CHAPTER 8

A CGE MODEL FOR SOUTH AFRICA: THE DATA BASE AND ELASTICITIES

8.1   INTRODUCTION

The examination of the ORANI-G theoretical structure indicated that it is necessary to obtain the relevant elasticities with respect to the South African economy, which will then be used within the ORANI-G framework to represent a relevant CGE model for South Africa. The model can then be applied to evaluate the economy-wide effects of different environmental policy suggestions. The purpose of this chapter is to briefly describe the database that is used for the South African CGE model and the methodology that is used to arrive at the relevant elasticities that are used within this model.

CGE models are frequently criticised for resting on weak empirical foundations. The use of (apparently) arbitrary values and a lack of model validation are two aspects that receive severe criticism (Liu *et al*, 2001, p3). According to Liu *et al* (2001), several approaches have been used for parameter estimation in CGE models. These approaches include micro-econometric studies, the calibration method, the econometric method and the semi-econometric method. The micro-econometric studies on parameter estimations are usually commodity and partial equilibrium based and have been criticised by many macro- and CGE-modellers for this reason.   The calibration method focuses on the selection of a particular functional form and its associated parameterisation. The parameters that must be estimated are then determined by forcing the model to replicate the data of the chosen benchmark year. This method requires limited data but has been criticised for its lack of statistical validity. Apart from this, the calibration method sometimes requires further "subjective inputs" when certain functional structures are used (such as the CES form). The econometric approach to CGE parameter estimation requires substantial time series data and is usually criticised for the onerous data requirements that it needs to allow for econometric estimation. It is also criticised for the fact that econometric estimation is usually conducted on separate subsystems of the general equilibrium system (Liu *et al*, 2001, p5).

Although there are caveats to each of these methods, the approach that is followed to determine the elasticities for the South African model is a combination of the micro-econometric and econometric methods in which the elasticities of several subsystems are estimated. Where data requirements are to onerous or where data is simply not available, elasticities are obtained from

the current economic literature of the South African economy. This is further complimented with elasticities that are suggested by the literature on the ORANI model of the South African economy.

8.2 DESCRIPTION OF THE SOUTH AFRICAN DATABASE THAT WILL BE USED FOR A CGE MODEL

The main source of data that will form the basis of the CGE model is a 2001 Social Accounting Matrix (SAM) produced by Quantec by request of the World Bank. This SAM distinguishes between 45 different products and 45 different industries. Each of these industries is allowed to produce only one output. Distinction is made between 4 different labour groups and 14 different households. The original SAM also distinguishes between 7 different types of government expenditures, 13 different export destinations and 12 different types of fixed investment in the South African economy. For purposes of this study the different export destinations, government expenditures and types of fixed investment are aggregated to allow for aggregated government expenditure, aggregated exports and aggregated investment for the South African economy.

The 45 different industries and products that are distinguished within the 2001 SAM are (abbreviation of the industry in brackets: Appendix One gives a thorough description of each of these industries):

1. Agriculture, forestry and fishing (Agric)
2. Coal mining (Coal)
3. Gold and uranium ore mining (Gold)
4. Other mining (Othmin)
5. Food (Food)
6. Beverages (Bev)
7. Tobacco (Tob)
8. Textiles (Text)
9. Wearing apparel (Wear)
10. Leather and leather products (Leath)
11. Footwear (Foot)
12. Wood and wood products (Wood)
13. Paper and paper products (Paper)
14. Printing, publishing and recording media (Print)

15. Coke and refined petroleum products (Coke)

16. Basic chemicals (BasChem)

17. Other chemicals and man-made fibres (OthChem)

18. Rubber products (RubProd)

19. Plastic products (PlastProd)

20. Glass and glass products (Glass)

21. Non-metallic minerals (NonMetMin)

22. Basic iron and steel (BasIrSt)

23. Basic non-ferrous metals (BasNFer)

24. Metal products excluding machinery (MetProd)

25. Machinery and equipment (MachEq)

26. Electrical machinery (ElecMach)

27. Television, radio and communication equipment (Telv)

28. Professional and scientific equipment (ProfEq)

29. Motor vehicles, parts and accessories (MotVeh)

30. Other transport equipment (OthTrnsp)

31. Furniture (Furn)

32. Other industries (OthInd)

33. Electricity, gas and steam (Elect)

34. Water supply (WatSup)

35. Building construction (BuildCnst)

36. Civil engineering and other construction (Civil)

37. Wholesale and retail trade (WhSale)

38. Catering and accommodation services (CatAcc)

39. Transport and storage (TrnspStor)

40. Communication (Com)

41. Finance and insurance (FinIns)

42. Business services (BusServ)

43. Medical, dental and other health and veterinary services (MedDent)

44. Other community, social and personal services (OthComServ)

45. Other producers (OthProd)

Given the 45 industries that are distinguished, the four different types of labour that are employed within these industries are:

1. Highly skilled (H)
2. Skilled (S)
3. Semi- and unskilled (SS)
4. Informal labour (I)

(Appendix One describes the labour types in more detail)

Households are distinguished according to income groups and the 14 different groups of households that are distinguished are (Classified according to real household incomes):

1. d0: (0 - 10):   R4.9 billion
2. d1 (10 – 20)   R7.0 billion
3. d2 (20 – 30)   R9.8 billion
4. d3 (30 – 40)   R13.2 billion
5. d4 (40 – 50)   R17.8 billion
6. d5 (50 – 60)   R23.3 billion
7. d6 (60 – 70)   R33.6 billion
8. d7 (70 – 80)   R49.3 billion
9. d8 (80 – 90)   R78.4 billion
10. d91 (90 – 95)   R63.5 billion
11. d921 (95 – 96.25)   R21.5 billion
12. d922 (96.25 – 97.5)   R25.2 billion
13. d923 (97.5 – 98.75)   R29.1 billion
14. d924 (98.75 – 100)   R58.0 billion

As stated above, distinction is also made between different export destinations, fixed investment categories and different types of government expenditures. Because these categories are aggregated for purposes of this study, these macroeconomic aggregates are described in Appendix One.

8.3   ELASTICITIES THAT NEED TO BE OBTAINED FOR A CGE MODEL OF THE SOUTH AFRICAN ECONOMY

Given the theoretical structure and the databases that are used for the South African version of the ORANI-G model, there are a number of elasticities that need to be obtained. These elasticities could have a significant effect on the outcome of policy simulations within the model. They are:

   i.   The CES substitution elasticity between different skill types.

  ii.   The CES substitution elasticity between primary factors.

 iii.   The Armington elasticities between the domestic and imported use of commodities for intermediate inputs.

  iv.   The CET transformation elasticities if the data base that is used allows for each industry to produce more than one output. The SAM that is applicable in this study only allows each industry to produce one product and the CET elasticity is therefore not applicable.

   v.   The elasticity of transformation between exports and locally used products. This elasticity allows for the possibility that goods that are destined for exports are not the same as those that are destined for local use. Once again, the database does not allow for export commodities to differ from domestic commodities and it can be assumed that this elasticity is zero.

  vi.   The Armington elasticities between the domestic and imported use of commodities for inputs into the production of investment.

 vii.   The Armington elasticities between the domestic and imported use of commodities by households.

viii.   The household expenditure elasticities for each of the products in the economy.

  ix.   The Frisch linear expenditure household consumption parameter.

   x.   The export demand elasticities for the individual export demand functions.

  xi.   The export demand elasticity for the collective export demand function.

The elasticities are obtained by a combination of econometric estimations and a review of the relevant literature. Despite this, a lack of historical data and relevant research material on the markets of the South African economy renders the attainment of the true elasticities a difficult task. There is significant room for research in this particular field of CGE modelling in South Africa. The methodology that is followed and the consequent results are described below.

i.   The CES substitution elasticity between different skill types

There is very little (if any) data available for the estimation of the CES substitution elasticities between highly skilled, semi-skilled, unskilled and informal sector workers. Despite the difficulty of obtaining reliable historical time series for the number of workers employed within each of these groups, reliable wage data on the industry level for each of these groups is virtually non-existent. Given this, econometric estimation of the elasticity of substitution between the different types of

labour would not yield statistically significant results. It is therefore not surprising that the current literature does not provide any insight into the exact values of these elasticities.

