971-2002.

The F ratio test for separability failed to reject the null hypothesis of weak separability in most cases, indicating that sunflower seed, soybeans, groundnuts and cotton could be included in the same system and modeled together.

The Hausman test for exogeneity was conducted and proved that the expenditure variable included in the estimated equations is indeed exogenous. The exogeneity of the expenditure variable provides assurance that the Restricted Seemingly Unrelated Regression (RSUR) method of estimation will provide efficient parameter estimates. Both the short run models are estimated in differenced form, from where the parameter estimates obtained were used to calculate compensated, uncompensated and expenditure elasticities of demand.

The compensated own price elasticity of soybeans is the largest in absolute terms, with coefficients ranging from -0.579 in the LA/AIDS to -0.666 in the ECM. Seed cotton has the second largest compensated own price elasticity with -0.399 and -0.542 respectively in the two models. The compensated cross product elasticities indicate a predominantly substituting relationship between these oilseeds, even though not all of them are significant. According to the calculated uncompensated own price elasticities, seed cotton is the most price responsive i.e. (-0.745) in the ECM and soybeans (-0.617), in the LA/AIDS.

According to the expenditure elasticities sunflower seed (1.105) and cotton (1.064) can be regarded as luxury oilseeds in South Africa. Soybeans, with expenditure elasticities of between 0.454 and 0.493 in the two respective models, can be regarded as a normal good. Groundnuts can also be regarded as a luxury commodity even though it has an expenditure elasticity of just below one. The fact that the compensated own price elasticity of groundnuts is smaller in absolute terms than the expenditure elasticity is also an indication of a luxury product, as proved by Hicks and Juréen (1962).

VRAAGVERWANTSKAPPE TUSSEN OLIESADE IN SUID-AFRIKA

deur

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SAMEVATTING

In die studie word vraagverwantskappe tussen primêre oliesade geskat en geïnterpreteer deur middel van ekonometriese modelle. Twee verskillende modelle, naamlik die *Linear Approximated Almost Ideal Demand System (LA/AIDS)* en die *Error Correction Model (ECM)*, is geskat met behulp van data vir oliesade vir die jare 1971-2002.

Die F-toets vir onderskeibaarheid het nie daarin geslaag om die nul hipotese van swak onderskeibaarheid te verwerp nie. Die resultaat van die toets beteken dat sonneblom, sojabone, grondbone en katoen in dieselfde sisteem gemoddeleer kan word.

Die Hausman toets vir eksogeniteit is uitgevoer en het bewys dat die bestedingsterm wat in die vergelykings ingesluit is, inderdaad eksogeen is. Die eksogeniteit van die bestedingsterm verskaf sekerheid dat die "Beperkte Skeinbare Onverwante Regressie" (RSUR) metode van skatting goeie en betroubare beraamde koëffisiënte sal verskaf. Beide die korttermyn modelle word in eerste verskille geskat, waarna die beraamde koëffisiente wat verkry is, gebruik word om die gekompenseerde, ongekompenseerde en bestedingselastisiteite van vraag te bereken.

Die gekompenseerde eieprys elastisiteit van sojabone is die grootste in absolute terme in beide modelle met koëffisiente van -0.579 in die LA/AIDS en -0.666 in die ECM. Katoen het die tweede grootste gekompenseerde eiepryselastisiteit, met -0.399 en -0.542 in die twee modelle respektiewelik. Die gekompenseerde kruiselingse pryselastisiteite dui aan dat die oliesade wat in die studie ingesluit is, oorwegend substitute is, al is daar van die elastisiteite wat nie betekenisvol is nie. Die ongekompenseerde eiepryselastisiteite wat bereken is, dui aan dat katoen die pryssensitiefste is met (-0.745) in die ECM. Sojabone is weer die meeste (-0.617) pryssensitief in die LA/AIDS.

Volgens die berekende bestedingselastisiteite is sonneblom (1.105) en katoen (1.064) luukse oliesade in Suid-Afrika. Sojabone se bestedingselastisiteite is tussen 0.454 en 0.493 in die twee modelle onderskeidelik en kan dus gesien word as ‘n normale produk. Grondbone kan ook gesien word as ‘n luukse produk, al is sy bestedingselastisiteit kleiner as een. Die blote feit dat grondbone se gekompenseerde eiepryselastisiteit in absolute terme kleiner is as sy bestedingselastisiteit gee ook die indruk van ‘n luukse produk, soos bewys deur Hick en Juréen (1962).

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LIST OF ABBREVIATIONS

AIDS ....Almost Ideal Demand System

LA/AIDS ....Linear Approximated Almost Ideal Demand System

ECM ....Error Correction Model

SUR..Seemingly Unrelated Regression

RSUR.....................................Restricted Seemingly Unrelated Regression

Df...Degrees of Freedom

OLS..Ordinary Least Squares

Translog ....Transcendental Logarithmic

3SLS.......................................3 Stage Least Squares

CHAPTER 1

INTRODUCTION

1.1 Background

Oilseeds are regarded as one of the most important field crops produced in South Africa. This is not only true regarding its contribution to the gross value of production for agricultural commodities, but also in terms of its value in the value-adding system of other commodities and products. The demand for oilseeds originates mainly from animal feed manufacturers, who use it for feed rations and from demand for vegetable oils for industrial use and human consumption. The largest increase in the demand for feed rations was from the dairy industry, that bought 13.91% more rations between 1999 and 2001. The dairy industry is followed closely by the cattle and sheep industry with an increase of 13.49% for the same period (AFMA, 2003). The increase in the demand for oilcake was met by importing 51.1% of the total oilcake used in South Africa. Soybean oilcake constitutes the largest portion of the imported oilcake.

The increase in imports emphasizes the importance of the liberalization of international markets. However the subsequent impact of liberalization on the South African oilseed industry needs to be analyzed and well understood. One of the effects of these changes is that local commodity prices follow international commodity prices closely. This affects a number of factors, including strong consumer demand for oilseed products and substitution between oilseeds and other food and feed products for health, price and income reasons.

The demand for each product is a function not only of its own price, but also of the price of every other commodity and service. All prices, in theory at least, are linked in an interdependent system. A change in the price of one commodity brings about shifts in the demand for other commodities. The direction of change in demand depends on the direction of change in the price of the related commodity and on whether the related commodity is a substitute or a complement. For substitutes, the change in the price of the substitute and the change in demand are usually positively related.

According to a study conducted by Liebenberg & Groenewald (1997) no recent studies have been done on the demand relations of oilseed products. Most of the studies cited by Liebenberg and Groenewald were conducted before 1994 and no estimates were made specifically for oilseed products. After 1994 many changes took place, among which income distribution changes (shifts between racial groups) and therefore also changes in consumer preferences. These factors have a major impact on substitution effects and therefore on demand relations.

During the last two decades, consumer demand analysis has moved towards system-wide approaches. Numerous algebraic specifications of demand systems now exist, including the linear and quadratic expenditure systems, the Rotterdam model, translog models and the Almost Ideal Demand System (AIDS). Generally, different demand specifications have different implications (Lee, Brown and Seale, 1994).

1.2 Problem statement and need for the study

From the above background it should be clear that there are several reasons why research in this field could make a valuable contribution towards improving the accuracy of demand change predictions. Demand relations of different oilseed products have not yet been estimated in South Africa. Demand relations for food in aggregate dates back before 1987 with the bulk dating as far back as the 1970's and 1980's. These elasticities cannot be used for predictions as many structural changes have occurred in South Africa since that time, and furthermore the predictions are only applicable to food aggregates. These changes have surely had a large impact on the demand relations of oilseed products.

Another very important reason for undertaking this type of study arises from the way that the demand system is estimated. As mentioned above the system-wide approach became increasingly popular in the last two decades, bringing about greater efficiency in the estimation of demand relations compared to single equations estimation methods, that ignore the restrictions on consumer demand. The testing and imposition of demand restrictions, namely homogeneity and symmetry by the system-wide approach is however not always successful. Cozzarin and Gilmour (1998) found that homogeneity and symmetry were only tested in 29 and 39 percent of the models that they surveyed respectively, and these restrictions were rejected in 57 and 51 percent of the cases respectively. The fact that the majority of these estimated models did not comply with the theory of consumer demand seriously impedes their usefulness and ability to predict reality. This increases the usefulness and importance of the present study on the demand relations of oilseeds in South Africa, because this study tested for these restrictions, and its findings proved to be consistent with the theory of consumer demand.

1.3 Objectives of the study

The overall objective of this study is to estimate and interpret the demand relations of oilseed products in South Africa with the use of a systems approach. The sub-objectives of the study are the following:

- The development of a model by which demand relations can be estimated and easily updated for future use.
- The evaluation of factors affecting the consumption of oilseed products in South Africa.
- Testing of alternative demand model specifications in relation to each other in order to determine the best fit for the South African oilseed industry.

1.4 Motivation

From an agricultural decision making perspective, information on the demand relations of the various oilseed products can be of great value. Agricultural policy makers and producer organizations will, for instance, be able to use the results to calculate the effect of changing prices on the demand for various commodities. In turn, the information can be used by the various role players in the supply chain for strategic planning.

The origin of other important effects of the demand for oilseed lies in the animal feed sector. The demand for animal feed is a derived demand i.e. any change in the demand for meat will lead to changes in the demand for different animal feed rations.

In order for the oilseed industry to be internationally competitive and to position itself in the market place, the impact of global effects on the demand for oilseed may prove to be very important strategic information.

1.5 Methodology used

Blanciforti, Green and King (1986) state that there are basically two approaches to estimating demand systems. The first approach starts with an utility function that satisfies certain axioms of choice, namely completeness, transitivity and continuity. The demand functions can then be obtained by maximizing the utility function subject to a budget constraint.

The alternative approach uses a system of demand equations and imposes cross-equation restrictions consistent with consumer demand in order to obtain efficient parameter estimates. The Almost Ideal Demand System (AIDS), which is used in this study, is an example of a systems wide-approach to estimating consumer demand relations.

The Linear Approximated Almost Ideal Demand System (LA/AIDS) developed by Deaton and Muelbauer in the 1980s was used to estimate the demand relations for oilseed products in South Africa. As mentioned previously this type of estimation procedure is nonexistent in the South African oilseed context. This type of econometric modeling allows for the estimation of parameter estimates from which elasticities are calculated by means of mathematical formulas. The theoretical specifications of this technique are discussed in more detail in Chapter 4.

An Error Correction Model (ECM) based on the AIDS is also estimated, enabling estimation of short and long run elasticities of demand by estimating equations over both horizons. The ECM model was introduced by Engle and Granger (1987) and it represents a new and increasing popular type of econometric modeling. The reason is that the majority of prior econometric modeling discarded the long run properties of the estimated parameters, and this is overcome in the ECM model by introducing the error term of the long run equations in the modeling of the short run. This model is discussed and estimated in more detail in Chapter 5.

1.6 Chapter outline

Chapter 2 provides an overview of the South African oilseed industry with the emphasis on the production and consumption of the various primary oilseeds and the various uses of the by-products generated from processing the seeds. A review of relevant literature is presented in **Chapter 3** as well as potential factors influencing the South African oilseed industry, followed by a description of the properties of the time series data used in the estimation. **Chapter 4** deals with the theoretical specification and estimation of the Almost Ideal Demand System (AIDS) and the associated demand elasticities calculated. An Error Correction version of the AIDS model is described and estimated in **Chapter 5,** where short and long run elasticities are also calculated. **Chapter 6** provides a summary of the study as well as recommendations for possible further research.

CHAPTER 2

OVERVIEW OF THE SOUTH AFRICAN OILSEED INDUSTRY

2.1 Introduction

Oilseeds constitute one of the most important field crops in South Africa, as is also the case in the rest of the world. This applies not only to its contribution to the gross value of total agricultural production, but also to its value in the value adding chain. The importance of oilseeds relates to the fact that very little of the oilseeds produced is consumed in primary form. Processing oilseeds provides inputs to various other sectors of the economy, including agricultural inputs in the form of animal feedstuffs and industrial inputs in the manufacturing of products such as paints and lubricants.

This chapter provides an overview of the production and consumption of primary oilseed products in South Africa. Data on primary oilseeds were used of this study. The majority of the international demand studies done on oilseeds, as discussed in Chapter 3, used data on the secondary products i.e. the oils and oilcake. Due to the unavailability of data, this proved to be a near impossible task for South Africa.

2.2 Contribution of the oilseed industry towards the South African economy

Though the contribution of the agricultural sector in South Africa towards the GDP remained relatively stable during the past decade, significant decreases in agriculture's contribution to the GDP have occurred during the 20th century. The joint contribution of total agricultural production in 1967 amounted to 10.3% of the total gross domestic product, compared to only 4.3% in the year 2001 (NDA, 2003). Nevertheless, agriculture remains as important as ever to the South African, economy bearing in mind that 8.1% of the economically active population is employed in the primary sector. Considering the contribution of all the business linkages within the food and fibre sector, the contribution of agriculture towards the GDP is estimated at 42.5% (Doyer, 2003).

Table 2.1 shows the gross value of agricultural production in real terms since 1990/91. It is clear that over the period 1990/91 to 2000/01 the livestock sector was the most dominant agricultural sub-sector. Its contribution to the gross value of agricultural production declined somewhat in real terms since 1991. On the other hand, field crops' contribution was relatively stable since 1990/91, whilst horticultural crops have shown an increase. The contribution of the livestock sector to gross agricultural production also has an effect on the importance of the oilseed industry, as South Africa is a net importer of oilseed by-products used in animal feedstuffs, and approximately 75% of total South African beef production originates from feedlots (AFMA, 2002).

Table 2.1: Real gross value of agricultural production (1995=100)

Year	Field crops		Horticultural crops		Animal production		Total
	Rand Million	Contribution %	Rand Million	Contribution %	Rand Million	Contribution %	Rand Million
1990/91	12130.15	34.69	7673.44	21.94	15166.39	43.37	34969.97
1991/92	8421.62	27.64	7514.22	24.66	14531.36	47.70	30467.19
1992/93	11567.59	36.30	6717.67	21.08	13577.29	42.61	31862.55
1993/94	11352.27	35.47	7045.00	22.01	13605.45	42.51	32002.73
1994/95	8963.57	28.93	7669.51	24.75	14351.36	46.32	30984.44
1995/96	12906.18	36.44	8248.00	23.28	14267.79	40.28	35421.97
1996/97	12418.45	34.74	8439.78	23.61	14888.22	41.65	35746.46
1997/98	11039.05	31.61	8683.19	24.86	15199.50	43.52	34921.74
1998/99	11519.72	33.92	8957.80	26.38	13482.65	39.70	33960.17
1999/00	11142.93	31.36	9507.02	26.75	14886.38	41.89	35536.34
2000/01	12982.04	34.29	9821.98	25.94	15060.52	39.77	37864.54

Source: Own calculations based on NDA (2002)

Table 2.2 shows the gross value of production of the most important field crops produced in South Africa. It is clear that maize is the most important, followed by wheat, sugarcane and oilseeds.

Table 2.2: Real gross value of production of different field crops (1995=100)

Year	Maize (Rand Million)	Wheat (Rand Million)	Sugar cane (Rand Million)	Oilseeds (Rand Million)
1990/91	5100.09	1400.91	1595.61	1106.30
1991/92	2051.61	1819.41	1570.30	409.42
1992/93	5124.48	1143.37	1519.02	610.40
1993/94	5532.29	1696.37	1276.37	631.17
1994/95	2923.61	1437.96	1682.86	773.67
1995/96	5862.10	1521.73	1698.90	1063.23
1996/97	5340.43	2183.96	2030.64	660.90
1997/98	3724.38	1660.69	2206.18	970.76
1998/99	4171.41	1181.89	2230.41	1641.62
1999/00	4886.88	1286.68	1990.70	878.80
2000/01	4836.84	1904.48	2408.22	1342.14

Source: Own calculations based on NDA (2002)

Table 2.3 shows the contribution of sunflower seed, soybeans and groundnuts to the real gross value of total oilseed production. With respect to gross value of production, sunflower seed is the most important oilseed crop in South Africa, contributing 54.28% of the value of total oilseeds in the year 2000, followed by groundnuts, contributing 28.33% and soybeans 17.4%. It is interesting to note that the deviation from the average gross value of production and the deviation of its contribution to total oilseed production is the lowest for soybeans compared to the other two oilseeds products.

Table 2.3: The contribution of oilseed production to the real gross value of field crop production (1995=100)

Year	All oilseeds Rand (million)	Sunflower seed		Soybeans		Groundnuts	
		Rand (million)	Contribution to oilseeds (%)	Rand (million)	Contribution to oilseeds (%)	Rand (million)	Contribution to oilseeds (%)
1990/91	1106.30	728.26	65.83	160.27	14.49	217.77	19.68
1991/92	409.42	210.11	51.32	71.57	17.48	127.74	31.20
1992/93	610.40	366.42	60.03	72.66	11.90	171.32	28.07
1993/94	631.17	373.86	59.23	66.12	10.48	191.19	30.29
1994/95	773.67	546.57	70.65	56.33	7.28	170.77	22.07
1995/96	1063.23	661.48	62.21	93.12	8.76	308.63	29.03
1996/97	660.90	418.02	63.25	148.60	22.48	94.28	14.26
1997/98	970.76	666.67	68.68	184.02	18.96	120.07	12.37
1998/99	1641.62	1275.14	77.68	188.99	11.51	177.49	10.81
1999/00	878.80	433.79	49.36	164.96	18.77	280.05	31.87
2000/01	1342.14	728.46	54.28	233.47	17.40	380.20	28.33
STD DEV	**358.73**	**285.48**	**8.52**	**60.95**	**4.86**	**87.12**	**7.98**

Source: Own calculations based on NDA (2002)

The importance of the oilseed industry on the micro-level can be illustrated by the contribution of oilseeds to the gross income of the different provinces, as is shown in Table2.4. In three provinces, Gauteng, Northern Province and North West, oilseeds are the second most important field crop in terms of its contribution to the gross income of production.

