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Construction of a Database for a Dynamic CGE Model for South Africa

by

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Construction of a database for a dynamic CGE model for South Africa

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Abstract

This paper describes the construction of database constructed for a dynamic CGE model for South Africa (hereafter SAGE). The starting point for creating a database for a CGE model are official data from an Input/output (IO) table, or from a Supply Use Table (SUT), or from a Social Accounting Matrix (SAM). Often the structure of the published data is not in the required format of a CGE database, and so a major task is to transform the official data into a form required by a CGE database. Four characteristics of the SAGE database are noted:

1. It contains information regarding the structure of the South African economy in the base year (2002).
2. It is the initial solution to the SAGE model.
3. It has the same basic structure as the ORANIG and MONASH databases.
4. The basic database is supplemented by additional data relating to dynamics.

The database is organised in four parts. The first includes data on the coefficients that are computed from the input–output (IO) table. These coefficients represent the basic flows of commodities between users, commodity taxes paid by users, margin flows that facilitate the flow of commodities and valued added matrices. The second part of the SAGE database contains information on behavioural parameters. The elasticities influence the degree to which economic agents change their behaviour when relative prices change. The third part of the database contains information on government accounts, accounts with the rest of the world and industry-specific capital stocks and depreciation rates. The fourth part of this paper describes the tests undertaken to test for model validity.

This paper is set out as follows: Section 1 describes the structure of the IO database. Section 2 reviews the official data sources used to create the IO database. Section 3 describes the steps taken to transform the official data into the correct format. Section 4 describes the elasticities and parameters adopted in for SAGE. Section 5 describes additional information regarding industry-specific capital stocks and government accounts. Section 6 describes various tests that were conducted to ensure that the database is balanced. The paper ends with a conclusion.

Key words: Computable general equilibrium (CGE), Database, Africa, Supply Use Tables

JEL Code: C81, C68, O55

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REFERNCES

LIST OF ABBREVIATIONS

CAPM	Capital Asset Pricing Model
CES	Constant elasticity of substitution
CET	Constant elasticity of transformation
CGE	Computable General Equilibrium
IES	Income and expenditure Survey
IMP	Imports
IO	Input-output
LFS	Labour Force Survey
R	Rand (South African currency)
RHS	Right hand side
SAGE	South African General Equilibrium model
SAM	Social Accounting Matrix
SAQB	South African Reserve Bank Quarterly Bulletin
SARB	South African Reserve Bank
SIC	Standard Industrial Classification of all economic activities
SNA	System of National Accounts
StatsSA	Statistics South Africa
SUT	Supply-Use Tables
UN	United Nations

LIST OF SETS

$COM \in$	Agricultural, Coal, Gold, Other mining, Food, Textiles, Petroleum, Other non-metallic mineral products, Basic iron/steel, Electrical machinery, Radio, Transport equipment, Other manufacturing, Electricity, Water, Construction, Trade, Hotels and restaurants, Transport services, Communications, Financial intermediation, Real estate, Other business activities, General government, Health and social work, Other activities, Owner Dwellings.
$IND \in$	Agricultural, Coal, Gold, Other mining, Food, Textiles, Petroleum, Other non-metallic mineral products, Basic iron/steel, Electrical machinery, Radio, Transport equipment, Other manufacturing, Electricity, Water, Construction, Trade, Hotels and restaurants, Transport services, Communications, Financial intermediation, Real estate, Other business activities, General government, Health and social work, Other activities, Owner Dwellings.
$MAR \in$	Trade, Transport services.
$OCC \in$	Legislators, Professionals, Technicians, Clerks, Service workers, Skilled agricultural workers, Craft workers, Plant and machine operators, Elementary occupations, Domestic workers and Occupations not else where specified.
$SRC \in$	Domestic, Import.

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1. BASIC STRUCTURE OF A CGE DATABASE

1.1 Introduction

The SAGE model requires a database with separate matrices for basic, tax and margin flows for both domestic and imported sources of commodities sold to domestic and foreign users, as well as matrices for the factors of production. The structure of the IO database is illustrated in Figure 1 and the ingredients in the database are listed in Table 1. The first three rows form the absorption matrix, rows 4 to 8 the production matrix and the two satellite matrices are the multi-production matrix and the tariff matrix.

In the absorption matrix, users are identified in the column headings and denoted by a number:

1. domestic producers divided into i industries;
2. investors divided into i industries;
3. a single representative household;
4. an aggregate foreign purchaser of exports;
5. government demand; and
6. changes in inventories.

The matrices in the first row, that is, V1BAS to V6BAS, represent direct flows of commodities, from all sources to users valued at basic prices. The first matrix, V1BAS, can be interpreted as the direct flow of commodity c, from source s, used by industry i as an input into current production. V2BAS shows the direct flow of commodity c, from source s, used by industry i as an input to capital formation. V3BAS shows the flow of commodity c from source s that is consumed by a representative household. V4BAS is a column vector and shows the flow of commodity c to exports. V5BAS and V6BAS show the flow of commodity c from source s to the government and change in inventories respectively. In the IO database, no imported commodity is exported without being processed in a domestic industry. Hence, V4BAS has no import dimension.

The matrices in row 1 contain only direct flows valued at basic prices. The basic price of a domestic commodity is the price the producer receives, and excludes margin costs and sales taxes. The basic price of an imported commodity is the duty-paid price, that is, the price at the port of entry just after the commodity has cleared customs. It excludes all sales taxes and margin costs but includes tariffs. It is assumed that the basic price is the same for all users. The row sums are the total direct usage of a commodity. It should be noted that all the values, with the exception of V6BAS, are positive. V6BAS records the *change in inventories,* and thus can be positive or negative.

Figure 1. The SAGE input–output database

			Absorption Matrix					
			1	2	3	4	5	6
			Producers	Investors	Household	Export	Government	Change in Inventories
		Size	← I →	← I →	← 1 →	← 1 →	← 1 →	← 1 →
1	Basic Flows	↑ C×S ↓	V1BAS	V2BAS	V3BAS	V4BAS	V5BAS	V6BAS
2	Margins	↑ C×S×M ↓	V1MAR	V2MAR	V3MAR	V4MAR	V5MAR	n/a
3	Taxes	↑ C×S ↓	V1TAX	V2TAX	V3TAX	V4TAX	V5TAX	n/a
4	Labour	↑ OCC ↓	V1LAB					
5	Capital	↑ 1 ↓	V1CAP					
6	Land	↑ 1 ↓	V1LND					
7	Production Taxes	↑ 1 ↓	V1PTX					
8	Other Costs tickets	↑ 1 ↓	V1OCT					

C = Number of commodities
I = Number of industries
S = Sources (domestic, imported)
OCC = Number of occupation types
M = Number of commodities used as margins

	Joint production matrix
Size	← I →
↑ C ↓	MAKE

	Tariffs
Size	← 1 →
↑ C ↓	V0TAR

Adapted from Horridge, 2006: 9.

