IMPACT ON SOUTH AFRICAN MEAT DEMAND OF A POSSIBLE FREE TRADE AGREEMENT WITH THE EUROPEAN UNION

BY

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I hereby certify that, unless specifically indicated to the contrary in the text, this dissertation is the result of my own original work.

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ABSTRACT

South Africa (SA) is currently negotiating for an 'interim agreement' which will lead to a Free Trade Agreement (FTA) with the European Union. In the 'interim agreement' trade barriers between the two are to be removed gradually. This study, therefore, examines the potential impacts of such an FTA on SA meat demand and prices. The objectives are to first, estimate a demand system model for SA beef, chicken, mutton and pork, and identify interrelationships among beef, chicken, pork and mutton consumption, using the Rotterdam Model developed by Barten (1964) and Theil (1965); and second, use the price elasticity of beef demand estimated from the model with a beef supply elasticity estimated by Lubbe (1992) to simulate the impact of EU beef imports on SA beef prices and meat consumption. Finally, the potential impacts on SA beef price of the likely outcomes of current FTA negotiations which include full reduction of current meat import tariffs, and/or reduction in EU beef export refunds, will be quantified. The extent of the reduction depends on the EU reclassifying SA as a meat producer or a meat importer, rather than the current EU classification of SA as a non-meat producer or importer. A review of literature indicates that no work on the study topic has been published in SA.

The study estimates the Rotterdam model of SA meat demand for the years 1971-1996 using data on annual per capita consumption of beef, pork, chicken and

mutton, annual average retail meat prices, and per capita disposable income. The model is formulated in terms of changes in budget share allocations within this group of meats, based on consumer utility maximization subject to a budget constraint. It satisfies the adding up, negativity, homogeneity, and the Slutsky symmetry conditions, with the latter two conditions being imposed during model estimation.

Conditional Slutsky cross-price elasticity estimates show that for a given 1 per cent change (rise or fall) in beef, chicken, mutton and pork prices, the beef price change would have the largest impact on consumption of the other meats which are all substitutes in consumption. The estimated conditional income elasticities show that beef and mutton are luxuries, while chicken and pork are necessities. Results show further that even if meat prices and per capita income do not change, there is a trend towards lower per capita beef and mutton consumption and higher per capita chicken consumption. A linear beef demand and supply model predicts that EU beef imports without an FTA reduced local beef prices by about 7 per cent in 1996. Cross-price elasticity estimates imply that the 7 per cent beef price fall reduced chicken, mutton and pork consumption by about 2.59, 5.53 and 3.36 per cent respectively in 1996. Local beef producers with small profit margins are probably adversely affected by current EU beef imports, while local consumers have probably benefited.

The net short term effect of an EU-SA FTA on SA meat prices would depend on the likely outcomes of the current negotiations. If EU export refunds are retained when the current 40 per cent SA import tariff on beef is removed, EU beef exports would rise by some 32000 tons based on 1996 data. Elimination of the EU export refund would offset the price lowering effect of no SA import tariff. This would have raised the import cleared price of EU beef by 91.10 per cent based on 1996 prices. Under this scenario, there would be no EU beef imports to SA, and local producers and other overseas exporters would benefit. Higher retail beef prices for local consumers must be weighed against potential increased long-term investment by producers in the domestic livestock industry, as additional investment would benefit SA producers of yellow maize which is fed to local beef animals.

INTRODUCTION

The Uruguay Round of the General Agreement on Tariffs and Trade (GATT) negotiations which ended in December 1993, focuses on detariffication as the backbone of world trade liberalization. Participating nations agreed that world trade has been distorted by agricultural policy in general and they proposed to overcome these long standing impediments by increasing market access, reducing internal trade-distorting refunds, and cutting export refunds (Huang, 1993). The GATT, which has attempted to deregulate trade since 1947, was succeeded by the World Trade Organization (WTO) in July 1994. All the institutional arrangements created by GATT were adopted by the WTO.

South African agricultural trade reform under the WTO rules has focused attention on tariff reduction and sanitary and phyto-sanitary measures associated with a possible Free Trade Agreement (FTA) between South Africa (SA) and the European Union (EU)[1]. In June 1995, the Council of the EU approved a negotiating mandate enabling the European Commission to enter into formal negotiations with SA. The negotiating mandate provides for a two-track approach. First, it includes the provision for South Africa's qualified membership of the Lomé Convention, subject to approval by the appropriate EU and African Caribbean Pacific (ACP) assemblies. Second, it provides for a separate bilateral free trade agreement, which covers all economic and trade relations, as far as

[1] The precise nature of the agreement and form it may take is examined in Section 2.3 below.

they are not addressed by South Africa's membership of Lomé (Directorate of Marketing, 1996). In December 1996, the South African Department of Trade and Industry approved a negotiating mandate which enabled formal negotiations between SA and EU to begin. To establish an FTA, the EU and SA have to agree on an 'interim agreement' which details the schedule for phasing out trade barriers between the two nations, such as the reduction of import tariffs to zero levels. At the time of writing, the 'interim agreement' was planned to be finalized by mid-1998 so that the FTA can be formally signed by the end of 1998. Implementation of the agreement could begin early in 1999 (Financial Mail, 1998a).

According to the 1995 EU FTA proposal, present import tariffs on EU live animal and animal product exports to SA would need to be eliminated within 3 years of a final agreement. This would make the SA meat market more attractive to EU meat exporters, particularly if current EU export refunds are also retained (Goodison, 1996). Given that EU beef exports to SA have risen from 3500 tons in 1992 to 38297 tons in 1996, a primary concern for SA policy makers is the impact which such an agreement would have on local meat prices, consumers' income and local producers' profits.

South Africa is a net importer of red meat and periodically imports chicken. A substantial volume of total SA beef, pork, and chicken imports comes from the

EU. However, mutton imports from overseas come mainly from Australia.[1] For example, EU beef (chicken) comprised an average of 76.80 per cent (29.56 per cent) of total overseas beef (chicken) imports in 1996. Beef, chicken, and pork imports consist mainly of manufacturing grades used for processed meat, while mutton imports are for direct consumption. Conversely, SA exports high quality beef cuts to its neighboring countries (Wessels, 1996).

The proposed FTA could result in a complete removal of SA import tariffs and EU export refunds which will particularly affect the traded quantities and prices of SA beef, chicken, mutton and pork. South Africa's import tariff structure for the livestock industry is far below the agreed bound rate required by GATT. Import tariffs have been reduced to 40, 27, 40 and 15 per cent for beef, chicken, lamb and pork, respectively, compared to the bound rates of 69, 83, 95 and 38 per cent. Given that the South African markets for beef, chicken, pork, and mutton are interrelated - for example beef and chicken are close substitutes in consumption (Hancock et *al.*, 1984) - changes in particular meat imports would probably cause the prices of all meats to change simultaneously.

Research by Hancock *et al.* (1984), Uys (1986), van Heerden *et al.* (1989b) and Bowmaker and Nieuwoudt (1990) has estimated demand for meat and investigated meat price inter-relationships and price leadership in SA. This thesis

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[1] The definition of overseas excludes Botswana, Lesotho, Namibia, and Swaziland (BLNS countries).

complements past work by presenting the first published empirical work to analyze the potential impact of a possible EU-SA FTA on SA meat demand and prices. To analyze these issues, the study first estimates the meat demand system for SA over the period 1971-1996 using the absolute price version of the Rotterdam Model developed by Barten (1964) and Theil (1965)[1]. Second, the price elasticity of beef demand estimated from this model will be used with a price elasticity of SA beef supply estimate from Lubbe (1992) to simulate the impacts of EU beef imports on SA beef price in 1996. The price analysis is restricted to beef only since no mutton is imported from the EU and supply elasticity estimates for chicken, mutton and pork are not available. However, given that SA markets for beef, chicken, pork, and mutton are interrelated, changes in the beef price would likely affect equilibrium prices and quantities of all other meats in the long run. Finally, the demand and supply elasticity estimates will be used to quantify the potential impacts on the SA beef price of the likely outcomes of current FTA negotiations. These include:

1. A full reduction of current meat import tariffs, and/or
2. A reduction in EU beef export refunds. The extent of the reduction depends on the EU reclassifying SA as a meat producer or importer, rather than a non-meat producer or importer as at present (see Section 2.3.3) (Otto, 1996).

[1] The wordings *Rotterdam model* in the text implies the absolute price version of the model.

The hypothesized impacts of the above outcomes on SA beef price is ambiguous since a full reduction of beef import tariff will reduce the local beef price while a reduction in EU beef refunds will raise the local beef price. The net effect will depend, therefore, on by how much the one change lowers beef price and the other change raises price.

To facilitate these objectives, trends in SA meat consumption, production, trade and prices from 1971-1996 are examined. Next, a review of literature on past studies of SA and international meat demand is given and the concept of an FTA for SA discussed. Research methodology for estimating the Rotterdam Model of South African meat demand is then explained followed by empirical results. Policy implications of the research are discussed in the conclusion.

CHAPTER 1

TRENDS IN SOUTH AFRICAN MEAT PRODUCTION, CONSUMPTION, PRICES AND TRADE

This chapter provides an overview of the SA meat industry which includes beef, chicken, mutton and pork. The pattern of SA meat production, consumption, prices and trade during the 1971-1996 period is analyzed using Table 1.1. Next, SA meat expenditures over the period 1971-1996, presented in Table 1.2, are used to analyze changes in the expenditures on the different meat types. Finally, SA meat imports by source from 1988 to 1996, given in Table 1.3, are used to identify those countries that are major meat exporters to SA.

1.1 The South African Meat Industry

Some 85 per cent of South African farm land is covered by natural grazing which offers very few alternatives to red meat production (Nieuwoudt, 1995). Low and intermittent rainfall causes red meat production to fluctuate and the need for SA to import red meat. Refunds on meat imports to SA from its major trading partners, especially the EU, prompted the SA government to adopt measures such as import tariffs mentioned in the introduction to protect local meat producers, to the possible detriment of local consumers.

1.2 South African Meat Production, Consumption, Prices and Trade

Table 1.1 shows the pattern of SA meat production, consumption and trade using five year period averages over 1971-1995, while Figures 1.1 and 1.2 depict the per capita consumption (kg per year) and real average retail prices (rand per kg) for beef and chicken (main meat substitutes) respectively[1].

1.2.1 The Beef Industry

Beef production rose from 469,400 tons in 1971-75 to 619,400 tons in 1981-85 before decreasing to 582,400 tons in 1986-90. However, beef production increased slightly to 595,300 tons in 1991-96. The production and trade of beef depend very much on the availability of feed, which is in turn influenced by climatic and rainfall patterns. During a period of severe drought, stockowners offload their cattle, hence increasing the supply of beef on the market and putting downward pressure on price - the volume of imports tends to decrease while that of exports increases. After the drought period, stockowners enter the herd-building phase. Consequently, there is a reduction in the supply which results in higher prices. The duration of this latter phase is characterized by a high volume of imports and low export volumes.

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[1] The real average retail prices of meat types are derived by averaging the prices of different cuts and/or grades as published by the Central Statistical Services and then deflated by the consumer price index (CPI) (1990 prices)..

TABLE 1.1 South African Meat Production, Consumption, and Trade: 1971-1996 (annual five-year average)

Period	1971-75	1976-80	1981-85	1986-90	1991-96[1]
Beef:					
Production (t)[2]	469400	598000	619400	582400	595300
Consumption (t)	594200	648600	658200	634400	652700
Imports (t)	148410	92854	69172	76698	83740
Exports (t)	39400	36200	24400	19000	20720
Per Capita Consumption(kg)	23.19	23.30	20.90	17.87	16.49
Imports/Consumption (%)	25.05	14.59	10.62	12.16	13.20
Exports/Production (%)	8.12	5.97	3.91	3.28	3.30
Chicken:					
Production (t)	212600	329200	460000	575400	691600
Consumption (t)	210400	309000	435000	559200	697500
Imports (t)	-	-	1600	5400	15170
Exports (t)	-	15000	15200	400	3900
Per Capita Consumption(kg)	8.43	11.11	13.78	15.72	17.41
Imports/Consumption (%)	-	-	0.35	1.00	2.16
Exports/Production (%)	-	4.38	3.38	0.06	0.59
Pork:					
Production (t)	89600	88800	105600	114000	123800
Consumption (t)	87200	85800	103400	113000	130000
Imports (t)	600	1000	800	1600	8900
Exports (t)	2200	3200	1800	1600	1400
Per Capita Consumption(kg)	3.51	3.09	3.28	3.18	3.25
Imports/Consumption (%)	0.74	1.16	0.77	1.40	6.73
Exports/Production (%)	2.35	3.59	1.69	1.45	1.14
Mutton:					
Production (t)	167600	177800	207800	174600	137300
Consumption (t)	170000	180000	215800	186800	170800
Imports (t)	4800	4800	10000	14200	34800
Exports (t)	800	600	-	-	163
Per Capita Consumption(kg)	6.88	6.36	6.84	5.27	4.29
Imports/Consumption (%)	2.85	2.70	4.70	7.61	21.27
Exports/Production (%)	0.47	0.36	-	-	0.14

Note: 1. Annual six-year average.
2. Metric tons

Source: Computed from Modipane (1997).

Beef imports over the period 1995-1997 have been influenced not only by domestic production but also by lower tariffs (as required by GATT) and subsidized exports from the EU. Both of these changes have resulted in an imported beef price (cost, insurance and freight) lower than the domestic price. The initial import tariff on beef was 115 per cent and is to fall by 40 per cent to 69 per cent over six years, starting in 1995 (Elliot, 1993). However, within the first one and half years of its implementation, SA has reduced the 115 per cent import

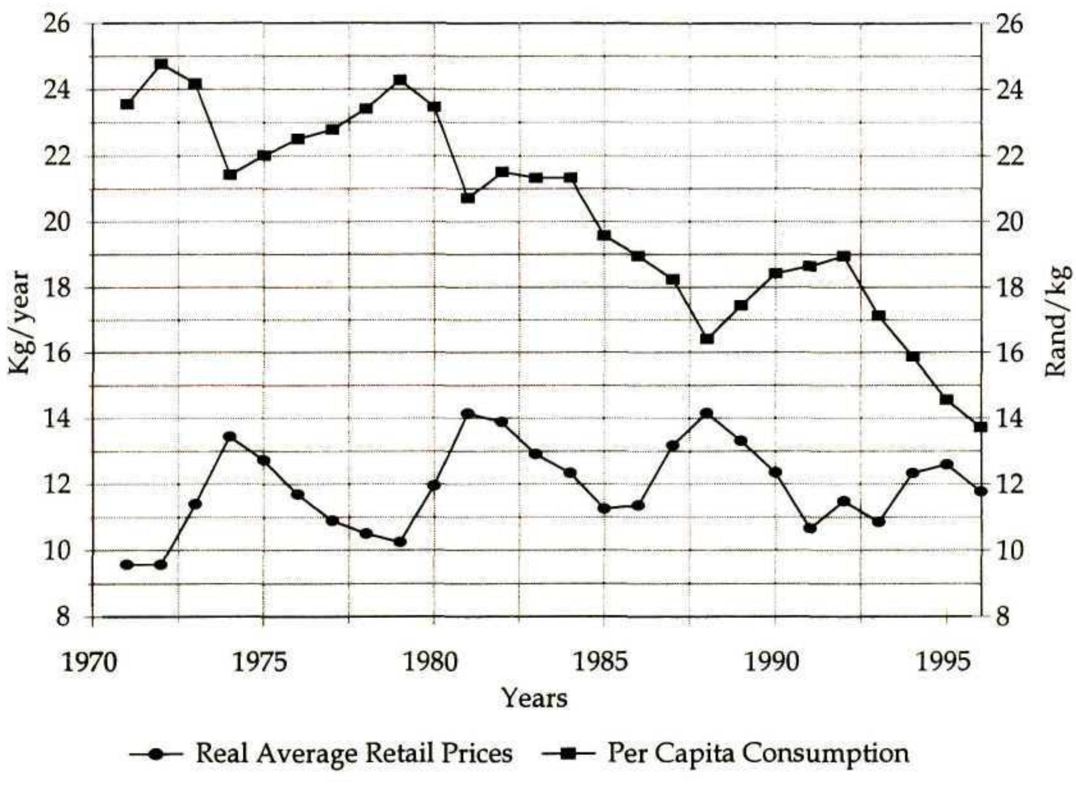

FIGURE 1.1 South African Beef Consumption and Prices: 1971-1996
***Source** : Modipane (1997) and Central Statistical Services (Various Issues)*

tariff on beef by 61 per cent to 40 per cent. The high import volumes of 148,410 tons and 92,854 tons over the periods 1971-75 and 1976-80 reflected severe drought in 1972/73 followed by the subsequent herd-building phase. Export volumes declined from 36,400 tons to 19,000 tons over the period 1971-75 and 1985-90, and then rose to 20,720 tons in 1991-96. Exports as a percentage of total production displayed a similar trend. The volume of beef imports is three times larger than that of exports, implying that South Africa is a net importer of beef.

Overall consumption of beef increased from 594,200 tons in 1971-75 to 658,200 tons in 1981-85 and then declined to 634,400 tons in 1986-90. Beef consumption, however, increased to 653,000 tons in 1991-96. But the per capita beef consumption fell sharply from 23.19 kg to 16.49 kg over the period 1971-75 and 1991-96. (Table 1.1).

The real (inflation adjusted) average retail (RAR) price of beef rose by some 26 per cent during 1971-1996, from R9.50 per kg to R12.00 per kg. Note that there seems to be an inverse relationship between the RAR price of beef and per capita beef consumption. However, the magnitude of change in per capita consumption does match that of its RAR price. This may be attributable to high responsiveness of the demand for beef to its relative price. The increase in the real price of beef with respect to that of chicken has most probably led to lower per capita beef consumption. The sharp decline in per capita beef consumption may also be explained by a change in consumer preferences as beef is known to contain high cholesterol, and hence a health hazard. High cholesterol means that the real cost of beef consumption has risen, and thus the change in per capita beef consumption. Consumers may also permanently reduce beef consumption as they acquire a taste for chicken and learn new chicken recipes (i.e. habit formation). Moreover, if growth in population outweighs growth in beef consumption, per capita beef consumption will fall.