Table 2.4: Percentage contribution of field crops to the gross income of production per province (average 1991-1995)

Field crop	North West	Gauteng	Northern Cape	Free State	Northern Province	Mpumalanga	Kwazulu-Natal
Maize	72.03	75.03	18.93	52.80	16.06	57.41	11.94
Oilseeds	14.28	8.52	9.49	11.84	18.38	6.57	0.98
Wheat	5.97	-	62.94	28.45	10.11	-	-
Tobacco	4.10	-	-	-	18.60	10.61	-
Drybeans	-	8.00	-	-	-	-	-
Hay	-	4.10	4.07	-	-	-	-
Sorghum	-	-	-	3.40	-	-	-
Sugar cane	-	-	-	-	-	3.40	79.78
Wattle bass	-	-	-	-	-	-	1.94

Source: NDA (1996)

In the Northern Cape and the Free State oilseeds are regarded as the third most important field crop. In Mpumalanga oilseeds contribute 6.57 percent to the gross income of field crops, i.e. the third most, whilst in KwaZulu-Natal its contribution is relatively small.

2.3 Oilseed production trends in South Africa

The following section provides an overview of the total hectares planted as well as the production of sunflower seed, groundnuts and soybeans for the period from 1990/91 to 2001/02.

Sunflower seed production

Figure 2.1 shows the area planted with sunflower and the total production in tonnes from 1990 to 2002. During the last decade, sunflower production fluctuated between 183 000 tonnes in 1991 and 1 212 000 tonnes in 1999. The annual demand over the last twelve years (1990/91 to 2001/02) for sunflower seeds was stable at approximately 562 000 tonnes. This means that whenever production exceeds 562 000 tonnes, downward pressure on prices can be expected. In fact, pressure on prices should start to bear when the sunflower crop approaches the 562 000 tonne level.

It is clear from Figure 2.1 that the yield per hectare has increased significantly since 1994/95. This increase in the quantity produced is an indication of increasing yields for sunflower seed producers, which could be attributed to better production practices and better technologies being applied. Another possible reason for the increase is that South Africa has experienced relatively good harvests in the last few years.

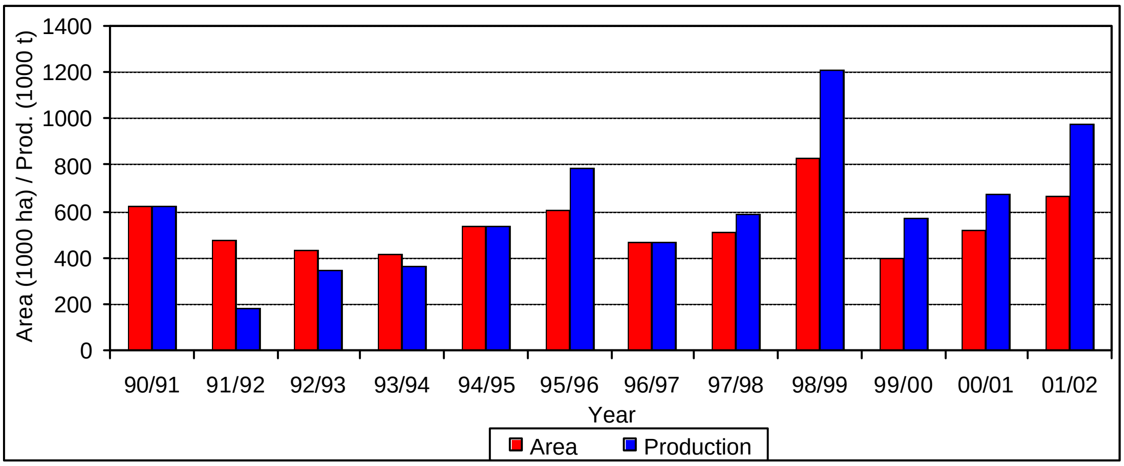

Figure 2.1: South African sunflower production ('000 tonnes and hectares) (1990/91 to 2001/02)

Source: NDA (2002).

Soybean production

Figure 2.2 shows the area planted and total production in tonnes of soybeans since 1990/91. After a decline in the area planted and production in the early 1990s, the area planted and total production rebounded to reach a record level in 2000/01. According to Van Zyl, Willemse and Weingartner (1999) the production of soybeans was hampered by the price support given to maize. The main difference between the profitability of maize and soybeans was a function of the maize price. Despite recent changes in the production of soybeans it is inadequate to meet domestic demand. According to AFMA (2003) the total amount of soybean oilcake available in 2002 for marketing in South Africa was

616 593 tonnes, of which 459 266 tonnes was imported. Most of these imports was imported as oilcake and not as primary soybeans.

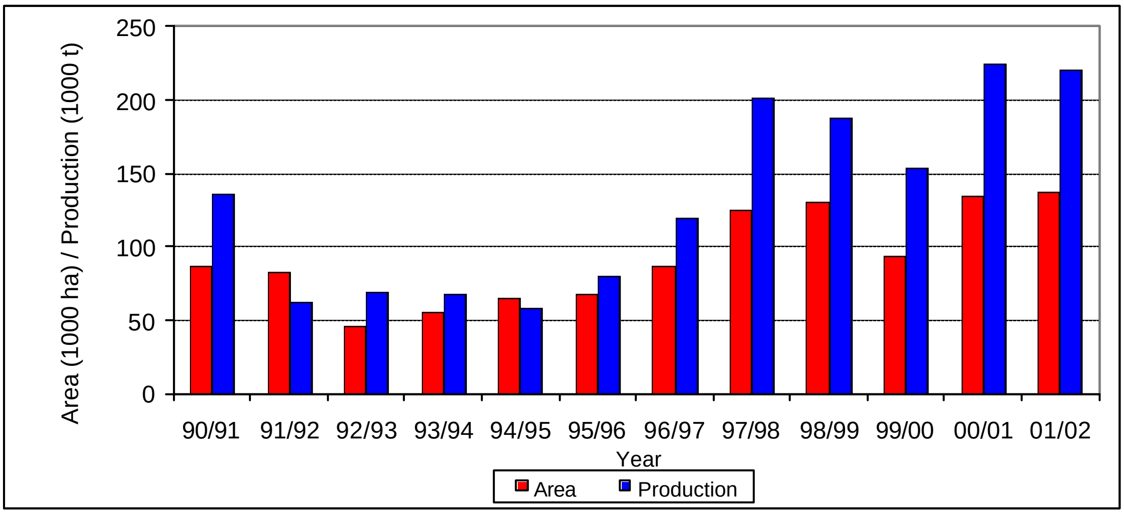

Figure 2.2: South African soybean production ('000 tonnes and hectares) (1990/91 to 2001/02)

Source: NDA (2002).

According to Van Zyl *et al.* (1999) the potential exists for local soybean production to increase to 250 000 tonnes. They, however, also provide reasons why soybean production has not fulfilled this potential:

- The South African industry is a price taker on the world market. Past policies protected the local industry. Relative to world markets, local soybean input costs are high, resulting in a comparative cost disadvantage for South African producers, even when taking the cost of transport into account.
- Soybean profitability does not compare favorably to alternatives, especially maize in some production areas. This is true even with a lower yellow maize price.
- Farmers have the view that soybean production requires much more managerial skills than maize production. Consequently they will only consider switching from maize production to soybean production if there is a relatively large difference in profitability.

Groundnut production

The area planted and total production of groundnuts since the beginning of 1990 is depicted in Figure 2.3.

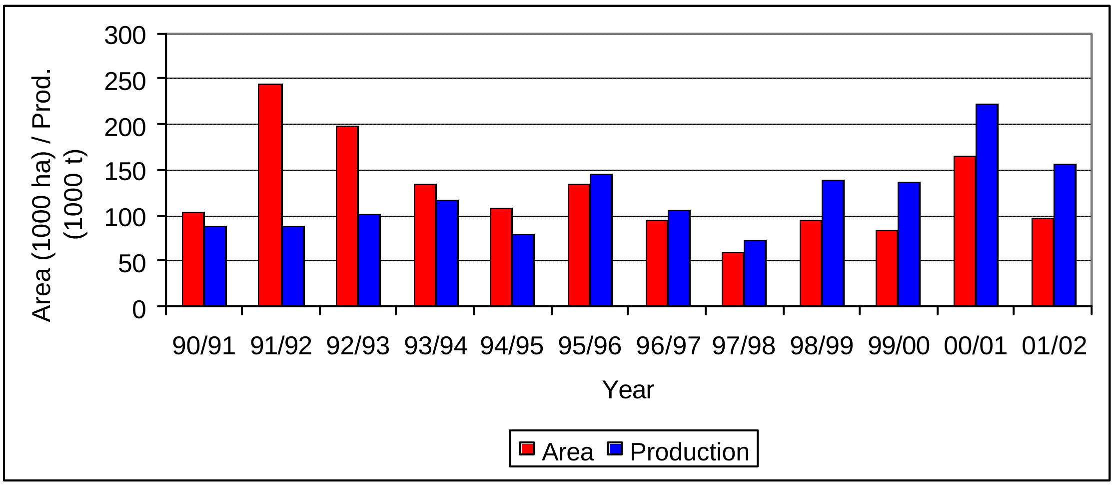

Figure 2.3: South African groundnut production ('000 tonnes and hectares) (1990/91 to 2001/02)
Source: NDA (2002).

It is clear from Figure 2.3 that the area under groundnut production declined between 1991/92 and 1997/98. During the last three years (1998/99 – 2000/01), the area planted with groundnuts increased again. For example, the area planted in 1995/96 represents an increase of 26 percent over 1994/95, but the increase in production from 1994/95 to 1995/96 was 84 percent. The relatively low volumes produced in 1997/98 can be attributed to the fact that farmers make their planting decisions on the previous year's prices and groundnut prices where 54.48% lower in 1996/97 than in the production year of 1995/96. Since 1997, when the oilseed board was abolished, the real price of groundnuts increased by 61%, which led to greater production volumes. It should furthermore be kept in mind that groundnut production is very sensitive to climatic conditions. The sensitivity of groundnuts to adverse climatic conditions probably contributes to the low correlation between area planted and production.

2.4 Domestic consumption of oilseeds

Sunflower seed

From Table 2.5 it is clear that the majority of sunflower seed, almost 70%, is destined for the expressers. When sunflower seeds are crushed, the oil obtained from the crushing amounts to 40% of the total content of the primary seed, 44% is oilcake or sunflower meal and the remaining 16% is waste. The sunflower oil obtained from crushing the seeds can be divided into edible oil and non-edible oils. The edible oils are used in the production of various products destined for human consumption, such as margarine, salad dressings and for the preparation of food. The non edible oils obtained from crushing are used in the manufacture of paints, shoe polish, beauty products, etc. The largest portion of the oilcake is used in the manufacture of animal feed rations. A small portion of the seeds is used in primary form in animal feeds as well as in breakfast cereals for humans. Of the sunflower seed produced locally, 72% is used domestically. Only in four years since 1990/91 was South Africa able to export sunflower seeds.

Table 2.5: Sunflower seed: Sales by producers, local sales and exports

Year	Producer sales	Local Sales (tonnes)			Exports (tonnes)
		To expressers	Seed and feed	Total	
1990	627897	580252	725	580977	-
1991	591461	641723	246	641969	-
1992	170140	171467	309	171776	-
1993	330138	329362	65	329427	-
1994	352277	352277[1)]	159[1)]	352436[1)]	-
1995	545680	485680[2)]	-	485680	-
1996	728000	637000[2)]	-	637000	51000
1997	490000	631000	2000	633000	-
1998	561000	609000	3000	612000	-
1999	1125000	760000	4000	764000	56000
2000[3)]	544800	814100	3400	817500	300
2001[3)]	651390	505500	2600	508100	-
2002[3)]	938466	639700	5000	678500	46200

Source: NDA (2002)

1) Excluding sales by the private sector

2) Excluding sales by the Oilseeds Board

3) Preliminary

Soybeans

Table 2.6 shows the sales of soybeans in South Africa. It is clear that, from 1990/91 to 1995/96, there was a considerable drop in producer sales. This is linked to production. However, sales have increased considerably since 1996/97. Sales to expressers nearly doubled in the period between 1992/93 and 1996/97, whereas local sales with respect to the edible market increased marginally since 1990/91. Sales for seed, feed and full-fat usage was relatively unstable, reaching a turning point in 1995/96 and rebounding to a historical maximum of 145 000 tonnes in 2000/01. The largest annual exports of 13 000 tonnes were reached in both 1997/98 and 1998, which is not really significantly higher than the previous maximum soybean exports of 10 707 tonnes in 1975/76.

Table 2.6: Soybeans - Sales by producers, local sales and exports

Year	Producer sales	Local Sales (tonnes)				Exports (tonnes)
		To expressers	Edible market	Seed, feed and full-fat	Total	
1990	108826	33874	18842	47184	99900	496
1991	125507	53978	17943	54656	126577	-
1992	58116	23052	16108	25695	64855	-
1993	63286	31868	15878	15540	63286	-
1994	67735	43735[1)]	12000[1)]	12000[1)]	67735[1)]	-
1995[2)]	58200	33200	15000	10000	58200	-
1996[2)]	83000	45000	18000	20000	83000	
1997[2)]	98000	38000	22000	36000	96000	13000
1998	215000	71000	23000	81000	175000	13000
1999[3)]	199000	91000	27000	102000	223000	2000
2000[3)]	153900	52000	36800	130200	219000	2800
2001[3)]	226000	32000	37000	145000	214000	-
2002[3)]	220600	10000	42000	155000	207000	600

Source: NDA (2002)

1) Excluding sales by the private sector

2) Excluding sales by the Oilseeds Board

3) Preliminary

Soybeans have various uses in primary as well as in processed form in animal feeds and products for human consumption. Crushing soybeans yields approximately 80% soybean oilcake and 17% soybean oil. The oilcake obtained from soybeans is preferred to the oilcake of sunflower because of its higher protein content and nutritional value for animals. This is also the reason why large quantities of soybean meal is imported to meet the domestic demand. The oilcake is also used in various human products such as dietary foods, cereals and meat products, to name a few. In its turn the edible oil obtained from crushing the seeds is used in cooking oils, ice creams and margarine and the non-edible component is used in lubrication products, for the foam in fire extinguishers and in the isolation of electrical wires, to name a few.

Groundnuts

Table 2.7 shows that, in contrast with soybeans and sunflower seed, large amounts of groundnuts are destined for the export market. Also, the largest proportion of groundnuts produced is destined for direct human consumption. The variability in production has a significant impact on the amount of groundnuts exported, which, will in turn influence the returns of farmers, as well as the industries' ability to generate foreign exchange.

Table 2.7: Groundnuts - Sales by producers, local sales and exports

Year	Producer sales	Local Sales (tonnes)				Exports (tons)
		Crushed Groundnuts	Edible Groundnuts	Seed, feed and unshelled	Total	Edible Groundnuts
90/91	79042	9808	34027	6053	49888	23423
91/92	78774	18489	29599	11210	59298	21478
92/93	79649	12555	30651	8630	51836	7720
93/94	90393	26523	39057	6578	72158	20955
94/95	107810	40000[1)]	50000[1)]	8000[1)]	98000[1)]	32000
95/96	70500	13000[2)]	38000[2)]	5500[2)]	56500[2)]	12000
96/97	130000	20000[2)]	55000[2)]	10000[2)]	85000[2)]	50000
97/98	95000	15160	29000	5000	49160	16000
98/99	77872	15750	31963	3177	50890	37900
99/00[3)]	124043	13600	48100	3300	65000	33900
00/01[3)]	122300	7800	47500	9700	65000	44900
01/02[3)]	200000	15000	52000	7000	74000	40000

Source: NDA (2002)
1) Excluding sales by the private sector
2) Excluding sales by the Oilseeds Board
3) Preliminary

As mentioned previously, 26% of the groundnuts produced in South Africa are consumed in their primary form whether it has been shelled or not. These groundnuts are used in the production of sweets, breakfast cereals and consumed as is. The crushing of groundnuts results in approximately equal amounts of oil and oilcake representing 40% of the seed content. The oilcake obtained from crushing is used in peanut butter, prepared baby food and animal feedstuffs. The oil obtained, as in the case of soybeans and sunflower, has both human and industrial uses. Edible groundnut oil is used for cooking and salad oils, mayonnaise and vegetable spreads, whereas its non-edible counterpart is used in soaps, varnish and shoe polish.

2.5 Domestic production and consumption of oilcake

It is commonly known that South Africa is a net importer of oilcake products. Table 2.8 shows the availability of total oilcake in South Africa. An interesting feature of the data in Table 2.8 is that sunflower oilcake shows a decreasing trend with respect to its total contribution to available oilcake, whereas the use of soybeans increased substantially over the relevant period. Other oilseed cake products remained relatively stable. Also of importance is the fact that the availability of oilcake has increased significantly since 1995/96. Growth in the total local availability of oilcake for use in animal feeds has been 73 percent since 1995/96.

Table 2.8: Summary of total oilcake available (tonnes) - (April 96 to 31 March 02)

Year	Sunflower	Groundnuts	Soybeans	Cotton	Canola	Other	Total
96/97	378525	15700	317836	116304	4235	566	833166
%	45.43	1.88	38.15	13.96	0.51	0.07	100
97/98	260741	10800	406730	99830	6500	800	785401
%	33.33	1.38	51.61	12.75	0.83	0.1	100
98/99	316895	10053	585304	143055	18150	6897	1080354
%	29.87	0.95	55.17	13.48	0.18	0.35	100
99/00	377466	6000	521399	118960	12650	13863	1050338
%	35.94	0.57	49.64	11.33	1.2	1.32	100
00/01	405144	4173	591826	108576	14602	7473	1131794
%	35.8	0.37	52.29	9.59	1.29	0.66	100
01/02	338891	7437	616593	146840	14163	8962	1132886
%	29.89	0.65	54.65	12.78	1.25	0.78	100

Source: AFMA (2002)

On average approximately 52 percent of the total amount of oilcake on the domestic market since 1996/97 was imported. Table 2.9 shows the imports of different types of oilcake since 1996/97. Imports have grown by nearly 73 percent since 1996/97, probably due to the fact that the production of oilcake on the domestic market decreased by 60 percent over the same period.

Table 2.9: Total oilcake used, local production and imports of oilcake

Year	Local production	Imports	% imported	Total oilcake used
96/97	400675	432491	51.91	833166
97/98	319006	466395	59.38	785401
98/99	493581	586773	54.31	782702
99/00	271009	508435	65.23	779444
00/01	113907	635134	84.79	749041
01/02	538093	561907	51.08	1100000

Source: AFMA (2002)

2.6 Prices of soybeans, sunflower seed and groundnuts

As with all other field crops, the prices of soybeans and sunflower seed varies substantially from one season to the next. This stems mainly from the fact that field crop production is highly dependent on climatic factors, especially rainfall. Since South Africa is not a role player in the field of oilseed production, international price trends also have a large impact on local prices.