The second row, V1MAR to V5MAR, represents the value of commodities used as margins to facilitate the basic flows in row 1. SAGE includes two margin commodities, trade and transport services. All margins are produced domestically. V1MAR and V2MAR are four-dimensional matrices and show the cost of margin service m used to facilitate the flow of commodity c, from source s to industry i. V3MAR and V5MAR are three dimensional and show the cost of margin service m that facilitates the flow of commodity c from source s to the representative household and the government respectively. V4MAR is a two-dimensional matrix and shows the cost of margin service m that facilitates commodities flows to exporters. There are flows that do not require any margins and therefore the values in these matrices are zero or the matrices are omitted. This is mainly for services and inventories (unsold commodities) (United Nations, 1999: 33).

The third row represents the tax matrices, V1TAX to V5TAX. These matrices show the taxes paid in the delivery of domestic and imported commodities to the different users. Positive values refer to taxes and negative values to subsidies. For example, a positive element in V1TAX and V2TAX can be interpreted as the tax associated with the delivery of commodity c from source s used by industry i as an input into current production and capital formation respectively. A negative value is interpreted as a subsidy paid on commodity c, from source s, used by industry i. V3TAX and V5TAX are interpreted as the taxes associated with the delivery of commodity c from source s used by households and government. V4TAX is associated with the taxes paid for the delivery of commodities to exporters. Taxes are not paid on inventories and therefore there is no V6TAX matrix. It should be noted that tax rates may differ between users and sources.

Rows 4 to 6 contain matrices that provide a breakdown of the primary factors used by industry in current production. These matrices include the inputs of three factors of production: occupation-specific labour (V1LAB), fixed capital (V1CAP) and agricultural land (V1LND). For example, V1LAB shows the purchase of labour of skill o by industry i that is used as an input into current production. V1CAP contains the rental value of each industry's fixed capital and V1LND shows the rental value of agricultural land used by each industry. Industry also pays production taxes such as business licences, payroll taxes and stamp duties (United Nations, 1999: 26). These taxes are contained in V1PTX in row 7. Other cost tickets are contained in matrix V1OCT in row 8. This is a useful device that allows for the cost of holding liquidity, cost of holding inventories and other miscellaneous production costs (Dixon *et al.*, 1982: 70). The database shows that labour, capital, land, production costs and other cost tickets are only used in current production and therefore these matrices are absent from entries in the capital formation, household consumption, exports, government and change in inventories columns.

The satellite matrices illustrate the multi-production matrix (MAKE) and tariff matrix. Each element in the MAKE matrix refers to the basic value of commodity c produced by industry i. In principal there are two different types of MAKE matrices. The first is where the entries in the matrix are diagonal, that is, an industry only produces one unique commodity and a commodity is only produced by one industry. All non-diagonal values are zero. The second type of matrix is a joint-production matrix where an industry can produce more than one commodity and a commodity can be produced by more than one industry. Therefore, a number of the off-diagonal values are non-zero. SAGE includes the second type of MAKE matrix. The implication of a joint-production matrix is that a producer will choose to produce a combination of output commodities that will maximise their revenue. For example, as the market price of commodity 1 increases relative to commodity 2, producers will shift their resources to producing more of commodity 1 and away from commodity 2.

The final matrix, V0TAR, contains tariff revenue by imported commodity. The tariff matrix is separate from the absorption matrix because the values of tariff revenues are already included in the basic price of imports, that is, they are already included in the basic flows in row 1. It enables the calculation of ad valorem rates as the ratio between tax revenues and the relevant basic flows of commodities on which the taxes are levied.

The interpretation of the columns and rows is important and should adhere to the following conditions:

- industry cost should equal industry sales (see Section 2.4.12). For all industries, the industry costs (sum across all inputs in column 1) should equal the basic values of industry output $\left(\sum_{c \in COM} MAKE_{(c,i)}\right)$;
- total domestic output should equal their total use (see Section 2.4.12). For non-margin commodities the domestic use of commodities (sum across all users in row 1) should equal the basic value of industry output $\left(\sum_{i \in IND} MAKE_{(c,i)}\right)$. For margin commodities, the use of commodity m should equal the sum of all direct usage of m (row 1 in Figure 1) plus the sum of all usage of m as a margin (row 2 in Figure 1); and
- except for matrices relating to taxes and inventories, matrices should not contain negative values.

Table 1. Contents of the SAGE Input–Output data files

TABLO name	Name	Dimension
1. Sets		
COM	Set COM commodities	28 Commodities
IND	Set IND industries	28 Industries
SRC	Set SRC sources	2 Sources
MAR	Set MAR margin commodities	2 Margins
OCC	Set OCC occupations	11 Occupations
2. Coefficients in the core database		
V1BAS	Intermediate basic	COM*SRC*IND
V2BAS	Investment basic	COM*SRC*IND
V3BAS	Household basic	COM*SRC
V4BAS	Exports basic	COM
V5BAS	Government basic	COM*SRC
V6BAS	Inventories basic	COM*SRC
V1MAR	Intermediate margins	COM*SRC*IND*MAR
V2MAR	Investment margins	COM*SRC*IND*MAR
V3MAR	Household margins	COM*SRC*MAR
V4MAR	Export margins	COM*MAR
V5MAR	Government margins	COM*SRC*MAR
V1TAX	Intermediate tax	COM*SRC*IND
V2TAX	Investment tax	COM*SRC*IND
V3TAX	Household tax	COM*SRC
V4TAX	Export tax	COM
V5TAX	Government tax	COM*SRC
V1CAP	Capital rentals	IND
V1LAB	Labour	IND*OCC
V1LND	Land rentals	IND
V1PTX	Production tax	IND
V1OCT	Other costs	IND
MAKE	Multi-product matrix	COM*IND
V0TAR	Tariff revenue	COM
3. Parameters and elasticities		
SIGMA0	Elasticity of transformation	IND
SIGMA1	Armington elasticity – intermediate inputs	COM
SIGMA2	Armington elasticity – capital inputs	COM
SIGMA3	Armington elasticity – household consumption	COM
SIGMA1PRIM	Elasticity of substitution for primary factors	IND
SIGMA1LAB	Elasticity of substitution between labour types	IND
FRISCH	Frisch parameter	1
DELTA	Household marginal budget share	COM
EXP_ELAST	Export elasticity	COM

1.2. Parameters

In this section the parameters required by SAGE during simulations are listed. Elasticities govern the magnitude by which economic agents adjust their behaviour due to changes in for example relative price. A detailed explanation is included in Section 5.

SIGMA1PRIM denotes the constant elasticity of substitution (CES) between the three primary factors, labour, land and capital, while SIGMA1LAB denotes the CES elasticity between skills types in industry i. SIGMA0 represents the constant elasticity of transformation (CET) and governs the behaviour of multi-product industries that choose their output to maximise revenue. SIGMA1, SIGMA2 and SIGMA3 are the Armington elasticities and reflect the degree of substitution between domestic and imported commodities for use in current production, capital formation and household consumption.

The FRISCH parameter shows the relationship between households' total expenditure and their luxury expenditure in the linear expenditure system (LES). DELTA denotes the household marginal budget shares. These are used to calculate the expenditure elasticities (EPS) in the household demand equations. EXP_ELAST is a vector of foreign-demand elasticities for South African commodities.