1.2.2 The Poultry Industry

The annual production of chicken tripled between 1971-75 and 1991-96 from 212600 kg to 691600 kg in order to keep pace with consumption which rose by slightly more than three-fold. Over the same period per capita consumption of

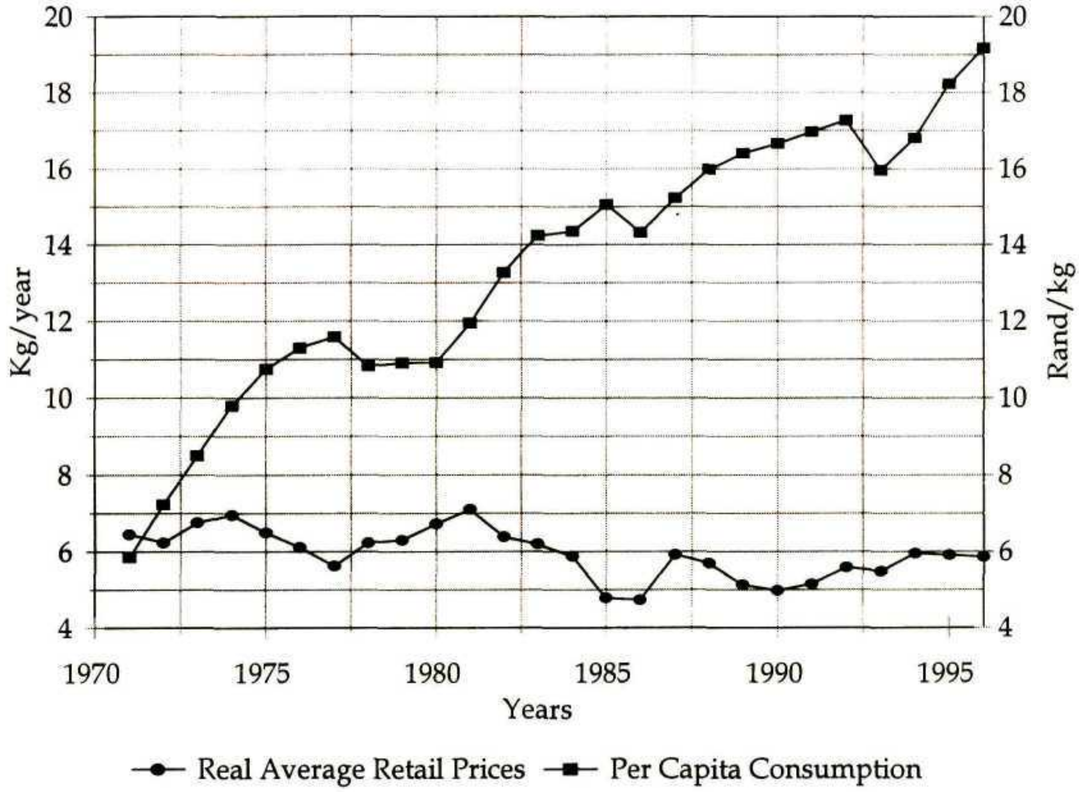

FIGURE 1.2 South African Chicken Consumption and Prices: 1971-1996
***Source** : Modipane (1997) and Central Statistical Services (Various Issues)*

chicken doubled (Table 1.1), probably due to the decline in the price of chicken relative to the prices of beef and mutton. Figure 1.2 depicts the upward trend in per capita consumption of chicken from 5.8 kg in 1971 to 19.2 kg in 1996. The RAR price of chicken fell from R6.50 per kg in 1971 to R5.00 per kg by 1990. However, from 1990 to 1996 the RAR price of chicken increased by 20 per cent from R5.00 per kg to R6.00 per kg, possibly due to Newcastle disease and labour strikes in the poultry industry.

Up until the 1981-85 period, SA was a net exporter of chicken but thereafter became an importer. Chicken imports increased rapidly from 1600 kg to 15200 kg over 1981-85 and 1990-96 period, with the share of consumption increasing from 0.35 to 2.16 per cent over the same period. The import tariff on frozen chicken (not cut in pieces) was 150 per cent until 1995 and was then reduced to 27 per cent. The 1993 GATT requirements allowed for a gradual reduction in the import tariff from 150 per cent to 83 per cent over a six year period starting January 1995 (Pather, 1996). Note that from July 1997, import tariff on chicken leg quarters increased from 27 to 64 per cent (Financial Mail, 1997).

1.2.3 The Mutton Industry

Table 1.1 shows that both production and consumption of mutton increased by about 25 per cent between 1971-75 and 1981-85 and then fell over the period

1986-90 to 1991-96. The fall in production was caused by climatic variations[1], a lower price of wool and theft which forced farmers in some regions to withdraw from mutton production (Standard Bank, 1996). Domestic production is also affected by declining per capita mutton consumption which fell from 6.88 kg in 1971 to 4.49 kg in 1996. The RAR price shows a slight upward trend over 1971-1996. Between 1971-75 and 1991-96 imports of mutton rose by more than seven-fold, with the major increase occurring over 1986-96. Imports as a percentage of consumption display a similar trend. This may be attributed to the substantial reduction in import tariffs from 190 per cent to 40 per cent for carcasses and half carcasses and from 110 per cent to 40 per cent for other cuts (Sutton, 1996).

1.2.4 The Pork Industry

The total consumption and production of pork rose over the period 1971-1996 (Table 1.1), with per capita consumption fairly stable, while RAR prices show a downward trend. On the foreign trade side there was a sharp increase in the volume of pork imports over the years 1991-96. The imports/consumption ratio shows a similar trend. This is probably mainly due to the reduction in import tariffs from 50 to 15 per cent (Sutton, 1996). Note that up until the period 1981-85, SA was a net exporter of pork (Table 1).

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[1] Notably the availability of natural grazing which depends on the level of rainfall.

1.3 Trends in South African Meat Expenditures

The proportion of total income spent on beef, chicken, mutton and pork in SA over the past twenty six years has been fairly stable at about 10 per cent on average (Computed from data supplied by CSS (1997) and Modipane (1997)). However, Table 1.2 shows that the expenditures on the different types of meat as a percentage of total meat expenditure, known as '**conditional**' expenditures, have changed over time. For example, in 1971, beef accounted for about 61 per cent of total meat expenditure. While the budget share of chicken has risen rapidly, the shares of beef and mutton fell markedly over 1971-1996. With these data, the Hotelling-Jureen relation can be estimated. This relation indicates that the cross-price elasticities between two meat products stand in inverse proportion to expenditures on the two products, provided that expenditure on meat products is a small fraction of total income and/or the income elasticities for the two meats are approximately equal (Tomek and Robinson, 1990). In notational form this is represented as

$$E_{bc}/E_{cb} = R_c/R_b \qquad (1.3.1)$$

where: R_b = expenditure on beef (b) as a proportion of total expenditures

R_c = expenditure on chicken (c) as a proportion of total expenditures

E_{bc}, E_{cb} = cross-price elasticities.

Equation (1.3.1) implies that the substitution effect of a beef price change on chicken consumption or vice-versa is in a sense symmetric, while the income effect of a price change is larger for the meat that takes a larger proportion of total expenditures (Tomek and Robinson, 1990). For example, in SA, a much smaller proportion of consumer's income is spent on pork than on beef,

TABLE 1.2 Conditional South African Meat Expenditures: 1971-1996

Year	Beef	Chicken	Lamb	Pork	$E_{bc}/E_{cb} = R_c/R_b$
1971	61.08	10.20	20.70	8.02	0.17
1972	61.42	11.67	18.47	8.45	0.19
1973	62.52	13.05	15.80	8.63	0.21
1974	60.92	14.41	16.13	8.54	0.24
1975	60.00	15.00	16.96	8.06	0.25
1976	59.87	15.71	16.49	7.93	0.26
1977	60.46	15.88	15.80	7.86	0.26
1978	59.70	16.37	16.66	7.26	0.27
1979	59.25	16.37	17.40	6.98	0.28
1980	59.76	15.66	17.42	7.15	0.26
1981	58.14	16.82	17.46	7.58	0.29
1982	58.90	16.69	17.00	7.41	0.28
1983	57.59	18.44	16.00	8.02	0.32
1984	55.62	17.82	18.65	7.91	0.32
1985	55.07	18.00	19.05	7.88	0.33
1986	56.30	17.85	18.89	7.10	0.32
1987	55.63	20.84	16.37	7.17	0.38
1988	55.03	21.54	15.80	7.63	0.39
1989	56.31	20.39	15.16	8.15	0.36
1990	55.99	20.41	15.96	7.63	0.37
1991	54.34	23.88	14.69	7.09	0.44
1992	54.44	24.13	14.04	7.38	0.44
1993	53.46	25.17	13.56	7.80	0.47
1994	51.70	26.44	14.09	7.77	0.51
1995	49.93	29.35	12.53	8.19	0.59
1996	46.91	32.66	12.22	8.21	0.70

***Source:** Computed from Modipane (1997) and Central Statistical Services (Various Issues)* averaging 1.5 per cent of income and 5.5 per cent of income, respectively, over the period 1971-1996 (Computed from data supplied by CSS (1997) and Modipane (1997)). Hence, a one per cent change in the price of pork will have a smaller effect on the consumption of beef (smaller cross-price elasticity) than the reverse, since a larger proportion of income is spent on beef than on pork.

Table 1.2 shows that the cross-price elasticity of beef with respect to chicken (E_{bc}) has increased relative to the cross-price elasticities of chicken with respect to beef (E_{cb}) from 0.17 and 0.70 over the period 1971-1996. In other words, the effect of a change in the chicken price on beef consumption has increased relative to the effect of a change in the beef price on chicken consumption. More chicken imports into SA following an FTA could reduce real chicken prices. If the E_{bc} keeps rising relative to E_{cb}, chicken could become the price-leader in the SA meat market. The next section outlines the main sources of South African meat imports.

1.4 Sources of South African Meat Imports

Table 1.3 provides SA meat imports by source from 1988 to 1996. Note that any reform in South African tariffs that could alter customs revenue would not only affect SA but also Botswana, Lesotho, Namibia and Swaziland (BLNS) who form the Southern African Custom Union (SACU) (Maasdorp, 1990). The BLNS countries receive a share of the customs revenue on the basis of the revenuesharing formula. This is a vital source of revenue for the BLNS which also includes compensatory payments for the disadvantages of being linked with a relatively more developed country (McCarthy, 1994). In return, SA gains from having the BLNS as a captive market for its goods.

1.4.1 Sources of Beef Imports

Beef imports from SACU member countries to SA are fairly stable, ranging between 50,000 and 65,000 tons per year, irrespective of droughts or the herd-building phase, with over 90 per cent coming from Namibia. However, imports of beef from the EU fluctuate markedly between 3,000 to 52,000 tons per year (Red Meat Industry of South Africa (RMISA), 1996). Two major factors, other than EU export refunds, influence the quantity of beef imports from the EU. The first factor is drought, followed by the subsequent herd-building phase. For example, during the drought of 1992, stockowners offloaded cattle on the market, thereby increasing the supply of beef and decreasing beef imports from the EU which were only 9.23 per cent of total imports. Conversely, beef imports from the EU were much higher during the herd-building phase, when there is an under supply of beef on the market. During the herd-building years 1993 and 1995, beef imports from the EU rose from 11.34 to 43.78 per cent of total imports before falling to 31.44 per cent in 1996.

TABLE 1.3 South African Meat Imports by Source: 1988-96

Meat/Country	1988	1989	1990	1991	1992	1993	1994	1995	1996
	As a Percentage of Total Imports								
BEEF									
EU	45.07	23.97	10.79	8.98	9.22	11.34	34.93	43.78	31.44
SACU	54.84	76.02	89.21	90.87	89.17	88.14	58.04	53.92	59.05
Argentina	-	-	-	-	-	-	-	-	2.61
Australia	-	-	-	-	-	-	-	-	4.41
Iran	-	-	-	-	-	-	6.36	-	-
Other	0.09	-	-	0.15	1.61	0.52	0.67	2.30	2.49
PORK									
EU	91.01	96.16	97.50	88.79	40.80	72.52	50.52	44.70	56.36
Canada	1.54	1.01	-	0.62	1.22	1.78	34.21	28.44	5.13
Hungary	-	-	-	10.54	57.96	25.19	11.02	10.51	21.03
Zimbabwe	7.45	2.83	-	0.05	-	0.51	1.95	9.84	15.00
Australia	-	-	-	-	-	-	-	5.42	-
Other	-	-	2.50	-	0.02	-	2.30	1.09	2.48
CHICKEN									
EU	92.08	98.19	88.83	97.69	57.86	78.47	44.48	29.56	14.80
Australia	-	-	-	-	-	-	-	-	4.61
Brazil	-	-	-	-	-	-	6.70	1.00	4.37
Canada	-	-	-	-	17.90	0.84	8.84	14.77	14.46
China	-	-	-	-	-	-	-	10.09	8.78
Singapore	-	-	-	-	-	-	-	3.87	0.42
Thailand	-	-	-	-	-	9.36	19.45	9.66	0.94
U.S.A	7.12	-	10.27	1.90	23.40	4.46	9.71	26.90	51.10
Zimbabwe	-	-	-	-	-	6.29	8.09	2.87	0.27
Other	0.80	1.81	0.90	0.41	0.84	0.58	2.73	1.28	0.25
MUTTON									
SACU	81.29	92.70	94.32	94.10	62.66	71.87	74.62	65.27	35.64
Australia	15.97	6.84	5.68	5.819	37.10	28.13	24.35	32.81	62.44
Other	2.74	0.46	-	0.08	0.24	-	1.03	1.92	1.92

***Source**: Computed from Scharneck (1997) and RMISA (Various Issues)*

The second factor affecting SA beef imports from EU is the beef price cycle. During the herd building phase, the reduced supply of beef raises prices which induce farmers to enter the cattle industry. The increase in beef supply over time drives beef prices down causing less profitable cattle farmers to exit the industry, thereby decreasing the supply of beef and so the process continues and shapes the beef price cycle which lasts about 7 years in SA (Figure 1.1). During the upward phase of the beef price cycle, beef imports from the EU rise and vice-versa.

1.4.2 Sources of Chicken Imports

Over the period 1988-1991, chicken imports originated mainly from the EU (95 per cent on average). Within the EU, France, the United Kingdom (UK), and Belgium are the major exporters of chicken to SA. From 1992, the European Union's dominance of the SA chicken imports market started to erode. For example, in 1996, chicken imports from the EU accounted to 14.80 per cent of total chicken imports compared to 92.08 per cent in 1988. Since 1992, Canada, China, Thailand and the USA, in particular, have gained market share of SA chicken imports. The main gainer is the USA, which accounted for 51.10 per cent of total SA chicken imports in 1996. Note that from 1993, Brazil and Zimbabwe have become potential chicken exporters to SA.

1.4.3 Sources of Mutton Imports

In contrast with chicken and pork imports which are dominated by the EU, mutton imports come mainly from SACU member countries and Australia. Over 95 per cent of mutton imports within the SACU come from Namibia (RMISA 1996). Since 1991, however, SACU has lost market share of SA mutton imports to Australia. For example, in 1996, mutton imports from Australia and SACU member countries accounted for 65.27 per cent and 32.91 per cent respectively.

1.4.4 Sources of Pork Imports

Table 1.3 shows that, on average, over 90 per cent of SA pork imports came from the EU up until 1991. The major EU exporters are France and Germany (Scharneck, 1997). From 1992, Hungary has acquired a considerable share of South Africa's pork imports, averaging 25 per cent of total pork imports over 1992-96 period. Canada and Zimbabwe were major sources of SA pork imports during the 1994-95 and 1995-96 periods respectively. As with chicken, the 1991-1994 period has seen a fall in the European Union's market share of SA pork imports.

The above trends show that, over the 1971-96 period, per capita consumption of beef fell by 50 per cent while per capita consumption of chicken rose threefold. The RAR prices for beef and chicken trend in opposite direction. The former trends upward while chicken trends. With the exception of mutton production, SA meat production (beef, chicken and pork) rose substantially. Meat exports have declined since 1971, while meat imports increased markedly, especially for chicken, mutton and pork. Beef, chicken and pork imports from the EU face import duties of 40, 27 and 15 per cent respectively. An FTA between SA and the EU should result in reduction of these import tariffs to the zero rate thereby making the SA meat market more attractive to EU meat exporters if the export refunds remain. Consequently, this could have major impacts on the equilibrium prices and traded quantities of meats in SA. The next Chapter gives a literature review of SA and international meat demand studies and outlines the economics of an FTA and key meat sector issues raised by an FTA with the EU.

CHAPTER 2

LITERATURE REVIEW

A literature review of both SA meat demand and international meat demand studies are presented in this chapter, followed by discussions of the issues that arise from an FTA. The literature review of SA meat demand studies shows the extent of research undertaken so far and details how this thesis can complement and update these studies, given the possibility of lower SA import tariffs and EU export refunds following an FTA. The international literature review of some meat demand studies provides some guidelines for applying the demand system methods locally. The final sections outline the economics of an FTA and key issues for the meat sector raised by an FTA with the EU.

2.1 South African Meat Demand Studies

Hancock *et al.* (1984) noted that despite the importance of the meat sector in SA[1], there was a lack of research on the SA demand for meat. To correct this, therefore, they estimate long-term price elasticities and flexibilities of meat demand. To do this they use annual data and short term price elasticities from quarterly data for 1962-1981 by using recursive models with constant elasticities.

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[1] beef is second to maize in terms of gross value of production.

Their aim was to provide agricultural policy-makers more information about meat price and consumption interrelationships.

The estimated long-term retail own price elasticities for beef, mutton, pork, and chicken were negative 0.96, negative 1.93, negative 1.86 and negative 1.66 respectively, while the short-term elasticity estimates were greater than unity for all red meats. The estimated coefficients had the expected signs except that for beef in the estimated poultry demand equation, where a complementary relationship between beef and poultry was estimated. Due to an insignificant *t*-value, the mutton variable in the pork demand equation was dropped, which led to a slight upward bias to the estimated beef coefficients. Little importance was given to the income elasticity estimates as such estimates derived from time series data include dynamic effects such as changes in income distribution, urbanization and changes in population structure over time. The implicit assumption of constant elasticities over an extended period of time was probably inappropriate since substantial changes in the consumption patterns of meat have occurred over the past twenty five years (see Table 1 and Uys (1986)).

Laubscher and Kotze (1984) analyze the relative importance of the South African beef cattle industry in the agricultural sector as a whole given developments in beef supply and demand up to 1984. They reported the income elasticity for meat and meat products of 0.73, but did not show how the it was estimated.

Uys (1986) derived dynamic demand functions for meat by maximizing a non-additive dynamically varying version of the Stone-Geary utility function subject to an expenditure constraint. The demand functions obtained were estimated for SA beef, mutton, pork and chicken consumption using annual data. The demand functions were estimated for the two periods 1956-69 and 1970-81 separately, since there was a distinct break in the time series in 1970, probably due to a change in the reporting requirements of the Central Statistical Services. Consequently, data for the two periods are not strictly comparable. The own price elasticity estimates from the dynamic model were greater than unity and did not change significantly between the 1956-70 and 1970-81 sample periods, except for mutton, and all had the expected negative sign. Uys (1986), however, could not explain why the demand for beef was price elastic. A possible reason for the relationship is the decline in the relative price of close substitute chicken over the study period.

Van Heerden *et al.* (1989a) described the theoretical aspects underlying the determination of price inter-relationships, price leadership and the time it takes for prices to react to changes in the SA meat market. They specified a time series model of meat prices based on four steps: stationary-stochastic processes, simple autoregressive models, causality testing and multiple autoregressive models. The model was then used to analyze the interrelationships amongst beef, mutton, pork, poultry, fish and egg prices in SA (Van Heerden *et al.*, 1989b). Data consisted of weighted average monthly retail trade prices (c per kg) of specified grades of beef (super A), mutton (super lamb), pork (grade 1), chicken (cleaned), fish (frozen hake) and eggs (grade 1-large) in 12 urban areas of SA.

Haugh-Pierce causality tests showed that all meat prices influence one another, at least in the short run. However, no causal relationship appears to exist between egg and meat prices, suggesting that price changes in the meat market do not influence the price of eggs or vice-versa. Furthermore, a particularly high mutual dependence exists between beef, mutton, pork and chicken prices. Beef appears to be the SA meat market price leader. Beef prices appear to lead chicken, mutton and pork prices. A change of one cent per kg in the beef price was estimated to change chicken, mutton and pork prices by 2.34 cents, 0.75 cents and 1.21 cents respectively over an eight to 12 week period. Note that the chicken price was most responsive to changes in the beef price. Chicken prices appear to also price lead pork and fish prices. They concluded that chicken could, therefore, enlarge its market share at the expense of beef, pork and fish.

Bowmaker and Nieuwoudt (1990) used two-stage least squares to estimate a set of demand equations for three South African demand systems, namely, red meat, fruits and vegetables, covering 18 products. Monthly data for the period December 1982 to February 1988 was used. Poultry was not part of the meat demand analysis, probably because monthly chicken data were not available. Since the demand equations were specified with price as the dependent variable, the estimated price coefficients represent own price flexibilities (responsiveness of price to changes in quantity demanded). The estimated (positive) own-price flexibilities for beef, mutton and pork were 0.28, 0.80, and 0.49, respectively. The study confirms the dominance of beef in the red meat market, which had estimated cross-price flexibilities with respect to mutton and pork quantity of 0.30 and 0.20, respectively.