The uncertainty that surrounds the substitution elasticity between different skill types in South Africa is, however, not unique when international literature is examined. Dixon *et al* (1980, p190) state that there is considerable uncertainty that exists within the literature about the extent to which changes in occupational wage relativities influence occupational labour demands in Australia. Dixon *et al* (1980) refer to a study done by Ryland and Parham (1978) in which an attempt was made to obtain substitution elasticities between five types of labour, and although the results were not entirely satisfactory, a fairly well-determined value of 0.2 was obtained for the labour-labour substitutional elasticity, where occupational labour inputs were assumed to be combined by a CES function to generate the overall labour input.

Despite the uncertainty and difficulty that surrounds these elasticities, the discussion of the South African labour market earlier in this study has indicated that one should not expect a high degree of substitutability between the different types of labour in South Africa, as there are structural and institutional factors that allow for very little substitution within the labour market. One could therefore also assume a low elasticity of substitution for the South African labour market. Given the Ryland and Parham (1978) result for the Australian economy, an elasticity of 0.2 is assumed for the South African model.

ii.   **Estimation of the CES parameter that reflects the degree of substitutability between the different primary factors in the production process of each industry.**

A review of current literature of the elasticity of substitution between primary factors in the South African economy has not shed any light on the expected elasticities for the industries included within this study. An attempt is therefore made on estimating these substitution elasticities by following a widely used approach pioneered by Ferguson (1965).

The CES production function has been well received and extensively analysed since its introduction by Arrow, Chenery, Minhas and Solow in 1961. In their groundbreaking paper, Arrow et al (1961) derive the CES production function and apply the form to time series of all non-farm production in the United States. The results indicated an overall elasticity of substitution between capital and labour that is significantly less than unity (Arrow et al, 1961). The elasticity of substitution of the

CES production function can be estimated by using conditions of profit maximisation. This results in the following equation that can be estimated with linear regression techniques:

$$\log(\frac{V}{L}) = \alpha + \sigma \log(\frac{w}{p})$$

where

$V = Value\ Added$ by capital and labour

$L = Labour$

$\sigma = Elasticity\ of\ substitution$

$\dfrac{w}{p} = \mathrm{Re}\,al\ wage\ per\ wor\,\mathrm{ker}$

However, Ferguson (1965) states that the above equation is only suitable for determining the elasticity of substitution from cross section data and not for use with time series data, due to there being no term to allow for technical progress or any other effects that the passage of time might have on the elasticity of substitution. He therefore expands the above specification to include a term for the rate of constant (neutral) technological progress that takes place over time. The time series counterpart for the above equation is therefore:

$$\log(\frac{V}{L}) = \alpha + \sigma \log(\frac{w}{p}) + \beta t$$

where

$t = $ constant technological change

Although the CGE model in this study distinguishes between capital, labour and land as factors of production, the strong assumption is made that the elasticity of substitution between capital and labour holds for the substitution between capital and land, and land and labour as well. In order to obtain estimates for the elasticity of substitution between capital and labour for the 45 industries included in this study, the "Ferguson specification" is applied. Given South Africa's recent history, the above specification is expanded to include two dummy variables. The first dummy variable captures the effect that sanctions had on the South African labour market from 1985 to 1994, while the second dummy variable captures the effect of South Africa's re-instatement into the world economy following the 1994 democratic elections. The complete specification is therefore:

$$\log(\frac{V_j}{L_j}) = \alpha + \sigma_j \log(\frac{w_j}{p_j}) + \beta_j t + \delta D_{sanction} + \gamma D_{int\,ernational}$$

where

$V_j = Value\ added\ by\ industry\ j$

$L_j = Labour\ employed\ by\ industry\ j$

$\sigma_j = Elasticity\ of\ substitution\ between\ labour\ and\ capital\ in industry\ j$

$\dfrac{w_j}{p_j} = \mathrm{Re}\,al\ wage\ per\ wor\ker\ in\ industry\ j$

$t = neutral\ techno\log ical\ change$

$D_{sanction} = Dummy\ var iable\ that\ represent\ the\ period\ of\ sanctions\ in\ South\ Africa$

$D_{int\,ernatonal} = Dummy\ var iable\ that\ represent\ the\ post\ 1994\ period$

Time series data for value added, labour employed and real wage per worker was obtained for each of the 45 industries from the BFA McGreggor input-output database.

An ordinary least squares regression of the functional form described above was estimated for each of the 45 industries that are distinguished within the model. In order to allow for a level of credibility for the estimated elasticities, the estimated equations had to conform to the following criteria:

- The coefficients of each variable in each equation had to make economic sense.
- The coefficients of each of the explanatory variables had to be statistically significant.
- The dependant variable and the explanatory variables had to form a cointegrating relationship.