1.3. Data required for SAGE's dynamic equations

SAGE requires data for the model's dynamic features. These data are summarised in Table 2. The first block of data lists the data and parameters required to use the rate of return and capital accumulation theory. Equations in the model require industry-specific depreciation rates, capital stock and trend growth rates for capital. Industry-specific depreciation rates are used in the capital accumulation equations as well as setting the maximum and minimum capital growth rates. DIFF is a parameter and is used to set the maximum industry capital growth rates. SCS is the reciprocal of the slope of the economy-wide capital supply curve. Kgr_i is the capital growth rate and RINT is the real interest rate. The final two scalars relate to the inflation rate. LEV_CPI and LEV_CPI_L are calculated from the base data for the beginning and end of the base year and are used to calculate inflation. The compilation of the capital and investment data is explained in Section 2.11, Step 11.

The second part of Table 2 lists the data required for the government accounts. The only industry-specific data required is government investment (G_VINVEST). Other data requirements include welfare payments to households (BENEFITS), net interest payment by the government (NETINT_G), public sector debt (PSDATT) and non-tax revenue

(NONTAXREV). The final two data requirements are the tax rates on capital and income. The tax rates are used to calculate the direct tax revenue collected from capital and labour. The compilation of the government data is explained in Section 5.2.

Table 2. Contents of the additional data files

TABLO name	Name	Dimension
1. Capital stocks, investment and rates of return		
DEP	Industry depreciation rate	IND
VCAP	Value of capital stock in the base year	IND
TREND_K	Trend growth rate for capital	IND
P1CAP	Rental price of capital	IND
DIFF	Difference between maximum and trend growth rates of capital	1
SCS	Slope of capital supply curve	1
C	Average sensitivity of capital growth to variations in expected rates of return	1
RINT	Real interest rate	1
LEV_CPI	Level of the CPI	1
LEV_CPI_L	Level of the CPI lagged	1
2. Government accounts		
G_VINVEST	Government investment	IND
BENEFITS	Welfare paid to households	1
NETINT_G	Net interest paid by government	1
PSDATT	Public sector debt	1
NFCURTGOV	Net foreign transfers to the government	1
NONTAXREV	Non tax revenue	1
TAX_K	Tax revenue on capital income	1
TAX_L	Tax revenue on labour income	1
3. Accounts with the rest of the world		
FDATT	Net foreign liabilities	1
ROIFOREIGN	Interest rate on foreign debt	1
NCURTRANS	Net primary income received	1
ϕ	Nominal exchange rate	1

The final section in Table 2 shows the data requirements for the accounts with the rest of the world. The first data requirement is net foreign liabilities (FDATT) in the base year. ROIFOREIGN is the interest rate on foreign debt. By multiplying the interest rate on foreign debt with the stock of debt, we can determine the interest payment on foreign debt. The above data is used to calculate the balance on the current account, which is defined as the difference between foreign income received (exports plus income receipts from foreigners to South Africans) and income payments (imports plus interest payments on foreign debt).

This concludes the description of the database requirements for the SAGE model. The remainder of this chapter describes the data sources and the steps taken to create each of the elements in the database.

2. DATA SOURCES

2.1. Note on the valuation of the tables

The 1993 System of National Accounts (SNA) recommends three ways in which production (output) of goods and services can be measured (Statistics South Africa, 2006c: 12; United Nations, 1999: 55). The definitions of these measures are given below.

Basic price: "The basic price is the amount receivable by the producer from the purchaser for a unit of a good or service produced as output, minus any tax payable (i.e. VAT and excise duties), and plus any subsidy receivable, on that unit as a consequence of its production or sale. Basic prices exclude any transport charges involved separately by the producer" (United Nations, 1999: 55).

Producers' price: "The producers' price is the amount receivable by the producer from the purchaser for a unit of a good or service produced as output, minus VAT, or similar deductible tax, invoiced to the producer. It excludes any transport charges invoiced separately by the producer" (United Nations, 1999: 55).

Purchasers' price: "The purchasers' price is the amount paid by the producer, excluding any deductible VAT or similar deductible tax, in order to take delivery of a unit of good and service at the time and place required by the purchaser. The purchasers' price includes any transport charges paid separately by the purchaser to take delivery at the required time and place" (United Nations, 1999: 55).

2.2. Basic structure of the Supply–Use tables for South Africa (2002)

The primary source of data is the Supply–Use tables (SUTs), published in 2002 by Statistics South Africa (2006c).[1] The Supply table (ST) contains information on the supply of commodities from all sources whereas the Use table (UT) shows the final users of these commodities.

[1] A new set of Supply-Use table for 2005 are available. A number of the data manipulating step described in this paper may be useful in creating the CGE database for 2005.

2.2.1. The Supply table (ST)

A simplified illustration of the Supply table is depicted in Figure 2. The first matrix, MAKE, shows the production of 153 domestic commodities (rows) and 94 domestic industries (columns) at basic price. The MAKE matrix is not diagonal, implying that an industry may produce more than one product and a product may be produced by more than one industry.

Figure 2. Format of the published Supply table

(1)	(2)	(3)	(4)	(5)
Size	IND 1 ... 94	1	1	1
COM 1 . . 153	MAKE	Imports	Taxes less subsidies on products	Trade and transport margins

The next matrix (column 3), Imports, is a vector of 153 commodities supplied by imports again valued at basic price. Total supply valued at basic prices is calculated by adding the domestically produced commodities with the imported commodities.

Total supply valued at basic price is transformed into producers' price by adding the next matrix (column 4), which contains net taxes on commodities. This is a vector of 153 commodities and consists of VAT, excise taxes, fuel levies and import duties. Subsidies on products are recorded in a similar way.

By adding column 5 (trade and transport margins), total supply at purchasers' price is calculated. The total supply of commodities at purchases' price is equal to the total use at purchases' price. The total use of commodities valued at purchasers' price is presented in the UT.

2.2.2. The Use table (UT)

The Use table contains information on the value of commodities purchased by different users. Commodities may be used for intermediate consumption by industries or final demand. The intermediate use matrix, V1PUR, is a 95*94 matrix of all commodities used by industry in current production. The final demand vectors consist of investors (V2PUR), private household (V3PUR) and public consumption (V5PUR) and change in inventories (V6PUR). Each vector is disaggregated by 95 commodities and valued at purchasers' prices.
The components of value added include compensation of employees (row 2), mixed income/operating surplus (row 3) and production taxes (row 4). These matrices are disaggregated by 94 industries. A summary of the Use table is included in Appendix 4A, Table 2.

Figure 3. Format of the published Use table

			(1) Producers	(2) Investors	(3) House-holds	(4) Exports	(5) Government	(6) Inventories
		Size	IND 1 … 94	1	1	1	1	1
(1)	**Flows**	COM 1 . . 95	V1PUR	V2PUR	V3PUR	V4PUR	V5PUR	V6PUR
(2)	**Labour**	1	V1LAB					
(3)	**Gross operating surplus**	1	V1CAP					
(4)	**Production tax**	1	V1PTX					

2.3. Other data sources

As well as the SUT, various other sources of data were used for verification, aggregation or disaggregation of data, or for borrowing shares to facilitate the creation of related matrices.