Nieuwoudt (1997) uses demand and supply elasticity estimates from Hancock *et. al.* (1984) and Lubbe (1992) respectively in a linear elasticity model to analyze the impact of EU beef export refunds on the Southern African beef industry. His results show that EU beef imports are expected to have depressed SA auction beef prices by about 10 per cent during 1995. His estimates show further that EU beef imports have displaced SA beef production and SACU beef imports by 23159 tons. He argues that the feedlotting of beef in SA is seriously affected by lower domestic prices as producers operate on small profit margins, partly due to the relatively low SA price for high quality meat. Since the Namibian minimum or floor price of beef is derived from the SA auction price, an estimated 10 per cent fall in SA auction prices as result of EU beef imports will similarly impact SACU exporters to SA markets. Finally, a 10 per cent drop in the beef prices in SACU countries could translate into an estimated 5.4 per cent fall in beef production in these countries.

Koester and Loy (1998) analyze the impacts of current EU beef export policy on Southern African beef markets. They hypothesize that EU beef export refunds have depressed Southern African beef prices. Their analysis shows that EU beef export policy has lowered world market prices of beef between 7 and 17 per cent. They reject the above mentioned hypothesis and doubt that the EU policy has further impacts on beef markets in Southern Africa. They argue that the SA beef price is primarily determined by the world market price and not by the EU export free on board (FOB) price. Ironically, the research confirms the presumption that the SA beef industry suffers from EU beef policy. However, they argue that the negative repercussions, are not due to high EU beef export refunds, but rather the result of depressed world market prices. Their findings can be criticized since from a policy point of view it does not matter whether the EU beef policy has directly depressed SA beef price or affected it indirectly via the world market price. The fact is that eventually the SA beef industry has been negatively affected by EU beef policy.

The above review of SA meat demand studies shows that no local published research (with the exception of published work arising from this thesis) has estimated the demand for SA meat (1) since 1990 and (2) using the Rotterdam model. There is an obvious need to update past studies, particularly given the changing role of chicken in SA meat consumption and the potential impacts on SA meat consumers and producers from import changes following possible lower SA import tariffs and EU export refunds as a result of an FTA. This research, therefore, complements past work by presenting the first published empirical work to analyze the potential impact of a possible EU-SA FTA on SA meat demand and prices. A review of international meat demand studies provides guidelines for using demand system methods for these purposes.

2.2 International Meat Demand Studies

Tomek and Robinson (1981; 1990) cite previous United States (US) meat demand studies by Brandow (1961), George and King (1971) and Huang (1985). All of these studies estimated retail price elasticities of demand for beef below (negative) one, and identified expected positive cross-price elasticities of demand between beef and pork, lamb and chicken (substitutes in consumption).

Theil (1978) applied the Rotterdam model to estimate the demand for meats in the United States over the period 1950-72. He used *conditional* expenditure which refers to the expenditure on different types of meats as a percentage of total share of income spent on all meat types. The conditional income elasticity estimates for beef and lamb were 1.39 and 1.80, while those of chicken and pork were 0.49 and 0.57 respectively. The conditional (negative) Slutsky price elasticity estimates agreed with *a priori* expectations. There were two outstanding results from Thiel's estimates. First, the estimated demand for lamb was very price elastic with an elasticity coefficient of 2.00. Second, the estimated conditional cross-price elasticity of lamb with respect to beef was highest (1.06) - a one per cent increase in the price of beef results in a 1.06 per cent increase in the consumption of lamb - while the corresponding elasticity for chicken with respect to beef was lowest

(0.27). The effect of a change in the relative price of beef on consumption of other meats was greater than the effect of the change of any other meat price, as beef accounted for the greatest share of meat expenditure.

Huang (1993) estimated a set of ordinary and inverse (price dependent) demand systems for U.S. quarterly meat consumption, from 1970 to 1990, to measure the effects of U.S. meat trade on consumers' welfare. The estimated quarterly demand for high quality beef and pork was relatively price elastic with price elasticities of negative 0.78 and negative 0.67, while the price elasticities for manufacturing grade beef and broilers were lower at negative 0.48 and negative 0.05 respectively. The estimated expenditure elasticities for high quality beef and pork were rather high (1.27 and 1.20), while the elasticities for manufacturing grade beef and broilers were statistically insignificant. Inverse demand equations estimated that increased imports of manufacturing grade beef would markedly reduce prices of both grades of beef and broilers. More pork imports would substantially reduce pork, broiler and high quality beef price. In both cases, consumers would benefit via savings in quarterly meat expenditures. The level of savings per 1 per cent change in imports was greater for pork than for manufacturing beef, as pork had a higher average share of US consumer meat expenditure over the study period (29 per cent versus 10 per cent).

Byrne *et al.* (1995) developed a Rotterdam demand system model for beef, pork, chicken and marine products in Korea and Taiwan. The aim was to project consumption and imports for beef to the year 2000 in Taiwan and South Korea under the assumption of trade liberalization (lower beef import controls and tariffs). The estimated own-price elasticities for beef in South Korea and Taiwan were negative 0.70 and negative 1.09, respectively. Estimates show that South Korea and Taiwan had similar own price elasticities of demand for pork of negative 0.95 and negative 0.91. The estimated own price elasticities for chicken were under one (negative 0.35 for Taiwan and negative 0.48 for Korea). The magnitude of own price elasticity and expenditure elasticities differed across countries and across commodities. The expenditure elasticity for beef, pork and chicken, ranged from 0.69 (South Korea) to 1.25 (Taiwan); 0.98 (Taiwan) to 1.37 (South Korea); and 0.53 (South Korea) to 0.98 (Taiwan), respectively. The estimated price elasticities suggest that if the gap between domestic retail price and US import price is narrowed by 50 per cent as a result of trade liberalization, beef consumption in Taiwan and pork consumption in South Korea will more than double by the year 2000. They concluded that future research should integrate the demand estimates of the Rotterdam model with livestock supply models in Taiwan and South Korea.

The international studies cited above show that estimated own and cross-price elasticities of demand can be used to forecast the impact of trade liberalization on meat consumption in countries which reduce trade barriers. The derivation of a Rotterdam model to help estimate such impacts for South African meat consumption following a potential FTA with the EU is described in Chapter 3.

The Rotterdam model is chosen since the constraints of consumer demand theory (adding-up, homogeneity and symmetry conditions) can be directly applied to the parameters of the model. The next sections outline the economics of an FTA and key meat sector issues raised by an FTA with the EU.

2.3 Free Trade Agreement Issues

2.3.1 Theoretical definition of a Free Trade Agreement

Lindert (1991) describes a free trade area in terms of the removal of *all trade* barriers among members, while separate national barriers against trade with any non-member country are kept by the member countries. In such an area, customs inspectors must still police the borders between members in order to tax or prohibit trade that might otherwise avoid some members' higher barriers by entering (or leaving) the area through countries with lower barriers. A free trade area, therefore, should enable each member country to exploit its comparative advantages. Protectionism prevents this in that it favours domestic producers and keeps out goods from more efficient producing countries (Maasdorp, 1997).

2.3.2 GATT Definition of Free Trade Agreement

Article I of GATT lays down the fundamental principle that members of the WTO must extend to all other members unconditionally any advantage, favour, privilege or immunity affecting customs duties, charges, rules and procedures that they give to products originating from or destined to any other country. This is described as the 'most-favoured-nation rule' (MFN) and on joining the WTO, members assume 'multilateral GATT obligations' in terms of the MFN principle. Article XXIV of GATT which deals with regional arrangements is perhaps *the* most important exception to the MFN principle. It recognizes that regional arrangements can 'increase the freedom of trade' through 'closer integration between the economies' of the members to a regional arrangement. But the framers also recognized that there was a danger of a region raising barriers to the trade of other WTO members (Kumar, 1995).

Article XXIV of the GATT agreement provides for three types of regional agreement, viz., a custom union, an FTA and an 'interim agreement' leading to the formation of either a customs union or an FTA. This section focuses on free trade agreements and 'interim agreements' as they are more common than customs unions. Article XXIV: (8b) of the GATT agreement defines the FTA as a group of two or more customs territories (e.g. EU and SA) in which the duties and other restrictive regulations of commerce are eliminated on *substantially all trade* between the constituent territories in products originating in such territories (Otto, 1996b).

The interim agreements are dealt with under Article XXIV: 5 of GATT. It provides that 'an interim agreement leading to the formation' of either a customs union or a free-trade area is eligible for a MFN exception if certain conditions are met. Kumar (1995) argues that the provision for such an interim period is logical since sudden removal of trade barriers between two or more countries could greatly disturb the economies involved and that gradual and substantial readjustment would always be needed. Article XXIV: 5c provides that any 'interim agreement ... (submitted to the WTO) shall include a plan and a schedule for the formation of such a customs union or a free-trade area within a reasonable length of time'. In a nutshell, Article XXIV: 5c requires (1) a 'plan and a schedule', that (2) will lead to the defined arrangement within a 'reasonable' time.

The definition of an FTA and customs union defined in article XXIV is somewhat ambiguous in the sense that it does not provide any guidance as to what is meant by *substantially all trade*. This requirement can be interpreted in both qualitative and quantitative terms (It is, however, generally accepted that at least 90 per cent of the current trade has to be included in the FTA, and no industry may be excluded). In qualitative terms, this means that trade must be freed in each sector of the economy by at least 90 per cent. In quantitative terms, this requires total trade to be freed by at least 90 per cent. Thus, some sectors of the economy may be excluded as long as, on average, 90 per cent of all trade is freed (Kumar, 1995).

For example, when the European Free Trade Association (EFTA) agreement came up for consideration at GATT, third parties argued that if an agreement specifically excluded a major sector of trade (such as unprocessed agricultural products), it would not qualitatively satisfy the *substantially all trade* requirement in respect of sectors of trade, even if the total trade that was freed quantitatively amounted to 90 per cent of all trade. The EU and EFTA members, however, argue that the words used were *substantially all trade* and not *trade in substantially all products or sectors*. On the basis of this argument, an agreement satisfies Article XXIV:8 requirements even if a sector of economic activity such as agriculture is excluded, so long as the overall percentage of trade that has been freed of trade restrictions is substantial. However, the GATT Working Party failed to reach a definite conclusion as to the definition of *substantially all trade* (Kumar, 1995). These issues have major relevance for the EU - SA FTA as outlined below.

2.3.3 Present Scenario of Beef Trade Between South Africa and the European Union

South Africa is currently negotiating for an 'interim agreement' which will lead to an FTA with the EU. In the 'interim agreement' trade barriers between the two nations are to be removed gradually. At present, SA meat imports from overseas face tariffs and the EU has a policy of paying refunds on beef exports. The impact of these trade barriers are analyzed in Figure 2.1a and 2.1b for beef imports, since EU export refunds are paid on beef only.

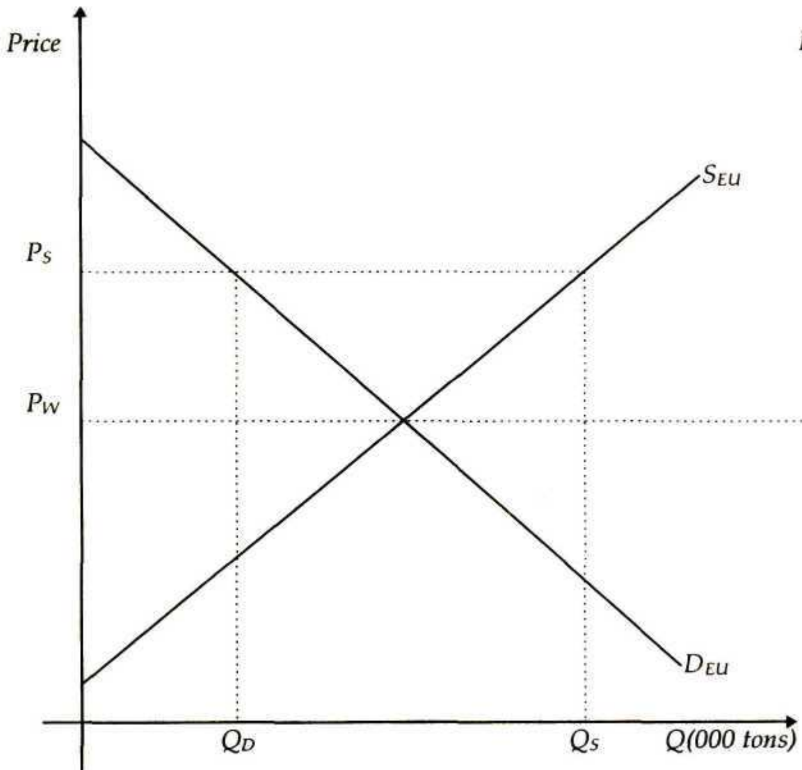

FIGURE 2.1a European Union Beef Market

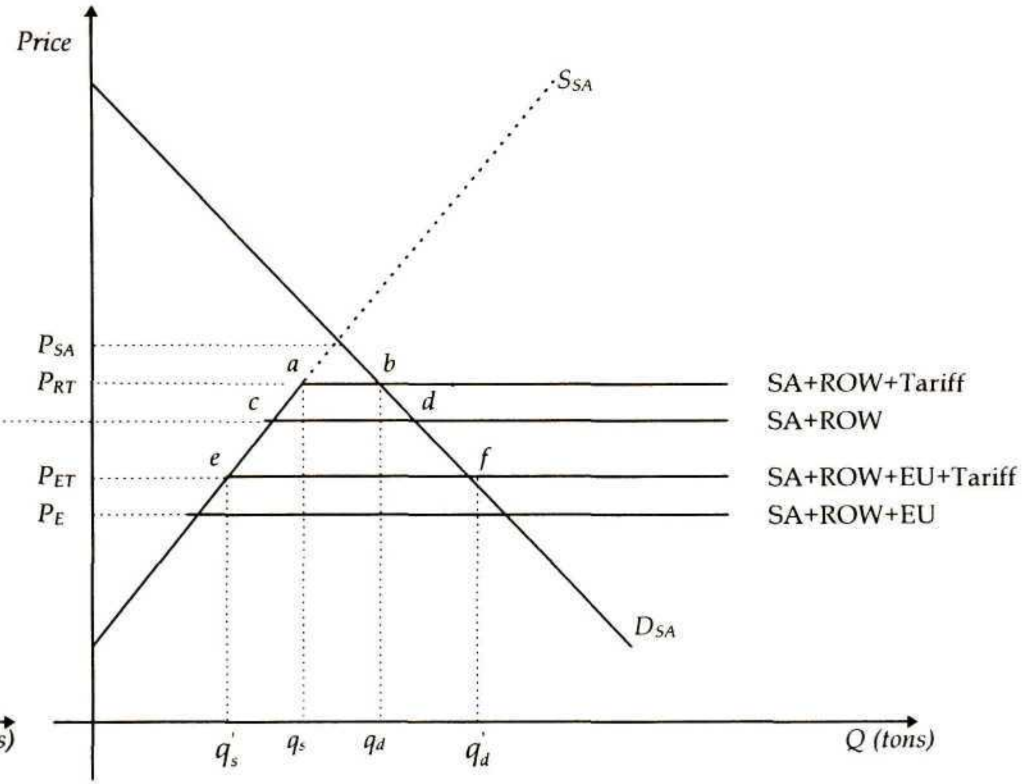

FIGURE 2.1b South African Beef Market

It is initially assumed that at the world beef price (P_W), the EU beef market is in equilibrium (i.e. the EU is neither a beef importer or exporter) while P_W is lower than the price which would clear the SA beef market (P_{SA}) without imports. Excess demand (*c* - *d*) in the SA beef market at P_W is met by importing beef from the rest of the world (ROW). A tariff on these imports raises the SA price to P_{RT} and reduces excess demand to (*a* - *b*). The effect of beef imports in this case is to shift the beef supply curve from point *a* to point *b* (i.e. SA beef supply plus ROW beef export to SA). The introduction of a beef export refund raises the EU beef price to P_S which creates an excess supply of beef on the world market. Since more than 75 per cent of SA beef imports from overseas come from the EU, this in turn lowers the SA beef price to P_E without the import tariff and to P_{ET} with the import tariff. At the price P_{ET}, the volume of imported beef increases from q_s - q_d to $q_s^{'} - q_d^{'}$, the difference being EU beef exports to SA.

It should be noted that an eventual SA-EU FTA would probably lead to trade barriers between the two nations being removed gradually, while separate national barriers against the ROW are to remain. When the SA import tariff on EU beef is scrapped, the beef price would drop from P_{ET} to P_E, and beef imports from the EU will increase further. Conversely, if export refunds from the EU are withdrawn, the SA beef price will increase from P_E to P_W. The net effect on the SA beef price of removing the tariff and export refunds depends, therefore, on by how much the one change lowers price and the other change raises price. The net empirical effect is discussed in Section 4.4.

2.3.4 *Issues Affecting an Free Trade Agreement Between South Africa and the European Union*

Agricultural exports to SA from the EU as a percentage of total EU exports dropped from 4.1 percent in 1992 to 3.72 per cent in 1994, as industrial export growth outpaced agricultural export growth. However, over the same period, EU exports of live animal and animal products to SA doubled, with these exports accounting for 35 per cent of EU agricultural exports to SA. According to the 1995 proposed EU timetable on the elimination of tariffs, import duties on EU live animal and animal product exports to SA would need to be eliminated within 3 years of the signing of the EU-South Africa FTA agreement. This would involve removing the present 40 per cent tariff protection which could make the SA meat market more attractive to EU meat exporters if the export refunds remain. Consequently, this could have major impacts on the equilibrium prices and traded quantities of meats in SA (Goodison, 1996).

South Africa's total agricultural exports to the EU comprise less than 2 per cent of the European Union's total agricultural imports. Ironically, the EU plans to exclude as much as 38.6 per cent of South Africa's current agricultural exports (4 per cent of total trade) to Europe, worth R1.3bn. The exclusion list includes fresh and canned fruit - with some variations according to the seasons. Provisions are also made for a range of products that SA is not (yet) exporting to the EU, such as beef, poultry, sugar, maize, powder milk and butter (Financial Mail, 1996). The ambiguity surrounding the GATT definition of *substantially all trade* (Article XXIV: 8) permits the EU to exclude as much as 38.6 per cent of SA agricultural exports from the FTA, so long as total trade is freed by at least 90 per cent (see Section 2.3.2).

In November 1997, SA tabled a detailed 500-page offer to the EU which includes plans for a four stage reduction in import tariffs on 80 per cent of SA-EU trade over 12 years, ending in 2011. However, certain particularly sensitive products such as the auto, textile, footwear, red meat and dairy sectors will be kept out of the trade deal until they are deemed to be strong enough to face foreign competition. South Africa also remains adamant to the EU farm products exclusion list which hits 4 per cent of trade between the two nations writing (Financial Mail, 1998a).

The counter offer from the EU was presented on the 27 January 1998. The tabled proposal covers 90 per cent of SA exports to the EU, with the prospect of full liberalization over 10 years. For the time being, however, the EU has proposed to exclude 45 per cent of SA farm produce from the FTA. This represents an increase of some 6 per cent from the first EU proposal of 38.6 per cent in 1996 based on the 1995's trade figures. The EU, however, maintains that the 45 per cent exclusion list is 'for the time being' only and at some stage in the negotiations the EU will improve this part of the offer (Financial Mail, 1998b). The SA negotiators, on the other hand, remain opposed to the exclusion list and argue that such a firm clause undermines the efforts to liberalize trade (Financial Mail, 1998a). The EU also proposed that the gradual reduction of EU import tariffs on red meats to the zero rate level will take place during the 6th to the 10th/12th year of the final agreement (Directorate General VIII, 1998).

Nieuwoudt (1995) maintains that since markets of beef, mutton, chicken and pork in SA are interrelated, prices of these products move in sympathy with one another over the long run. He argues that imports of a particular meat will not only depress its price, but also prices of other meats. This interdependent nature of meat demands was shown in local and international studies cited in Section 2.2.

The EU classifies countries to which it exports red meat into export zones.[1] Different refunds are paid (per kg) for different meat cuts exported to the various zones as shown in Table 2.3.1. The export refunds are adjusted accordingly, from time to time, by the EU. Non meat-producing countries are included in zone 2, 8 and 9, where the first two zones have the highest possible refunds on different meat cuts. Zones 8 and 9 include only the boneless (individually wrapped) cut and the latter's export refund is about 10 per cent less than that of the former.