Although the coefficients of the dummy and technological variable were not significant in all of the estimations, the real wage rate per worker was significant in most of the equations. The equations, in which some of the explanatory variables were insignificant, were re-estimated without including the insignificant variables. This resulted in estimations that complied with the above criteria for 40 of the industries. The only industries for which a cointegrating relationship could not be established were textiles, other production and other transport industries, while the coefficients for the tobacco industry and motor vehicle industries were insignificant. Although it was not part of the criteria, most of the estimations resulted in Adjusted R^2 values higher than 0.80. Appendix Two contains the results of the statistical tests performed on the estimations.

Table 8.1 summarises the estimated substitution elasticities for each of the industries. The average elasticity of substitution between labour and capital in the 40 industries is 0.66, with the water supply industry having the lowest elasticity of 0.17 and the communications industry the highest elasticity of 1.45. The average elasticity of 0.66 is assigned to the industries for which significant elasticity results could not be estimated.

Table 8.1: **Elasticity of substitution between capital and labour in the South African economy.**

Industry	Elasticity of substitution	Industry	Elasticity of substitution
Agric	0.74	MetProd	0.91
Coal	0.38	Macheq	0.77
Gold	0.42	ElecMach	0.66
Othmin	0.29	Telv	0.83
Food	0.34	ProfEq	0.77
Bev	0.28	MotVeh	0.66
Tob	0.66	OthTrnsp	0.91
Text	0.66	Furn	0.58
Wear	0.78	OthInd	0.66
Leath	1.02	Elect	0.26
Foot	0.81	WatSup	0.173
Wood	0.38	BuildCnst	1.05
Paper	0.36	Civil	0.91
Print	0.61	WhSale	0.74
Coke	0.28	CatAcc	0.5
BasChem	0.83	TranspStor	0.66
OthChem	0.27	Com	1.45
RubProd	0.85	FinIns	0.34
PlastProd	0.73	BusServ	0.29
Glass	0.72	MedDent	0.35
NonMetMin	0.69	OthComServ	0.66
BasIrSt	1.01	OthProd	0.66
BasNFer	0.81		

Source: Own calculations

The above results indicate that most of South Africa's industries operate at an elasticity of substitution below one. A one percent increase in the use of capital will therefore result in a less than one percent decrease in the use of labour (and vice versa) for most of the industries.

iii.   Estimation of the elasticity of substitution between domestic and foreign sources for use as a current input in the production, investment and household consumption.

Traditional trade theory analysis of import demand is founded on the assumption of perfect substitution between domestic and imported goods. However, this assumption fails to explain the continued demand for both sources of the same good despite changes in their relative prices over time. This observation has given rise to the notion of Armington elasticities. Armington elasticities capture the degree of substitutability between domestic and foreign sources of supply. The higher the value of this parameter, the closer the degree of substitution between the two sources, while a low value would mean that these sources are weak substitutes.

Although Armington elasticities can be estimated separately for each level of demand (as seen in the specification of the CGE model), available data can seldom support such an attempt. Because of data inadequacies, this study follows Dixon et al (1980, p181) and imposes the restriction:

$$\sigma_{ij}^1 = \sigma_{ij}^2 = \sigma_i^3 = \sigma_i$$

That is, the elasticity of substitution between domestic and imported good *i* is the same for use as an input in the production process, investment or household consumption. Dixon *et al* (1980, p182) defend this assumption by pointing out that most of Australia's major imports are used predominantly in the one end-use category only, and this assumption will suffice for South Africa as well.