2.3.1. Social accounting matrix (2002)

In addition to the SUT, Statistics South Africa published the Social Accounting Matrix (SAM) for 2002. The SAM integrates the SUT and institutional-sector accounts into a single matrix format. The main focus of the 2002 SAM is on households and their income and expenditure patterns. The population is divided into four population groups and 12 household expenditure groups. Several additional labour matrices are introduced. These labour matrices provide additional information regarding the labour distribution across industry and occupation by persons and wage bills. It should be noted that the dimensions in the SUT and SAM are different. The SUT dimensions are mapped to the SAM dimensions. This is explained in Section 2.4.1, Step 1.

2.3.2. South Africa Reserve Bank **Quarterly Bulletin**

The South African Reserve Bank (SARB) publishes the *Quarterly Bulletin* (SAQB) which contains the National Accounts. These accounts were used to compare the values organised in the SUT with those published in the SAQB. Comparisons were made for value added by industry, capital formation, exports, imports, taxes and margins. The *Quarterly Bulletin* was also helpful in creating the government accounts. The data in the December (2005) *Quarterly Bulletin* is consistent with the 2002 SUT (South African Reserve Bank, 2005).

2.3.3. Government accounts

It was very difficult to find consistent government data. Treasury, Statistics South Africa and the Reserve Bank publish government data, but the data are not consistent, which makes comparison very difficult. The December 2005 *Quarterly Bulletin* contains information on government accounts which is broadly consistent with the government information in the SUT. The information in the SAQB is used to create the government accounts.

2.3.4. Use of GTAP data to specify land rents

The GTAP 6.0 database (Dimaranan, 2006) includes an extra factor of production, namely land. None of the above data sources explicitly provides data on land and therefore the GTAP database for South Africa is used to create land rentals for the agricultural and mining industries.

2.3.5. Sector-specific data

In the SUT and SAM, gross fixed capital-formation data is given as a vector. This vector shows which commodities are used for investment by a single aggregate investor. However, SAGE requires capital formation to be disaggregated by industry. Hence, industry-specific information is required so that the single investment column can be split into 28 industry columns. The Annual Financial Statistics Survey is used to obtain such industry-specific data (Statistics South Africa, 2006a).

3. STAGES IN THE CONSTRUCTION OF THE SAGE DATABASE

The core database required by SAGE is described in Section 1 and Figure 1. The final SAGE database, which fits this form, includes 28 commodities, 28 industries, 11 occupational groups, two margin commodities and two sources. The elements of the different dimensions (sets) are listed in Appendix 1. Although the SUT conforms to the international statistical standards for the measurement of an economy as set out in the 1993 System of National Accounts (SNA), it is not in the correct format needed for the SAGE database. Several steps were taken to convert the published data into the required format. These steps are discussed in this section.

To promote transparency and to facilitate auditing, the process of converting the published data into the SAGE database was automated by writing a sequence of procedures coded in GEMPACK (Harrison & Pearson, 1996, 2002; Pearson, 2002). Each step in the data manipulation process addresses a specific data query and the output of a step is used as an input in the next step. The process is as follows (Horridge, 2006):

- Data are converted from their original hard copy or Excel format into Header Array files;
- Each data manipulation process is programmed in a TABLO file. The TABLO file includes all the data manipulation equations, written in TABLO code, and uses the VIEWHAR files as input files; and
- To make sure that the balancing requirements are not violated *test* or *check* commands are included in each step.

This automated process has a number of advantages. Firstly, each TABLO file serves as a record of the process used to manipulate the data. Secondly, adjustments and corrections to formulas can easily be made. Thirdly, the automation enables fast replications of the process when needed. This is very useful when new data becomes available. Finally, recording each step promotes transparency and avoids any "black box" issues, that is, the data programs become a permanent documentation of the data manipulation process. The next section describes the steps taken to convert the published data into the required IO database.

3.1. Step 1: Data mapping and aggregation

The dimensions of the SAGE database differ from those of the published data. SAGE includes an aggregated database with the dimensions of 28 commodities, 28 industries, 11 occupational groups, two margin commodities and two sources. There are several reasons to support a smaller, aggregated database. Firstly, the aggregated database ensures improved management of data. Secondly, most of the secondary data used to verify or compare data, are published either on a macro level or on a highly aggregated level. Thirdly, when it is necessary to disaggregate a commodity or industry, it is easier to adapt shares from other sources. Finally, it is not necessary to include a highly disaggregated database. The focus of this thesis is on the effects of HIV/AIDS on the labour market with specific emphasis on labour supply. The emphasis is to ensure that (1) the linkages between SAGE and the health extension are correct and (2) that the dynamic features are operational. If required, the core database can be disaggregated.

The commodities and industries, as they appear in the SUT, are mapped to 27[2] commodities and industries by using the Standard Industrial Classification of all Economic Activities (SIC) (Statistics South Africa). The GEMPACK program, VIEWHAR, was used to turn

[2] The final database includes 28 commodities and 28 industries. The additional commodity and industry (Owner dwelling) is created in Step 7.

spreadsheet data into entries in a single HAR file called *FID.HAR*. An additional file, *SETINFO*, is also created where all the set information is organised. This file remains the same in all steps.

Firstly, the 153 commodities are mapped to 27 commodities and the 94 industries are mapped to 27 industries (Statistics South Africa, 2006c: 46). The mapping of commodities and industries is useful in identifying any misprints and irregularities that may be present in the data. Since, in this step, no data adjustment has occurred and in the absence of any irregularities, the mapped data should correspond to the published SAM data. No misprints or irregularities were noted.

3.2. Step 2: Distribution of the residual

The output files of Step 1, *FID.HAR* and *SETINFO.HAR*, are used as input files in Step 2. The Use tables include a commodity-specific residual. This residual is included because GDP calculated according to the production and income approach, differs from GDP calculated from the expenditure side. Firstly, the production and generation of income accounts are compiled for each industry. These accounts are consistent with both the production and income approach. GDP is therefore calculated from the supply side and then transferred to the demand side (Use table). Secondly, the values for the components of final demand, as they appear in the Use table, are then adjusted to be consistent with the values published by the South African Reserve Bank (SARB). The SARB calculates GDP using the expenditure approach. Their estimations allow for the compilation of the goods and services account in which the residual item can be calculated.

In the 2002 SUT the residual item is negligible and therefore allocated to the "change in inventories" vector. This ensures that commodity-specific aggregated supply is equal to commodity-specific aggregate demand with only the "change to inventory" vector changed.