Zone 4, on the other hand, comprises of meat-producing countries which are net-importers. The EU red meat exports to these countries are the least subsidized.

[1] SA faces only an EU beef export refund.

Chapter one showed that SA is a meat-producing country and a net importer of red meat, being more or less self sufficient in poultry, eggs and dairy products.

Table 2.3.1 European Union Beef Export Refunds as per 28th September 1996 (Rand/kg)

	Zone 2	Zone 4	Zone 8	Zone 9
Fresh/Chilled Beef (average over Cuts)	9.30	3.20	-	-
Frozen Beef (average over Cuts)	7.46	2.60	-	-
Individually Wrapped Beef Cut (Fresh/Chilled or Frozen)	-	-	9.50	8.72

Source: *Meat and Livestock Commission Economic Services (MLCES) (1996)*

The EU, however, incorrectly classifies SA as a non-meat producing country and hence SA was, up until February 1997, grouped in zones 2 and 8 by the EU, where the highest beef export refunds were paid. South Africa was thereafter reclassified from zone 8 to 9 (Otto, 1997). The effect of this reclassification on the price of imported EU beef is relatively low since it involves a mere 10 per cent fall in export refunds and affects only a particular beef cut, namely, fresh/chilled and frozen boneless (individually wrapped).

Kempen (1996) indicates that past export refunds paid by the SA Meat Board to local producers have been phased out, while EU exports to SA are heavily subsidized. For example, average EU export refunds for 1996 on fresh/chilled and frozen beef for zone 2 and 9 countries were R5.97 and R7.50 per kg, while for zone 4 countries they were R1.95 and R2.97 per kg, respectively (Wessels, 1997).

Kempen (1996) also points out that while the import tariff structure for the livestock industry is already far under the agreed bound rate for the year 2000 (see Introduction) , that of the EU is still higher than their agreed bound rate. High export refunds from the EU have led to the average nominal import cleared price (R6.06 per kg in 1996) of EU beef (frozen boneless) exports to SA being considerably lower than the SA wholesale price (R12.04 per kg in 1996).

Nieuwoudt (1997) points out that in real terms (1990 prices), the EU import cleared beef price of R3.31 per kg in 1996 was 30.46 per cent lower than the 1993 price of R4.76 per kg. These imports have risen at the same time as real 1994-1995 SA beef auction prices (R3.54 per kg and R3.34 per kg, respectively) have remained below the level for 1988 (R4.71 per kg) which was a normal production year. This is not expected as real auction prices should be rising as SA beef producers are in a herd rebuilding phase following increased slaughterings in 1990-1993 after widespread drought. Beef imports from the EU have, therefore, probably contributed to lower SA beef price.

From August 1996 to July 1997 there has been a substantial reduction in EU export refunds, averaging about 43 per cent, independent of the zone classification. Average EU export refunds in August 1996 (1ECU = R6.01) on fresh/chilled and frozen beef were R9.30 and R7.45 compared with July 1997 (1ECU = R5.10) levels of R5.74 and R3.85, respectively (Wessels, 1997). This reduction is due to EU commitments *vis-à-vis* the WTO with regards to export refunds, and the *Bovine Spongiform Encephalopathy* (BSE) disease which caused the demand for beef to fall in Europe. In Germany and Italy, for example, beef consumption plummeted by 70 and 50 per cent in the week after the British government's announcement on March 20 1996 of a possible link between BSE and *Creutzfeidt-Jakob* disease (Southey, 1996). This resulted in an over-supply of EU beef, at the refund induced support price, which needed to be exported. However, WTO regulations require the EU budgetary expenditure on export refunds to be lowered by 36 per cent from the 1986-90 base period and the volume of subsidized exports to be reduced by 21 per cent over six years starting in 1995 (Valdes & McCalla, 1996). Higher beef exports means that the EU budgetary expenditure on export refunds for the financial year 1996/1997 was being exhausted quite rapidly. In order to circumvent the budget reaching its ceiling, the EU had no option but to reduce the export refunds.

Otto (1996a) reports that South Africa's position on meat in an FTA is that the EU should view SA as a meat-producing country and a net importer. If this is accepted, SA will be classified as a zone 4 country (together with Switzerland), where the lowest export refunds are paid. On the other hand, if the EU insists in not removing or at least reducing refunds on its meat exports, then SA will reserve the right to impose countervailing duties (Parliament of The Republic of South Africa, 1996). Kempen (1996) concludes that although most of the different sectors and products of the livestock industry in SA are, or can be regarded as, sensitive to an eventual FTA with the EU, this is the result of the existing distortion of trade through subsidization and tariffication.

The above literature review shows a need for an updated demand systems model of meat consumption in SA to quantify the potential effects on the prices and consumption of different meat types of a possible FTA with the EU. Chapter 3 describes the research methodology and economic theory which will be used to specify and estimate a Rotterdam model for this purpose. The full derivation of the model is carried out in order to show how it links with the economic theory of the consumer. While the detailed derivation of the model may seem tedious, the Rotterdam model itself is a simple and flexible approximation to an unknown demand system. The model satisfies the classical consumer demand conditions - negativity, adding-up, homogeneity, and symmetry - and the latter two conditions can be easily imposed onto the model so that the estimates of demand parameters conform to theory (Capps *et al.*, 1994). The groupwise extensions of the Rotterdam model are derived so as to indicate how the model may be used for narrowly defined goods such as beef, chicken, mutton and pork.

CHAPTER 3

RESEARCH METHODOLOGY

This chapter provides the link between consumer demand theory and the Rotterdam model of demand equations for a set of narrowly defined goods such as beef, chicken, mutton and pork. The next four sections set out to review the economic theory of consumer demand concepts. This is followed by the full derivation of the Rotterdam model. The groupwise extensions of the Rotterdam model which provide the conditional demand equations are presented next. A final section specifies the hypothesized model of meat demand equations for SA and its use in assessing the potential effects of an FTA with the EU is discussed.

3.1 Consumer Demand Concepts

The theory of utility-maximizing consumer is widely used in economic studies. This theory suggests that the consumer chooses from some specified set of options that option which maximizes some objective function. Consumers' preferences are represented by a utility function, and they choose those options that maximize their utility subject to a budget constraint. We can think of the budget constraint as the amount of money (income) available to the consumer. So the consumption of a good will depend on the amount of income the consumer has and the prices he faces.

Central to the utility-maximizing theory, therefore, is to describe the way in which consumption of a good is affected by the consumer's income and the prices he encounters. Much progress has been made in recent years to combine the consumer utility-maximization theory with the empirical analysis of consumption data. The data are used to test the theory, and the theory is in turn used to provide structure to the empirical analysis. This work is known as the *system-wide approach* in which demand equations for all *n* goods are estimated simultaneously. A leading example of a system of demand equations is the Rotterdam model developed by Barten (1964) and Theil (1965)[1]. This model has a strong links with the economic theory of the consumer and its elegant simplicity has had an influential role in the development of the system-wide approach (Clements and Selvanathan, 1988).

The literature review of SA meat demand studies shows that no local published work has yet applied the Rotterdam model to estimate a SA meat demand system. A cursory survey, in fact, shows that no local published work has yet used the Rotterdam model to estimate a demand system. This is probably due to the unawareness of the qualities and simplicity of the model or how the model can be applied. A detailed derivation of the Rotterdam model is provided so as (1) to give a self-contained account of the model that will make it accessible to nonspecialists and (2) to expose the strong links between the model and the economic theory of the consumer. The most frequent use of the Rotterdam model

[1] The name "Rotterdam" comes from the location of Barten and Theil in the 1960s.

involves the demand for broad commodity groups such as food, clothing, housing and so on. For our purpose however, these groups are much too broad. Fortunately, under certain conditions the model can be reformulated (via a groupwise extension) so that it can be applied to narrower groups of goods such as beef, chicken, mutton, and pork.

3.1.1 Review of Consumer Demand Theory

Let p_i and q_i be the price and quantity of good i $(i = 1, \ldots, n)$ respectively which the consumer may purchase. Barten (1967) shows that a number of axioms on the ordering preferences lead to the possibility of formulating a differentiable utility function

$$u = u(q_1, \ldots\ldots, q_n) \qquad (3.1.1)$$

where u measures the consumer's satisfaction when he buys and consumes a certain bundle of quantities of n commodities and q_i $(i = 1, \ldots, n)$ is the quantity of commodity i that the consumer purchases in a certain time interval in order to maximize his utility function subject to his financial constraints. These constraints are expressed by

$$\Sigma p_i q_i = m \qquad (i = 1, \ldots\ldots, n) \qquad (3.1.2)$$

where p_i is the price of commodity i and m is total expenditure or, loosely, income.

Let the consumer take m and the p_i's as given, so that his objective is to maximize utility (3.1.1) subject to his financial constraints (3.1.2). If the utility function has a unique solution with only positive q_i's for any values of income and prices concerned, the solution is written as,

$$q_i = f_i(m, p_1, \ldots\ldots, p_N) \qquad i = 1, \ldots, N \qquad (3.1.3)$$

which is a system of N demand equations, each describing the consumption of some goods in terms of income and prices of all N goods.

Theil (1978) shows that if income and all prices are multiplied by a constant, say, $k > 0$ then (3.1.2) becomes $\Sigma_i(kp_i)q_i = km$, which implies the same constraint on the q_i's as the original budget constraint (3.1.1). Also, the utility function is not affected when income and prices are multiplied by k. Hence, when this function is maximized subject to the budget constraint, with all prices and income multiplied by $k > 0$, the quantities remain unchanged. Thus, the demand equations (3.1.3) satisfy,

$$f_i(km, kp_1, \ldots\ldots, kp_N) = f_i(m, p_1, \ldots\ldots, p_N) \qquad i = 1, \ldots N \text{ and } k > 0 \qquad (3.1.4)$$

When k is interpreted as the reciprocal of a deflator P, the arguments in the left-hand side of (3.1.4) become m/P (real income) and p_1/P, ..., p_N/P (relative prices). Therefore, using this interpretation in conjunction with (3.1.3), yields

$$q_i = f_i(m/P, p_1/P, ..., p_N/P) \qquad i = 1, ..., N \qquad (3.1.5)$$

which describes the demand for each good as a function of real income and all relative prices. The deflator P is some function of the prices p_1, ..., p_N and can thus be written as $P(p_1, ..., p_N)$, so that the relative prices become

$$\frac{p_1}{P(p_1,......,p_N)},.......,\frac{p_N}{P(p_1,......,p_N)}$$

This shows that the N arguments in (3.1.5) are all determined by p_1, ..., p_N; hence, these arguments, as described by Theil (1978), can just as well be replaced by the undeflated prices p_1, ..., p_N. Thus, writing $\overline{m} = m / P$ for real income, the demand equations can be formulated as,

$$q_i = q_i(\overline{m}, p_1,......,p_N) \qquad i = 1, ..., N \qquad (3.1.6)$$

which describes the demand for each good as a function of real income and undeflated prices.

Theil (1978) emphasizes on the difference between (3.1.3) and (3.1.6). The derivative $\delta f_i/\delta p_j$ of (3.1.3) shows how a change in p_j affects the demand for the *i*th good when money income (m) remains constant, while $\delta q_i/\delta p_j$ of (3.1.6) shows the effect of a change in p_j on the demand for the *i*th good when real income is held constant. The latter effect is simply the substitution effect of the change in p_j on the demand for the *i*th good.

3.1.2 Slutsky Conditions

Barten (1967) held that in the course of development of demand theory a number of restrictions on the demand equations have been formulated. These restrictions are mainly properties of the partial derivatives of (3.1.2) with respect to income and prices or can be formulated as such. First is the adding-up property,

$$\Sigma p_i \, \delta q_i/\delta m = 1 \qquad (3.1.7)$$

which implies that an increase in total expenditure is completely allocated to all commodities in the budget. The other properties originate from the breakdown of the partial derivatives of 3.1.3 with respect to price in two components,

$$\delta q_i/\delta p_j = k_{ij} - (\delta q_i/\delta m)q_j \qquad (3.1.8)$$

where the first represents the substitution effect and the second term corresponds to the income effect. The breakdown was first proposed by Slutsky (1915). While the decomposition in itself is not a real restriction, its importance lies in the restrictions on the substitution terms, k_{ij}. The second restriction is known as the homogeneity property since it ensures in combination with (3.1.8) that an equal relative increase in all prices and income leaves the amounts of commodities purchased unaltered. In notational form this means,

$$\Sigma_j k_{ij} p_j = 0 \qquad (3.1.9)$$

where the substitution terms for one commodity multiplied by the appropriate prices add up to zero. There are n of these restrictions, one for each demand equation.

The next set of restrictions is provided by the symmetry property which implies,

$$k_{ij} = k_{ji} \qquad (\delta q_i / \delta p_j = \delta q_j / \delta p_i) \qquad (3.1.10)$$

There are $n \times n$ k_{ij} terms as there exists n commodities in the bundle and n prices. The symmetry condition concerns only those k_{ij} terms, where $i \neq j$, that is the substitution parts of the partial derivative with respect to prices other than the price of the commodity which is being replaced. There are $n^2 - n$ of these k_{ij} terms.

Barten (1967) argued that perhaps the most important restriction of all is the negativity property for the substitution part of the own price derivative, namely:

$$k_{ij} < 0 \qquad (3.1.11)$$

This restriction shows that in the case where the income derivative in 3.1.6 is positive or zero (that is, normal goods), an increase in the price of this commodity results in a fall in the quantity bought. Barten (1967) referred properties, (3.1.7), (3.1.9), (3.1.10), and (3.1.11) as the Slutsky conditions.

3.1.3 Demand Equations with Constant Elasticities

Theil (1978) maintained that a common mathematical form of demand equation in economics is,

$$\log_e q_i = a_i + b_i \log_e m + \Sigma c_{ij} \log_e p_j \qquad j = 1, \ldots, n \qquad (3.1.12)$$

where, a_i, b_i, c_{i1}, ..., c_{in} are constants, with b_i representing the income elasticity of the demand for the *i*th good. The cross-price elasticity of demand for the *i*th good with respect to p_j is,

$$c_{ij} = (\delta q_i / \delta p_j)(p_j / q_i) \qquad i, j = 1, \ldots\ldots, n \qquad (3.1.13)$$

The implications of the Slutsky symmetry under (3.1.12) can be verified by multiplying (3.1.10) by p_j/q_i,

$$\left(\frac{\delta q_i}{\delta p_j}\right)\left(\frac{p_j}{q_i}\right)=\left(\frac{\delta q_j}{\delta p_i}\right)\left(\frac{p_j}{q_i}\right) \qquad i, j = 1, \ldots\ldots, n \qquad (3.1.14)$$

The left-hand side of (3.1.14) is nothing but c_{ij} and multiplying its right-hand side by (p_iq_j/p_iq_j) gives,

$$\left(\frac{\delta q_j}{\delta p_i}\right)\left(\frac{p_j}{q_i}\right)*\left(\frac{p_iq_j}{p_iq_j}\right)=\left(\frac{\delta q_j}{\delta p_i}\right)\left(\frac{p_i}{q_j}\right)\left(\frac{p_jq_j}{p_iq_i}\right)=c_{ji}\left(\frac{p_jq_j}{p_iq_i}\right)$$

So after manipulation of (3.1.14), the Slutsky symmetry amounts to,

$$c_{ij}=c_{ji}\left(\frac{p_jq_j}{p_iq_i}\right),$$

which is rearranged to give,

$$\frac{c_{ij}}{c_{ji}}=\left(\frac{p_jq_j}{p_iq_i}\right) \qquad i, j = 1, \ldots\ldots, n \qquad (3.1.15)$$

Since c_{ij}'s are constant under (3.1.12), the left-hand side of (3.1.15) is also constant. Hence, Slutsky symmetry under constant elasticities demand functions, requires constant ratios of expenditures on all n goods, irrespective of the values of income and all prices. Theil (1978), however, argues that this is unrealistic and hence makes the constant elasticity model (3.1.12) unattractive when the research is interested in Slutsky symmetry. Since the symmetry condition is a vital theoretical constraint in the consumer demand theory, the application of a model that incorporates such a constraint is preferred. Hence, the use of Rotterdam model in this research is justified as it possesses this feature.

3.2 Derivation of the Rotterdam Model

The derivation of the Rotterdam Model is adapted from Theil (1975 and 1978) and follows from section 3.1. After concluding that (3.1.12) is not attractive when interested in Slutsky symmetry, Theil (1978) viewed consumer demand theory as an allocation theory: The consumer is concerned with the dollar amount to be allocated to each good, given the total amount of income available (m) and the prices of all goods ($p_1,....,\ p_n$). This is the same as saying that consumer demand theory is concerned with N allocation proportions,

$$w_i = p_i q_i / m \qquad\qquad i = 1,\ ....,\ N \qquad\qquad (3.2.1)$$

which are known as the budget shares of the N goods. The next task is to develop demand equations which are formulated in terms of changes in budget shares over time. Note that the N budget shares add up to 1,

$$\sum_{i=1}^{N} w_i = 1 \tag{3.2.2}$$

which follows from (3.2.2) after dividing both sides by m. For example, the proportion of income spent on food, is the combined budget share of all goods that fall under food.

3.2.1 *The Change in a Budget Share and Its Three Components*

Let $Y(x_1, \ldots\ldots, x_n)$ be a differentiable function of n arguments and consider its differential,

$$dY = \sum_{k=1}^{n} \frac{\delta Y}{\delta x_k} dx_k \tag{3.2.3}$$

which gives the change in the value of the function when all the arguments are subject to infinitesimal changes. Equation (3.2.1) describes w_i as a function of three arguments, viz., p_i, q_i, and m. The partial derivatives of w_i with respect to p_i, q_i, and m in (3.2.1) are q_i/m, p_i/m, and $-p_iq_i/m^2$, respectively.

Hence, applying (3.2.3) to (3.2.1) yields the following:

$$dw_i = \frac{q_i}{m} dp_i + \frac{p_i}{m} dq_i - \frac{p_i q_i}{m^2} dm \tag{3.2.4}$$

Multiplying each of the arguments on the right-hand side of equation (3.2.4) by p_i/p_i, q_i/q_i, and m/m, respectively, gives:

$$dw_i = \frac{p_i q_i}{m}\frac{dp_i}{p_i} + \frac{p_i q_i}{m}\frac{dq_i}{q_i} - \frac{p_i q_i}{m}\frac{dm}{m} \qquad (3.2.5)$$

Equation (3.2.5) can be written as,

$$dw_i = w_i d(\log_e p_i) + w_i d(\log_e q_i) - w_i d(\log_e m) \qquad (3.2.6)$$

which shows that the change in the *i*th budget share consists of three parts:

- one which is attributable to the change in the *i*th price,
- one for the change in the *i*th quantity, and
- one for the income change.

Recall that the consumer takes prices and income as given and then decides on the *N* quantities. As a result, let $w_i d(\log_e q_i)$, the quantity component of dw_i in (3.2.6) be the dependent variable of the demand equation for the *i*th good. Theil (1978) maintains that this selection is justifiable since using the quantity component emphasizes that the consumer takes price and income as given and controls quantity bought.

3.2.2 A Demand System in Infinitesimal Changes

Writing (3.1.6) in logarithmic form gives:

$$\log_e q_i = \log_e q_i(\overline{m}, p_1, \ldots\ldots, p_N)$$
$$\log_e q_i = \log_e q_i(e^{\log_e \overline{m}}, e^{\log_e p_1}, \ldots\ldots, e^{\log_e p_N})$$

The second line shows that (3.1.6) can be interpreted as the logarithm of a quantity in terms of the logarithms of real income and all prices. Applying (3.2.3) to this logarithmic function yields,

$$d(\log_e q_i) = \frac{\delta \log q_i}{\delta \log \overline{m}} d(\log_e \overline{m}) + \sum_{j=1}^{N} \frac{\delta \log q_i}{\delta \log p_j} d(\log_e p_j)$$

This can be equivalently written in the following form,

$$d(\log_e q_i) = \frac{\delta \log q_i}{\delta \log m} d(\log_e \overline{m}) + \sum_{j=1}^{N} \frac{\delta \log q_i}{\delta \log p_j} d(\log_e p_j) \qquad (3.2.7)$$

as $\delta(\log q_i)/\delta(\log \overline{m}) = \delta(\log q_i)/\delta(\log m)$. This is so because the partial derivative procedure means that prices are kept constant in the evaluation of these two derivatives, such that the changes in money income (m) and real income ($\overline{m}$) are identical.