Figure 2.4 shows the movement of soybean prices from 1990/91 to 2001/02. It is clear that nominal producer prices increased steadily from 1990/91 to 1996/97, but declined substantially during 1997/98 as a result of significant increases in soybean production. More important, however, is the movement in real producer prices of soybeans. Real prices moved sideways for the depicted period. In fact, the real soybean price in 2000/01 was at a lower level than in the early 1990s.

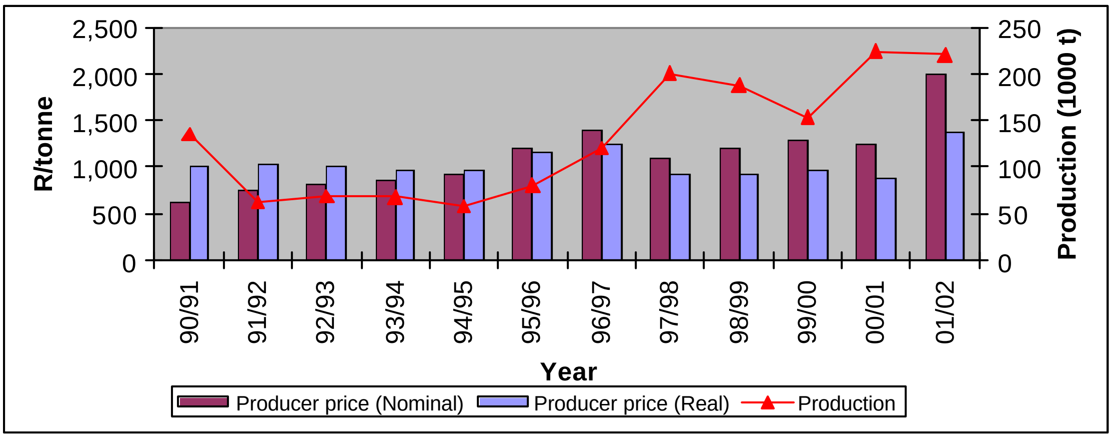

Figure 2.4: Nominal and real producer prices and production of soybeans (1990/91 to 2001/02)

Source: NDA (2002)

From Figure 2.5 it is clear that, although nominal producer prices of sunflower seed increased after 1990/91, real producer prices of sunflower seed showed a declining trend until 1995/96. Thereafter real prices recovered for the next two years. In 1998/99 real prices declined again, reaching the lowest point during the last decade in 1999/00. However, significant increases in production should dampen any further price increases. Real prices are now even lower than they were in the early nineties.

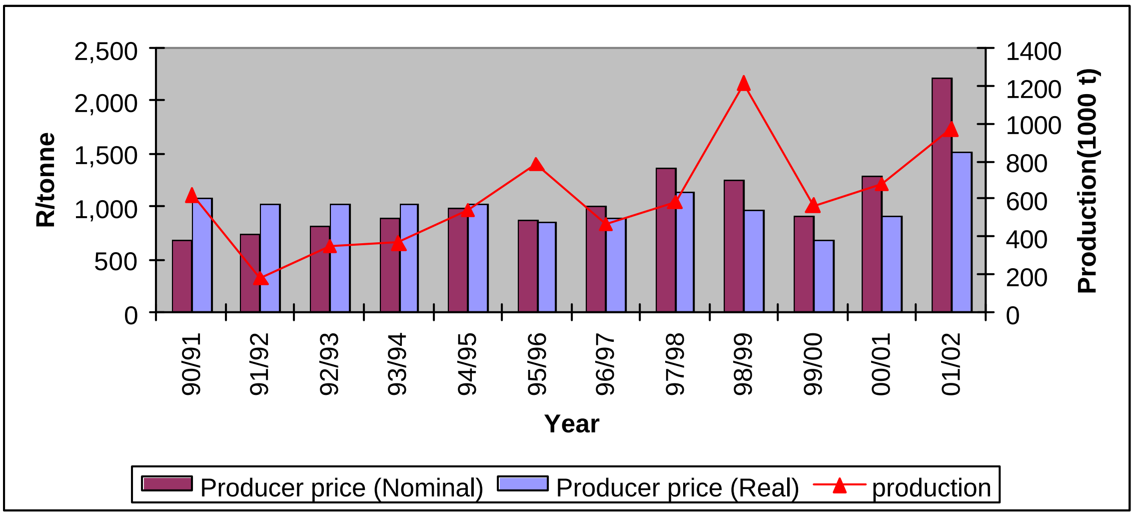

Figure 2.5: Nominal and real producer prices and production of sunflower seed (1990/91 to 2001/02)

Source: NDA (2002)

Figure 2.6 shows that the nominal price for groundnuts declined for the first three years of the depicted period. Nominal prices increased significantly from 1992/93 to 1994/95. Since 1995/96 nominal prices showed a steady growth. Real prices, on the other hand, followed nominal prices relatively closely. In contrast to soybeans and sunflower seed, real groundnut prices are currently slightly higher than in the early 1990s. The fact that groundnuts have higher prices than soybeans and sunflower seed will definitely influence the rate at which groundnuts will be crushed in future. Consequently groundnuts could be produced exclusively for the edible market, which is currently the case.

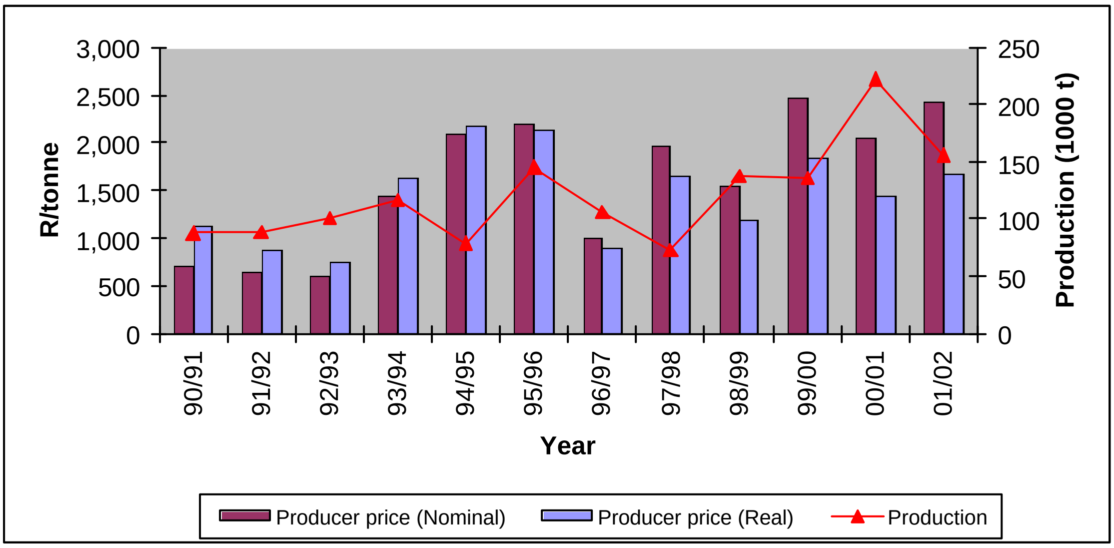

Figure 2.6: Nominal and real producer prices and production of groundnuts (1990/91 to 2001/02)

Source: NDA (2002)

2.7 Expenditure on oilseeds in South Africa

The total expenditure on primary oilseeds in South Africa depends largely on demand by processors, who crush the seeds in order to obtain the oilcake that is used in the composition of animal feeds and the various oils used to manufacture products for human consumption and used for industrial applications. Figure 2.7 indicates the expenditure share of sunflower, soybeans, groundnuts and seed cotton in terms of the total expenditure on these four oilseeds for South Africa since 1971.

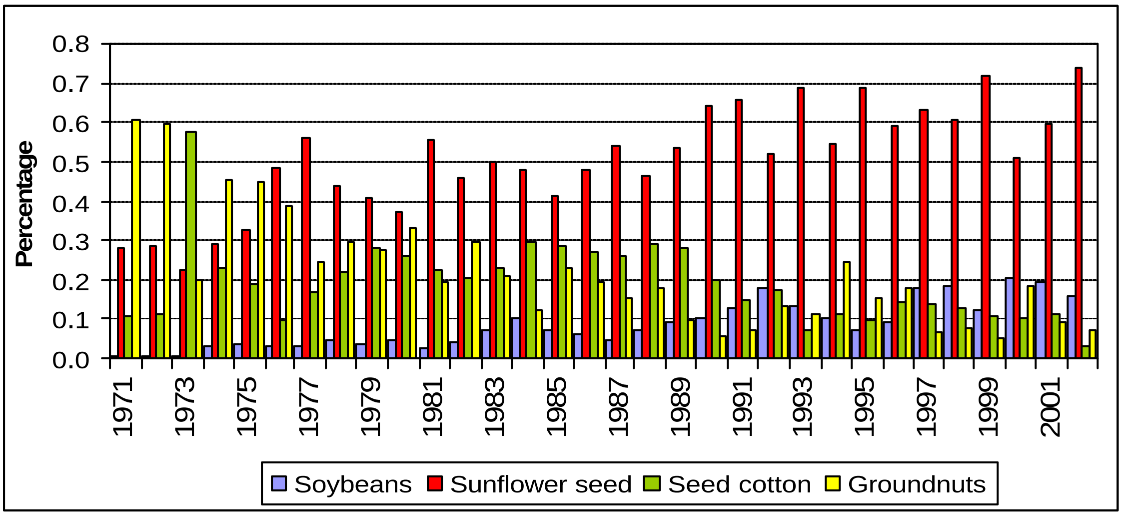

Figure 2.7: Total expenditure shares of soybeans, sunflower, groundnuts and cotton (1970 to 2002)

Source: NDA (2002) and own calculations

As can be seen in Figure 2.7, the expenditure share of sunflower dominates all the other oilseeds, with an average expenditure share of 50.6 percent over the sample period. In the case of groundnuts, the total share has declined dramatically since the early seventies and this can be attributed to the fact that the local producer sales declined from 175 125 tonnes in 1971 to 87 000 tonnes in 2002, representing a decline in sales of 50.32 percent. The expenditure share of soybeans increased from almost zero in 1971 to approximately 16 percent in the year 2002.

2.8 Conclusion

This chapter provided an overview of the South African oilseed industry, with special reference to sunflower, soybeans and groundnuts. The gross value of agricultural production as well as the contribution made by oilseeds were identified on national as well as provincial level. The latter part of this chapter dealt with the production and consumption of oilseeds and the various uses of oilseeds as primary products and in their processed form. The chapter concluded by considering the individual expenditure of each of the oilseeds as a percentage of total oilseed expenditure. It was found that sunflower seed is by far the most important oilseed with regard to total oilseed expenditure.

CHAPTER 3

LITERATURE REVIEW AND DATA PROPERTIES

3.1 Introduction

This chapter provides an overview of similar studies done in the oilseed complex, both locally and internationally. Selected studies are reviewed in terms of their methodologies, results and findings. Unfortunately very few of the international studies cited estimated demand relations for primary oilseed products, opting to estimate elasticities for the processed products instead.

In this study demand relations for primary oilseeds in South Africa are estimated with the use of econometric estimation methods and computer software. The two models estimated in this study are the Almost Ideal Demand System (AIDS) proposed by Deaton and Muelbauer (1980) and a two-step Error Correction Model (ECM) introduced by Engle and Granger (1987). Both will be discussed in detail in Chapters four and five. Both demand model specifications applied to estimate elasticities of demand make use of budget (expenditure) share equations which express the expenditure on each commodity as a percentage of total expenditure on all the oilseeds considered in this study.

In this chapter all the testing procedures required to estimate a demand system are identified and conducted to ensure that efficient parameter estimates are obtained, after which elasticities will be calculated. This chapter consists of three main components, with the **first** part focusing on potential factors that influence the South African oilseed industry. In the **second** part of this chapter, related studies done on oilseeds and oilseed products are identified and discussed briefly, and **lastly** the properties of the data used in the final estimation of the demand models are examined and adjusted in order to provide efficient parameter estimates.

3.2 Potential factors influencing the demand for oilseeds in South Africa

Very little of the primary oilseeds produced in South Africa are used in their raw, unprocessed form in the manufacturing of feedstuffs for animals and food for human consumption. The actual demand for these products originates from the crushers, who extract the oilcake and vegetable oils from these seeds, which are then used for a variety of applications as mentioned in the previous chapter (AFMA 2002). This indicates that the demand for these primary products is limited by the demand for the by-product generated from crushing the product. South Africa however, as indicated previously, is a net importer of oilcake used in the manufacture of animal feed, and large amounts of soybean meal, in particular, are imported annually.

The demand for oilcake, whether it is produced locally or imported has been defined by animal feed manufacturers as a function of not only the price at which the manufacturers buy the meal from the crushers, but also of the protein and fibre content of the different types of oilcake available. Although many different types of vegetable meals (oilcake) are used to make animal feed rations, substitution between these different commodities take place as long as the substitute product provides the same nutritional value as the products being substituted.

The market for vegetable oil consumed by humans in the preparation of foods and in canned foods has also experienced various changes over the past years. Increased health consciousness and the occurrence of coronary heart diseases have changed the consumption patterns of consumers. Yen and Chern (1992) concluded, from their study of U.S data, that there has been a definite shift in consumption from fats towards the healthier alternative of vegetable oils as more information becomes available to consumers. Demographic variables such as race, age and education also significantly influence the consumption patterns of people. Varying levels of health consciousness among younger and older people will subsequently affect their demand for these oils, as will disposable income, keeping in mind that olive oil, for example is considered to be a very healthy alternative, though it is too expensive for most people.

Figure 3.1 indicates factors that could possibly have an effect on the South African oilseed industry, not only on the demand side but from different angles. In this diagram it can be seen that there are various factors that could influence the oilseed industry. Factors that affect the demand for oilseeds, which is the focus of this particular study, will be greatly influenced by changes in substitutes and particularly their prices, the prices of the by-products and the quality of the products supplied by producers. From the diagram it is also clear that the government could also influence the demand for oilseed products by enforcing regulatory policies to govern these products.

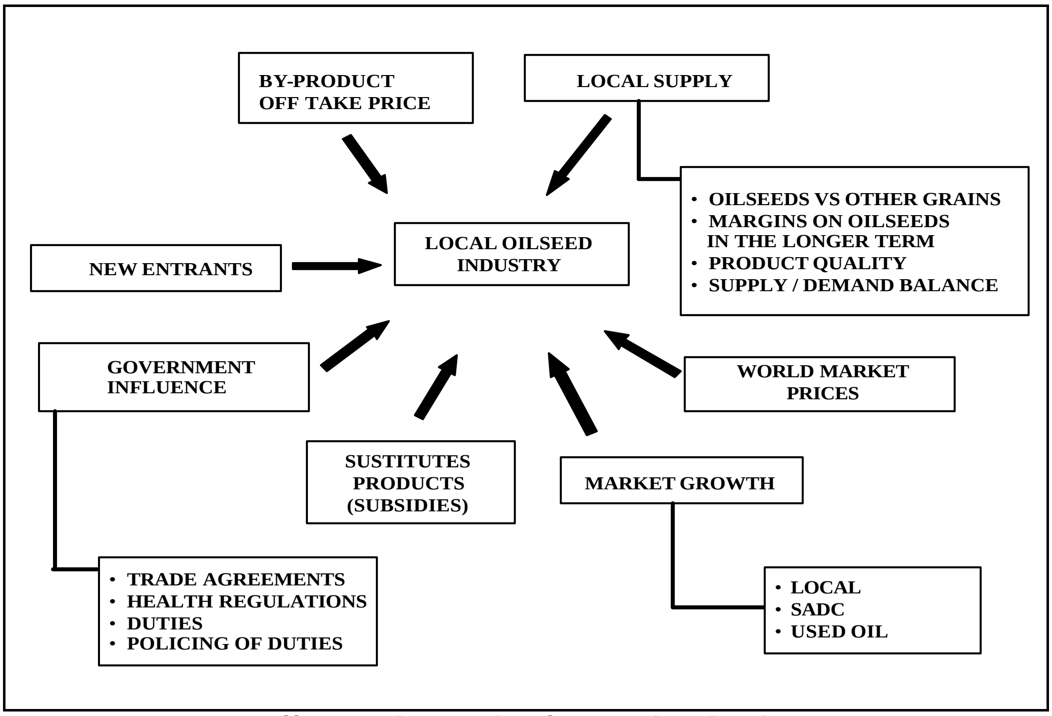

Figure 3.1: Factors affecting the South African oilseed industry
Source: Fourie (2002).

3.3 Related studies on the demand for oilseeds and oilseed products

Many studies conducted on the demand for oilseeds focused on the products resulting from the processing of these oilseeds, i.e. the vegetable oils and meals. Most of these studies however, were done in the international environment and very few studies exist for the demand relations for oilseeds in South Africa.

According Liebenberg and Groenewald (1997) no recent studies have been conducted on the local demand relations of oilseeds and oilseed products. Most of the studies cited by Liebenberg and Groenewald were conducted before 1994 and nothing specifically addressed estimations for oilseeds. After 1994 many changes took place, among which changes in income distribution (shifts between racial groups) and therefore also changes in consumer preferences. These factors have had a major impact on the estimation of demand relations.

As previously mentioned, most of the international studies cited estimated the demand for vegetable oils and not much work has been done on primary commodities. Goddard and Amuah (1989) estimated elasticities of demand for fats and oils in Canada using a two-stage demand model with single equations derived from a translog indirect utility function. The elasticities were estimated with quarterly data from 1973 to 1986. They also estimated the effect of advertising efficiency on the demand for these fats and oils by lagging the expenditure of these products to advertising.

Goddard and Glance (1989) derived demand elasticities of fats and oils for Canada, United States and Japan using a translog utility function and by assuming separability between these products. Annual data from 1962 to 1986 were used. In the analysis cotton oil and groundnut oil are identified as own-price elastic vegetable oils and the majority of the cross-price elasticities indicate that there is evidence of a complementary relationship.

Gould, Cox and Perali (1991) estimated the demand for food fats and oils for the United States by including demographic variables such as age, education and race. The effect of government donations was also tested. The estimation was done using an almost ideal demand system with quarterly time series data for 1962-1987. The elasticities derived from the analysis indicate that age had a negative impact on the consumption of fats and oils. The cross price elasticities also indicated a gross complementary effect, with very little of these elasticities indicating that the products are substitutes.