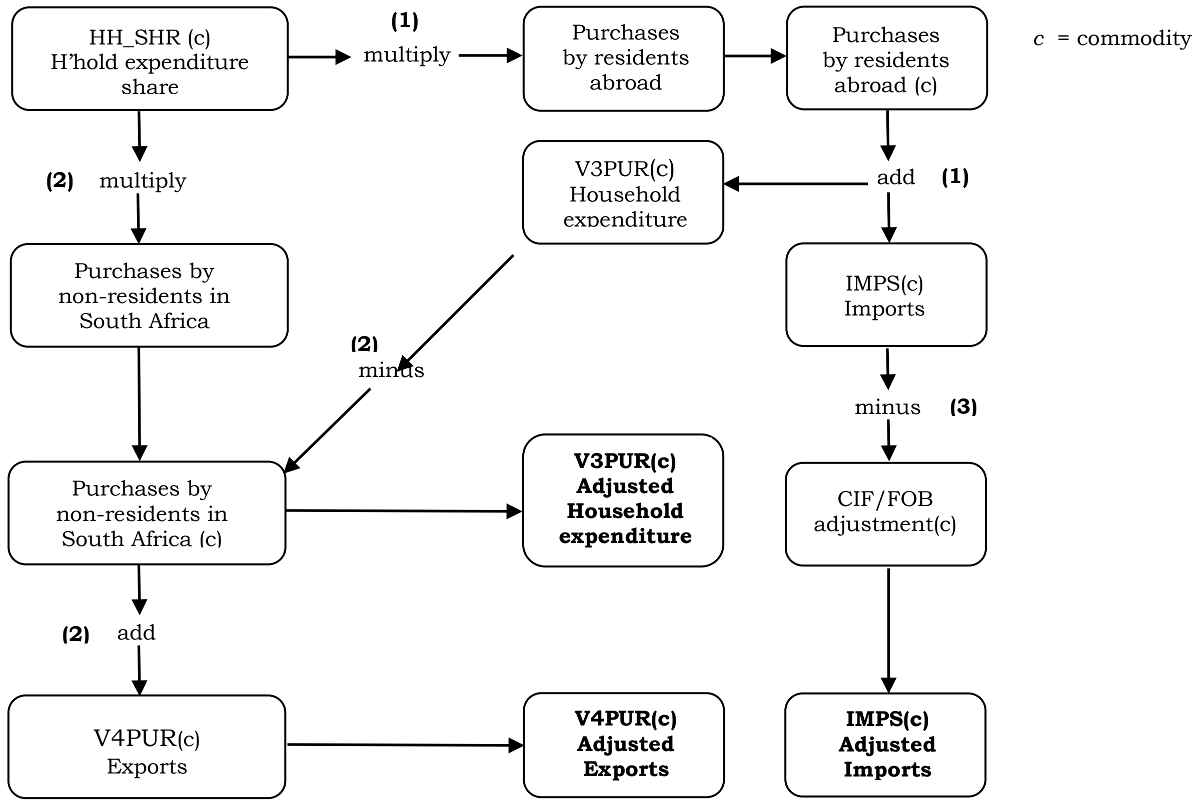
3.3. Step 3: Adjustments to the Supply and Use table

Several adjustments are included in the SUT published by Statistics South Africa. The first adjustment relates to "purchases by residents abroad" and the second to "purchases by non-residents in South Africa". "Purchases by residents abroad" affect both the import column and the household expenditure column. This adjustment is accounted for by adding a positive value to both these columns. There is no detailed information regarding commodity-specific purchases by residents abroad; only one value is given in the Use table (R19,601 million).

To preserve the condition that commodity-specific aggregate supply should equal commodity-specific aggregate demand, the same commodity shares are used when the "purchases by residents abroad" is distributed. I use the commodity-specific household expenditure shares[3], which are multiplied by 19,601 to determine the commodity-specific purchases by residents abroad. These values are then added to the original commodity-specific household expenditure and commodity-specific imports (United Nations, 1999: 154). This is the first step illustrated in Figure 4.

"Purchases by non-residents" (R20,732 million) in South Africa are included in the household expenditure column. As this represents expenditure by foreigners, it should be deducted from domestic household expenditure and treated as exports (United Nations, 1999:33). To keep the SUT balanced, the same household expenditure shares, which are used to distribute the "purchases by residents abroad", are used to adjust commodity-specific household expenditure and exports with the "purchases by non-residents". Purchases by non-residents are added to exports and deducted from household expenditure. This is Step 2 in Figure 4.

Figure 4. Adjustment of purchases by residents abroad and non-residents domestically



[3] The commodity-specific household expenditure shares are calculated as $HH\_SHR_{(c)} = \frac{HHEXP_{(c)}}{\sum_{c \in COM} HHEXP_{(c)}}$, with commodities referring to all the commodities that households consume.

The final adjustment is regarding imports and is shown in Step 3 in Figure 4. The imports of goods CIF includes the value of imported goods FOB and transport and insurance services rendered by both residents and non-residents. However, when the latter services are rendered by non-residents, they are already included in the imports of services. Similarly, when these services are rendered by residents they are considered to be domestic output and cannot be included in the imports column. If no adjustment is made, imports will be overestimated by the value of transport and insurance services rendered by both residents and non-residents. To adjust imports, adjustments are introduced to correct the two relevant service commodities. The adjustment value is the total value of transport services (R18,639 million) and insurance services (R2,093 million) rendered by both residents and non-resident producers. These values are deducted from the import value for that specific commodity (United Nations, 1999: 31).

3.4. Step 4: Check that aggregate supply is equal to aggregate demand

To ensure that the adjustments in the previous steps were correctly implemented, this step is introduced to confirm that the Input–Output table is still balanced, that is, aggregate demand is equal to aggregate supply when valued at the same price.

Commodity-specific supply valued at purchases' price is given as:

$$SUPPLY_{(c)} = \sum_{i \in IND} MAKE_{(c,i)} + IMPORT_{(c)} + MARGINS_{(c)} + TAX_{(c)} \qquad \text{(E4.1)}$$

where
- $MAKE_{(c)}$ is the domestic production of commodity c, summed across all domestic industries i;
- $IMPORT_{(c)}$ is the commodity-specific imports after the CIF/FOB adjustment;
- $MARGINS_{(c)}$ refers to the margins associated with each commodity c; and
- $TAX_{(c)}$ refers to commodity taxes less subsidies for each commodity c.

Commodity-specific demand valued at purchases' prices is given as:

$$DEMAND_{(c)} = \sum_{i \in IND} V1PUR_{(c,i)} + \sum_{i \in IND} V2PUR_{(c,i)} + V3PUR_{(c)} + V4PUR_{(c)} + V5PUR_{(c)} + V6PUR_{(c)}$$

(E4.2)

where
- $V1PUR_{(c,i)}$ and $V2PUR_{(c,i)}$ are the commodity and industry-specific flow values, after all adjustments have been made for user 1 (current

production) and user 2 (investors). These flows are summed across industries;

- $V3PUR_{(c)}$ is the commodity-specific flow values, after all adjustments have been made for user 3 (households);
- $V4PUR_{(c)}$ is commodity-specific flow values for user 4 (exports);
- $V5PUR_{(c)}$ is commodity-specific flow values for user 5 (government); and
- $V6PUR_{(c)}$ is commodity-specific flow values for user 6 (inventories).