In order to estimate the Armington elasticities for the 45 industries of the South African economy, the methodology set out by Reinert and Roland-Holst (1992) is followed. According to these authors, if a representative consumer has a well-behaved utility function, then the consumption decision is amenable to neoclassical utility maximisation or expenditure minimisation. In terms of the choice between imported and domestically produced goods, the hypothetical consumer obtains utility from a composite (Q) of imported (M) and domestic (D) goods, and it is assumed that there are continuous substitution possibilities. The consumer's decision problem is then to choose a mix of M and D that minimises expenditure, given respective prices p_M and p_D and the desired level of Q. In the Armington specification, a CES functional form is chosen for Q:

$$Q = \alpha\left[\beta M^{\delta} + (1-\beta)D^{\delta}\right]^{\frac{1}{\delta}}$$

where α and β are calibrated parameters and $\sigma = \dfrac{1}{1+\delta}$ is the constant elasticity of substitution between imports and domestic goods. The solution to the consumer's optimisation problem is then to choose imports and domestic goods whose ratios satisfy the first order condition:

$$\frac{M}{D} = \left[\frac{\beta}{1-\beta}\frac{P_D}{P_M}\right]^{\sigma}$$

Under the assumption that the utilities in composite consumption are weakly separable, Armington elasticities can be estimated for disaggregated commodity categories, by taking the logarithmic form of the above first order condition. That is:

$$\log(\frac{M}{D}) = \sigma \log\left[\frac{\beta}{1-\beta}\right] + \sigma \log\left[\frac{P_D}{P_M}\right]$$

which can be estimated accordingly:

$$y = b_0 + b_1 x$$

where
$$x = \log(\frac{P_D}{P_M})$$
$$b_1 = \sigma$$

Kapuscinsky and Warr (1996) highlight some problems with this specification:

- The above specification is a static specification. It is therefore not likely to adequately capture dynamic relationships between imports, domestic production and prices.
- The quantity of imports entering a country is frequently subject to various regulations, such as tariffs, and it is important to include variables that capture these factors.

According to Kapuscinsky *et al* (1996) these problems can be addressed by making use of a partial adjustment model or an error correction model (dynamic specification), as proposed by Engle and

Granger (1987). They include dummy variables to represent qualitative events in each sector for which Armington elasticities are estimated.

In their study, the problems highlighted by Kapuscinsky *et al* (1996) are addressed by including dummy variables in the Reinert *et al* (1992) specification that will represent qualitative factors in each industry. These will include factors such as the sanctions that have been imposed on the South African economy between 1985 and 1994 and restricted trade between South Africa and the rest of the world. The model used to estimate the Armington elasticities for the 45 products distinguished within the South African CGE model is given by:

$$y = b_0 + b_1 x + b_2 Z$$

where

$$x = \log(\frac{P_D}{P_M})$$

$$b_1 = \sigma$$

Z = Dummy variables

As was the case in the estimation of the elasticities of substitution between capital and labour, an ordinary least squares regression was estimated for each of the 45 industries that are distinguished within the model. The same evaluation criteria were used in this instance (as was the case for the elasticities of substitution).

The result for the Armington elasticities for each industry is summarised in Table 8.2, while the statistical results are presented in Appendix Two.

Table 8.2:   Estimated Armington elasticities for 45 South African industries

Product	Armington elasticity	Product	Armington elasticity
Agric	0.318	MetProd	0.85
Coal	1.423	Macheq	1.07
Gold	No imports	ElecMach	0.94
Othmin	0.94	Telv	0.91
Food	1.14	ProfEq	0.99
Bev	0.68	MotVeh	0.71
Tob	0.73	OthTrnsp	1.37
Text	1.24	Furn	0.75
Wear	0.68	OthInd	0.43
Leath	1.83	Elect	0.94
Foot	0.94	WatSup	No imports
Wood	0.37	BuildCnst	1.57
Paper	1.37	Civil	2.84
Print	0.42	WhSale	0.94
Coke	0.47	CatAcc	0.94
BasChem	0.56	TranspStor	1.17
OthChem	0.71	Com	0.94
RubProd	1.00	FinIns	0.94
PlastProd	0.94	BusServ	0.98
Glass	0.35	MedDent	1.05
NonMetMin	0.94	OthComServ	0.58
BasIrSt	0.94	OthProd	0.65
BasNFer	0.94		

Source: Own calculations

The elasticities for the footwear, plastic products, non-metal and minerals, basic iron and steel, basic non-ferrous metals, electricity, wholesale and finance & insurance industries were either insignificant or did not form a cointegrating relationship. The average elasticity is therefore assigned to these industries. With the exception of a few industries, the estimated Armington elasticities are below 1 and the average elasticity is 0.94 which indicates that there is not a very high degree of substitution between imported and domestic commodities at this level of disaggregation of the South African economy. This result can be expected, as each of the 45 industries that are distinguished within this study, could be disaggregated further, which could increase the substitution between imported and domestic commodities. It can be deducted therefore that at this level of aggregation there is a low degree of substitutability between imported and domestic goods within the 45 industries distinguished within this study.

iv.   The household expenditure elasticities for each product in the economy.