Equation (3.2.7) is then multiplied by the budget share, $w_i = \frac{p_i q_i}{m}$ to give:

$$w_i d(\log_e q_i) = w_i \frac{\delta \log q_i}{\delta \log m} d(\log_e \overline{m}) + w_i \sum_{j=1}^{N} \frac{\delta \log q_i}{\delta \log p_j} d(\log_e p_j)$$

$$w_i d(\log_e q_i) = \frac{p_i q_i}{m} \frac{\delta q_i}{q_i} \frac{m}{\delta m} d(\log_e \overline{m}) + \frac{p_i q_i}{m} \sum_{j=1}^{N} \frac{\delta q_i}{q_i} \frac{p_j}{\delta p_j} d(\log_e p_j)$$

After simplifying, this gives

$$w_i d(\log_e q_i) = p_i \frac{\delta q_i}{\delta m} d(\log_e \overline{m}) + \sum_{j=1}^{N} \frac{p_i p_j}{m} \frac{\delta q_i}{\delta p_j} d(\log_e p_j) \qquad (3.2.8)$$

The left - hand side of (3.2.8) represents the quantity component of the *i*th budget share change. The coefficient of $d(\log_e p_j)$ on the right is

$$\frac{p_i p_j}{m} \frac{\delta q_i}{\delta p_j} = \frac{p_j p_i}{m} \frac{\delta q_j}{\delta p_i} \qquad (3.2.9)$$

The equal sign in (3.2.9) is based on the Slutsky symmetry depicted in (3.1.10). This symmetry is equivalent to that of the coefficients of the logarithmic price changes in the model (3.2.8). In addition,

$$\sum_{j=1}^{N} \frac{p_i p_j}{m} \frac{\delta q_i}{\delta p_j} = \frac{p_i}{m} \sum_{j=1}^{N} p_j \frac{\delta q_i}{\delta p_j} = 0 \qquad (\delta q_i / \delta p_j = k_{ij}) \qquad (3.2.10)$$

where the last step is based on (3.1.9).

3.2.3 *Slutsky Coefficients*

Equation (3.2.8) is derived in terms of infinitesimal changes, but the estimation of the demand equation systems required finite changes. As a result, $d(\log_e p_j)$ is approximated by Dp_{jt}, which represents the log-change in the jth price from period t - 1 to period t. Hence,

$$Dp_{jt} = \log_e p_{jt} - \log_e p_{j,t-1} = \log_e \frac{p_{jt}}{p_{j,t-1}} \tag{3.2.11}$$

Next, the substitution term on the far right in (3.2.8) is replaced by

$$\sum_{j=1}^{N} \pi_{ij} Dp_{jt}, \qquad \text{where } \pi_{ij} = \frac{p_i p_j}{m} \frac{\delta q_i}{\delta p_j} \tag{3.2.12}$$

This π_{ij} is called the (i, j)th Slutsky coefficient. It follows from (3.2.9) and (3.2.10) that the Slutsky coefficients satisfy

$$\pi_{ij} = \pi_{ji} \qquad i, j = 1,\dots, N \tag{3.2.13}$$

$$\sum_{j=1}^{N} \pi_{ij} = 0 \qquad i = 1, \dots, N \tag{3.2.14}$$

Also the negativity condition instituted in (3.1.8) combined with the π_{ij} definition in (3.2.12) gives

$$\pi_{ii} < 0 \qquad\qquad i = 1, \ldots, N \qquad\qquad (3.2.15)$$

3.2.4 Marginal Shares

The coefficient of $d(\log_e \overline{m})$ in (3.2.8) is written as

$$\mu_i = p_i \frac{\delta q_i}{\delta m} = \frac{\delta (p_i q_i)}{\delta m} \qquad\qquad (3.2.16)$$

where the last argument of (3.2.16) is based on the fact that when we take the partial derivative of $p_i q_i$ with respect to m, p_i must be taken as a constant.

The coefficient μ_i is termed the ith marginal share and shows the effect of a change in money income on the expenditure on the ith good. That is, it answers the following question: if income increases by one rand, how much of this increase is allocated to the ith good? Note that a marginal share may be negative if the good in question is inferior, that is, demand falls as income rises. The marginal shares must add up to 1,

$$\sum_{i=1}^{N} \mu_i = 1 \qquad\qquad (3.2.17)$$

which follows from the budget shares in (3.2.2). Equation (3.2.17) can be proven by differentiating (3.2.2) with respect to m which gives $\Sigma_i p_i(\delta q_i / \delta m) = 1$. This is similar to (3.2.17) in view of (3.2.16).

3.2.5 *A Demand Model in Finite Changes*

Recall that the argument, $d(\log_e q_i)$, on left-hand side of (3.2.8) represents the quantity component of an infinitesimal change in quantity. So, once again this infinitesimal change is approximated by a log-change in quantity,

$$Dq_{it} = \log_e q_{it} - \log_e q_{i,t-1} = \log_e \frac{q_{it}}{q_{i,t-1}} \qquad (3.2.18)$$

The other argument on the right-hand side of (3.2.8), w_i, represents the budget share of the ith good. In the finite-change version we have a budget share in time t (w_{it}) and one in time t - 1 ($w_{i,t-1}$). Selecting their arithmetic average,

$$\overline{w}_{it} = \frac{1}{2}(w_{i,t-1} + w_{it}) \qquad (3.2.19)$$

the finite-change demand equation has $\overline{w}_{it} Dq_{it}$ on the left-hand side.

This term takes the form

$$\overline{w}_{it} Dq_{it} = \mu_i DQ_t + \sum_{j=1}^{N} \pi_{ij} Dp_{jt} + \varepsilon_{it} \qquad i = 1, \ldots, N \tag{3.2.20}$$

where $\sum_j \pi_{ij} Dp_j$ is the substitution term illustrated in (3.2.12) and ε_{it} is a random error term with zero mean, while

$$DQ_t = \sum_{i=1}^{N} \overline{w}_{it} Dq_{it} \tag{3.2.21}$$

is the log-change in real income. The argument of (3.2.21) is explained in the next subsection. The model (3.2.20), with the μ_i's and π_i's treated as unknown parameters, illustrates the absolute price version of the so-called Rotterdam Model of systems of consumer demand equations.

3.2.6 *The Measurement of Real Income*

Since (3.2.2) holds for any values of income and prices, the sum of the left-hand side of (3.2.6) over $i = 1, \ldots, N$ is zero. Hence, adding (3.2.6) over i yields

$$0 = \sum_{i=1}^{N} w_i d(\log_e p_i) + \sum_{i=1}^{N} w_i d(\log_e q_i) - \sum_{i=1}^{N} w_i d(\log_e m) \tag{3.2.22}$$

The last term of (3.2.22) is simply $d(log_e m)$, as the sum of all the budget shares over i is one. This said, (3.2.22) can be equivalently expressed as

$$d(\log_e m) = \sum_{i=1}^{N} w_i d(\log_e p_i) + \sum_{i=1}^{N} w_i d(\log_e q_i) \qquad (3.2.23)$$

Equation (3.2.22) shows that the logarithmic change in the consumer's total expenditure is the sum of a price component and a quantity component. These two components are termed Divisia indexes (a price index and a quantity or volume index) of total expenditures.

Recall from (3.1.6) that real income is interpreted as $\overline{m} = m / P$, where money income, m, is deflated by a price index, P. Defining P as the Divisia price index yields

$$d(\log_e P) = \sum_{i=1}^{N} w_i d(\log_e p_i) \qquad (3.2.24)$$

Substituting the left-hand term of (3.2.24) in (3.2.23) and re-arranging gives

$$d(\log_e m) - d(\log_e P) = \sum_{i=1}^{N} w_i d(\log_e q_i)$$

which is equivalent to

$$d(\log_e \frac{m}{P}) = \sum_{i=1}^{N} w_i d(\log_e q_i) \quad \left[= d(\log_e \overline{m})\right] \qquad (3.2.25)$$

The left-hand side of (3.2.25) is the logarithmic change in real income where money income is deflated by the Divisia price index defined in (3.2.24). Hence, it is clear from (3.2.25) that the logarithmic change is equal to the Divisia volume index of (3.2.23). The right-hand side of (3.2.25) is simply a finite-change version of this volume index. Therefore, the real-income definition (3.2.21) used in the demand model (3.2.20) is a finite-change version of the Divisia volume index of the consumer's total expenditure.

It is important to clarify two points: First, the log-change in real income defined in (3.2.21) is, in fact, the sum of the left-hand variable in (3.2.20) over all i. This latter variable shows the contribution of the ith good to the log-change in real income. Hence, the model (3.2.20) illustrates each such contribution as a linear function of their sum (the log-change in real income) and the log-changes in the prices, thus emphasizing that it is an allocation model for the change in the demand for each good, given the changes in income and prices. Second, the real-income definition of (3.2.21) is in terms of quantity changes, not in terms of the change in money income deflated by a price index. The latter approach is also possible, but Theil (1978) argues that it has the disadvantage that if applied to (3.2.20), the disturbances $\varepsilon_{1t}, \ldots, \varepsilon_{Nt}$ from do not add up to zero as will be shown next. The definition (3.2.21) has the advantage that the ε_{it}'s have zero sum, which again emphasizes the fact that (3.2.20) is an allocation model.

Equation (3.2.25) can be approximated by (3.2.26) to illustrate finite changes, i.e.,

$$DQ_t \equiv D\left(\frac{m}{P}\right) \equiv Dm_t - \sum_{i=1}^{N} \overline{w}_{it} Dp_{it} \tag{3.2.26}$$

where DQ_t and Dp_{it} are as defined in (3.2.21) and (3.2.11) respectively and Dm_t is $log_e\ m_t$ minus $log_e\ m_{t-1}$. The last term of (3.2.26) comes from (3.2.24). Next, DQ_t in (3.2.20) is substituted by the right-hand argument of (3.2.26) which gives

$$\overline{w}_{it} Dq_{it} = \mu_i (Dm_t - \sum_{i=1}^{N} \overline{w}_{it} Dp_{it}) + \sum_{j=1}^{N} \pi_{ij} Dp_{ji} + \varepsilon_{it} \tag{3.2.27}$$

Adding (3.2.27) over i results in

$$\sum_{i=1}^{N} \overline{w}_{it} Dq_{it} = \sum_{i=1}^{N} \mu_i (Dm_t - \sum_{i=1}^{N} \overline{w}_{it} Dp_{it}) + \sum_{i=1}^{N} \sum_{j=1}^{N} \pi_{ij} Dp_{ji} + \sum_{i=1}^{N} \varepsilon_{it}$$

By using definitions (3.2.14), (3.2.17) and (3.2.21), the above equation reduces to

$$DQ_t = Dm_t - \sum_{i=1}^{N} \overline{w}_{it} Dp_{it} + \sum_{i=1}^{N} \varepsilon_{it}$$

$$DQ_t - (Dm_t - \sum_{i=1}^{N} \overline{w}_{it} Dp_{it}) = \sum_{i=1}^{N} \varepsilon_{it} \tag{3.2.28}$$

Hence (3.2.28) clearly shows that if real income is defined by changes in money income deflated by a price index, then the sum of error terms, $\varepsilon_{1t}, \ldots, \varepsilon_{Nt}$ will not add up to zero.

The definition of (3.2.21) has the advantage that the ε_{it}'s have zero sum. To prove this, sum (3.2.20) over i,

$$\sum_{i=1}^{N} \overline{w}_{it} Dq_{it} = \sum_{i=1}^{N} \mu_i DQ_t + \sum_{i=1}^{N} \sum_{j=1}^{N} \pi_{ij} Dp_{ji} + \sum_{i=1}^{N} \varepsilon_{it} \qquad (3.2.29)$$

Again, using definitions (3.2.14), (3.2.17) and (3.2.21), equation 3.2.29 reduces to

$$DQ_t = DQ_t + \sum_{i=1}^{N} \varepsilon_{it}$$

$$\sum_{i=1}^{N} \varepsilon_{it} = 0 \qquad (3.2.30)$$

Thus (3.2.30) shows that using definition (3.2.21) results in the zero sum of the error terms ε_{it} which again emphasizes that (3.2.20) is an allocation model, since there can be no part of the budget that is not allocated. That is, there is no error in mis-estimating budget allocation since all budget is allocated.

3.2.7 Estimation of the Rotterdam Equations Without Slutsky Symmetry

Recall from (3.2.14) that $\sum_{j=1}^{N} \pi_{ij} = 0$. That is,

$$\pi_{i1} + \pi_{i2} + \ldots + \pi_{i,N-1} + \pi_{iN} = 0$$

which is rearranged to yield

$$\pi_{iN} = -\pi_{i1} - \pi_{i2} - \ldots - \pi_{i,N-1}$$

This shows that the term (3.2.12) in (3.2.20) can be written as

$$\begin{aligned} \sum_{j=1}^{N-1} \pi_{ij} Dp_{jt} + \pi_{iN} Dp_{Nt} &= \sum_{j=1}^{N-1} \pi_{ij} Dp_{jt} - Dp_{Nt} \sum_{j=1}^{N-1} \pi_{ij} \\ &= \sum_{j=1}^{N-1} \pi_{ij} (Dp_{jt} - Dp_{Nt}) \end{aligned}$$

so that (3.2.20) becomes

$$\overline{w}_{it} Dq_{it} = \mu_i DQ_t + \sum_{j=1}^{N-1} \pi_{ij} (Dp_{jt} - Dp_{Nt}) + \varepsilon_{it} \qquad (3.2.31)$$

Suppose that the standard linear model holds for (3.2.31), with DQ_t and Dp_{1t} - Dp_{Nt}, ..., $Dp_{N-1,t}$ - Dp_{Nt} as the ith observations on N explanatory variables and uncorrelated disturbances $\varepsilon_{i1}, \varepsilon_{i2}, \ldots, \varepsilon_{iN}$ with zero mean and constant variance.

Least squares (LS) can then be applied by regressing $\bar{w}_{it} Dq_{it}$ on the above mentioned explanatory variables, hence yielding estimated μ_i, $\pi_{i1}, \ldots, \pi_{i,N-1}$. The estimate π_{iN} is obtained by imposing the constraint (3.2.14) that was used to eliminate π_{iN} onto the (3.2.31). Hence, when disregarding the Slutsky symmetry of (3.2.13), LS yields best linear unbiased estimates of the parameters of (3.2.31) which is the unconditional absolute price version of the Rotterdam model. A constant term and the Slutsky symmetry which may be imposed onto (3.2.31) are discussed next.

3.2.8 The Constant Term

Equation 3.2.31 can be estimated with a constant term added to the right-hand side to represent the expectation of the quantity component of a budget share under the condition that real income and relative prices remain unaltered. Hence, the constant term can be interpreted as a proxy for the gradual and persistent shift in consumer's preferences due to, say, habit formation. (see Section 1.2.1).

3.2.9 Imposing Slutsky Symmetry

Theil (1978) uses the Student test statistic to test for Slutsky symmetry, but argues that using such a test is not a routine application, since π_{12} is a coefficient in the demand equation for the first good and π_{21} occurs in the equation of the second good. If the two equations have correlated error terms, the Student test is then no longer appropriate. Also one should not test one single symmetry relation such as $\pi_{12} = \pi_{21}$, but rather test the symmetry relations $\pi_{ij} = \pi_{ji}$ for all pairs (i, j) simultaneously using an F test obtained by applying the generalized least squares (GLS) method. Generalization estimates all equations simultaneously, which is necessary in order to impose the constraints on coefficients of different equations such as $\pi_{12} = \pi_{21}$.

3.2.10 Unconditional Elasticity Estimates

Dividing equation (3.2.20) by the average budget share, $\overline{w}_{it}$, gives

$$Dq_{it} = \frac{\mu_i}{\overline{w}_{it}} DQ_t + \sum_{j=1}^{N} \frac{\pi_{ij}}{\overline{w}_{it}} Dp_{jt} + \frac{\varepsilon_{it}}{\overline{w}_{it}} \qquad (3.2.32)$$

Since the marginal share, μ_i, and the budget share equals $p_i \frac{\delta q_i}{\delta m}$ and $\frac{p_i q_i}{m}$ respectively, the coefficient of the log-change in real income (DQ_t), $\frac{\mu_i}{\overline{w}_{it}}$, is in fact the income elasticity of demand for the ith good. This coefficient is not constant since $\overline{w}_{it}$ varies over time. Similarly, the elasticity of demand for the ith good with respect to the jth price is $\frac{\pi_{ij}}{\overline{w}_{it}}$, since π_{ij} equals $\frac{p_i p_j}{m} \frac{\delta q_i}{\delta p_j}$. Note that this is not equal to $\frac{\pi_{ji}}{\overline{w}_{jt}}$, even when π_{ij} equals π_{ji}, so that these elasticities are not symmetric.

The next section shows the groupwise extensions of the Rotterdam model as it yields conditional demand equations. It is plausible to regard beef, chicken, mutton and pork as goods that shape meat as a group. If this is true, the consumer first decides on expenditure on meat as a group and then allocates the expenditure amongst beef, chicken, mutton and pork (i.e. goods within the group). The expenditure on, say, beef is therefore conditional upon the initial allocation of income to the meat group. If the amount of income allocated to the meat group changes, then expenditure on the individual meat will also change. The first decision is described by the formulation of demand equation for the meat group which will be a function of real income and the relative price of the group, but not the prices of the individual meat type. The formulation of demand equations for each meat type, known as conditional demand equations, describes the second decision and is determined by total expenditure on the meat group, as determined by the first decision, and relative prices of the individual meats.

3.3 Groupwise Extensions of the Rotterdam Model

The above developments which lead to the model (3.2.20) analyzed the demand for all N goods. When dealing with a large number of goods, the N parameters in (3.2.31) amount to an unmanageable number of unknowns. However, the approach can be reformulated so that it becomes more manageable when certain separability conditions on the utility function are imposed. The implied strategy is then to formulate, first, demand equations for groups of goods and, second, demand equations for individual goods within their respective groups. This is particularly relevant since it allows us to estimate the demand for quite narrowly defined goods such as beef, chicken, mutton and pork.

3.3.1 Groups of Goods

Let the N goods be divided into G groups of goods and assume that the utility function (3.2.1) can be expressed as the sum of G functions, one for each group,

$$u(q_1, \ldots, q_N) = u_1(\mathbf{g_1}) + u_2(\mathbf{g_2}) + \ldots + u_G(\mathbf{g_G}) \qquad (3.3.1)$$

where the arguments of the G functions on the right are the q_i's of the corresponding group (for example, $\mathbf{g_1}$ = those of the N goods belonging to group 1). The marginal utility of the ith good is independent of the quantities of all goods which belongs to groups other than that of the ith. Equations 3.3.1 therefore specifies block-independent preferences which imply *a two-level decision hierarchy*. The consumer first determines expenditure on a particular group, G, and then allocates expenditure to goods within the group based on relative prices (Clements and Selvanathan 1988).

Consider one particular group, the gth, and arrange the goods in such a way that those belonging to this group have subscripts $1, \ldots, N_g$, where N_g is the number of goods of the gth group. The budget share of the group ($\overline{W}_{gt}$) and its marginal share M_g are respectively defined as,

$$\overline{W}_{gt} = \sum_{i=1}^{N_g} \overline{w}_{it}, \qquad M_g = \sum_{i=1}^{N_g} \mu_i \tag{3.3.2}$$

Note that $\overline{W}_{gt}$ represents the sum of the budget share of the goods within the group only (averaged over periods t - 1 and t). The M_g shows how much of a rand increase in income is allocated the goods of the gth group only.