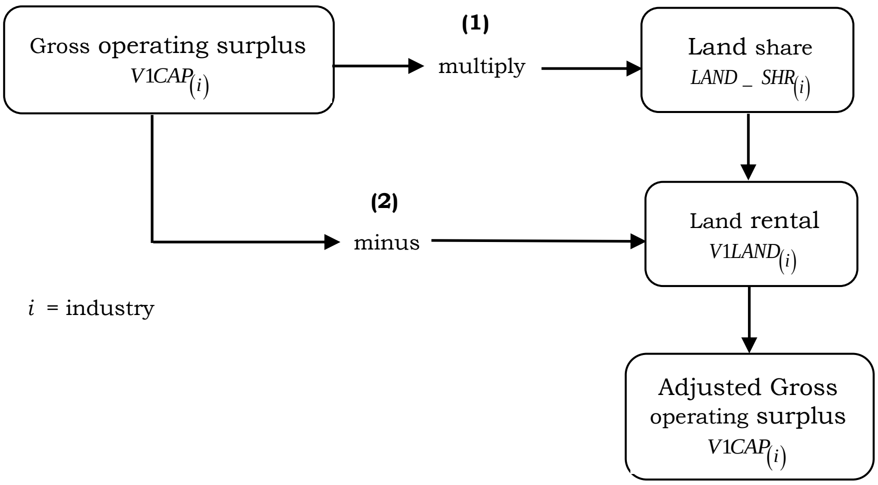
This check confirms that the adjustment had been performed correctly.

3.5. Step 5: Creating land rentals

SAGE distinguishes between three types of factors of production: labour, capital and land. The UT includes information on compensation of employees (COE), gross operating surplus (GOS) and production taxes. There are no values for land rentals. I therefore allocate some part of the gross operating surplus to land-using[4] industries. The share of land, as it appears in the GTAP 6.0 database for South Africa, is used to determine the share of gross operating surplus allocated to land rentals (Dimaranan, 2006).

The industries that use land in the production process are *agriculture*, *coal*, *gold*, and *other mining*. The percentage of gross operating surplus that is allocated to land rentals, that is, the land share, is 15 per cent for *agriculture* and 30 per cent each for the remaining land-using industries. For non-land-using industries, none of the gross operating surplus was allocated to land.

Figure 5. Creating land rentals



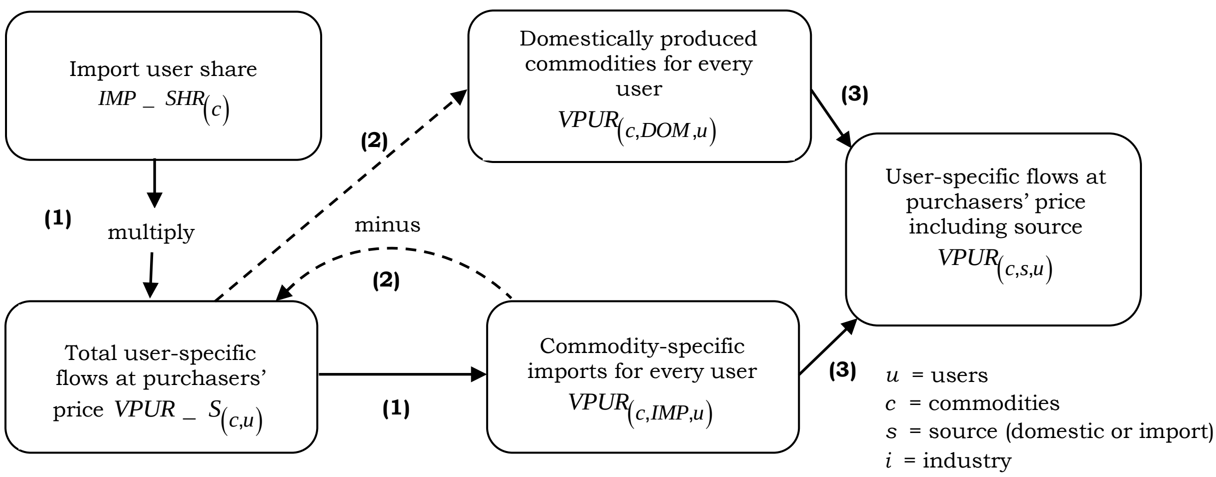
[4] Land refers to cultivated land area, forests and natural resources such as minerals, gold and oil.

3.6. Step 6: Splitting total flows into sources

SAGE requires the VBAS, VMAR and VTAX flow matrices, the first three rows in Figure 4.1, to be split into domestic and imported flows. The task at hand is to distribute imports across users. However, this task is made difficult because I only know the commodity-specific import value. Since there is no information available on user-specific imports, I assume that the share of imports in total use of commodity c, is the same for all users. For example, if imported meat makes up 10 per cent of total sales (use) of meat from both domestic and imported sources, then all users of meat will use 10 per cent of imported meat in their meat purchases.

The commodity-specific flows, as they appear in the Use table, are valued at purchasers' prices and include imports. Because it is assumed that (1) no imported commodity is re-exported and (2) the percentage of imports used by each user is the same as the share of imports in total use, the import share[5] of each commodity can be calculated. To determine how much of each commodity is imported, this share is then multiplied by each user's total use of a commodity. This is illustrated by the first step in Figure 6. The user-specific domestic flows are calculated by deducting the user-specific imported flow from the total use of that commodity. This is illustrated by Step 2 in Figure 6. Step 3 in Figure 6 illustrates the user-specific matrices including the source dimension.

Figure 6. Creating source dimensions: domestic and imports



[5] $IMP\_SHR_{(c)} = \dfrac{IMPORTS_{(c)} + V0TARf_{(c)}}{\sum_{u \in USERS} VPUR_{(c,u)}}$ where u refers to the following users, (1) current production, (2) investors, (3) private consumption, (4) exports (5) public consumption and (6) change in inventories. Because no imported good is re-exported, there is no import dimension for any of the flows associated with exports.

3.7. Step 7: Creating an "Ownership of Dwellings" commodity and industry

In the original SUT there was no explicit recognition of the imputed value of owner-occupied dwellings (*OwnerDwel*). Ownership of dwellings is an important component of household expenditure as it is closely linked to household income and as such can give additional insight into the economic wellbeing of the population. In a dynamic setting, we would also expect that as per capita income increases, the household budget share of dwellings will also increase. It is therefore important, for proper modelling of civil construction and non-dwelling consumption of commodities, to explicitly model household demand for dwellings.

According to the latest Income and Expenditure Survey (IES), 23.6 per cent[6] of total household consumption is spent on housing, water, electricity, gas and other fuels (Statistics South Africa, 2008b). Housing includes the:

- annual rental value of a dwelling unit; or
- the annual estimated rental value of the dwelling unit if the unit was rented free in the case of rented dwelling units; or
- if it is an owner-occupied dwelling unit, 7 per cent of the value of the dwelling unit (Statistics South Africa, 2008b and United Nations, 1999: 134).