In order to obtain the relevant parameters for the commodity demand equations for each of the 14 households that are distinguished within the South African database, it is necessary to obtain an estimate of the expenditure elasticity of each household for every product that these households consume in the South African economy. Analysis of the SAM indicates that households do not consume any products that are produced by the gold, other mining, the basic iron and steel, the non-ferrous metals, the construction and the civil engineering industries. Expenditure elasticities must be obtained for the remaining 39 products.

Once again, the literature of the South African household expenditure does not provide expenditure elasticities at a level that will provide insight into the expenditure pattern of each one of the 14 households. This is not surprising, as very little historical data is available for the expenditure of each household on each of the 39 commodities in the South African economy. The lack of data also hampers econometric estimation of the expenditure elasticities for each of the 14 households.

Because of the lack of detailed historical data, expenditure elasticities are estimated for an "aggregated household" that encompasses the expenditure of the 14 households that are distinguished within this study.   It is then assumed that these expenditure elasticities are representative for each of the individual households. Despite the lack of data for disaggregated households, there is sufficient data available to estimate the aggregated household's expenditure elasticity for each of the 39 products in the model.

The demand function that is estimated for each of the 39 products is the commonly used log-linear demand equation of the form (Intrilligator, 1978, p218):

$$\ln(C_i) = \alpha_i + \beta_i \ln(Yd) + \delta_i \ln(\frac{P_i}{P}) + \varepsilon_i$$

where

C_i = Expenditure on good i

Yd = Personal disposable income

$\dfrac{P_i}{P}$ = Relative price of good i to all goods

β_i = Expenditure elasticity of good i

δ_i = Price elasticity of good i

The same criteria that were established for the estimation of the Armington and CES substitution elasticities were used for each of the 39 household demand equations that were estimated. The complete set of statistical tests is presented in Appendix Two. Table 8.3 includes the estimated expenditure elasticities for the 39 products. The results indicate that the elasticities for the leather, footwear, non-metal and mineral and machinery equipment industries are not significant, or that the estimated equation does not form a cointegrating relationship. For these industries the average elasticity of 0.89 is adopted. Except for the household expenditure elasticity of tobacco, all the other elasticities are economically viable. The estimated expenditure elasticity for tobacco is, however, negative and a very low elasticity of 0.05 is assigned.

Table 8.3: Household expenditure elasticities for 39 commodities distinguished within a CGE model for South Africa

Product	Expenditure Elasticity	Product	Expenditure elasticity
Agric	0.99	MetProd	0.86
Coal	1.72	Macheq	0.72
Gold	0	ElecMach	0.03
Othmin	0	Telv	2.24
Food	0.96	ProfEq	1.2
Bev	1	MotVeh	1.2
Tob	0.05	OthTrnsp	1.41
Text	0.43	Furn	1.85
Wear	0.25	OthInd	0.19
Leath	0.89	Elect	0.89
Foot	0.89	WatSup	0.62
Wood	0.65	BuildCnst	0
Paper	1.11	Civil	0
Print	0.75	WhSale	0.81
Coke	1.62	CatAcc	0.9
BasChem	1.69	TranspStor	1.68
OthChem	1.17	Com	2.31
RubProd	0.35	FinIns	1.84
PlastProd	0.71	BusServ	1.28
Glass	0.83	MedDent	1.83
NonMetMin	0.89	OthComServ	0.72
BasIrSt	0	OthProd	0.72
BasNFer	0		

Source: Own calculations

v.   **The Frisch linear expenditure household consumption parameter.**

As indicated in the previous chapter, the linear expenditure system that represents household demand distinguishes between luxury expenditure and subsistence demand. Because of this distinction, it is necessary to obtain the ratio of household luxury expenditure to total expenditure. It has also been indicated that the ORANI methodology makes use of the household expenditure elasticities, as well as the Frisch parameter to calculate this ratio. The Frisch parameter is usually fixed at a value of -1.82 in the ORANI models. This value represents a weighted average of values for different types of Australian households.   This value is, however, also based on pooled international evidence and the same assumption is made for the South African version of the ORANI-G model.