Next, the log-change in the quantity index of the gth group is defined as

$$DQ_{gt} = \sum_{i=1}^{N_g} \frac{\overline{w}_{it}}{\overline{W}_{gt}} Dq_{it} \tag{3.3.3}$$

where the right-hand side is a weighted mean of the Dq_{it}'s of this group with weights of the form $\overline{w}_{it} / \overline{W}_{gt}$.

3.3.2 Demand Equations for Groups of Goods

Multiplying (3.3.3) by $\overline{W}_{gt}$ yields,

$$\overline{W}_{gt} DQ_{gt} = \sum_{i=1}^{N_g} \overline{w}_{it} Dq_{it} \tag{3.3.4}$$

The left-hand side of (3.3.4) is the group version of the left-hand side variable $\overline{w}_{it} Dq_{it}$ of the demand equation (3.2.31) for an individual good. Hence, (3.3.4) implies that if we want a demand equation for the group with $\overline{W}_{gt} DQ_{gt}$ on the left, we must sum the equations (3.2.31) for the goods of this group. Using M_g defined in (3.3.2), the equation for the group becomes

$$\overline{W}_{gt} DQ_{gt} = M_g DQ_t + \sum_{i=1}^{N_g} \sum_{j=1}^{N} \pi_{ij} Dp_{jt} + E_{gt} \tag{3.3.5}$$

where $E_{gt} = \Sigma_i \, \varepsilon_{it}$ (sum over $i = 1, \ldots, N_g$) is the sum of the demand disturbances of all goods of the group. The G group demand equations (3.3.5) describes the first decision of block-independent preferences which involves the allocation of income to the G groups. Each of these demand equations contains real income and the relative price of the group in question, but not the prices of the individual good. Next, to accomplish the second decision where, for each of the groups, expenditure is allocated to the goods *within their own group*, conditional demand equations are formulated.

3.3.3 *Conditional Budget Shares*

The three components of the infinitesimal change in a budget share were derived in (3.2.6). The quantity component of that equation was subsequently used as the left-hand variable in the demand equation (3.2.8). Here we proceed similarly for the infinitesimal change in the ratio of w_i to $W_g = \sum_j w_j$ (sum over $j = 1, \ldots, N_g$). The ratio w_i/W_g is known as the conditional budget share of the ith good within its group. For example, if the consumer spends 15 per cent of his income on the group (meat) and 5 per cent on a good belonging to this group (beef), then W_g = 0.15 and w_i = .05, such that the conditional budget share of this good within the group is (.05)/(.15) = .333 or 33.3 per cent. In this context, "conditional" is interpreted as meaning "within the group".

It is known from calculus that

$$d(\log_e x) = dx/x \tag{3.3.6}$$

which can be rearranged to yield

$$dx = xd(\log_e x)$$

for any positive variable x. This is applied to $x = w_i/W_g$ to give:

$$d\left(\frac{w_i}{W_g}\right) = \frac{w_i}{W_g} d\left(\log_e \frac{w_i}{W_g}\right) = \frac{w_i}{W_g} d(\log_e w_i) - \frac{w_i}{W_g} d(\log_e W_g)$$

Applying (3.3.6), the first term of the third argument becomes $(w_i/W_g)(dw_i/w_i) = dw_i/W_g$, such that

$$d\left(\frac{w_i}{W_g}\right) = \frac{dw_i}{W_g} - \frac{w_i}{W_g} d(\log_e W_g)$$

Next dw_i is substituted by the expression in (3.2.6) which yields

$$d\left(\frac{w_i}{W_g}\right) = \frac{w_i d(\log_e p_i) + w_i d(\log_e q_i) - w_i d(\log_e m)}{W_g} - \frac{w_i}{W_g} d(\log_e W_g)$$

$$= \frac{w_i d(\log_e p_i) + w_i d(\log_e q_i)}{W_g} - \left(\frac{w_i d(\log_e m) + w_i d(\log_e W_g)}{W_g}\right)$$

The above equation can be expressed in a simpler form,

$$d\left(\frac{w_i}{W_g}\right) = \frac{w_i}{W_g} d(\log_e p_i) + \frac{w_i}{W_g} d(\log_e q_i) - \frac{w_i}{W_g} d(\log_e W_g m) \qquad (3.3.7)$$

which is a within-group version of (3.2.6). The first two arguments on the right in (3.3.7) are the price and quantity components of the change in the conditional budget share.

3.3.4 Conditional Demand Equations

Recall from (3.2.20) that the left-hand side variable $\overline{w}_{it} Dq_{it}$ is a finite-change version of the quantity component of dw_i. Similarly, finite-change version of $(w_i/W_g)d(\log_e q_i)$, the quantity component of the change in the conditional budget share expressed in (3.3.7) is derived when formulating a demand equation for the *i*th good within its group. Hence, $(\overline{w}_{it} / \overline{W}_{gt})Dq_{it}$ is chosen as this finite-change version, where $\overline{W}_{gt}$ is defined in (3.3.2). This variable is obtained on the left by dividing both sides of 3.2.20 by $\overline{W}_{gt}$:

$$\frac{\overline{w}_{it}}{\overline{W}_{gt}} Dq_{it} = \frac{\mu_i}{\overline{W}_{gt}} DQ_t + \sum_{j=1}^{N} \frac{\pi_{ij}}{\overline{W}_{gt}} Dp_{jt} + \frac{\varepsilon_{it}}{\overline{W}_{gt}} \qquad (3.3.8)$$

Next, 3.3.5 is multiplied by $\mu_i / M_g \overline{W}_{gt}$,

$$\frac{\mu_i}{M_g} DQ_{gt} = \frac{\mu_i}{\overline{W}_{gt}} DQ_t + \sum_{k=1}^{N_g} \sum_{j=1}^{N} \frac{\mu_i}{M_g} \frac{\pi_{kj}}{\overline{W}_{gt}} Dp_{jt} + \frac{\mu_i}{M_g} \frac{E_{gt}}{\overline{W}_{gt}}$$

and this is subtracted from 3.3.8 so that the two terms involving DQ_t cancel each other out. The result may be expressed as

$$\frac{\overline{w}_{it}}{\overline{W}_{gt}} Dq_{it} = \frac{\mu_i}{M_g} DQ_{gt} + \text{ price term } + \varepsilon_{it}^{*}$$

where $\varepsilon_{it}^{*} = \varepsilon_{it} / \overline{W}_{gt} - \mu_i E_{gt} / M_g \overline{W}_{gt}$ and $\overline{w}_{it} / \overline{W}_{gt}$ is the conditional budget share of the *i*th good within its group. Theil (1978) shows that if the utility function satisfies condition (3.3.1), the price term can be simplified so that the equation takes the form

$$\frac{\overline{w}_{it}}{\overline{W}_{gt}} Dq_{it} = \frac{\mu_i}{M_g} DQ_{gt} + \sum_{j=1}^{N_g} \pi_{ij}^{*} Dp_{jt} + \varepsilon_{it}^{*} \qquad (3.3.9)$$

This is a conditional demand equation for each good of the group ($i = 1, \ldots, N_g$) with the coefficients of the Dp_{jt}'s satisfying the Slutsky conditions described earlier. These are termed 'conditional' demand equations as the change in the allocation of budget to a particular good is conditional on the proportion of income spent on the group to which that good belongs. The coefficient of DQ_{gt} in (3.3.9), μ_i/M_g, is referred to as the conditional marginal share of the *i*th good within its group and answers the following question: If income increases by one *rand*, so that an additional amount M_g is spent on the *g*th group, what proportion of this amount is allocated to the *i*th good? The coefficients of the Dp_{jt}'s are known as the conditional Slutsky coefficients and they measure the effect of a change in the *j*th price on the demand of the *i*th good when the volume index of the group (real income) remains constant ($DQ_{gt} = 0$) and the prices of the N_g - 1 other goods of this group remain unchanged.

Empirical estimates of μ_i / M_g and the π^*_{ij} for each good are obtained by imposing the Slutsky symmetry, homogeneity condition and applying GLS to regress the Dq_{it}'s on the DQ_{gt} and the Dp_{jt}'s. These estimates can then be used to estimate the conditional income elasticity of the *i*th good within its group, I_i, and the conditional Slutsky elasticities (cross-price elasticity proxies) for the *i*th good within its group, S_{ij}, as (Theil, 1978):

$$I_i = \frac{\mu_i / M_g}{\overline{w}_{it} / \overline{W}_{gt}} \qquad\qquad S_{ij} = \frac{\pi_{ij}}{\overline{w}_{it} / \overline{W}_{gt}} \qquad (3.3.10)$$

The I_j's show the proportionate effect of a change in the amount of money allocated to meat expenditure as a group on the demand for the *j*th good when all prices and the volume index of meat consumption ($DQ_{gt} = 0$) remain constant. The S_{ij}'s estimate the proportionate effect of a change in p_j on the demand for the *i*th good when $DQ_{gt} = 0$ and prices of the other goods of the group are also unchanged. These estimates can hence show policymakers which price changes have the largest relative impacts on demand for individual goods. This is relevant to a study of SA meat demand, as local policymakers can identify the potential relative impacts on demand for, say, chicken and pork, of changes in beef price if EU meat exports to SA increase and/or decrease following an eventual FTA (see section 3.5).

3.3.5 Conditional and Unconditional Demand Elasticities Compared

Clements and Selvanathan (1988) estimate both conditional and unconditional Slutsky elasticity estimates for beer, wine and spirits for Australia for the period 1956-77. All the estimated conditional own-price elasticities were smaller in absolute terms than the corresponding unconditional elasticity estimates. One of the determinants of the magnitude of own-price elasticity of demand is the number of equivalent products available. If there are many products that can be substituted for the product, demand will be more price-elastic (Pashigian, 1995). Since the conditional elasticity estimates hold total expenditure on the group (e.g. alcohol) constant, so that they reflect inter-group (e.g. beverage) competition (fewer substitutes) only, while the unconditional elasticity estimates hold real income constant and allow total good (e.g. alcohol) expenditure to vary and so reflect inter-product competition, the former are expected to be smaller in absolute terms than the latter.

Theil (1978) explains the difference between the absolute value of the two elasticity estimates from another angle. He argues that the unconditional elasticity, $\pi_{i1}/\overline{w}_{it}$, in (3.2.20) can be viewed as the proportionate effect of an increase in the *i*th price on demand for the *i*th good when the consumer receives an income compensation so that real income is unchanged. Similarly, the corresponding conditional elasticity in (3.3.9) may be viewed as the proportionate effect of this price increase when it is accompanied by an income compensation so that the volume index of the group is unchanged ($DQ_{gt} = 0$). The latter compensation has to be larger than the former, since an increase in the *i*th price will have a larger proportionate impact on the group consumption than on real income. Because the compensation for the volume index group change is bigger, this implies that the reduction in consumption for the *i*th good is smaller. Since the extent of change is smaller, the conditional elasticity takes a smaller negative value than the unconditional elasticity.

3.3.6 *The Rotterdam Model Compared to Other Demand Models*

Parks (1969) compares three demand models, viz., the indirect addilog system, the linear expenditure system, and the Rotterdam differential logarithmic system in terms of their theoretical properties and empirical usefulness using the same time series data for Sweden for eight sectors of the economy - agriculture, manufacturing, transportation and communications, commerce and insurance, domestic services, housing services, public services, and imported goods - during 1861-1955. All three models are based on the utility maximization subject to a budget constraint. Although all three satisfy the adding-up, homogeneity, negativity and symmetry conditions, the latter two must be imposed to estimate the Rotterdam model. The differential model includes a larger number of parameters than its counterparts and hence offers more descriptive flexibility. This advantage must be weighed against the advantages of simplicity offered by other models.

The empirical models were compared on the basis of fit to sample data for each commodity separately; the concept of average information inaccuracy was used to evaluate the overall fit of the model to the data for the entire budget; and the elasticity estimates for mean expenditure shares were contrasted. The percentage of unexplained variation was low for all of the models, but when compared with predictions based on a naive no-change model, only the Rotterdam model displayed consistently better results for all commodities together. Predictions of the Rotterdam model for individual commodities were generally good, but the linear expenditure model (with trend) showed somewhat better predictions for several commodities. However, the linear expenditure model without trend and the indirect addilog model were generally inferior.

The above completes the derivation of the Rotterdam model which provides the link between consumer demand theory and conditional demand equations. We now turn to the more important task of applying the model to estimate SA meat demand. The next section, therefore, provides the hypothesized Rotterdam model of SA meat demand.

3.4 Hypothesized Rotterdam Model of South African Meat Demand

In applying the Rotterdam model to estimate the demand for meat in SA, DQ_{gt} and Dp_{jt} 's of (3.3.9) are treated as nonstochastic values taken by explanatory variables, and ε^{*}_{it} as a random disturbance with zero mean and constant variance which is uncorrelated over time. This section uses the demand equation for beef to show how the Rotterdam model is specified. Consider meat as a group where $N_g = 4$ for the ith meat. Imposing the homogeneity condition on equation (3.3.9) using the Seemingly Unrelated Regression (SUR) technique SHAZAM (1997), allows the demand equation for beef to be written as,

$$\frac{\overline{w}_{1t}}{\overline{W}_{gt}} Dq_{1t} = a + \frac{\mu_1}{M_g} DQ_{gt} + \sum_{j=1}^{4} p^{*}_{1j} Dp_{jt} + e^{*}_{1t} \qquad (3.4.1)$$

where:

w_{1t} = budget share of beef during time t,

$\overline{w}_{1t}$ = $(w_{1,t-1} + w_{1t})/2$

W_{gt} = $\sum_{i=1}^{4} w_{it}$, budget share of all meats as a group during time t,

$\overline{W}_{gt}$ = $(W_{1,t-1} + W_{1t})/2$,

g = all types of meats as a group,

i, j = individual meat (1 = beef, 2 = chicken, 3 = mutton and 4 = pork),

t = time (in years),

q_{1t} = per capita consumption of beef during time t,

Dq_{1t} = $\log(q_{1t}/q_{1,t-1})$

a = a constant

$DQ_{gt} = \sum_{i=1}^{4}(\overline{w}_{it} / \overline{W}_{gt})Dq_{it}$,

μ_1 = marginal share of beef,

$M_g = \sum_{i=1}^{4}\mu_i$

μ_1/M_g = conditional marginal share of beef,

p_{1t} = average retail price of beef,

$Dp_{jt} = \log (p_{jt}/p_{j,t-1})$,

π^*_{1j} = conditional Slutsky price coefficient of beef,

ε^*_{1t} = disturbance term of the beef equation.

The coefficients $\mu_1 / M_g, \pi^*_{11}, \pi^*_{12}$, and π^*_{13}, π^*_{14} are estimated by SUR regression of $(\overline{w}_{1t} / \overline{W}_{gt})Dq_{it}$, on the four right-hand variables in (3.4.1) after imposing Slutsky symmetry and homogeneity condition using SHAZAM (1997). With the exception of π^*_{11}, all the other coefficients are expected to have a positive relationship (substitutes in consumption). A constant term, α, is incorporated in equation 3.4.1 to capture changes in preferences and tastes (e.g. habit formation, see Section 1.2.1). The conditional income and Slutsky elasticities are obtained by dividing the conditional marginal shares and conditional Slutsky coefficients by the average conditional budget shares in the period 1971-1996 (see equation 3.3.10). The conditional income elasticity will show which of the meats in the group are luxuries or necessities. The conditional Slutsky elasticities will show which meat price changes have the largest effect on consumption of beef and the other meats. This will identify which meat types are most likely to be affected by changes EU meat imports to SA following an eventual FTA. Four equations like (3.4.1) will be estimated, one for each meat and the results are presented in chapter 4.

Appendix A tables the basic and derived annual data for the period 1971-1996 used to fit the demand system of equation (3.4.1). This period is chosen since there was a change in the response panel reporting to the Central Statistical Services in 1970, so that data prior to, and after, 1970 are not strictly comparable (Uys, 1986). The first four columns of Table A-1 contain the per capita consumption (kg per year) of the four meats: Beef, Chicken, Mutton and Pork (Modipane, 1997; Scharneck, 1997). The next four columns of the table give the annual average retail prices (cents per kg) of the four meats (Central Statistical Services, various issues). The last column contains the per capita disposable income in current rand, which is needed for the computation of budget shares (Jansen, 1997).

The budget shares of the four meats $w_{1t},......,w_{4t}$ (the subscripts 1 to 4 refer to beef, chicken, mutton and pork, respectively) are given in the first four columns of Table A-2. The fifth column contains the total meat budget share $W_{gt} = w_{1t}+......+w_{4t}$. The last four columns give the conditional budget shares within meats, w_{it} / W_{gt} for i = 1, . . ., 4. The meat group is indicated by the subscript, g. Table A-3 contains the left-hand variables of the demand equations and the price log-changes of the four meats. The last column of the table gives the log-change in total meat consumption, DQ_{gt}, which is obtained by summing $\bar{w}_{it}Dq_{it}$ over $i = 1, \ldots, 4$.

This chapter derives the absolute price version of the Rotterdam model (3.4.1) which effectively estimates changes in the conditional budget share of each meat as a function of changes in expenditure on the meat group and changes in the prices of all the meats. Equation (3.4.1) is empirically applied to the SA meat demand system and the results thereof are analyzed in the next chapter. The conditional own-price beef elasticity estimate derived from the model is used with a price elasticity of SA beef supply estimate from Lubbe (1992) to simulate the impacts of EU beef imports on SA beef price. Estimated conditional demand and supply elasticities are used to quantify the impact of different FTA scenarios on the SA beef price.

CHAPTER 4

EMPIRICAL RESULTS

This chapter presents the empirical estimates for the Rotterdam model of SA meat demand. Conditional marginal shares and Slutsky coefficients (Table 4.1), and conditional expenditure and Slutsky elasticities (Table 4.4) estimated from this model are then analyzed. The conditional own-price elasticity of beef demand is used with a price elasticity of SA beef supply estimate from Lubbe (1992) to simulate the impacts of EU beef imports on SA beef price. These estimates are also used in the final section to quantify the potential impacts on the SA beef price of the likely outcomes of current FTA negotiations.

4.1 Empirical Rotterdam model of South African Meat Demand

The Rotterdam model for SA beef, chicken, mutton and pork demand specified below following equation (3.4.1)

$$\frac{\overline{w}_{1t}}{\overline{W}_{gt}} Dq_{1t} = a + \frac{\mu_1}{M_g} DQ_{gt} + \sum_{j=1}^{4} p^{\bullet}_{1j} Dp_{jt} + e^{\bullet}_{1t} \qquad (4.1.1)$$

was estimated after the symmetry and homogeneity conditions were imposed using SHAZAM (1997). A proxy variable showing increasing proportion of the black population becoming urbanized over time was considered to reflect the effect of changing income distribution on SA meat demand. However, lack of data prevented an appropriate variable being specified. Also, an attempt was made to split beef consumption into table cuts for direct consumption and processed beef. As most of SA beef imports are used for processing purposes, the demand elasticity for processed beef would probably be a more appropriate estimate to analyze the impact of beef imports on the SA meat industry. Again, limited time series data prevented this specification of the model. However, in line with Kinnucan *et al.* (1997), an intercept (constant) is included in each equation as a proxy for trend-related changes in demographics or income distribution which could affect local meat demand.

The estimated coefficients and associated *t* ratios of the parameters are presented in Table 4.1. The *t* ratios indicate that most of the coefficients are statistically significant at least at the 15 per cent level. Due to the symmetry constraint, the bottom half (not shown) is a mirror image of the top half. The *runs* test confirmed that the model was free of autocorrelation at the 5 per cent level. This is not surprising since the Rotterdam model fits data in first differences. The Wald χ^2 test statistic of 10.78 shows that the conditional cross-price Slutsky coefficients (π_{ij}'s) are statistically symmetrical at the 10 per cent level. The Wald χ^2 test with restrictions that all parameters are zero is rejected at the 1 per cent level.