Heien and Pick (1991) estimated the structure of the international demand for soybean products. They applied the LA/AIDS model specification to quarterly data from 1976(I) to 1984(IV) for the United States, Brazil and Argentina. Elasticities were estimated for each of the countries, for soybeans as primary products and for soybean meal obtained from crushing soybeans. Demand restrictions, i.e. homogeneity, symmetry and adding up, were directly imposed in the estimation. The demand relations were also inverted in order to estimate the impact of a change in exports by each of the exporting countries on gross farm income.

Yen and Chern (1992) applied a flexible demand system proposed by Lewbel in order to estimate demand relations for fat and oil consumption in the United States. Their results indicate that the Lewbel model outperformed both the translog and AIDS models. Annual time series from 1950 to 1986 were used in the estimation. The own-price elasticities calculated varied very little between the different models but differences occurred in the expenditure elasticities. Their findings indicate that price and income effects, together with increasing public health concerns, determine demand for fat and oil in the United States.

Goodwin, Harper and Schnepf (2000) estimated short-run demand relations for the U.S. fats and oils complex with an inverse almost ideal demand system (IAIDS). Monthly data from October 1981 untill May 1999 were used in this estimation. Price flexibility coefficients were estimated because the short run supply is assumed to be fixed and the changes in price due to a change in quantities are determined, which is the inverse of price elasticity. Demographic variables such as race, age and education were also included. From this study it was detemined that U.S. consumers consider animal fats as less desirable compared to vegetable oils.

Chang and Nguyen (2002) estimated elasticities of demand for Australian cotton in Japan. The authors also applied the linear version of the AIDS model to annual data from 1972 to 1998 on Japan’s cotton imports from Australia. This study tested and rejected the demand restriction and it were subsequently imposed. The study nevertheless indicated that the Japanese demand for cotton originating in Australia is much more price sensitive than their demand for cotton imported from the U.S. The conclusion drawn from this study is that Japanese buyers are very sensitive to quality fluctuations.

As can be seen from the studies cited, very little has been done to investigate the demand for primary oilseed products, and the demand relations do not always comply with the restrictions on these demand systems.

3.4 Data properties

Annual data is used for estimating by means of the AIDS and ECM models in order to estimate elasticities of demand for four of the primary oilseeds in South Africa. The data were obtained from the National Department of Agriculture of South Africa and cover the period from 1972 to 2002. The data used in the estimation of these demand systems had to undergo a series of tests to ensure that the time series data would provide useful estimates. According to Karagiannis and Velentzas (2000) previous efforts relating to demand estimation focused more on the choice of the functional form, and not much attention has been paid to the statistical properties of the data itself.

Four types of tests will be conducted to ensure that the data used in the estimation of the demand system do not cause spurious regression results. Firstly, the statistical properties of the data used will be tested, that is, the individual variables for stationarity will be tested to ensure that the common trend is removed within a series and, secondly, a method will be used to capture possible structural breaks that may occur in the data. Thirdly, tests will be conducted to ensure that the commodities included in the demand system are separable and that they belong in the same system. Finally, tests will be conducted to ensure that the expenditure variables included in the equations are exogenous, which is a necessary condition for application of the seemingly unrelated regression method of estimation.

3.4.1 Stationarity of the variables

The majority of econometric modeling makes use of economic data in the estimation of various relationships. The fact that these economic variables could be connected in many different ways, such as inflation has often not been considered. In order to capture and account for these occurrences, it is necessary to ensure the stationarity of all the variables included in the system of demand equations. A series is said to be stationary if the residual (error term) obtained by estimating that equation has an expected value of zero $(E(u_t) = 0)$ and fluctuations around its mean value are not growing or declining over time i.e. constant variance $(E(u_t^2) = s^2)$. Fedderke (2000) defines a stationary process by the fact that the distribution of the random error term must be the same throughout the distribution, i.e. constant mean and constant variance.

If a series is found to be non-stationary, the remedial measure for transforming a series to a stationary one is by differencing that series. For example, if Y is found to be non-stationary, it could be rendered stationary by estimating $\Delta Y_t = (Y_t - Y_{t-1})$ and using ΔY_t in the estimation of the equations. According to Studenmund (2001) the major drawback of using first differences to change a series to a stationary series is that this process discards information about the long run trend in that particular series. This issue will be discussed during the estimation of the ECM model in chapter 5.

It is thus clear that each time series variable included in a model must be tested for its time series characteristics, i.e. whether it is stationary or not. Where a series is non-stationary, the number of times it must be differenced in order to render it stationary is important. Various tests exist for testing the characteristics of a series, namely the spectral density function, the Phillips-Perron test and the Dickey-Fuller tests. In this particular study the variables included are tested for stationarity using the Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF) tests.

Table 3.1 reports the DF and ADF test statistics for all the variables included in the demand analysis. The two test statistics are calculated for each variable, that is, whether the variable is stationary with a constant or with a constant and a trend. The variables in the table below are tested and reported in levels (without differencing them) and in first differences. The hypothesis to be tested is:

H_0: The series is stationary

H_A: The series is non-stationary

If the calculated DF and ADF statistics are smaller than the 95% critical value, then the series is said to be non-stationary, but if the calculated statistic is larger than the critical value the series is stationary. The statistics reported in Table 3.1 indicate that the variables used in the demand analysis are integrated of order one I(1), this means that the variables are stationary only after first differences.

Table 3.1: Test statistics for unit roots in variables

Variables in levels	**Intercept**		**Variables in 1st difference**	**Intercept**	
	DF	**ADF**		**DF**	**ADF**
WCS	-3.562	-2.623	**DWCS**	-13.166	-8.447
WSF	-2.428	-1.667	**DWSF**	-8.582	-5.281
WSB	-1.691	-1.604	**DWSB**	-5.483	-5.666
WGN	-3.944	-3.341	**DWGN**	-12.961	-7.961
LNPCS	-1.215	-1.525	**DLNPCS**	-7.913	-5.739
LNPSF	-0.513	-0.501	**DLNPSF**	-4.421	-8.375
LNPSB	-1.214	-1.495	**DLNPSB**	-7.532	-6.191
LNPGN	-1.201	-1.027	**DLNPGN**	-7.469	-4.364
EXP	-2.593	-2.071	**DEXP**	-7.409	-5.856
95% critical value	-2.9627		**95% critical value**	-2.9665	

3.4.2 Structural breaks

Structural breaks occur in time series data whenever a variable undergoes significant changes over a certain period compared to another period in the same sample (Gujarati, 1995). The presence of structural breaks in the data used will have a significant impact on the estimated parameters between these two periods where the break occurred. In order to counter the problem of structural breaks and the effects it could have on the estimated parameters, dummy variables are included to capture or quantify that break.

Newbold, Rayner and Kellard (2000) developed a systematic method to identify and capture structural breaks that may occur in a dataset. According to Alemu, Oosthuizen and Van Schalkwyk (2002), this method enables the researcher to detect and evaluate exogenous variables and to ensure structural stability within these variables. To capture possible structural breaks that may occur in the data, each of the equations included in the demand system must be estimated in order to obtain the plot of the residuals of each of the equations. The equations estimated consist of the individual commodities budget share as the dependant variable, which represents the percentage share of the total expenditure that accrues to that specific commodity, regressed on the logarithmic prices of all the commodities included in the system as well as a linear price index (Stones index). The mathematical derivation of these equations will be discussed in more detail in chapters four and five.

This method of identifying potential structural breaks relies on the plot of the residuals of each of the budget share equation estimated within two standard error bands. The occurrence of a structural break is identified at the point where the plotted residual exits these two standard error bands. The potential breaks in the data are corrected with the use of dummy variables and testing them for significance.

Figures 3.2 to 3.4 illustrate the residual plots of the three budget share equations used in the estimation of the demand system. These share equations are regressed in first differences to identify possible structural breaks and to quantify them before further estimation can proceed.

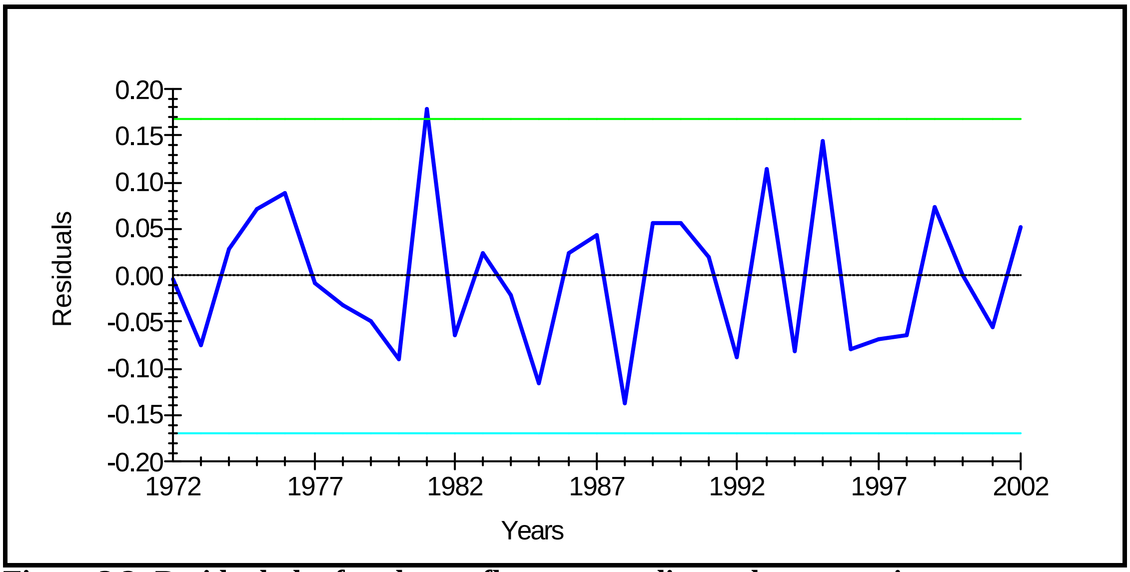

Figure 3.2: Residual plot for the sunflower expenditure share equation

The lower and upper most horizontal lines in the figure above represent the two standard error bands used in the identification of possible structural breaks. In Figure 3.2 the residual plot of sunflower seeds indicates a break in the marketing year of 1981, which is probably due to the fact that South Africa experienced a bumper crop in 1980. South African sunflower production increased by 59.1 percent from 1979 to 1980 as a result of the bumper crop in the production year 1980.

Figure 3.3 shows the residual plot for the soybean budget share equation, which also identifies a possible structural break in the data used. The explanation of a dummy variable included for 1997 is not as simple as in the previous case. South African agriculture underwent a process of deregulation after 1995 and the oilseeds marketing board governing soybeans was finally abolished at the end of September 1997, possibly explaining the structural break for the soybeans budget share equation in 1997.

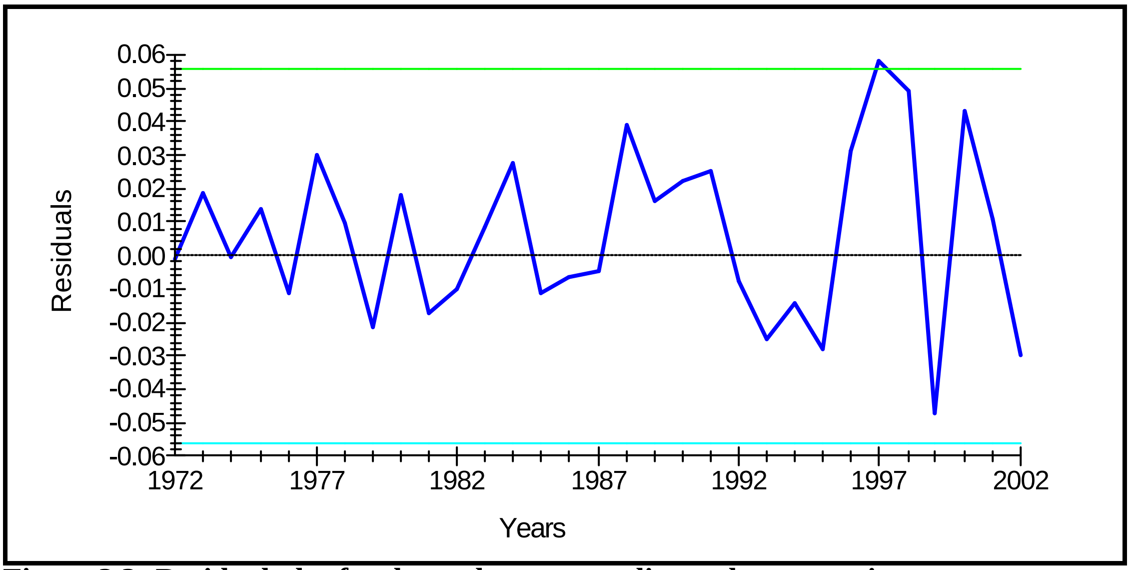

Figure 3.3: Residual plot for the soybean expenditure share equation

The residual plot of the groundnuts budget share equation in Figure 3.4 indicates that groundnuts also experienced a structural break in the year 1973. South Africa experienced severe drought conditions in the early 1970s and that is reflected in the producer sales of groundnuts, which decreased from 183 431 tonnes in 1972 to 128 264 in 1973.

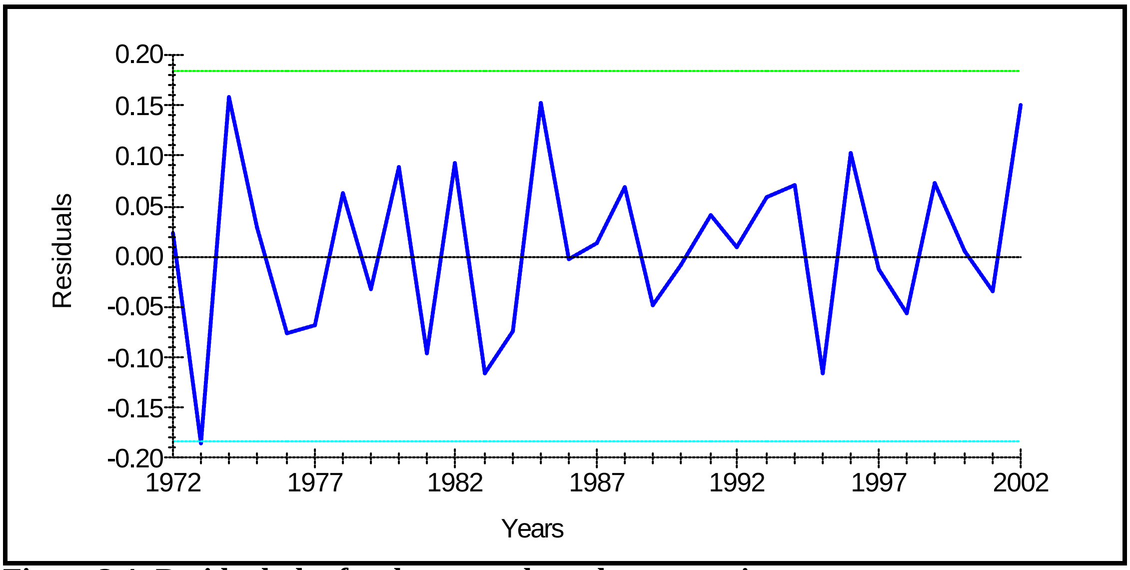

Figure 3.4: Residual plot for the groundnut share equation

After the structural breaks have been quantified and introduced, the residuals of each of the budget share equations was plotted again to identify additional breaks in the data. This process was repeated until all possible breaks were accounted for. The final equations with all the dummies included will be specified and illustrated in Chapter 4 and 5.

3.4.3 Testing separability between oilseeds

To ensure the accurate estimation of a demand system the commodities included in the demand system must belong to the same group in order to limit the number of parameters included. The commodities included in this study are included as primary products and the demand for the products is primarily from the processors who crush the products to obtain oilcake for the animal feed industry and oils for human and industrial use.

The obvious question is under what conditions commodities can be aggregated into a single group (Philips, 1974). It would be ideal if the commodities in a demand system are closer substitutes for or complements to each other than any other commodities in the particular industry. This would ensure efficient estimation of the demand system and associated elasticities of demand.

Consumers allocate their expenditure in two stages, in the first stage they allocate total expenditure over a broad group of goods and in the second stage group expenditures over individual commodities within each group (Jung, 2000). Figure 3.5 illustrates the two-stage budgeting process.