Given the household expenditure elasticities that have been estimated above, and the Frisch parameter, the ratio of luxury to total expenditure can be calculated for the base year of the model. This ratio should change for each household and every product as relative prices adjust in the economy.

vi.   **Estimation of the foreign elasticity of demand for the 45 different commodities**

The theoretical summary of the ORANI-G export equations indicates that a distinction is made between individual export demand functions and a collective export demand function. As indicated, the collective export demand function usually includes service commodities. For this reason three commodities are included in the collective export demand function. These are;

- medical, dental and other health services,
- other producers; and
- other community and social services.

In order to derive and motivate the use of the price elasticities of exports for the remaining 42 individual commodities within the model, the methodology behind the ORANI model of the Australian economy has been used. Demand elasticities in the ORANI model are assumed to be –4 for those goods for which Australia does not have sufficient market share to influence the market price.

In this regard, South Africa is generally accepted to be a small open economy with little pricing power in international markets. Figure 8.1 below indicates the small market share that South Africa enjoys within total world exports for 9 broad groups of commodities. These groups include each of the 45 industries that are distinguished within this model.

Figure 8.1:   South Africa's share of total world exports in 9 broad commodity categories
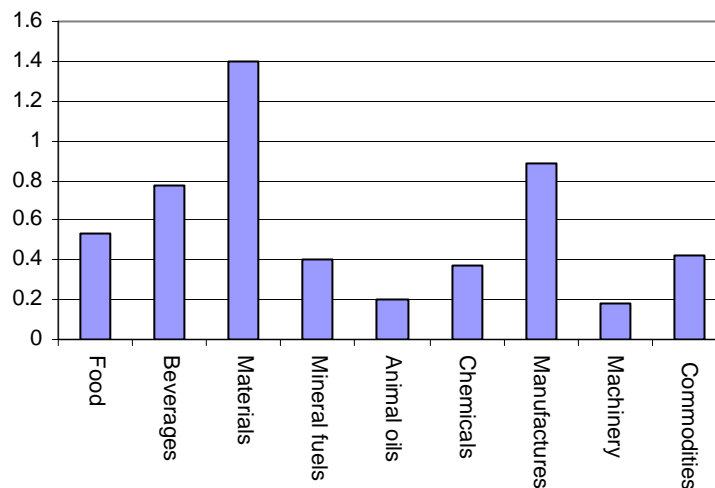
Source: BFA, McGreggor, 2001

Given the 41 commodities for which individual price elasticities of demand need to be determined within the South African version of ORANI-G model, South Africa can only expect to exert sufficient market power in the gold market, as the country remains the world's biggest exporter of gold. In spite of this, the international gold price is set exogenously and South African gold mines are price takers at a given international gold price. Therefore, the price elasticity of –4, has been adopted for all of the 41 individual industries included in the South African version of the ORANI model. As is the case in the ORANI model, the price demand elasticity for common export products are assumed to be –4.

vii.   The economy-wide rate of return on investment

The theoretical exposition in the previous chapter has indicated that investment for each industry can be determined according to three alternative investment rules. One of the investment rules allows investment to be endogenised. In this case investment is determined by the profitability of each industry. This rule represents the investment decision for most of the industries in the South African version of the ORANI-G model. The other investment rule which is assigned to the remaining industries allows investment to grow at a rate that is equal to the economic growth rate in

the model. The industries for which investment is determined in this manner are the industries that have a high degree of government intervention. These are the electricity & gas & steam, water supply; other community & social services and other producers. For the remaining industries the parameter β_j (the elasticities of the expected rate of return schedule) must be estimated.

In order to find a value for β_j, Dixon et al (1980, p197) solve industry j's next period rate of return schedule (see previous chapter) for β_j, that is:

$$\beta_j = \frac{\ln R_j(0) - \ln \Omega}{\ln(\dfrac{K_j(1)}{K_j(0)})}$$

where Ω represents the economy-wide safe rate of return on investment.

8.4   CONCLUSION

This chapter described the database, and the elasticities used within the South African version of the ORANI-G model. It also described the assumptions and methodology that were used to obtain them. It is evident that there is room for improving the current elasticity file (as data availability and economic literature develops). Given the scope of this study, however, these elasticities currently represent the best available data and should be utilised and adapted as new information becomes available.