TABLE 4.1 Estimated Conditional Marginal Shares and Slutsky Coefficients of South African Meats: 1971-1996

	Constant	μ_i / M_g	π_{i1}	π_{i2}	π_{i3}	π_{i4}
Beef	-0.430	0.667	-0.237	0.070	0.129	0.037
	(-2.07)[1]	*(12.68)*	*(-5.66)*	*(2.96)*	*(4.05)*	*(2.75)*
Chicken	0.780	0.076		-0.061	-0.002	-0.008
	(4.28)	*(1.63)*		*(-2.76)*	*(-0.09)*	*(-0.82)*
Mutton	-0.330	0.222			-0.131	0.004
	(-1.36)	*(3.74)*			*(-3.48)*	*(0.28)*
Pork	-0.005	0.041				-0.030
	(-0.07)	*(2.09)*				*(-2.29)*

[1] The *t* ratios are in parentheses.

The Capps *et al.* (1994) study of demand equations for meat products in Taiwan, South Korea and Japan used single-equation R^2 to measure the goodness-of-fit for each of their equations. Seale *et al.* (1992), on the other hand, use a Rotterdam import allocation model to fit import data for fresh apples in four importing markets important to U.S. apple exporters. They argue that single-equation measures of R^2 are not appropriate in measuring the goodness-of-fit of a system of equations. Instead, they used a systemwide R^2 suggested by Mc Elroy (1977) which is also used in this study. This R^2 can be related to a *Wald* test with restrictions that all parameters are zero as follows:

$$R^2 = 1 - \frac{1}{1 + W^* / (T-k)(n-1)} \tag{4.1.2}$$

where W^* is Wald test statistic, T is the number of observations, k is the number of regressors in each equation, and n is the number of equations in the full system (Bewley, 1986). The calculated systemwide R^2 of 0.82 for the SA meat demand model indicates a reasonably good model fit.

The constant terms show that per capita consumption of beef and mutton seems to be falling while per capita demand for chicken seems to be increasing even if the volume index of the group ($DQ_{gt} = 0$) and the prices of the N_g - 1 other goods of this group remain constant. A number of factors in addition to consumers acquiring a taste for chicken, may have contributed to this trend. First could be the effect of changes in the South Africa black urbanization ratio . The percentage of black urban to black total population rose from 11.85 per cent in 1970 to 55.04 per cent in 1997 (Table 4.2). Local beef production comprise of high quality meat used for direct consumption while, beef imports are of manufacturing grades used for processed meat which is consumed mainly by the lower income group.

TABLE 4.2 Changes in South African Black Demographic Composition: 1970-1997

	Urban	Rural	Total	Urban/Total
		million		*percentage*
1970	2.25	16.74	18.99	11.85
1975	3.66	16.49	20.15	18.16
1980	5.94	16.24	22.18	26.78
1985	9.63	16,04	25.67	37.51
1990	13.76	15.94	29.70	46.33
1995	17.83	15.93	33.76	52.81
1997[1]	19.50	15.93	35.43	55.04

Note: 1. Projection Figures
Source: Calitz (1997)

Assuming that those who urbanize find a better paid job than previously and can improve their incomes, they may shift from processed meat to chicken which is a relatively cheaper substitute than higher quality beef.

Also, the increase in per capita chicken consumption relative to that of red meat most probably reflects consumers' health concerns regarding red meat which is known to contain a high level of cholesterol. Urbanization which makes information more accessible could lead to the newly urbanized consumers becoming more aware of the health risk associated with red meat consumption.

The second factor is the change in real personal per capita (PPC) disposable income by population group since 1970. Table 4.3 shows that real PPC disposable income (1990 prices) of the asian, black and coloured population increased markedly over 1970-94, while that of the white population rose modestly from 1970-90 and then has fallen. The real PPC disposable income of the black population group rose from R1440 in 1970 to R2360 in 1994, a 64 per cent increase. This rise in PCC disposable income may have resulted in a shift from processed beef to relatively better quality chicken.

The shift from processed beef to chicken and not higher quality beef may be simply because even with a higher real PCC disposable income, consumers choose more chicken because it is relatively less expensive than higher quality beef.

TABLE 4.3 Real Personal Disposable Income Per Head in South Africa by Population Group: 1970-1994

Period	Asians	Blacks	Coloureds	Whites
	Rand (1990 Prices)			
1970	3699	1440	3053	17357
1975	4954	1841	3864	18400
1980	5754	2055	4142	18661
1985	6744	2191	4529	19308
1990	7196	2352	4767	19401
1991	7249	2343	4800	18542
1992	7368	2353	4859	18059
1993	7337	2361	4831	17843
1994	7312	2360	4867	17681

Source: Van Wyk (1995)

These factors may have added to the rise in per capita chicken consumption resulting from a change in consumers' tastes for chicken as they acquire a taste, and learn new recipes, for chicken (habit formation). During a period in which the price of chicken decreases relative to the beef price, consumers adjust to consuming chicken at a certain level. In the following period when the price of chicken relative to beef starts to rise, consumers would reduce their consumption of chicken but probably at a lower rate than that at which it was increased (Goodwin *et al.*, 1968).

4.1.1 *Conditional Marginal Shares and Conditional Slutsky Coefficients*

The estimated conditional marginal shares (μ_i/M_g) are positive, as expected, and show that for each extra amount spent on meat as a group, 66.70, 7.60, 22.20, and

4.10 per cent will go to beef, chicken, mutton and pork, respectively (Table 4.1). Note that the estimated conditional marginal shares add up to one based on equations (3.2.17) and (3.3.2).

The conditional own-price Slutsky coefficients (π_{ii}) are all statistically significant at the 5 per cent level or below and agree *a priori* with theory (inverse relationship between meat consumption and their respective prices). The estimated conditional cross-price Slutsky effects between chicken and mutton (π_{23}), chicken and pork (π_{24}), and mutton and pork (π_{34}) are not statistically significant. The other coefficients, however, are statistically significant at least at the 5 per cent level and positive. These results imply that beef and chicken (π_{12}), beef and mutton (π_{13}), beef and pork (π_{14}) are substitutes in consumption.

4.1.2 *Conditional Expenditure and Slutsky Elasticities*

Based on equation (3.3.10), the conditional expenditure and Slutsky elasticity estimates are derived by dividing the conditional marginal shares and Slutsky coefficients in Table 4.1 by the mean of the sample conditional budget share. For example, the conditional expenditure elasticity estimate for beef would be 0.667 divided by 0.570 (sample mean of conditional beef budget share during 1971-1996). These conditional elasticity estimates are presented in Table 4.4. The estimated conditional income elasticities for beef and mutton exceed one, indicating that these meats are luxuries within the meat group, while the opposite holds true for chicken and pork. The conditional Slutsky elasticity estimates indicate that a 1 per cent change in the beef price, following an FTA between SA and the EU, would have relatively greater impact on the consumption of other meats than would a 1 per cent change in chicken, mutton

TABLE 4.4 Conditional Income and Slutsky Elasticity Estimates of South African Meats: 1971-1996[1]

		Conditional Slutsky elasticity estimates with respect to the price of			
	Conditional income elasticity	*Beef*	*Chicken*	*Mutton*	*Pork*
Beef	1.17	-0.42	0.12	0.23	0.06
Chicken	0.40	0.37	-0.32	-0.01[2]	-0.04[2]
Mutton	1.37	0.79	-0.01[2]	-0.80	0.02[2]
Pork	0.53	0.48	-0.10[2]	0.05[2]	-0.43

[1] Elasticity estimates are calculated at the sample conditional budget share means.
[2] Elasticity estimate is not statistically different from zero.

or pork prices. For example, a 1 per cent fall in beef price would cause chicken consumption to fall by 0.37 per cent, while a 1 per cent fall in chicken price would reduce beef consumption by only 0.12 per cent. The reason for this may be that beef accounted for a much greater proportion of *average* annual meat expenditure (57 per cent) than did chicken (19 per cent), mutton (16 per cent) or pork (8 per cent) during 1971-1996. However, the conditional budget shares of beef and mutton fell from 61.30 per cent and 19.60 per cent in 1971 to 48.50 per cent and 12.40 per cent in 1996, while that of chicken rose from 10.90 per cent in 1971 to 30.90 per cent in 1996. This indicates that if chicken continues to gain a greater share of annual meat expenditure at the expense of beef and mutton, the effect of a change in its price on consumption of other meats will grow.

Note that the conditional own-price Slutsky elasticity estimates are smaller in absolute terms than the unconditional own-price elasticity estimates reported by Hancock *et al* (1984) and Uys (1986). Both of these price elasticities are estimated holding real income constant (see Friedman, 1976). The difference occurs because the conditional own-price elasticity estimates assume block-independent preferences (fewer substitutes for meat within the meat group) as explained in section 3.3.5.

The conditional own-price elasticity for beef estimated in Table 4.4 is used in the next section to analyze the impact of EU beef imports on SA beef price and meat consumption.

4.2 Impacts of European Union Beef Imports on South African Beef Price and Meat Consumption

To assess the impacts of EU beef imports on SA meat prices and consumption, estimates of price elasticities of demand and supply are required. Conventional (partial) own-price elasticity of demand estimates for SA beef demand by Hancock *et al.* (1984), Laubscher (1984) and Jooste *et al* (1996) were around negative 1.0. These estimates show the responsiveness of quantity demanded to a change in price, holding all other factors constant. Buse (1958), however, argues that other prices cannot be held constant in a free-market situation since prices of related commodities are mutually determined. For example, if the price of beef rises, the quantity of beef consumed falls but the demand for chicken (a substitute) would rise. This is supported by the positive 0.37 Slutsky elasticity estimate in Table 4.4. Given a constant supply of chicken, the price of chicken would rise, and this price change would, in turn, influence the demand for, and price of, beef. Buse derived the concept of total demand elasticity to show the *net* quantity response after accounting for concurrent changes in prices and quantities of other commodities. Total demand elasticity is less elastic than the (partial) own-price elasticity of demand if the main commodity interrelationships are substitute relations.

The estimated conditional own-price Slutsky elasticity for beef reported in Table 4.4 for the Rotterdam model is -0.42. Since this elasticity estimate reflects only substitution effects holding real income constant, it is a plausible proxy for the total demand elasticity for SA beef. Combined with Lubbe's (1992) estimate of the price elasticity of supply for SA beef of 0.54 (if real prices are lagged three years) for the period 1956-1990, this estimate can be used in the following linear model to assess the effects on SA beef price of a possible EU-SA FTA:

Demand Function (*D*): $$P = \beta_0 - \beta_1 Q_d \qquad (4.2.1)$$

Supply Function (*S*): $$P = \beta_2 + \beta_3 Q_s \qquad (4.2.2)$$

where:

P = retail price of beef,

β_0 = a constant,

Q_d, Q_s = market equilibrium quantity of beef demanded and supplied,

β_1 = $- 1/(E_d) * (P/Q_d)$,

E_d = estimated total demand elasticity,

β_2 = a constant,

β_3 = $1/(E_s) * (P/Q_s)$ and,

E_s = estimated price elasticity of supply for beef.

The model presented in equations (4.2.1) and (4.2.2) is a linear approximation of the underlying (unknown) demand and supply functions. The model's accuracy depends upon the degree of nonlinearity of the true functional forms, and the magnitude of deviations from equilibrium being simulated. Hence, the model is less accurate the more nonlinear the true underlying demand and supply functions, and as larger deviations from equilibrium are considered, since constant elasticities between equilibria are assumed (Brester, 1998 and Brester and Wohlgenant, 1997).

The proxies used for total demand elasticity (E_d) and supply elasticity (E_s) are -0.42 and 0.54 respectively. In 1996, average retail beef price (P) with import tariff was R21.57 per kg or R21570 per ton, total SA beef consumption *including* EU imports (Q_d) was 578000 tons, and total beef supply from local production and imports *other than EU imports* (Q_s) was 539703 tons. Substituting these figures in equations (4.2.1) and (4.2.2) gives the estimated SA beef demand and supply functions as:

$$P = 73012.000 - 0.089Q_d$$

$$P = -18218.616 + 0.074Q_s.$$

These functions are solved simultaneously to give point *b* in Figure 4.1 at which SA beef quantity and price without EU imports, but with tariff, are 559697 tons and R23199 per ton in 1996 respectively. This figure is an empirical analysis of the effects of EU beef imports outlined in Figures 2.1a and 2.1b. Note that point *b* in Figure 4.1 corresponds to point *b* in Figure 2.1b (effect of non-EU beef imports on the SA beef price). Hence, EU beef imports of 38297 tons (578000 tons less 539703) - assuming that they are close substitutes for local beef - without an FTA during 1996 would have depressed local beef price from R23199 per ton to R21570 per ton, or by an estimated 7 per cent. These results compare with a study by the SA Meat Board in 1995, which showed that beef imports (lagged three months) had a significant negative impact, reducing local beef price by 4 per cent. The conclusion was that due to small profit margins encountered by the beef industry a small decline in price of 4 per cent meant the difference between SA producer profits and losses during 1994 and 1995. Nieuwoudt (1997) estimated that EU beef imports had depressed local beef price by some 10 per cent in 1995.

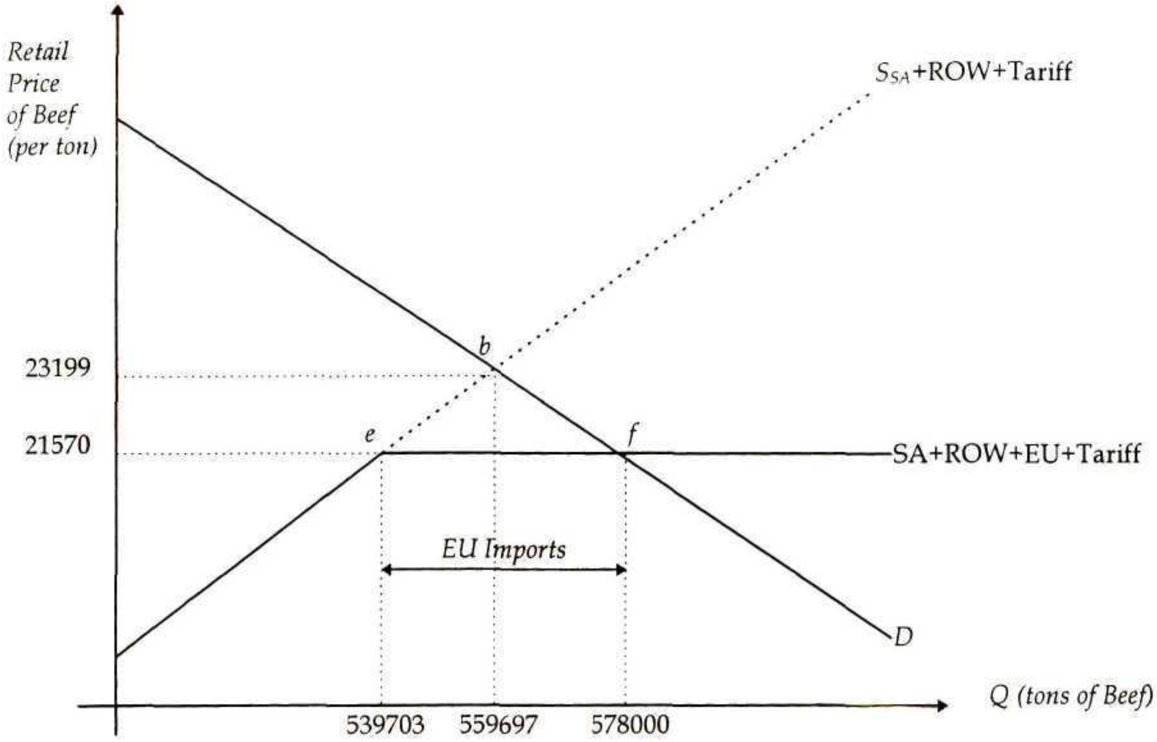

FIGURE 4.1 South African Retail Beef Demand and Supply: 1996

Since beef was shown in section 4.1.1 to substitute for chicken, pork and mutton in consumption, lower beef price would probably depress traded quantities and prices of all other meats over time. Conditional cross-price elasticity estimates in Table 4.4 imply that the 7 per cent beef price fall will reduce chicken, mutton and pork consumption by about 2.59 per cent, 5.53 per cent and 3.36 per cent respectively. The next section shows the impacts of different FTA scenarios on SA beef price using 1996 data.

4.3 Impacts of Free Trade Agreement Scenarios on SA Beef Price

The estimated impacts of EU beef imports on SA beef price under different FTA scenarios are given in Table 4.5 for 1996 data. The analysis is based on two strong assumptions; first, SA average retail beef price is driven by the EU import cleared price and second, the margin between the import cleared price and retail price is relatively constant in the short run and independent of the import cleared price. The EU beef export refund in 1996 for zones 2 (R5.97 per kg) and 9 (R7.50 per kg) averaged R6.74 per kg. The Free on Board (FOB) price for beef includes the EU

TABLE 4.5 Impacts of Free Trade Agreement Scenarios on South African Beef Price: 1996

12-Month Average Amounts in Rand per kg (1996)	Present Scenario	Scenario 1	Scenario 2	Scenario 3
Export Refund (Zone 2 & 9)[1]	6.74	6.74	-	-
Export Refund (Zone 4)[1]	-	-	2.46	-
FOB Price	3.06	3.06	7.34	9.80
Import Tariff (40% of FOB Price)[2]	1.22	-	-	-
Insurance, Freight & Clearing[2]	1.78	1.78	1.78	1.78
Import Cleared Price	6.06	4.84	9.12	11.58
Expected Margins	15.51	15.51	15.51	15.51
Present Retail Price[3]	21.57	-	-	-
Expected Retail Price	-	20.35	24.63	27.09
Expected Change in Imports	-	+32213	-38297	-38297

Source: 1. MLCES (1997)
2. Venter (1998)
3. Coetser (1997)

export refunds, if any, depending on the scenarios. The import tariff of 40 per cent is charged on the average 1996 FOB price. The import cleared price is calculated by adding insurance, freight and clearing charges to the FOB price plus tariff. The expected margin of R15.51 per kg is the difference between the average import cleared price and the present retail price of beef.

The Present Scenario with an average export refund of R6.74 per kg and a 40 per cent import tariff gives the average retail price of beef of R21.57 per kg used in Figure 4.1. Scenarios 1 to 3 show the likely range of outcomes of an FTA in the short run. In Scenario 1, probably the most unlikely outcome of the FTA, the EU export refund of R6.94 per kg is paid but the import tariff is scrapped, leading to an expected average retail of price of R20.35 per kg. Scenario 2 accounts for a reclassification of SA into zone 4, which reduces the export refund from R6.74 per kg to R2.46 per kg, and the abolition of the 40 per cent import tariff. Under this scenario the expected average retail price of beef is estimated as R24.63 per kg. Scenario 3 occurs where both the EU export refund and import tariff are removed. The expected average retail price of beef is estimated to be R27.09 per kg.

For scenarios 2 and 3, the expected average retail price of beef is above both the present average retail price and the estimated equilibrium price of beef (about R23.20 per kg) in Figure 4.1. The complete reduction in EU beef imports from the present situation (calculated from equations (4.2.1) and (4.2.2)) under these scenarios implies that there will probably be gains in market share for local producers and other overseas suppliers. Under Scenario 1, the expected average retail price of beef is below both the present average retail and equilibrium price of beef, and the volume of EU beef imports increases by some 32213 tons.

This chapter details the results of the empirical Rotterdam model for SA meat demand. The conditional income elasticity estimates show that during 1971-1996, beef and mutton were luxuries while chicken and pork were necessities. Per capita consumer demand for beef and mutton seems to be falling while demand for chicken seems to be increasing (even if income and meat prices are unchanged). Conditional cross-price Slutsky elasticity estimates show that for a given one per cent change in beef, chicken, pork and mutton prices, the beef price change would have the largest impact on consumption of the other (substitute) meats. A linear beef demand and supply model predicts that EU beef imports without an FTA reduced local beef price by about 7 per cent in 1996. Policy implications of the impacts of an EU-SA FTA on SA meat demand and prices are considered in the conclusion.