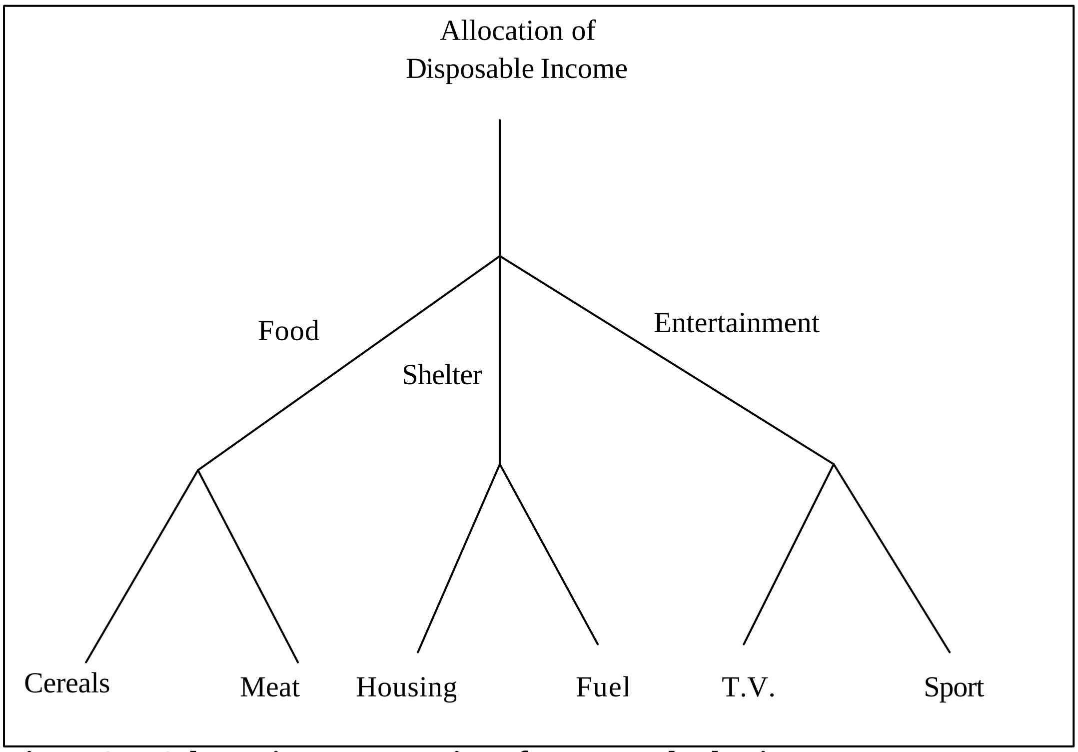

Figure 3.5: Schematic representation of two-stage budgeting
Source: Deaton and Meulbauer (1999)

In order to test for separability between the different oilseeds included in this study a LA/AIDS is specified under the assumption that the four oilseeds are not separable:

$$w_{it} = a_i + \sum_{j=1}^{4} g_{ij} \ln p_{jt} + b(LnE - \sum_{i=1}^{n} w_{i,t-1} \ln p_{i.t}) + u_{i,t} \quad \text{i=1,2,3,4…………3.1}$$

Equation 3.1 is called the unrestricted model (UR) in the testing procedure. The equation is unrestricted in the sense that it includes all four of the oilseeds presented in this study. If one of the four oilseeds is assumed to be separable from the other three, the LA/AIDS for the remaining oilseeds that are supposed to be in the same group is as follows:

$$w_{it} = a_i + \sum_{j=1}^{3} g_{ij} \ln p_{jt} + b(LnE - \sum_{i=1}^{n} w_{i,t-1} \ln p_{i.t}) + u_{i,t} \quad i=1,2,3 \ldots\ldots\ldots\ldots 3.2$$

Equation 3.2 is the restricted model (R) that is used in the testing procedure. This model is restricted in the way that one of the oilseeds is dropped from Equation 3.1 and then tested for separability. This procedure is executed with all the price variables included in the demand system. In order to test the hypothesis of separability Equations 3.1 and 3.2 are estimated with annual data for 1971 to 2002.

Two types of tests can be executed, i.e. the F test and the Likelihood Ratio (LR) test. The F test uses the R^2 of both the restricted and unrestricted models:

$$\frac{(R^2_{UR} - R^2_R)/q}{(1 - R^2_{UR})/(n-k)} \approx F_{q,n-k} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.3$$

where the R^2_R and R^2_{UR} are the R^2 values obtained from the restricted and unrestricted models. If the calculated F statistic is larger than the critical value at the appropriate degrees of freedom, the null hypothesis of weak separability can be rejected. This would indicate that the commodities under question can be estimated in the same system.

The Likelihood Ratio test for separability is done using the following equation:

$$LR \equiv 2[L_{UR} - L_R] \sim c^2_{k-q} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.4$$

where L_R and L_{UR} represent the maximum values of the log-likelihood function when the restriction do and do not apply. The LR test follows the Chi-squared distribution with (k-q) degrees of freedom.

Table 3.2 gives the calculated F statistics for the three expenditure share equations estimated in the demand system.

Table 3.2: Calculated F statistics to test for separability

Dependent variable	Price variable dropped for testing			
	Cotton	**Soybeans**	**Sunflower**	**Groundnuts**
DWSF	2.74*	3.38*	-	6.97*
DWSB	0.07	-	2.55*	1.89*
DWGN	5.72*	0.31	2.43*	-
95% critical value	1.708			

* Indicates significance at 5% level

Since it is important to make sure that the commodities included in any demand system are not separable, i.e. that they could be grouped together, it would be sensible to assume that these four oilseeds can be grouped together because seven of the nine possible combinations are significant at a 5 percent level.

Several authors, including Goddard and Glance (1989), Karagiannis *et al.*, (2000) and Duffy (2003), estimated demand relations with the use of a systems approach without testing the separability of the included variables and directly assuming that the variables included are not separable. Without testing separability, but simply imposing it, poses serious questions about the usefulness of the above mentioned studies.

3.4.4 Test for exogeneity of the expenditure variable

In order to estimate a demand system using the seemingly unrelated regression (SUR) method, the expenditure variable (X) in each of the share equations must be tested and proved to be exogenous. Edgerton (1993) showed that if the expenditure variable in the model is endogenous, i.e. correlated with the random error term, the SUR estimators are no longer unbiased. If the expenditure variable is found to be endogenous the three-stage least squares (3SLS) method of estimation should be used to obtain the necessary parameter estimates.

LaFrance (1991) suggested the Hausman test to test the exogeneity of the expenditure variable. The following section has been largely duplicated from Jung (2000).

Let q be a consistent and asymptotic efficient estimator. q^* is a consistent but inefficient estimator under the null hypothesis. The Hausman statistic can be written as:

$$m = T(q^* - q)'[Var(q^*) - Var(q)]^{-1}(q^* - q) \quad \ldots\ldots 3.5$$

which has a Chi-squared distribution with the degrees of freedom being equal to the number of unknown parameters in q. If the calculated m is larger than the critical value, then the null hypothesis of exogeneity is rejected. In the calculation of the Hausman statistic to test for exogeneity, q is the SUR estimator and q^* is the three-stage least squares (3SLS) estimator.

All of the calculated m values for the oilseeds under consideration are smaller than the Chi-squared critical value with 5 degrees of freedom at 5% level of significance (see Table 3.3). This indicates that the expenditure variable tested is indeed exogenous and ensures that the (SUR) method of estimating the LA/AIDS will indeed provide the best linear unbiased estimators (BLUE).

Table 3.3: Exogeneity test of the expenditure variable (Df = 5)

	Calculated statistic	**Critical value (a =0.05)**
Sunflower	3.34961	11.07
Soybeans	0.02518	11.07
Groundnuts	4.97932	11.07
System	8.35412	33.21

CHAPTER 4

ESTIMATION OF AN ALMOST IDEAL DEMAND SYSTEM (AIDS) ON THE SOUTH AFRICAN OILSEED INDUSTRY

4.1 Introduction

This chapter deals with the theoretical aspects of estimating an Almost Ideal Demand System (AIDS) and all the testing procedures associated with this particular system of demand equations. This type of demand estimation makes use of expenditure share equations which are regressed on the prices of all the commodities included in that system, as well as a common price index. The expenditure share of a single commodity represents the percentage of total expenditure on all the oilseeds included in the study that accrues to that specific commodity. In this study the AIDS model will be linearized by means of a price index to simplify the estimation procedure. The model will then be applied to annual time series data obtained from the Abstract of Agricultural Statistics (NDA, 2003).

The parameter estimates obtained from the Linear Approximated Almost Ideal Demand System (LA/AIDS) will be used to estimate compensated, uncompensated and expenditure elasticities for sunflower, soybeans, groundnuts and cotton.

4.2 Specification of the AIDS model

The Almost Ideal Demand System developed by Deaton and Meulbauer in the early 1980s which has proven to be the most widely used system for estimating demand relations. This method of estimation uses microeconomic restrictions on demand to ensure that the system of equations provide estimates that are at least consistent with theory. The following section deals with the theoretical specifications of the AIDS system.

The i^{th} equation in the AIDS model can be defined as follows:

$$w_{it} = a_i + \sum_{j}^{n} g_{jt} \ln p_{jt} + b_i \ln(X_t / P_t) + u_{it} \qquad \text{i=1,2,n} \ldots\ldots\ldots\ldots\ldots\ldots 4.1$$

where w_{it} is the budget share equation of the i^{th} good, p_{jt} is the nominal price of the j^{th} good, $\ln X_t$ represents total expenditure and $\ln P_t$ is the translog price index defined by:

$$\ln P_t = a_0 + \sum a_j \ln p_j + \frac{1}{2} \sum_{i}^{n} \sum_{j}^{n} g_{it} \ln p_{it} \ln p_{jt} \qquad \text{t=1,2,T} \ldots\ldots\ldots\ldots 4.2$$

This price index however, makes the system nonlinear, which complicates the estimation procedure. To overcome this problem of non-linearity, Deaton and Meulbauer (1980) suggested using another price index for ease of estimation.

The Stones price index is one of a few indices that can be used to replace the non linear price index and this index will subsequently make the system linear. In addition to the Stones index, three other price indices have been suggested by Asche and Wessels (1997) and they include the Thornqvist, Paasche and Laspeyres which will also transform the system to a linear one. For the purpose of this study the Stones price index will be used and it is specified as follows:

$$LogP = \sum_{i=1}^{n} w_{i,t} \log p_{i,t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 4.3$$

This price index also attracted criticism after Eales and Unnevehr (1988) indicated that the substitution of the translog price index with the Stones price index causes a simultaneity problem because the expenditure weight (w_{it}) variable appeared on the left and right hand side of the equation. They suggested using the lagged share ($w_{i,t-1}$) in Equation 4.3. By substituting the AIDS model with the Stones price index and the lagged budget shares results in a properly linearized version of the system:

$$w_{it} = a_i + \sum_{j}^{n} g_{ij} \ln p_{jt} + b_i (LnX - \sum_{i=1}^{n} w_{i,t-1} \ln p_{i,t}) + u_{i,t} \text{ ....4.4}$$

As mentioned previously this method of estimation allows for the testing of microeconomic theory with regards to consumer demand. The demand restrictions that can be tested and imposed are homogeneity, symmetry and the adding-up restriction. The homogeneity restriction implies that the substitution and income effect of an own price change must be consistent with the cross and income elasticities for that commodity. In terms of the equations estimated, homogeneity implies that the price parameters in a single equation are equal to zero.

Symmetry restrictions are tested and imposed to ensure that the estimated cross price parameters of the estimated equations are identical and this restriction will also give an indication of how the cross price elasticities are related.

The adding up restriction in demand analysis states that the sum of the income elasticities in a consumers' budget is equal to one (Tomek and Robinson, 1990). This restriction is not tested in the demand system because only three of the four budget share equations are econometrically estimated and the fourth calculated by pure summation in order to satisfy the adding up restriction.

Mathematically the different restrictions can be expressed as follows:

Homogeneity: $\sum_j g_{ij} = 0$ 4.5

Adding-up: $\sum_i a_i = 1, \sum_i g_{ij} = 0, \sum_i b_i = 0$ 4.6

Symmetry: $g_{ij} = g_{ji}$ 4.7

These restrictions will be tested for and imposed in the estimation of the LA/AIDS and test statistics of the significance of these restrictions will be provided in the following section. In order to test and impose the above mentioned restrictions the seemingly unrelated regressions (SUR) estimation method in Microfit 4.1 is used.

4.3 Estimated results

As mentioned in Chapter 3, before any estimation can begin the properties of the data must be studied. This is done to ensure that the output obtained from the estimation procedure will provide one with efficient parameters on which to base the rest of the calculations. The tests that will be carried out ensure that the variables included in the estimation are stationary as described in Chapter 3, and to capture potential structural breaks that may occur. After these two issues have been dealt with the equations are estimated to determine whether they adhere to the general restrictions of demand.

After the stationarity of the variables have been ensured, each of the budget share equations specified in Chapter 3, which are used in the estimation of the demand model, were also tested for additional dummy variables that must be included to account for possible structural breaks. The same method as in Chapter 3 was used by simply plotting the residuals of each of the expenditure share equations and identifying points where the graph of the residuals breaks out of the two standard error bands. This procedure was repeated until all necessary structural breaks were identified. Residual plots as shown in Figures 4.1 to 4.3 where obtained after all the necessary dummies had been included in the three budget share equations estimated.

As can be seen from Figures 4.1 to 4.3 no significant structural breaks are visible from the plotting of the residuals after the necessary dummy variables have been included in the three estimated budget share equations. The following section also provides an explanation for each of the structural breaks that occurred in each of the equations estimated.

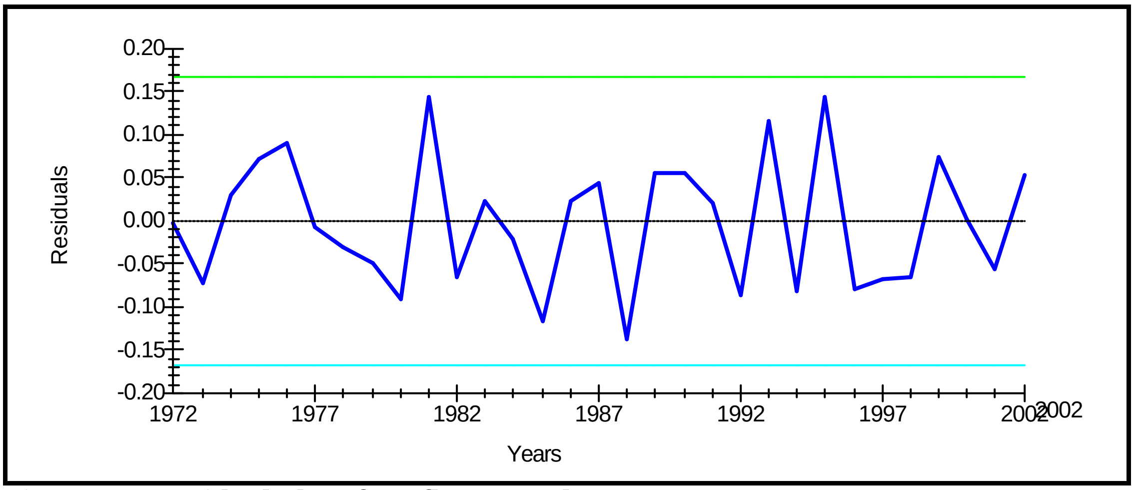

Figure 4.1: Residual plot of sunflower seed

The structural break that occurred in the sunflower seed equation for the marketing year 1981 can be explained by the fact that South Africa experienced an increase of 59.1% in sunflower seed production in the production year of 1980. This increase in the production was carried through to the marketing year of 1981 by an increase in the producer sales of the same magnitude. An intercept dummy was subsequently included for the marketing year 1981 in order to capture that effect.

The dummy variable included for the marketing year 1997 in the soybean expenditure share equation as seen in Figure 4.2 can be explained by the process of deregulation that took place in South African agriculture. The oilseeds board governing the oilseed industry was abolished in September of 1997. This, together with an increase of 44.6% in the producer sales, accounted for the structural break in that year.

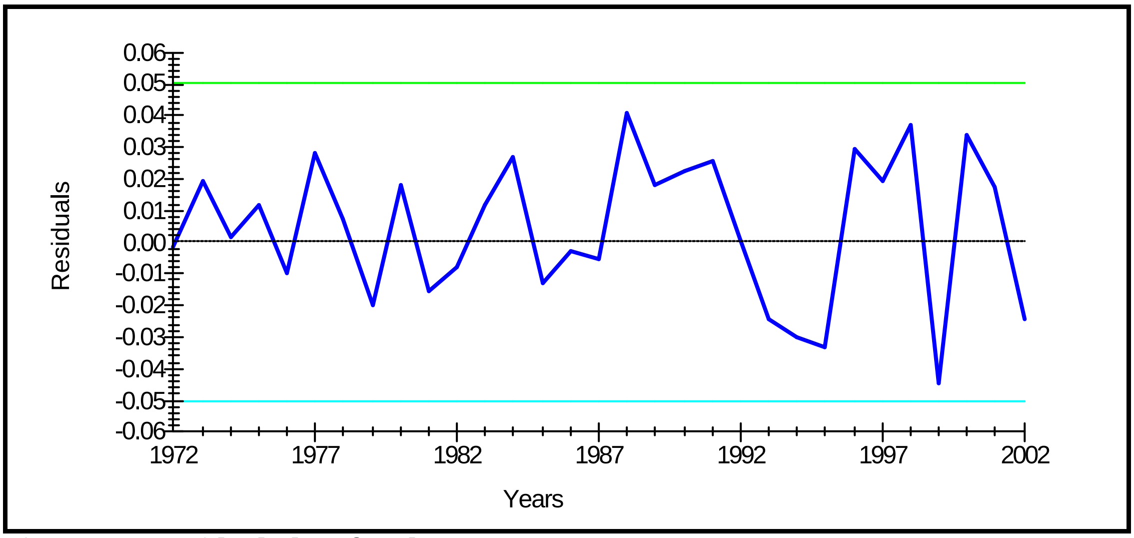

Figure 4.2: Residual plot of soybeans

The residual plot of the groundnuts budget share equation after all the necessary dummy variables had been included is presented in Figure 4.3. Structural breaks were identified for 1973, 1974 and 1985 and the dummy variables have been included accordingly. The dummy variable included for 1973 can be explained by a decrease of 30% in the producer sales of groundnuts, followed by a 74% increase in sales in the marketing year of 1974. The total local sales of groundnuts experienced a major increase of 172.8% in 1985, which explains the structural break that occurred in that year.

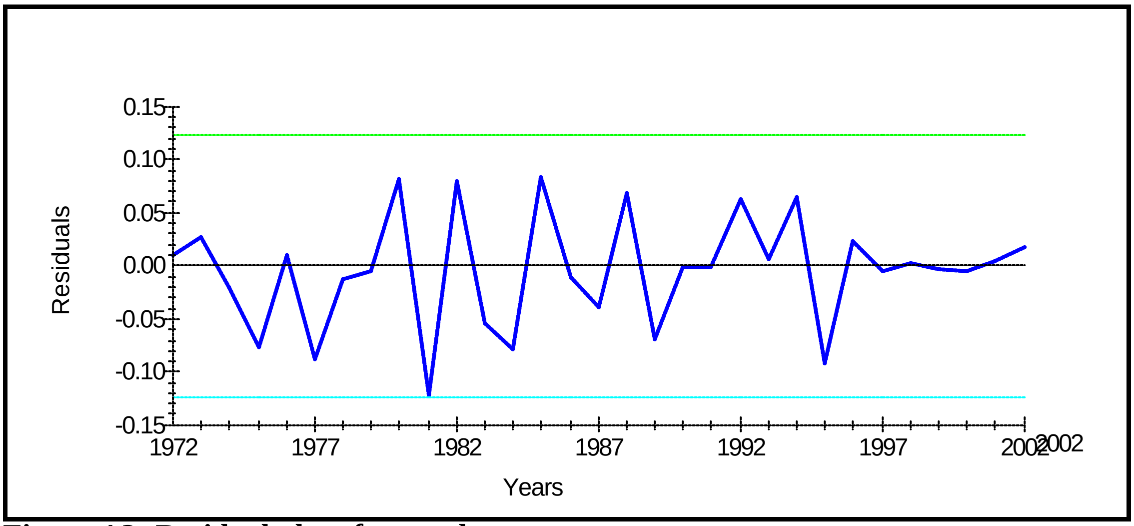

Figure 4.3: Residual plot of groundnuts

After identifying and accounting for all the structural breaks in the equations mentioned above, it is clear from the residual graphs that no additional dummy variables need to be included since the residual graphs do not “break” the two standard error bands in any of the three graphs.