In this section the creation of the *Owner Dwellings* sector, with an appropriate cost and sale structure, is explained. In the SUTs, *Owner Dwellings* is originally included in the *Real Estate*[7] sector. This sector is disaggregated into a *Real Estate* sector, which mainly captures fee-paying real estate activities, and an *Owner Dwelling* sector, which represents the housing stock.

There are two specific characteristics that distinguish the *Owner Dwellings* commodity from other commodities. Firstly, *Owner Dwellings* are only produced domestically. No *Owner Dwellings* are imported, and secondly, the commodity *Owner Dwellings* is only consumed by households. The industry, *Owner Dwellings*, only uses intermediate commodities and capital as a primary input in the construction of dwellings. No land or labour is used.

To disaggregate the *Total Real Estate* sector, the following information regarding *Owner Dwellings* is needed (1) the value of outputs, (2) input structure, and (3) sales structure.

[6] The 23.6 per cent includes: Actual rentals for housing (3.6%), Imputed rentals for housing (12.6%), Maintenance and repair of the dwelling (1.7%), Water supply and miscellaneous services relating to the dwelling (3.2%) and Electricity, gas and other fuels (2.4%) (Statistics South Africa, 2008: 46).

[7] Real Estate falls under major division 8 in the SIC, and consists of Real Estate Activities with own or leased property (sub division 841) and Real Estate Activities on a fee or contract basis (sub division 842).

3.7.1. *Value of output*

The National Accounts for 2002 shows the value of rents[8] as R65,633 million (SARB, 2005: S–118). In the SUT, the value for *Real Estate*, which includes *Owner Dwellings*, is R62,508 million. This discrepancy may be due to the purchases by residents abroad and purchases by non-residents domestically.

Based on information in the IES and National Accounts data, I assumed that housing comprises approximately 8 per cent of total household expenditure as it appears in the SUT. This percentage is slightly higher than the 7.2 per cent share of *Dwellings* in the world's private household consumption in the GTAP 6.0 database. The calculated value of output of the Owner Dwellings sector is R57,762 million, which is approximately 93 per cent of the total value of Real Estate in household expenditure. This share is used to split the *Total Real Estate* element into two separate elements called *Owner Dwellings* and *Real Estate*.

3.7.2. *Sales structure*

It is assumed that households are the only users who consume the commodity *Owner Dwellings.* Hence, the sales structure of *Owner Dwellings* is known. The sales structure of a commodity is indicated by row 1 in Figure 1. Households spend R57,767 million on the commodity, *Owner Dwellings*. This value is then subtracted from *Total Real Estate* to determine the *Real Estate* commodity dealing mostly with real estate services. This implies that:

$$V3BAS(OwnerDwel,"dom") = R57\,762 \text{ million and}$$

$$V3BAS(\text{Real } Estate,"dom") = V3BAS(Total \text{ Real } Estate,"dom") - V3BAS(OwnerDwel,"dom") \quad \text{(E4.3)}$$

No other user buys the commodity *Owner Dwellings*, and therefore the corresponding flows from this commodity to those users are set to zero. For all other users the *Real Estate* value remains the same.

3.7.3. *Input structure*

The next step is to split the *Total Real Estate* column into an *Owner Dwellings* column and *Real Estate* column. This is difficult because of (1) lack of information regarding industry-specific input and cost structures and (2) the input structure of the industries may differ.

[8] Rents include actual rent and imputed rent for owner-occupied dwellings.

Due to the lack of information, the cost structure for the *Owner Dwellings* industry is based on MONASH data. Hence, for each of the *Owner Dwellings* and *Real Estate* industries (1) the source-specific intermediate input commodities and (2) the share in which each of these commodities are used are borrowed from the MONASH database. The shares of the source-specific intermediate commodities used by the *Owner Dwellings* industry are listed in Appendix 4E.

The next step is to determine, for both the *Real Estate* and *Owner Dwellings* industry, what percentage of the cost structure will be allocated to source specific intermediate inputs and primary inputs. It is assumed that the *Owner Dwellings* industry only uses capital in the production process. For the cost shares pertaining to *Owner Dwellings*, I base my decision on the MONASH cost shares. In the MONASH database, 17 per cent of total cost are allocated to domestic commodities used as intermediate inputs $\left(V1BAS\left(c,"dom","OwnerDwel"\right)\right)$, 1 per cent is allocated to imported commodities used as intermediate inputs $\left(V1BAS\left(c,"imp","OwnerDwel"\right)\right)$ and 82 per cent are allocated to capital $\left(V1CAP\left("OwnerDwel"\right)\right)$. The cost structure[9] of the *Real Estate* industry is the difference between the values of the original *Real Estate* industry and *Owner Dwellings,* that is:

$$V1BAS\left(c,s,"\text{Real Estate}"\right) = V1BAS\left(c,s,"\text{Real Estate}"\right) - V1BAS\left(c,s,"\text{OwnerDwel}"\right) \qquad \text{(E4.4)}$$

No other commodity is used by the *Owner Dwellings* industry as an input in current production and therefore all the remaining elements are set to zero. The elements of the commodity and industry sets have increased from 27 to 28.

After this split, the database is slightly unbalanced. This imbalance is corrected in Step 12.

3.8. Step 8: Creating margin matrices

The output of wholesalers and retailers is measured by the value of the trade margins realised on the goods they sell, that is, the difference between the sale value of products sold and the cost of purchasing these products. The reason for this is that the productive activity associated with distribution is understood to be the provision of services of displaying the goods in an informative and attractive way (Statistics South Africa, 2006c: 14).

Trade and transport margins are the difference between the purchasers' price and the producers' price of a product. It is therefore possible that a product can be sold at different

[9] The output value of the Owner Dwellings is R57,762 million. Seventeen per cent, R9,820, which is allocated to the use of domestic commodities as an intermediate input, 1 per cent is approximately 578 and is allocated to imported commodities used as an intermediate input, and 82 per cent, 47,365, are allocated to the use of capital.

purchasers' prices due to differences in margins and net taxes (United Nations, 1999: 56). A clear distinction should be made between transport services and margins. Transport services move people, while transport margins move goods. Transport margins can be treated in two different ways. Firstly, when transport is arranged in such a way that the purchaser has to pay separately for the transport costs, that is, the transport costs are billed separately, it is identified as transport margins. The customer not only buys the goods, but also the transport services from producers. Secondly, if transport services are not billed separately, that is, the producer transports the goods without extra cost to the purchaser, transportation will appear as intermediate consumption to the producer and at the same time will be included in the basic price (Statistics South Africa, 2006c: 14; United Nations, 1999: 133).

For all agricultural, mining and manufacturing commodities, margins are given as the sum of trade and transport margins. The following should be noted:

- there are no margins for services provided because services are delivered directly from producers to consumers, and hence do not require margins;
- there are no margins on inventories because they comprise unfinished commodities and materials; and
- only domestically produced margins are used, i.e. margins are not imported.