CONCLUSION AND POLICY IMPLICATIONS

This study examines the potential impacts on SA demand for beef, chicken, mutton and pork, and SA beef price, of the most likely outcomes of a Free Trade Agreement (FTA) between SA and the EU. The per capita consumption of chicken relative to beef in SA has increased by nearly fourfold over the last 25 years. Given that the markets for various meats are interrelated, changes in a given meat price are likely to cause prices of all other meats to change in sympathy over time. The South African meat trade in recent years has been characterized by increasing imports of beef, pork, chicken and mutton. While most of the beef and pork imports are of manufacturing quality meat, imported chicken and mutton are used for direct consumption. A substantial volume of SA total beef, chicken and pork imports comes from the EU. An eventual EU-SA FTA could result in the complete removal of SA import tariffs and EU export refunds which will particularly affect the traded quantities and prices of SA beef, chicken and pork meat. This study aims to provide information on the impacts of such an agreement on local meat prices, consumers and producers.

Producer refunds in the SA livestock industry have more or less been totally phased out, while those in the EU have been maintained at 49 per cent. Furthermore, despite SA being a meat producing country, the EU incorrectly regards SA as a non-meat producing country and, up until February 1997, classified SA in zone 2 and 8, for export refund purposes. These zones have the highest EU beef export refunds. The EU thereafter reclassified SA from zone 8 to 9 which resulted in little change in EU beef import prices since it involved a mere 10 per cent refund reduction for a particular beef cut only. Also, the import tariff structure for the SA livestock industry as set out by GATT is already under the agreed bound rate for the year 2000, while that of the EU is still higher than their agreed bound rate.

A Rotterdam model is used in this study to develop a demand system model for SA beef, chicken, mutton and pork consumption. Model conditional income elasticity estimates show that during 1971-1996, beef and mutton were luxuries while chicken and pork were necessities in SA. Per capita consumer demand for beef and mutton seems to be falling while demand for chicken seems to be increasing (even if income and meat prices are unchanged). This could reflect consumers acquiring a taste for chicken (habit formation), increasing urbanization of the black population and/or changes in SA income distribution. Conditional cross-price Slutsky elasticity estimates show that for a given 1 per cent change in each meat price, the beef price change would have the largest impact on consumption of the other (substitute) meats.

A linear beef demand and supply model using the conditional beef own-price elasticity of demand of negative 0.42 and an own-price elasticity of supply of 0.54 by Lubbe (1992) predicts that EU beef imports without an FTA reduced local beef price by about 7 per cent in 1996. Local beef producers with small profit margins have probably been adversely affected by current EU beef imports, while local consumers have probably benefited. Since beef is a close substitute for chicken, pork and mutton, lower beef price would probably depress traded quantities and prices of all other meats simultaneously over time. Conditional cross-price elasticity estimates imply that the 7 per cent beef price fall will reduce chicken, mutton and pork consumption by about 2.59 per cent, 5.53 per cent and 3.36 per cent respectively.

The net short term effect of an EU-SA FTA on SA meat prices would depend on the likely outcomes of the trade negotiations. Retention of export refunds when the current 40 per cent import tariff is removed would have increased EU beef exports by an estimated 32000 tons in 1996. Elimination of the EU export refund would offset the price reducing effect of abolishing the import tariff. The net effect is that the import cleared price of EU beef would rise by 91.10 per cent based on 1996 prices. This would probably eliminate all EU beef imports to the short run benefit of local producers and other overseas exporters, but short run disadvantage of local consumers.

Higher retail beef price for local consumers must be weighed against potential increased long-term investment by producers in the domestic livestock industry. This additional investment would benefit SA producers of yellow maize which is fed to beef animals. Finally, South African negotiators should bear in mind that an eventual FTA between SA and the EU will reduce beef import customs revenue which would lead to a fall in the share of revenue received by SACU member countries.

Since the model specified in this study focuses on the demand side while the supply side is not explicitly recognized, an extension of this research to a general demand-supply equilibrium model would identify impacts of the FTA on SA meat producers. In addition, a general equilibrium model would allow the calculation of more up to date estimates of meat supply elasticities. Furthermore, other areas of future research could include the empirical analysis of the economic effects of the removal or reduction in EU meat trade barriers such as high level of import tariffs and sanitary and phyto-sanitary regulation on SA meat exports to the EU and hence local meat producers.

SUMMARY

South African trade reform under the GATT and subsequent WTO rules has focused attention on a possible Free Trade Agreement (FTA) between SA and the EU. Meat trade between SA and the EU is quite substantial. For example, EU beef (chicken) comprised an average of 76.80 per cent (29.56 per cent) of total overseas beef (chicken) imports in 1996. An eventual FTA between SA and the EU would have major impacts on local meat prices, and thus local consumers and domestic producers.

This research firstly uses a Rotterdam model to estimate a demand system for SA beef, chicken, mutton and pork using annual data for the period 1971-1996. Secondly, the price elasticity of beef demand estimated from the model is used with a beef supply elasticity estimated by Lubbe (1992) to simulate the impact of EU beef imports on SA beef price and meat consumption. Finally, the potential impacts on SA beef price of the likely outcomes of current FTA negotiations are quantified. While past SA meat demand analyses have focused on price inter-relationship and price leaderships, no published work has yet analyzed the potential impact on meat demand and prices of a possible FTA between SA and the EU. Also, since 1990, no published work has estimated the demand for meat in SA, so an updated study is necessary.

The major changes in SA meat consumption over the last 26 years have been the fall in per capita consumption of beef by 50 per cent and a threefold rise in per capita consumption of chicken over the 1971-1996 period. The real average retail prices for beef and chicken have trended upward and downward respectively. With the exception of mutton production, SA meat production (beef, chicken and pork) rose substantially. For example, chicken production has increased from 212,600 tons over 1971-1975 to 691,600 tons over 1991-1996. Red meat production relies very much on natural grazing which is subject to frequent rainfall variations, and the resultant production fluctuations cause imports into SA to rise. Meat exports have declined since 1971, while meat imports have increased markedly, especially for chicken, mutton and pork. Beef, chicken and pork imports from the EU face import duties of 40, 27 and 15 per cent respectively. Hence an FTA between SA and the EU should result in reduction of these import tariffs to the zero rate thereby also reducing customs revenue. This could mean a reduction revenue shares of other South African Customs Union states.

A free trade agreement, theoretically, involves the removal of all trade barriers among member countries, while separate national barriers against trade with nonmembers are kept by the member countries. The removal of trade barriers, say import tariffs, is trade-creating where the society as a whole stands to gain. The GATT defines an FTA as a group of two or more custom territories in which import duties and other restrictive regulations of commerce are eliminated on *substantially all trade* between the constituent territories in product originating in such territories. This definition is, however, ambiguous as it does not provide any guidance as to what is meant by substantially all trade. This requirement can be interpreted in both qualitative and quantitative terms. In qualitative terms, this means that trade must be freed in each sectors of the economy by at least 90 per cent. In quantitative terms, this requires total trade to be freed by at least 90 per cent per cent. The latter definition means that some sectors of the economy may be excluded as long as, on average, 90 per cent of overall trade is freed. On this basis, an agreement can safely exclude a sector of economic activity such as agriculture.

South Africa is currently negotiating for an 'interim agreement' which will lead to an FTA with the EU. In the 'interim agreement' trade barriers between the two nations are to be removed gradually. The EU presently regards SA as a non-meat producer and importer and up until February 1997, classified SA in zones 2 and 8 for EU exports refund purposes - where the highest beef export refunds are paid. South Africa was thereafter reclassified from zone 8 to 9 which involved a mere 10% refund reduction on only boneless individually wrapped beef cuts. If the EU rather identified SA as a meat producer and importer, SA would be in zone 4 where the lowest export refund applies. For example, average EU export refunds for 1996 on fresh/chilled and frozen beef for zone 2 and 9 countries were R5.97 and R7.50 per kg, while for zone 4 countries they were R1.95 and R2.97 per kg respectively. High export refunds from the EU have resulted in the average nominal import cleared price (R6.06 per kg in 1996) of EU beef (frozen boneless) exports to SA being considerably lower than the SA nominal wholesale price (R12.04 per kg in 1996). The import tariff structure for SA livestock industry set out by GATT is already under the agreed bound rate for the year 2000, while that of the EU is still higher than their agreed bound rate.

The absolute price version of the Rotterdam model is used to estimate the demand equations for the four SA meat types simultaneously in terms of changes in budget share allocations, based on consumer utility-maximization subject to a budget constraint. The model assumes block-independent preferences which imply that the consumer first determines expenditure on meat as a group, and then allocates expenditure to beef, chicken, mutton and pork, which shape the group, based on relative prices. The model satisfies the negativity, adding-up, homogeneity, and the Slutsky symmetry conditions, where the latter two conditions are imposed as part of the econometric estimation.

Conditional Slutsky cross-price elasticity coefficients derived from the estimated conditional meat demand equations show that for a given one per cent change in beef, chicken, mutton and pork prices, the beef price change would have the largest impact on consumption of the other meats which are substitutes in consumption. Conditional expenditure elasticities show that beef and mutton are luxuries, while chicken and pork are necessities. Results show further that even if meat prices and per capita income do not change, there is a trend towards lower per capita beef and mutton consumption and higher per capita chicken consumption. This could be attributed to consumers acquiring a taste for chicken (habit formation), increasing urbanization of the black population and/or changes in SA income distribution. A linear beef demand and supply model predicts that EU beef imports without a FTA reduced local beef price by about 7 per cent based on 1996 data. Cross-price elasticity estimates imply that the 7 per cent beef price fall reduced chicken, mutton and pork consumption by about 2.59 per cent, 5.53 per cent and 3.36 per cent, respectively. Local beef producers with small profit margins have probably been adversely affected by current EU beef imports, while local consumers have probably benefited.

The net short term effect of an EU-SA FTA on SA meat prices would depend on the likely outcomes of the current negotiations. If EU export refunds are retained when the current 40 per cent SA import tariff on beef is removed, EU beef exports would rise by some 32000 tons based on 1996 data. Elimination of the EU export refund would offset the price lowering effect of no SA import tariff. This would have raised the import cleared price of EU beef by 91.10 per cent based on 1996 prices. Under this scenario, there would be no EU beef imports to SA, and local producers and other overseas exporters would benefit. Higher retail beef price for local consumers must be weighed against potential increased long-term investment by producers in the domestic livestock industry. This additional investment would benefit SA producers of yellow maize which is fed to beef animals.

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APPENDIX A

TABLE A-1 Basic Annual Data on South African Meats: 1971-1996

Years	Per Capita Meat Consumption (kg/year)				Average Retail Meat prices (cents/kg)[1]				PCDY[2]
	Beef	Chicken	Mutton	Pork	Beef	Chicken	Mutton	Pork	
1971	23.57	5.85	9.12	3.27	93.90	63.20	82.20	88.90	418.32
1972	24.78	7.23	7.11	3.39	100.60	65.50	105.40	101.10	457.79
1973	24.18	8.51	5.87	3.71	131.20	77.80	136.60	118.00	537.53
1974	21.42	9.80	5.85	3.71	172.30	89.10	167.10	139.40	570.51
1975	22.00	10.76	6.46	3.47	184.60	94.20	177.70	157.30	659.99
1976	22.51	11.30	6.12	3.32	189.60	99.10	192.10	170.20	693.88
1977	22.79	11.59	5.87	3.25	196.20	101.30	199.10	178.90	799.93
1978	23.43	10.83	6.59	3.08	208.00	123.40	206.30	192.40	838.24
1979	24.27	10.92	6.88	2.89	229.80	141.10	238.10	227.20	997.29
1980	23.48	10.93	6.85	2.92	304.90	171.60	304.70	293.40	1227.93
1981	20.73	11.95	6.56	3.01	416.00	208.80	394.70	373.30	1351.80
1982	21.51	13.27	6.91	3.25	468.20	215.00	420.80	389.70	1541.60
1983	21.33	14.24	6.76	3.62	488.20	234.10	426.60	400.80	1650.92
1984	21.33	14.36	7.23	3.36	521.00	247.90	515.30	470.60	1942.33
1985	19.58	15.06	6.75	3.18	553.00	235.00	555.00	487.30	2145.28
1986	18.95	14.32	5.81	3.01	661.00	276.00	724.00	525.00	2396.98
1987	18.25	15.23	5.50	3.00	891.20	400.00	870.00	698.70	2832.66
1988	16.43	15.99	4.92	3.08	1079.40	434.00	1035.00	798.30	3333.94
1989	17.45	16.41	4.81	3.30	1163.50	448.00	1136.00	890.10	3836.07
1990	18.43	16.66	5.36	3.50	1235.90	498.50	1211.50	887.30	4360.43
1991	18.65	16.98	5.21	3.27	1230.40	594.00	1190.30	915.40	4935.94
1992	18.96	17.27	5.08	3.29	1508.20	734.00	1452.00	1177.70	5639.09
1993	17.14	15.97	4.33	3.17	1563.60	790.00	1570.40	1234.00	6182.57
1994	15.88	16.81	4.17	3.17	1937.60	936.00	2011.20	1458.00	6723.61
1995	14.56	18.24	3.51	3.24	2150.00	1009.00	2238.00	1585.00	7342.72
1996	13.73	19.18	3.42	3.35	2157.00	1075.00	2255.00	1547.00	8010.10

Notes: 1. Weighted averages of all cuts and/or grades
2. Per Capita Disposable Income in Current Rand

Sources: Modipane (1997); Scharneck (1997) and; Jansen (1997)

TABLE A-2 Budget Shares and Conditional Budget Shares of Meats IN South Africa: 1971-1996

Years	Budget Shares (w_{it})					Conditional Budget Shares (w_{it}/W_{gt})			
	Beef	Chicken	Mutton	Pork	Total Meat	Beef	Chicken	Mutton	Pork
1971	5.30	0.88	1.79	0.70	8.66	61.08	10.20	20.69	8.02
1972	5.45	1.03	1.64	0.75	8.87	61.42	11.67	18.46	8.44
1973	5.90	1.23	1.49	0.81	9.44	62.52	13.05	15.80	8.63
1974	6.47	1.53	1.71	0.91	10.62	60.92	14.41	16.13	8.54
1975	6.15	1.54	1.74	0.83	10.26	60.00	14.97	16.96	8.06
1976	6.15	1.61	1.70	0.81	10.27	59.87	15.71	16.49	7.93
1977	5.59	1.47	1.46	0.73	9.25	60.46	15.88	15.80	7.86
1978	5.81	1.59	1.62	0.71	9.74	59.71	16.37	16.66	7.26
1979	5.59	1.55	1.64	0.66	9.44	59.25	16.37	17.40	6.98
1980	5.83	1.53	1.70	0.70	9.76	59.77	15.66	17.42	7.15
1981	6.38	1.85	1.92	0.83	10.97	58.14	16.82	17.46	7.58
1982	6.53	1.85	1.89	0.82	11.09	58.90	16.69	17.01	7.41
1983	6.31	2.02	1.75	0.88	10.95	57.59	18.44	15.95	8.02
1984	5.72	1.83	1.92	0.81	10.29	55.62	17.82	18.65	7.91
1985	5.05	1.65	1.75	0.72	9.17	55.07	18.00	19.05	7.88
1986	5.23	1.65	1.76	0.66	9.29	56.26	17.75	18.89	7.10
1987	5.74	2.15	1.69	0.74	10.32	55.63	20.84	16.37	7.17
1988	5.32	2.08	1.53	0.74	9.67	55.03	21.53	15.80	7.63
1989	5.29	1.92	1.42	0.77	9.40	56.31	20.39	15.15	8.15
1990	5.22	1.91	1.49	0.71	9.33	55.99	20.41	15.96	7.63
1991	4.65	2.04	1.26	0.61	8.56	54.34	23.88	14.69	7.09
1992	5.07	2.25	1.31	0.69	9.31	54.44	24.13	14.04	7.38
1993	4.34	2.04	1.10	0.63	8.11	53.46	25.17	13.56	7.80
1994	4.58	2.34	1.25	0.69	8.85	51.70	26.44	14.09	7.77
1995	4.26	2.51	1.07	0.70	8.54	49.93	29.35	12.53	8.19
1996	3.70	2.57	0.96	0.65	7.88	46.91	32.66	12.22	8.21

TABLE A-3 Quantity Components of Budget Share Changes, Price Log-Changes of Meats and Log-Changes in the Volume of Total Meat Consumption in South Africa: 1971-1996

Years	$\frac{\bar{w}_{1t}}{\bar{W}_{gt}} Dq_{1t}$	$\frac{\bar{w}_{2t}}{\bar{W}_{gt}} Dq_{2t}$	$\frac{\bar{w}_{3t}}{\bar{W}_{gt}} Dq_{3t}$	$\frac{\bar{w}_{4t}}{\bar{W}_{gt}} Dq_{4t}$	Dp_{1t}	Dp_{2t}	Dp_{3t}	Dp_{4t}	DQ_{gt}
1971-72	3.07	2.32	-4.87	0.30	6.89	3.57	24.86	12.86	0.81
1972-73	-1.52	2.02	-3.28	0.77	26.56	17.21	25.93	15.46	-2.01
1973-74	-7.47	1.94	-0.05	0.00	27.25	13.56	20.15	16.67	-5.59
1974-75	1.62	1.37	1.64	-0.56	6.90	5.57	6.15	12.08	4.07
1975-76	1.37	0.75	-0.90	-0.35	2.67	5.07	7.79	7.88	0.87
1976-77	0.74	0.40	-0.67	-0.17	3.42	2.20	3.58	4.99	0.30
1977-78	1.66	-1.09	1.88	-0.41	5.84	19.73	3.55	7.27	2.04
1978-79	2.10	0.14	0.73	-0.45	9.97	13.40	14.34	16.63	2.51
1979-80	-1.97	0.01	-0.08	0.07	28.28	19.57	24.66	25.57	-1.96
1980-81	-7.34	1.45	-0.75	0.22	31.07	19.62	25.88	24.08	-6.42
1981-82	2.16	1.76	0.90	0.57	11.82	2.93	6.40	4.30	5.39
1982-83	-0.49	1.24	-0.36	0.83	4.18	8.51	1.37	2.81	1.22
1983-84	0.00	0.15	1.16	-0.59	6.50	5.73	18.89	16.05	0.72
1984-85	-4.74	0.85	-1.29	-0.43	5.96	-5.34	7.42	3.49	-5.62
1985-86	-1.82	0.90	-2.85	-0.41	17.84	16.08	26.58	7.45	-5.98
1986-87	-2.11	1.19	-0.96	-0.02	29.88	37.11	18.37	28.58	-1.90
1987-88	-5.81	1.03	-1.79	0.19	19.16	8.16	17.37	13.33	-6.38
1988-89	3.35	0.54	-0.35	0.54	7.50	3.17	9.31	10.88	4.09
1989-90	3.07	0.31	1.68	0.46	6.04	10.68	6.43	-0.32	5.53
1990-91	0.66	0.42	-0.44	-0.50	-0.45	17.53	-1.77	3.12	0.14
1991-92	0.90	0.41	-0.36	0.04	20.36	21.16	19.87	25.20	0.98
1992-93	-5.45	-1.93	-2.21	-0.28	3.61	7.35	7.84	4.67	-9.86
1993-94	-4.01	1.32	-0.52	0.00	21.45	16.96	24.74	16.68	-3.21
1994-95	-4.41	2.28	-2.30	0.17	10.40	7.51	10.69	8.35	-4.26
1995-96	-2.85	1.55	-0.32	0.27	0.33	6.34	0.76	-2.43	-1.34

Notes. All entries are multiplied by 100. The subscript i of $\frac{\bar{w}_{it}}{\bar{W}_{gt}} Dq_{it}$ and Dp_{it} refers to Beef (i = 1), Chicken (i = 2), Mutton (i = 3) and Pork (i = 4). The last column conatins the log-change in total meat consumption.