The estimation of the demand system was done using the seemingly unrelated regression (SUR) method in Micro Fit 4.1. The seemingly unrelated regression (SUR) method allows for the estimation of system equations and the cross-equation restrictions of demand could easily be tested and imposed. After these demand restrictions had been tested and they proved to be significant, the restrictions were imposed in the system of equations with the use of the restricted seemingly unrelated regressions method (RSUR) from where the parameter estimates were be obtained.

Table 41 provides the calculated Wald test statistics and the associated p values that were used for testing the homogeneity and symmetry restrictions. The null hypothesis is that the prices are homogenous of degree zero and that they are symmetric. The calculated p values presented in the table below indicate the chance of making an error if the null hypothesis is rejected. Ideally one would prefer the chance of making an error when rejecting the null hypothesis to be at least 5 percent.

Table 4.1: Wald statistics for testing homogeneity and symmetry restrictions

Restriction	Wald test statistic	P-Value
Homogeneity in:		
Sunflower share equation	1.4195	0.233
Soybeans share equation	0.0835	0.835
Groundnuts share equation	1.6822	0.195
Symmetry for:		
Sunflower and soybeans price parameters	1.1254	0.289
Sunflower and groundnuts price parameters	0.0793	0.778
Chicken and groundnuts price parameters	0.6628	0.416

For both homogeneity and symmetry, the chance of making an error when rejecting the null hypothesis is at least 19.5% for all three budget share equations. Thus the specified equations of the LA/AIDS model for oilseeds in South Africa are homogeneous of degree zero, and symmetrical. Once these restrictions had been tested and proved, they were imposed in the estimation of the necessary parameter estimates needed to calculate the elasticities of primary oilseeds in South Africa.

The parameter estimates obtained from the restricted seemingly unrelated regression (RSUR) are given in table 4.2. The cotton budget share equation has been omitted to satisfy the adding up restriction. The parameter estimates obtained for the cotton budget share equation in the table below was obtained by simple calculations by means of the adding up restriction.

Table 4.2: Parameter estimates of the LA/AIDS model

		Dependent variables			
		Sunflower	**Soybeans**	**Groundnuts**	**Cotton**
	Sunflower	0.24355 (2.8962)***			
	Soybeans	-0.047796 (-1.7843)**	0.028384 (1.2850)		
	Groundnuts	-0.12739 (-2.8749)***	0.015962 (1.0852)	0.12480 (3.5768)***	
	Cotton	-0.068366 (-1.3073)*	0.0034499 (0.15167)	-0.013376 (-0.52508)	0.07829
Explanatory variables	**Expenditure**	0.068527 (1.6497)*	-0.045928 (-4.0289)***	-0.021832 (-0.69098)	-0.00077
	Dummy 1973			-0.43044 (-11.1921)***	
	Dummy 1974			0.32370 (8.4717)***	
	Dummy 1981	0.027331 (0.63029)			
	Dummy 1985			0.043986 (1.2601)	
	Dummy 1997		0.062807 (2.9432)***		

T-ratios in parentheses
* indicates significance at 10%
** indicates significance at 5%
*** indicates significance at 1%

The sunflower expenditure share equation performed the best of the three equations estimated with five of the six explanatory variables, being significant at a 10% level of significance. The expenditure variables included in the estimation was significant at a 10% level of significance in the sunflower equation and at a 1% level in the soybeans share equation. Three of the five dummy variables included in the estimated equations to account for the occurrence of structural breaks, are significant at 1%. The two dummy variables that are not statistically significant, i.e. the one in the sunflower equation and the 1985 dummy in the groundnuts equation, were still included in the model to account for the structural breaks identified earlier. The system weighted average R^2 of the three models is 50%, indicating that the estimated LA/AIDS performed relatively well.

4.4 Calculated elasticities

The parameter estimates of the LA/AIDS shown in Table 4.2 are used to calculate own price, cross price and expenditure elasticities of demand. The price elasticities calculated represent the percentage change in the quantity demanded a result of a 1% change in the price of that product.

The own price elasticity of a product is expected to have a negative sign, according to economic theory, indicating the negative slope of the demand curve. Cross price elasticities indicate the relationship between two products, i.e. whether the products are compliments or substitutes. A negative cross price elasticity indicates that the two products considered are complements and positive cross price elasticity indicates that the two products under consideration are substitutes. The expenditure elasticities calculated represent the change in the quantity demanded of a specific product as the expenditure on all four oilseeds increases. If the expenditure elasticity is positive and greater than one, the product is classified as a luxury product. An expenditure elasticity between 0 and 1 indicates that the product is considered a normal good, whereas a negative elasticity indicates an inferior product.

Two types of price elasticities, compensated and uncompensated, were calculated by means of the formulas indicated below. Uncompensated or Marshallian price elasticities contain both the price and income effect of a change in price and the compensated or Hicksian elasticities represent only the price effects and are thus compensated for the change in income.

The compensated and uncompensated elasticities are derived using formulae 4.8 and 4.9 respectively:

$$e_{i,t}{}^{*} = e_{it} + \overline{w} + \hat{b}(\frac{\overline{w}_j}{\overline{w}_i}) = -d + \frac{\hat{g}_{it}}{\overline{w}_t} + \overline{w}_j \qquad \text{i,j=1,2,…,n} \quad \text{.........................4.8}$$

$$e_{i,t} = -d + \frac{\hat{g}_{it}}{\overline{w}_t} - \hat{b}_t(\frac{\overline{w}_j}{\overline{w}_i}) \quad \text{…………………………………………………4.9}$$

where $d = 1$ for $i = j$ and $d = 0$ otherwise. The average expenditure shares are represented by $\overline{w}_t$ whereas $\hat{b}_t$, $\hat{g}_{it}$ are the RSUR parameter estimates of the LA/AIDS model.

The variances of the compensated and uncompensated price elasticities which are used to determine the significance of the estimated elasticities, can be calculated by applying the variance operator for the compensated and uncompensated price elasticities respectively as:

$$Var(e_{ij}*) = \frac{1}{\overline{w}^2} Var(\hat{g}_{ij}) \quad \text{…………………………………………………4.10}$$

$$Var(e_{ij}) = \frac{1}{\overline{w}^2} Var(\hat{g}_{ij}) + \frac{\overline{w}_j{}^2}{\overline{w}_i{}^2} Var(b_t) - 2(\frac{\overline{w}_j{}^2}{\overline{w}_i{}^2}) Cov(\hat{g}, \hat{b}) \quad \text{………………...4.11}$$

The formula, taken from Jung (2000) for the expenditure elasticity, can be written as:

$$h_i = 1 + \frac{\hat{b}_i}{\overline{w}_i} \quad \text{.......... 4.12}$$

The variance of the expenditure elasticity can be calculated by:

$$Var(h_i) = \frac{1}{\overline{w}^2} Var(\hat{b}_i) \quad \text{.......... 4.13}$$

The compensated, uncompensated and expenditure elasticities calculated with the above mentioned formulas as well as the parameters estimated earlier are given in Tables 4.3, 4.4 and 4.5 respectively.

Table 4.3: Compensated or Hicksian elasticities of oilseeds in South Africa

	Sunflower	**Soybeans**	**Groundnuts**	**Cotton**
Sunflower	**-0.013**	-0.061	-0.077*	0.149*
	(-0.424)	(-1.076)	(-2.110)	
Soybeans	-0.010	**-0.579***	0.157*	0.102*
	(-1.076)	(-12.277)	(13.001)	
Groundnuts	-0.033*	0.408*	**-0.210***	0.148*
	(-2.110)	(13.001)	(-7.326)	
Cotton	0.056*	0.232*	0.130*	**-0.399**
	(3.021)	(4.781)	(6.198)	

* indicates significance at a 5% level, t-ratios are in parentheses.

As can be seen from Table 4.3, all the compensated own price elasticities have the expected negative signs, with all of them being relatively inelastic. Soybeans have the largest (in absolute terms) own price elasticity namely, -0.579, followed by cotton with an own price elasticity of -0.399. Of all the elasticities reported in the table above, only four of the elasticities are not significant at a 5% level of significance. The cross price elasticities indicate that most of the products are considered to be substitutes, except the sunflower share equation that indicates that sunflower seed and soybeans are complements (-0.01) as is sunflower seed and groundnuts (-0.03). This complementary relationship between sunflower seed, soybeans and groundnuts is further supported by the groundnut and soybean share equations which also indicate such a relationship. These calculated cross price elasticities indicating that the cross products are complements are not all significant at a 5% level of significance.

A priori the expectation would be that these oilseeds are substitutes but, as mentioned previously, many of the international studies done on the demand relations of fats and oils indicate that these products have a complementary relationship (Goddard and Glance, 1989 and Gould *et al.* 1991).

The uncompensated own price and cross price elasticities are given in Table 4.4. These elasticities were calculated at the sample mean of the weight. These uncompensated elasticities include both the price and income effects.

Table 4.4: Uncompensated or Marshallian elasticities of oilseeds in South Africa

	Sunflower	Soybeans	Groundnuts	Cotton
Sunflower	**-0.588***	-0.292*	-0.533*	-0.356
	(-19.123)	(-4.987)	(-13.755)	
Soybeans	-0.106*	**-0.617***	0.081*	0.018*
	(-11.042)	(-13.076)	(6.631)	
Groundnuts	-0.281*	0.309*	**-0.407***	-0.069
	(-17.530)	(9.702)	(-13.911)	
Cotton	-0.161*	0.145*	-0.042*	**-0.589***
	(-8.577)	(2.979)	(-1.958)	

* indicates significance at a 5% level, t-ratios are in parentheses.

As in the case of the compensated own price, the uncompensated own price elasticities once again have the *a priori* negative signs, and all four elasticities calculated are significant at a 5% level of significance. Soybeans have the largest (in absolute terms) own price elasticity of -0.617, followed by cotton with -0.589. Although all of the elasticities are significant some of the signs were again unexpectedly indicating complementary relationships. All of the calculated elasticities are less than one, indicating that they are relatively inelastic. The own price elasticity of groundnuts is the smallest in absolute terms, indicating that groundnuts is the least sensitive to changes in its own price. A possible explanation for the complementary relationship between these oilseeds could be the fact that very little of these products are used in their primary form and it is therefore mainly processed. The products obtained after processing i.e. vegetable oils and oilcake, are used for human consumption and animal feeds. Thus these products are mixed together in animal feeds and could therefore be compliments. Many of the oils used as cooking oils also comprise a mixture of different vegetable oils.

Table 4.5 presents the expenditure elasticities for the four oilseeds under consideration in this study. As mentioned earlier, an expenditure elasticity greater than one is an indication that the product is a luxury product and between zero and one is an indication of a normal good.

Table 4.5: Expenditure elasticities of oilseeds in South Africa

	Sunflower	Soybeans	Groundnuts	Cotton
Expenditure	1.135*	0.454*	0.900*	0.996
	(77.053)	(18.679)	(34.642)	

* indicates significance at a 5% level of significance, t-ratios are in parentheses.

A priori the expectation would be that seed cotton is a luxury good, even though its expenditure elasticity is less than one it is close enough to one to be considered a luxury product. Normally sunflower seed will not be considered a luxury product but the elasticity indicates that it is indeed (1.135). The explanation for this could be that the expenditure elasticity depends greatly on the size of the average budget share weight and sunflower constitutes approximately 51% of total oilseed expenditure. Soybeans have the smallest expenditure elasticity, indicating that soybeans can be considered a normal good with an elasticity of 0.454. According to Wold and Juréen (1962) a product can also be regarded as a luxury product when the calculated expenditure elasticity is greater in absolute terms than the commodities' compensated own price elasticity. This theory would imply that sunflower, groundnuts and cotton can be regarded as luxury products, whereas the compensated own price elasticity of soybeans (-0.579) exceeds the calculated expenditure elasticity of soybeans (0.454).

In the study by Yen and Chern (1992) the expenditure elasticity of cotton oil was 1.3 which also indicates that cotton oil is a luxury product. The expenditure elasticity calculated for soybean oil is 0.412 which is close to the expenditure elasticity for soybeans as a primary product of 0.454, as obtained is this study.

4.5 Conclusion

This chapter provided the theoretical background for and the application of the Linearized Almost Ideal Demand System (LA/AIDS) on the South African primary oilseed industry. Compensated, uncompensated and expenditure elasticities were calculated, with the majority of them being statistically significant at a 5% level of significance. All the own price and cross price elasticities calculated are relatively inelastic, indicating that the change in the quantity demanded is smaller than the subsequent change in the price.

CHAPTER 5

ESTIMATION OF AN ERROR CORRECTION LA/AIDS MODEL ON THE SOUTH AFRICAN OILSEED INDUSTRY

5.1 Introduction

An error correction specification of the LA/AIDS enables estimations of short run and long run elasticities of demand, even though the long run equations estimated in levels are, more often than not, non-stationary (Harris, 1995). This type of dynamic modeling is a new and expanding area of modern econometrics and has only really received attention since the late 1980s, even though Davidson, Hendry, Srba and Yeo (1978) introduced the first notion of an error correction model in the context of the consumption function. This type of dynamic modeling of both the short and the long run has become increasingly popular compared to the LA/AIDS model used for estimations in Chapter 4. The reason for this is that all the variables used in the AIDS estimation were differenced and therefore their long run properties were lost (Studenmund, 2001). In the ECM version the long run properties of the data are not lost, because the residuals of the long run equilibrium equations are used in the modeling of the short run as soon as the stationarity of these residuals has been ensured.

An Error Correction Almost Ideal Demand System can be estimated as soon as a co-integrating relationship between the dependant variable and a linear combination of independent variables has been ensured (Karagiannis *et. al*, 2000). The dependant variables in the estimated equations are the expenditure shares of the individual commodities regressed on the logarithmic prices of all the oilseeds included in the study.

In the analysis of the South African oilseed industry the two step estimation procedure proposed by Engle and Granger (1987) for an error correction AIDS, was used to estimate demand elasticities for the long and short run horizons.

5.2 Specification of the model

In order to estimate an error correction version of the LA/AIDS, both long and short run equations have to be specified and estimated. The long run equation is specified as follows:

$$w_{it} = a_i + \sum_{j}^{n} g_{ij} \ln p_{jt} + b_i (LnX - \sum_{i=1}^{n} w_{i,t-1} \ln p_{i,t}) + u_{i,t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots 5.1$$

which appears to be exactly the same as that of the LA/AIDS; the only difference is the fact that these equations are estimated in levels. To estimate an equation in levels means that the variables are not corrected for non-stationarity by differencing them. The reason for not differencing the variables is to enable capture of the long run equilibrium effects and differencing a series removes those effects. Another difference is that Equation 5.1 is estimated by means of the ordinary least squares (OLS) estimation method and not a systems approach, as in the case of the LA/AIDS. This type of regression estimation on economic variables in levels that are non stationary, will only make sense if the aim is to test whether these variables are co-integrated (Yule, 1926 and Granger and Newbold, 1974, 1977)

The residuals term of the long run equation 5.1 $(u_{i,t})$ is saved and included in the short run equations as an additional explanatory variable in order to capture the long run equilibrium effects as they present the equilibrium error of the short run model (Engle and Granger, 1987). These saved residuals included in Equation 5.2 are tested for stationarity before they are included in the short run equations. The stationarity of these residuals is a necessary condition for estimating the Error Correction Model. According to Engle and Granger (1987), if a series is only stationary after the variables have been differenced, that series may have linear combinations that are stationary without differencing them, therefore those variables are set to be co-integrated. This means that if these included residuals are stationary without being differenced, then it is confirmed that the long run equations are in fact in equilibrium. The short run demand equations are estimated using Equation 5.2.

$$w_{it} = a_i + \sum_{j}^{n} g_{ij} \ln p_{jt} + b_i (LnX - \sum_{i=1}^{n} w_{i,t-1} \ln p_{i,t}) + l_i u_{i,t-1} + u_{i,t} \ldots\ldots.5.2$$

All of the variables included in Equation 5.2 are included in differenced form to ensure stationarity, except the included residuals saved from the long run equations ($l_i u_{i,t-1}$), which need to be stationary without being differenced. The same procedure for testing and ensuring the stationarity of the variables was done as in Chapter 3. The same time series data was used as in the case of the LA/AIDS and thus the DF and ADF test statistics to ensure stationarity in Table 3.1 is also applicable to the dynamic ECM model and ensuring that the variables used are stationary after 1st differencing them. After the stationarity of the dynamic model as well as the saved residual has been ensured, further estimation of these two models can proceed. The short run equations are estimated using the seemingly unrelated regressions (SUR) method of estimation, as OLS estimates of the short run model can lead to a loss of statistical efficiency of the estimated coefficients (Phillips, 1991).

The general demand restrictions of homogeneity and symmetry are tested for and imposed in the short run equations. The test statistics will follow in the next section of this chapter. The reason for not testing or imposing the restrictions in the long run is that the long run is a non-stationary series and the imposition of these restrictions will adjust the estimated coefficients, thus changing the long run equilibrium relationship. According to Engle and Yoo (1987) the long run equations should be used to estimate the residuals by means of an OLS estimation method and the short run equations with the lagged residuals of the long run included should form the basis for testing and imposing cross equation restrictions.

The demand restrictions tested and imposed on the short run equations are the following:

Homogeneity: $\sum_{j} g_{ij} = 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..5.3$

Adding up: $\sum_{i} a_i = 1, \sum_{i} g_{ij} = 0, \sum_{i} b_i = 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..5.4$

Symmetry: $g_{ij} = g_{ji}$ ……………………………………………..5.5

As can be seen from Equations 5.3 to 5.5, the restrictions of the error correction version of the LA/AIDS are the same as in the previous chapter.

5.3 Estimated results

As mentioned in the section above the long run estimates are obtained by using the ordinary least squares estimation procedure with the expenditure weight and logarithmic price variables included in levels. No dummy variables were included in these long run estimates as this would influence the long run equilibrium relationship.

Table 5.1 provides the OLS parameter estimates of the long run equations estimated. The cotton budget share equation was once again omitted to satisfy the adding up restriction in the short run estimation, but in the static model the cotton OLS equation was estimated because the demand restrictions are not tested for or imposed in the long run.

Table 5.1: Long run parameter estimates of the ECM model

		Dependant variable			
		Sunflower	**Soybeans**	**Groundnuts**	**Cotton**
	Sunflower	0.24332***	-0.014641	-0.092153	-0.21035**
		(2.4519)	(-0.32262)	(-0.96980)	(-1.6910)
	Soybeans	-0.19948**	0.078962**	-0.031938	0.28672***
		(-1.7877)	(1.5474)	(-0.29892)	(2.1248)
Explanatory variables	**Groundnuts**	-0.056146	-0.023427	0.14061	-0.068877
		(-1.1130)	(-1.0154)	(2.9108)***	(-1.0319)
	Cotton	0.12002	0.022511	-0.10153	-0.071057
		(0.99230)	(0.40698)	(-0.87662)	(-0.44597)
	Expenditure	0.032629	-0.014788	-0.046959	0.035143
		(0.85342)	(-0.84574)	(-1.2827)	(0.69434)

t-ratios in parentheses
* indicates significance at 10%
** indicates significance at 5%
*** indicates significance at 1%

The parameter estimates given in Table 5.1 of the estimated long run equations did not perform well, as can be seen by their t-values, even though the average adjusted R^2 of the four models is 57.4. The reason for the poor significance of the estimated coefficients and a relatively good R^2 could be attributed to the non-stationarity of the variables included. However, this is not uncommon as, in this case, the interest is in the error term originating from these long run equations and their stationarity (Currie, 1981 and Stock, 1984).

The next step in the two-step estimation procedure proposed by Engle and Granger (1987) is to test whether the residuals saved from the long run equations are indeed stationary, which would imply that the long run equations are in fact in a state of equilibrium. According to Karagiannis *et al.* (2000) co-integration only needs to be established for at least one of the expenditure share equations in order to proceed with the estimation of an ECM model. In other words, at least one of the saved residuals from the static (long run) model needs to be stationary without differencing it. Stationarity of the residuals was tested with the use of the Dickey Fuller and Augmented Dickey Fuller test statistics. Table 5.2 presents the calculated and test statistics to ensure the stationarity of the residuals.

Table 5.2: Testing the residuals of the static model for stationarity

Residuals tested for stationarity	**Calculated ADF(1) statistic**
Residual of sunflower share equation	-3.2793
Residual of soybean share equation	-3.3624
Residual of groundnuts share equation	-3.8551
95% critical value	**-2.9627**

From the test results of the stationarity of the residuals of the long run equations it is clear that the null hypothesis of a unit root is rejected, i.e. that all three of the saved residuals are stationary without being differenced. Once the stationarity of the residuals has been proved, it can be concluded that the long run equations estimated are indeed in a state of long run equilibrium and the estimation of the short run (dynamic) model can proceed.

The first step in the estimation of the dynamic (short run) equations is to ensure that the variables included in the estimation procedure are stationary by differencing these variables. In Table 3.1 it was shown that all the variables included in these equations are I(1). This means that the variables are all stationary after first differencing them. The fact that differencing the variables removes the long run relationship between the variables is overcome by the fact that the stationary residuals from the long run equations are included in the short run model in order to capture that effect.

Once the stationarity of the variables in the dynamic model has been ensured, structural breaks in the time series can be identified. These structural breaks are identified by estimating the three budget share equations with the SUR estimation method and plotting the residuals of each of the equations as described in Chapter 3. The dummy variables included in the ECM version of the LA/AIDS will not necessarily be the same as in the case of the model estimated in Chapter 4. The reason for this is that an additional variable (the lag of the long run residual) is included in this model. The method discussed in Chapter 3 is used to identify possible structural breaks. After plotting the residuals of the three expenditure share equations of sunflower, soybeans and groundnuts, the only dummy variables included are one for soybeans in 1997, as was the case in the LA/AIDS model, and for groundnuts for 1973 and 1974. Each of the intercept dummies included in the estimated equations will be explained in the following section.

Figure 5.1 to 5.3 indicates the final residual plots of the budget share equations after the dummies have been included.

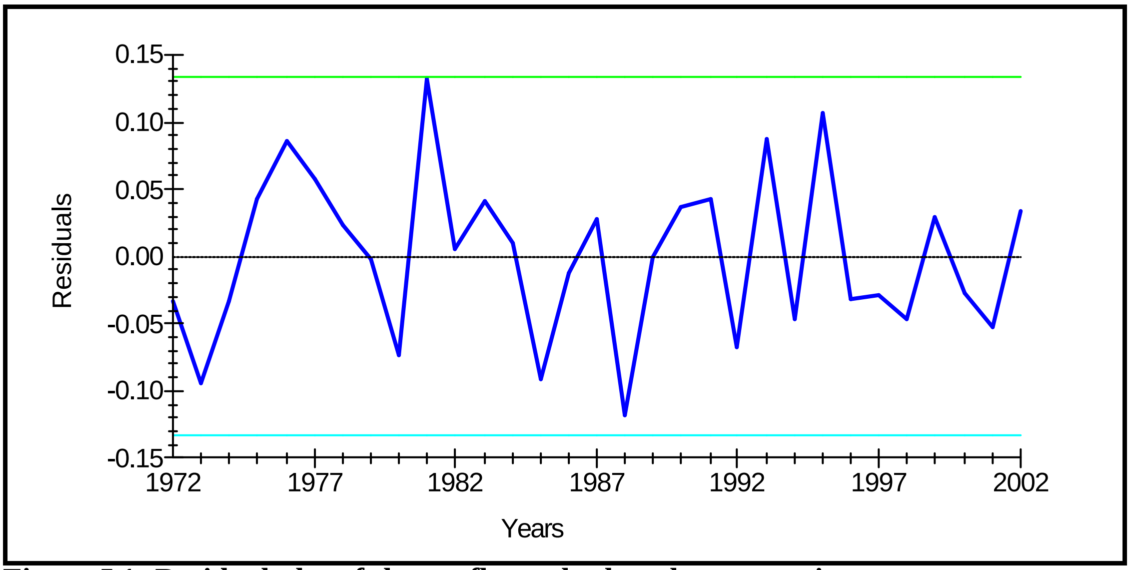

Figure 5.1: Residual plot of the sunflower budget share equation

It is clear from the plot of the residuals of the sunflower budget share equation that there is no need to include the dummy variable for 1981 as was required for the LA/AIDS, and that effect (structural break) was removed when the lag of the residual was included in the ECM model.

Figure 5.2 represents the final residual plot of the soybean equation after the dummy of 1997 was included, as was done for the model estimated in Chapter 4. The explanation for the structural break that occurred in 1997 is the same as in the case of the LA/AIDS model, and can be attributed to the effects of deregulation that took place in the soybean industry.

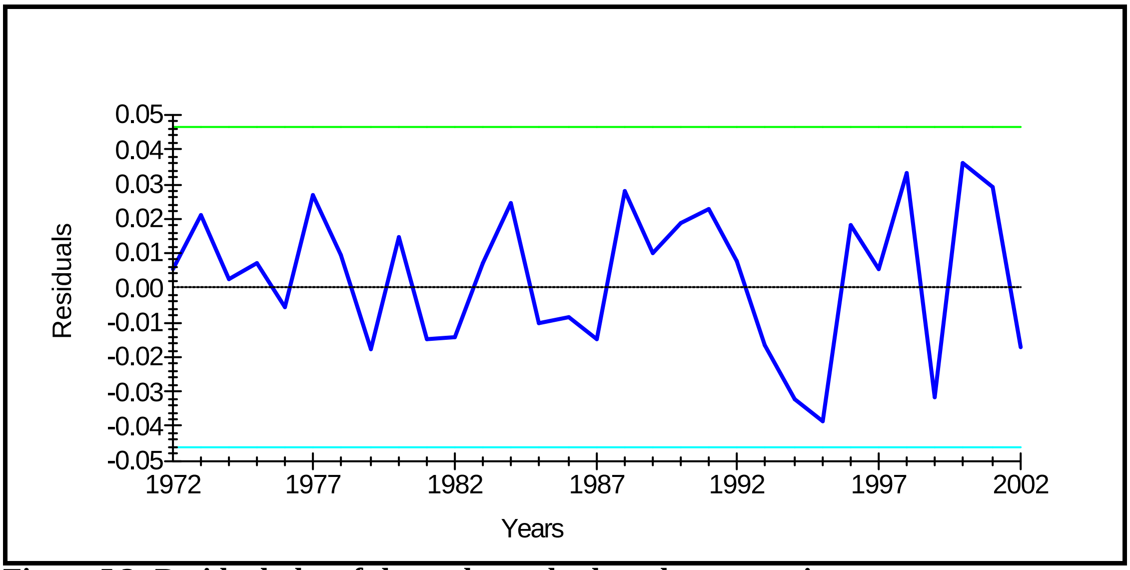

Figure 5.2: Residual plot of the soybeans budget share equation

The dummy variables included in the groundnut expenditure share equations for 1973 and 1974 were sufficient to prevent additional structural breaks, as can be seen in Figure 5.3. The dummy variables can be explained by the high variability of producer sales in these particular years.

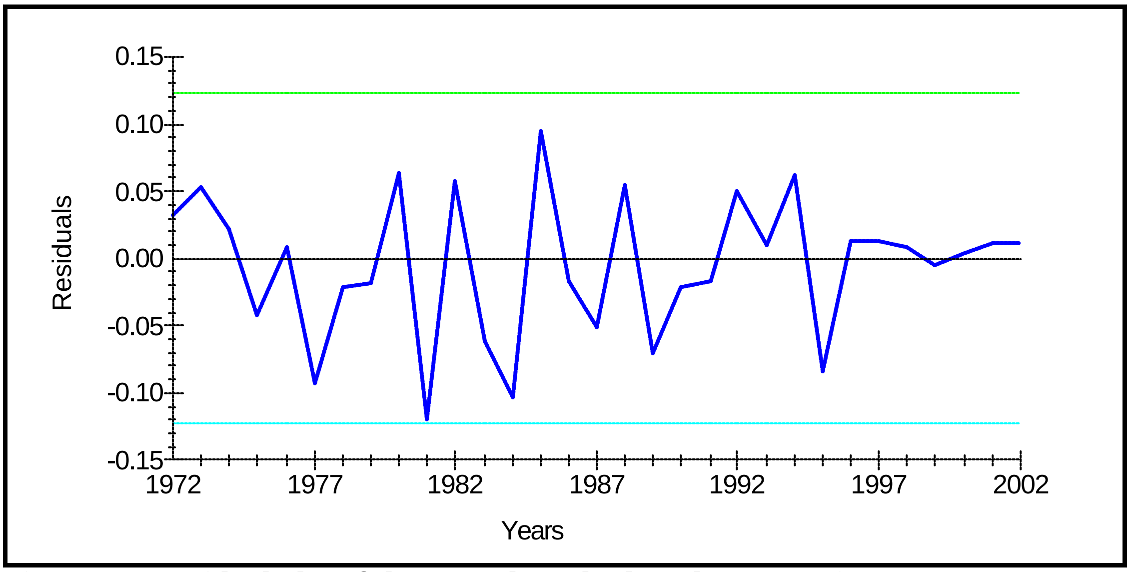

Figure 5.3: Residual plot of the groundnuts budget share equation

After all the possible structural breaks had been identified and dealt with, the equations were estimated again with the necessary dummies included in order to determine whether these equations obey the general restrictions of demand.

The restrictions of homogeneity and symmetry were tested by applying Wald test statistics obtained from the Micro Fit 4.1 econometric software, and using the seemingly unrelated regressions method of estimation.

As mentioned previously, many of the cited studies on demand relations did not test for the general demand restrictions of homogeneity, symmetry and adding up, which could have a major impact on the estimated elasticities. Table 5.3 presents the Wald test statistics and associated p values to test whether the short run equations adhere to the general demand restrictions.

The null hypothesis for testing the demand restrictions are that the logarithmic prices included in the equations are homogenous of degree zero and that they are symmetric. The chance of making an error when rejecting the null hypothesis in the case of the ECM model is at least 16% and it can be concluded that the prices are homogenous of degree zero and they are symmetric, indicating that the sum of the prices in a single equation is equal to 0 and that the cross price coefficients are equal. This critically important testing procedure of the demand restrictions, which was previously neglected, ensures that the estimated parameters and associated elasticities will be consistant with economic theory of consumer demand.

Table 5.3: Wald statistics for testing the homogeneity and symmetry restrictions

Restriction	Wald test statistic	P-Value
Homogeneity in:		
Sunflower share equation	1.9607	0.161
Soybeans share equation	0.1643	0.685
Groundnuts share equation	0.5770	0.447
Symmetry for:		
Sunflower and soybeans price parameters	1.3672	0.242
Sunflower and groundnuts price parameters	0.0049	0.944
Chicken and groundnuts price parameters	0.4971	0.481

After being tested and confirmed, these restrictions are imposed in the equations of sunflower seed, soybeans and groundnuts in order to estimate the parameters of the ECM version of the LA/AIDS from which the short run elasticities will be calculated. As in the case of the LA/AIDS estimated in Chapter 4, the cotton budget share equation was excluded to satisfy the adding up restriction. The dynamic (short run) ECM equations are estimated with the use of the restricted seemingly unrelated regressions (RSUR) procedure after the restrictions have been tested for and proved. The equations are again specified with the budget share as the dependant variable regressed on the logarithmic prices of all four oilseeds and the Stones price index.

Table 5.4 presents the estimated parameter estimates obtained by using the above mentioned iterative procedure on the system of dynamic equations. Of the 12 parameter estimates calculated, 7 of them are significant at a 5% level of significance. The dummy variables included to account for the structural breaks that occurred were all significant at a 1% level of significance, indicating that the breaks identified earlier had been correctly quantified. The two parameters estimated for the cotton budget share equation were calculated by means of the adding up restriction and because this specific equation was not estimated econometrically its significance could not be determined.

Table: 5.4: Parameter estimates of the dynamic Error Correction Model

		Dependant variables			
		Sunflower	**Soybeans**	**Groundnuts**	**Cotton**
	Sunflower	0.16710*** (2.5083)			
	Soybeans	-0.042677** (-1.6259)	0.021044 (0.98127)		
	Groundnuts	-0.10970*** (-2.9512)	0.016520 (1.1265)	013467*** (4.0845)	
	Cotton	-0.014721 (-0.33692)	0.0051125 (0.24008)	-0.041485** (-1.7589)	0.0511
Explanatory variables	**Expenditure**	0.053013** (1.5961)	-0.042678*** (-4.0039)	-0.022545 (-0.77015)	0.0122
	Residual (-1)	-0.66161*** (-5.2845)	-0.18968* (-1.4413)	-0.24348** (-2.3190)	
	Dummy 1973			-0.41601*** (-10.4921)	
	Dummy 1974			0.25481*** (6.2923)	
	Dummy 1997		0.6985*** (3.0026)		

t-ratios in parentheses
* indicates significance at 10%
** indicates significance at 5%
*** indicates significance at 1%

The system weighted R^2 performed much better than in the case of the LA/AIDS model and indicated that 62.2% of the variation in the dependant variable can be explained by the explanatory variables. The lagged error terms which were saved from the static equations and included in the short run equations performed relatively well, with the residuals of sunflower seed and groundnuts being significant at a 5% level of significance and the residual of soybeans significant at a 10% level, and all of them carried the expected (negative) signs because they represent the deviation from the long run equilibrium. If the short run model is considered to be in equilibrium, the coefficient of the residuals will be equal to zero (Townsend, 1997). The estimated parameters of the residuals in the dynamic model can be interpreted as coefficients of adjustment. They indicate the speed of adjustment of the short run model towards a state of long run equilibrium and, according to theory the magnitude of these parameters, should range between zero and one (Harris, 1995). The speed of adjustment of the sunflower seed equation is 66.2%, indicating that 66% of the deviation from the long run equilibrium is corrected with in a single year. The speed of adjustment for soybeans and groundnuts is much slower than that of sunflower, with coefficients of 18.9% and 24.3% respectively.

5.4 Calculated elasticities

The Error Correction Model enables estimation of long run and short run elasticities of demand once the equilibrium of the static (long run) equations have been tested and confirmed. The formulas for calculating the own price, cross price and expenditure elasticities are the same as in the case of the LA/AIDS model and Equations 4.8 to 4.13 were therefore used to calculate the elasticities as well as the associated variances to determine the significance of them (Karagiannis *et al.* 2000). The long run elasticities are calculated by using the same formulas, but the parameter estimates of the co-integration equations (long run) are used in the estimation (Johnson, Oksanen, Veall and Fretz, 1992).

5.4.1 Calculated long run elasticities

Table 5.5 presents the long run expenditure and compensated own price elasticities of sunflower seed, soybeans, groundnuts and cotton. The compensated own price elasticities which indicates the substitution effect of a change in price, are again all negative, as expected from the theory, but the own price elasticities of sunflower seed and soybeans are not significant. The long run expenditure elasticities are positive, as expected, and as in the case of the LA/AIDS, sunflower seed and cotton is seen as luxury goods with an expenditure elasticity greater that one.

The long run compensated own price elasticity of seed cotton is greater than one, indicating that cotton is relatively elastic in the long run i.e. the change in the quantity demanded is greater than the change in the price.

Table 5.5: Long run expenditure and compensated own price elasticities

	Sunflower	Soybeans	Groundnuts	Cotton
Own price elasticity	-0.013	-0.047	-0.717*	-1.181*
	(-0.378)	(-0.440)	(-18.344)	(-21.483)
Expenditure elasticity	1.064*	0.824*	0.785*	2.839*
	(79.744)	(22.448)	(26.494)	(33.891)

* indicates significance at 5%, t-ratios in parentheses

The LeChatelier principle states that, in the case of long run equilibrium, the long run compensated own price elasticities should be larger in magnitude than the short run compensated own price elasticities (Milgrom and Roberts, 1996).

5.4.2 Calculated short run elasticities

From Table 5.6 it can be seen that the short run compensated own price elasticities are smaller in magnitude than their long run counterparts with respect to groundnuts and cotton. The own price elasticities of sunflower and soybeans are smaller (less elastic) in the long run than in the short run but, as mentioned earlier, neither of them are significant at a 5% level of significance.

Table 5.6: Short run compensated elasticities of oilseeds in South Africa

	Sunflower	Soybeans	Groundnuts	Cotton
Sunflower	**-0.164***	0.001	0.004	0.429*
	(-6.925)	(0.012)	(0.134)	
Soybeans	0.000	**-0.666***	0.160*	0.111*
	(0.003)	(-14.550)	(13.252)	
Groundnuts	0.002	0.415*	**-0.165***	0.001
	(0.134)	(13.252)	(-6.087)	
Cotton	0.162*	0.252*	0.001	**-0.542***
	(10.453)	(5.542)	(0.059)	

* indicates significance at 5%, t-ratios in parentheses

The short run ECM model did not perform as well as the LA/AIDS in the estimation of the short run compensated own price and cross price elasticities. Of the 16 elasticities calculated in the table above, only 10 are significant at a 5% level of significance, compared to the LA/AIDS, where only 3 of them were not significant. The difference in the magnitude of the compensated own price elasticities provided by the two estimated models, reveals that the only relatively large difference occurs in the own price elasticity of sunflower which is -0.164 in the ECM model and -0.013 in the LA/AIDS. But, as mentioned earlier, the calculated coefficient of sunflower is not significant in the latter model. Soybeans has an own price elasticity of -0.666 in the ECM compared to an elasticity of -0.579 in the AIDS model. The calculated cross price elasticities presented in Table 5.6 indicate a dominantly substitutionary relationship between these oilseeds, which was also the case in the LA/AIDS. However it must be taken into account that some of these cross product elasticities are not statistically significant. The cross price elasticities which are significant in the ECM model carry the same signs as in the case of the LA/AIDS, indicating that these cross products are substitutes.

The uncompensated own price and cross price elasticities which includes both the income and substitution effect of a change in price, as mentioned earlier, are given in Table 5.7. These elasticities of the Error Correction Model performed much better than the compensated elasticities because all 16 elasticities calculated are statistically significant at a 5% level of significance.

Table 5.7: Short run uncompensated elasticities of oilseeds in South Africa

	Sunflower	**Soybeans**	**Groundnuts**	**Cotton**
Sunflower	**-0.723***	-0.250*	-0.450*	-0.109*
	(-29.681)	(-4.378)	(-13.679)	
Soybeans	-0.093*	**-0.707***	0.084*	0.021*
	(-9.944)	(-15.444)	(6.896)	
Groundnuts	-0.240*	0.307*	**-0.361***	-0.231*
	(-17.833)	(9.690)	(-13.070)	
Cotton	-0.049*	0.158*	-0.170*	**-0.745***
	(-3.134)	(3.453)	(-8.541)	

* indicates significance at 5%, t-ratios in parentheses

The uncompensated elasticities calculated and presented in the table above compare very well with the elasticities of the LA/AIDS calculated in Chapter 4 in terms of their signs as well as their magnitude. All of the calculated own price elasticities had the expected negative sign, with all of them except groundnuts being slightly more elastic than was the case with the LA/AIDS model. The difference in the size of the own price elasticities between the two models are again comparable with soybeans, having an own price elasticity of -0.707 in the ECM model and -0.617 in the AIDS model, with both being highly significant.

In the case of sunflower seed and cotton the differences in the own price elasticities between the two models are however a bit larger, with sunflower having an elasticity of -0.723 in the ECM and -0.588 in the LA/AIDS and cotton -0.745 and -0.589 in the two models respectively.

The comparison of the cross price elasticities of the two uncompensated models reveals that the signs indicating whether the products have a complementary or substitutionary relationship remained exactly the same, with the majority indicating that these products are complements. A possible explanation for this could be that the income effect of a price change outweighs the substitution effect.

The estimated short run expenditure elasticities of the Error Correction Model followed those of the AIDS model very closely and indicated that sunflower seed and cotton can be regarded as luxury commodities, with elasticities of 1.105 and 1.064 respectively. These elasticities, presented in Table 5.8, are all positive as expected with the expenditure elasticities of the three equations estimated all being significant. Sunflower seed, groundnuts and cotton can again be regarded as luxury products because their expenditure elasticities are greater in absolute terms than their compensated own price elasticities (Wold and Juréen, 1962).

Table 5.8: Short run expenditure elasticities of oilseeds in South Africa

	Sunflower	**Soybeans**	**Groundnuts**	**Cotton**
Expenditure	1.105*	0.493*	0.897*	1.064
	(93.769)	(21.676)	(37.254)	

* indicates significance at 5%, t-ratios in parentheses

5.5 Conclusion

This chapter dealt with the specification and estimation of an Error Correction version of the LA/AIDS, which enables the estimation of short run and long run elasticities of demand. Long run equilibrium was identified in the oilseed industry by testing the residuals of the long run equations for stationarity. The short run parameter estimates include coefficients of adjustment, which indicate the speed of adjustment towards a state of long run equilibrium, as they represent the equilibrium error of the short run. Except for the long run uncompensated own price elasticity of cotton of -1.723, the rest of the elasticities calculated were all relatively inelastic, as was the case in the model estimated in Chapter 4. The size of the elasticities calculated with the two different models did not vary greatly and is an indication that these elasticities are significant, as can be seen from their test statistics. The expenditure elasticities calculated for both the short run and the long run once again indicated that cotton and sunflower seed can be regarded as luxury products.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This study focused on the estimation of demand relations for primary oilseeds in South Africa. The oilseeds included in this particular study were sunflower seeds, soybeans, groundnuts and cotton, because they represent the major oilseeds in the South African context. Data on the primary, unprocessed oilseeds were used in the estimation because of the lack of available data on the vegetable oils and oilcake which is obtained after oilseeds are crushed. In estimating theoretical demand models, certain difficulties that have to be dealt with can arise and they include the selection of an appropriate model, separability between the commodities included, theoretical demand properties and the time series properties of the data included in the estimation procedure. All of the above mentioned aspects of estimating a demand model have been considered and dealt with.

Demand relations for oilseeds in South Africa were estimated with the use of two different models. The models used in this study include the Almost Ideal Demand System (AIDS) and an Error Correction Model (ECM). The ECM enables estimation of short run as well as long run elasticities of demand.

The next section of this chapter provides a comparison between the results estimated with the two different models used in this study and their associated elasticities. The final section of the chapter provides recommendations for possible further research in the South African oilseeds industry.

6.2 Comparing the results of the LA/AIDS and ECM models

The LA/AIDS and ECM models estimated in this study, enables calculation of two different types of elasticties of demand i.e. compensated and uncompensated. As mentioned previously the uncompensated elasticities contain both the income and price effects, whereas the compensated elasticities are reduced to contain only the price effects and thus compensated for the effect of income on a change in the demand for a certain commodity. Expenditure elasticities of all the individual oilseeds included in this study are also calculated by means of the parameter estimates obtained from the two models.

Comparing the compensated price elasticities of the two models reveals that the LA/AIDS model performed best when considering the significance of the individual elasticities. With the LA/AIDS model 12 of the possible 16 own price and cross price elasticities were significant at a 5% level of significance. The ECM produced only 10 significant estimates. The difference in the magnitude of the own price elasticities between the two estimated models is also comparable. The compensated own price elasticity of soybeans is -0.579 according to the Aids model and -0.666 in the ECM, whereas the elasticities of groundnuts are -0.210 and -0.165 in the two models respectively. Both the estimated models produced elasticities that are relatively inelastic, indicating that the change in the price of these oilseeds is larger than the change in the quantity demanded.

The uncompensated price elasticities calculated performed better than their compensated counterparts. The uncompensated own price and cross price elasticities calculated with the ECM were all significant at a 5% level of significance and the AIDS model produced 14 significant estimates out of a possible 16. Comparing the different elasticities calculated reveals that these elasticities are once again comparable. The own price elasticity of soybeans is -0.617 according to the AIDS model and -0.707 in the the ECM. The calculated own price elasticity of sunflower is -0.588 and -0.723 in the two models respectively. Except for the own price elasticity of groundnuts, all the own price elasticities calculated with the ECM are more elastic than was the case of the LA/AIDS model.

The expenditure elasticities calculated with the two models provides information on whether a commodity can be regarded as a luxury, normal or inferior product. *A priori* one would expect cotton to be a luxury commodity (elasticity larger than one), which was confirmed by the elasticities of 0.996 and 1.064 in the two models respectively. Against expectations sunflower seeds can also regarded as a luxury commodity, with an expenditure elasticity of 1.135 in the AIDS model and 1.105 in the ECM. Groundnuts and soybeans are both normal commodities with expenditure elasticities ranging between zero and one.

6.3 Practical implications of the calculated elasticities

The compensated cross price elasticities represent the change in the quantity of a certain product demanded due to a 1% change in the price of another product assuming that real income is unchanged (Badurally-Adam and Darroch, 1997). From the results of the LA/AIDS model it is clear that a 1% change in the price of soybeans would have the largest impact on the consumption of the other oilseeds. For example, a 1% increase in the price of soybeans will cause the consumption of groundnuts to increase by 0.41%, the same increase in the price of soybeans will cause the consumption of seed cotton to increase by 0.23%.

The calculated own price elasticities indicate that soybeans are the most price sensitive oilseed of the four major oilseeds included in this study. A 1% change in the price of soybeans will lead to a decrease of 0.58% in the quantity demanded of soybeans. A possible explanation for soybeans being the most price sensitive, is the fact that large amounts of soybean by-products are imported to meet the demand for animal feed rations. The elasticities calculated with both the applied models indicate that the demand for oilseeds are relatively inelastic i.e. the change in the quantity demanded is smaller than the associated change in the price.

6.4 Recommendations for further research

Despite the severe shortage of data on oilseed products in South Africa, research in the following areas could be of great value to the oilseed industry:

- **Demand for vegetable oils and oilcake:** As mentioned previously in the study the majority of international oilseed demand studies used data on oilseed products that are obtained from crushing the seeds. South African data on these processed products are very scarce and further complicates such a study. International oil and oilcake prices could be used for the estimation procedure or alternatively cross-sectional data could possibly be obtained from the expressers. This type of study will be especially valuable, keeping in mind that these two products are used as inputs for two different sectors.

- **Including demographic variables in the demand estimation:** By including demographic variables in the estimation of demand relations, various behavioural aspects can be studied. Chern, Loehman and Yen (1995) included a cholesterol information index in their demand estimation to determine the degree of health consciousness of the consumers purchasing oilseed products. The effect of advertising efficiency can also be estimated by studying the occurrence of advertisements of a certain commodity and its substitutes. Goddard and Amuah (1989) studied the effect of advertisements after Canada launched an advertising campaign to increase the consumption of industrial milk and cheese. Demographic variables such as age, race and education can also be included in the demand estimation to determine their effect on the quantity consumed.

- **Demand for imported oilseed products:** Studying the demand for imported oilseed products, especially the oilcake used in animal feed rations, can be very valuable. As mentioned previously South Africa imported 51% of the total available oilcake in 2001/02. This type of demand estimation can further be extended to estimate the demand for oilcake from the different import destinations, which will provide information on the most price sensitive import destinations. Such a study has been done by Chang and Nguyeni (2002), who estimated the demand for Australian cotton in Japan and the price sensitivity of the Japanese cotton market.

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EXECUTIVE SUMMARY

Introduction

The majority of demand relations estimation in a South African context has been done prior to 1994 after which a lot of changes took place. The usefulness of these calculated elasticities in making predictions are therefore debatable. Another shortfall is due to the fact that nothing has been done in the context of the South African oilseed industry and the estimation of elasticities that are industry specific.

From an agricultural decision making perspective, information on the demand relations of the various oilseeds products can be of great value. Agricultural policy makers and producer organizations will, for instance, be able to use the results to calculate the effect of changing prices on the demand for the various oilseeds. In turn, the information can be used by the various role players in the supply chain for strategic planning.

Objective of the study

The primary objective of this study were to estimate compensated, uncompensated and expenditure elasticities of demand with the use of econometric models and to interpret these elasticities to determine the effect of changing prices on the quantity demanded. Two different econometric models, namely the Almost Ideal Demand System and an Error Correction Model were used which can easily be updated with new data to estimate new demand relations as data becomes available.

Methodology used

According to Blanciforti, Green and King (1986) there are basically two approaches to estimating demand systems. The first approach starts with utility functions that satisfy certain axioms of choice, namely completeness, transitivity and continuity. The demand

functions can then be obtained by maximizing the utility function subject to a budget constraint. The majority of demand functions estimated in South Africa followed this approach.

The alternative approach uses a system of demand equations and imposes cross-equation restrictions consistent with consumer demand in order to obtain efficient parameter estimates. The Linear Approximated Almost Ideal Demand System (LA/AIDS) proposed by Deaton and Meulbauer (1980), which is used in this study, is an example of a systems-wide approach to estimating consumer demand relations. The second demand system estimated in this study includes an Error Correction Model (ECM) proposed by Engle and Granger (1987) which allows the estimation of short run and long run elasticities of demand.

Data properties

The LA/AIDS and ECM models estimated for Oilseed products in South Africa include sunflower seeds, soybeans, groundnuts and cotton seed and covered the period 1971 to 2002. The variables included in the estimation are the prices of the individual oilseeds, budget shares for each commodity and a common price index.

The variables included in the estimation were tested for stationarity and it was found that the variables are non-stationary, i.e. the mean and variance of the time series varies over time and this could lead to spurious (nonsense) regressions. This problem was overcome by first differencing the variables and thereby rendering the time series to a stationary one and using the first differences of the variables in the estimation.

The Hausman test, suggested by LaFrance (1991), was used to test for exogeneity of the expenditure variable. The expenditure term included in all the budget share equations was found to be exogenous, i.e. not correlated with the error term. Edgerton (1993) showed that if the expenditure variable is found to be exogenous, the Seemingly Unrelated Regression (SUR) will provide efficient parameter estimates.

Calculated results

The general restrictions of demand, i.e. homogeneity and symmetry, are enforced in the estimation of the two models by using the Restricted Seemingly Unrelated Regression (RSUR) method of estimation in Microfit 4.1. From the models estimated, parameter estimates were obtained and used in the calculation of compensated, uncompensated and expenditure elasticities of demand. These calculated elasticities and their corresponding t-ratios are presented in the next three tables.

Compensated elasticities of Oilseed Products in South Africa

	Sunflower	***Soybeans***	***Groundnuts***	***Cotton***
Sunflower	***-0.013***	*-0.061*	*-0.077**	*0.149**
	(-0.424)	*(-1.076)*	*(-2.110)*	
Soybeans	*-0.010*	***-0.579****	*0.157**	*0.102**
	(-1.076)	*(-12.277)*	*(13.001)*	
Groundnuts	*-0.033**	*0.408**	***-0.210****	*0.148**
	(-2.110)	*(13.001)*	*(-7.326)*	
Cotton	*0.056**	*0.232**	*0.130**	***-0.399***
	(3.021)	*(4.781)*	*(6.198)*	

** indicates significance at a 5% level, t-ratios are in parentheses.*

The compensated elasticities calculated contains only the price effect and therefore are compensated for the effect of changing income on demand. The calculated compensated own price elasticities were all negative as expected from theory with the own price elasticity of soybeans (-0.579) being the most elastic followed by the own price elasticity of cotton seed (-0.399), groundnuts (-0.210) and sunflower (-0.013). These calculated elasticities can be interpreted as follows: a 1 percent increase (decrease) in the price of soybeans will lead to a decrease (increase) of 0.58% in the quantity demanded of soybeans. The majority of the cross product elasticities carried the a priori positive sign indicting that the oilseeds can be regarded as substitutes.

Uncompensated elasticities of Oilseed Products in South Africa

	Sunflower	*Soybeans*	*Groundnuts*	*Cotton*
Sunflower	***-0.588****	*-0.292**	*-0.533**	*-0.356*
	(-19.123)	*(-4.987)*	*(-13.755)*	
Soybeans	*-0.106**	***-0.617****	*0.081**	*0.018**
	(-11.042)	*(-13.076)*	*(6.631)*	
Groundnuts	*-0.281**	*0.309**	***-0.407****	*-0.069*
	(-17.530)	*(9.702)*	*(-13.911)*	
Cotton	*-0.161**	*0.145**	*-0.042**	***-0.589****
	(-8.577)	*(2.979)*	*(-1.958)*	

** indicates significance at a 5% level, t-ratios are in parentheses.*

The uncompensated elasticities reported in the table above, include both the price and income effects and are therefore larger in magnitude than their compensated counterparts. As in the case of the compensated elasticities, the uncompensated own price elaticities were all negative as expected and again all of the being relatively inelastic. The elasticities being relatively inelastic indicates that the change in the quantity demanded is smaller than the associated change in the price of the commodity. The own price elaasticities reported in the table above again indicated that soybeans are the most price elastic of the four oilseeds included in the present study. The uncompensated own price elasticities of soybeans (-0.617), cotton seed (-0.589), sunflower (-0.588) and groundnuts (-0.407) were all significant at a 5% level of significance.

The table below presents the expenditure elasticities calculated with the LA/AIDS model and represents the change in the quantity demanded of a certain commodity due to a change in total expenditure on the group of oilseeds. An expenditure elasticity greater than 1 is an indication of a luxury product and an expenditure elasticity ranging between 0 and 1 is an indication of a normal good.

Expenditure elasticities of Oilseed Products in South Africa

	Sunflower	*Soybeans*	*Groundnuts*	*Cotton*
Expenditure	*1.135**	*0.454**	*0.900**	*0.996*
	(77.053)	*(18.679)*	*(34.642)*	

** indicates significance at a 5% level of significance, t-ratios are in parentheses.*

From the expenditure elasticities presented in the table above it can be seen that sunflower seed (1.135) and cotton seed (0.996) can be regarded as luxury products. All the calculated expenditure elasticities are positive as expected and all of them are highly significant. The expenditure elasticity for sunflower is the most elastic; indicating that the consumption of sunflower seeds will increase as the total expenditure on these oilseed products increase. In other words the quantity demanded of sunflower seeds are expected to increase with 1.135% if the expenditure on sunflower seed, soybeans, groundnuts and cotton seed increases with 1%. The expenditure elasticity of groundnuts (0.900) and soybeans (0.454) indicates that the change in the quantity demanded of these products will be less than the average increase in total expenditure on the four oilseed products.

The parameter estimates and associated elasticities obtained by applying the Error Correction Model are presented in the main document. A comparison between the elasticities calculated with the two different model specification is also presented in the study.