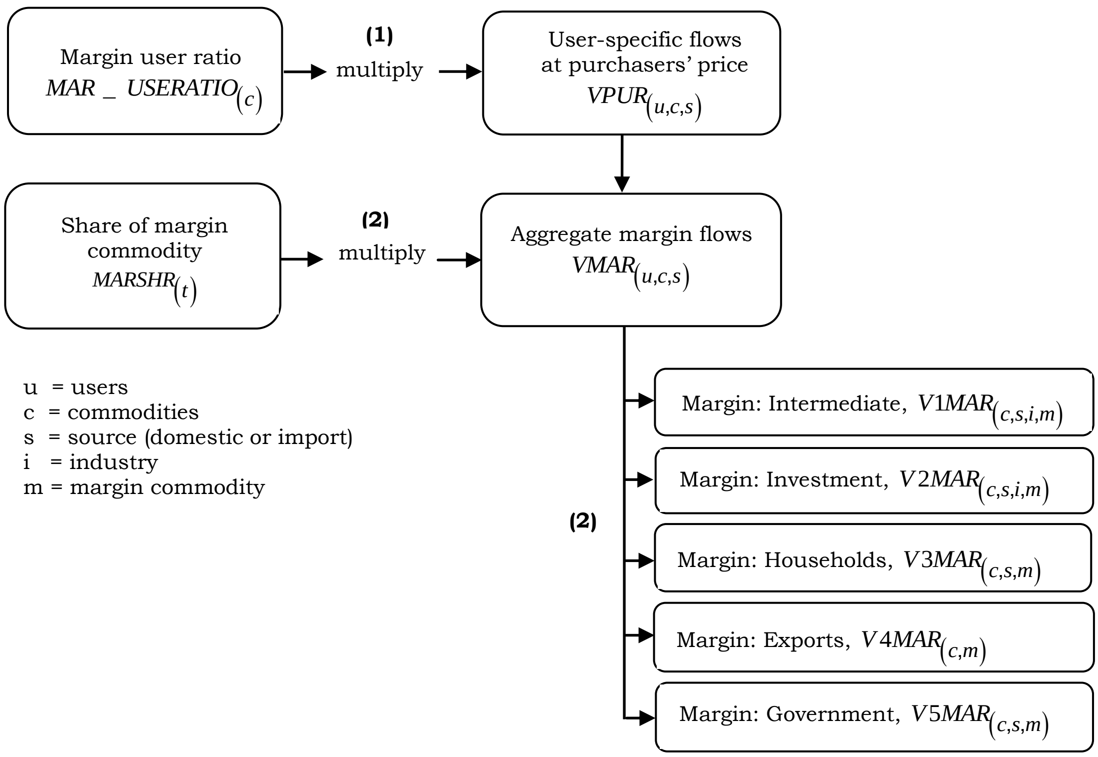
Included in the margin column are two negative values. Values are negative for Trade and Transport services. The reason for this is that in the Use table, the values for trade and transport services (commodities 85 and 87) show only those that are consumed directly and do not include any margins. Instead, margins are included in the value of the goods at purchasers' prices shown in the rest of the Use table. Consequently, in the Supply table, trade and transport margins should be deducted from the total supply of market services. This is done by entering trade and transport margins as a negative number in order to balance the supply and use of trade and transport services at purchasers' prices (United Nations, 1999: 33).

The total value of margins (R235,736 million) is the sum of transport services (R14,694 million) and trade (R221,042 million). The data for non-service commodities in the Use table are valued at purchasers' price and therefore include margins. On the other hand, the Supply table only contains information on commodity-specific margins and not user-specific margins. The aim is therefore to create the matrices in row 3 of Figure 4.1. The task at hand is two-fold: (1) determine user and commodity-specific margins, that is, V1MAR_M to V5MAR_M and (2) split the user and commodity-specific margins between trade and transport margins commodities.

3.8.1. *Calculation of aggregate margin matrices by user*

In this step the margin matrices, V1MAR_M to V5MAR_M, are determined. This is done by calculating the margin-use ratio for each commodity. To create these matrices I assumed that the margin-use ratio is the same for all users, that is, if the margin-use ratio for commodity c is 8 per cent, it is 8 per cent for all users of commodity c. Secondly, the margin rate is the same for both domestic and imported commodities. Since the flows in the Use table are at purchasers' prices, that is, include margin commodities, and given that the commodity-specific margins are given in the Supply table, the margin-use ratio is calculated.[10] The margin-use ratio is then multiplied with the user-specific flow valued at purchasers' prices to create the user-specific aggregate margins. This is illustrated by (1) in Figure 7.

Figure 7. Creating source dimensions for the margin matrices



3.8.2. *Creating margin matrices by type of margin commodity*

The next step is to distribute the aggregate user-specific margin for each commodity

[10] $MAR\_USERATIO_{(c)} = \dfrac{MARGIN_{(c)}}{\sum_{u \in USER} \sum_{s \in SRC} VPUR_{(u,c,s)}}$ where u refers to the following users, (1) current production, (2) investors, (3) private consumption, (4) exporters and (5) public consumption. Because inventories are unsold commodities, there is no margin matrix associated with inventories.

between transport and trade margins. Since the total value of trade and transport margins is known, the share of trade and transport in total margin is calculated.[11] Again, it is assumed that the all users use the same proportion of trade and transport margins. The margin commodity share is then multiplied with the aggregate user-specific margin. This yields margin matrices by commodity, source and user for all margin commodities. This is illustrated by (2) in Figure 7.

3.9. Step 9: Creating tax matrices

3.9.1. Defining the different taxes

Indirect taxes includes taxes on products that are payable by the user and taxes on production that are paid by producers. The SUT contains information on both these types of taxes. Commodity-specific taxes, payable by users, are recorded in the Supply table while industry-specific production taxes, payable by producers, are recorded in the Use table.

Taxes on products are payable on goods and services when they are produced, delivered, sold, transferred or otherwise disposed of by their producers and are proportional to their production values (United Nations, 1999: 26). There is only one column in the Supply table that reports commodity-specific taxes on products. SAGE requires the creation of user-specific tax matrices, V1TAX to V5TAX, which implies that the values in the tax column have to be distributed across users. This proves to be difficult because we do not know who is responsible for the tax. Additional data breaks this column into four different types of commodity taxes: VAT, customs and excise taxes, fuel levies and other taxes (Statistics South Africa, 2007). Table 3 lists these taxes and subsidies paid on each commodity. The row totals of the net taxes (column 7) are consistent with the data in the SUT. The elements in columns 2 to 5 are based on expert knowledge and the column total in column 6 is consistent with data published by the SARB (South African Reserve Bank, 2005: S-136).

VAT is by far the most important indirect tax source and contributes 62 per cent to net taxes on products. VAT is a consumption-type tax and the revenue is raised for the government by certain traders. These trades are registered and charge VAT on taxable supplies for goods and services on behalf of the government. The tax burden of the tax falls on the final consumer.

[11] $MARSHR_{(t)} = \frac{MARGIN_{(t)}}{\sum_{t=1}^{2} MARGINS_{(t)}}$ where t is the margin commodity, t = 1 (transport services) and t = 2 (trade)

Excise duties contribute 12 per cent to net taxes on products and can be levied on both domestic and imported goods.[12] Excise duties are levied on alcoholic beverages, tobacco products and petroleum. They are also sometimes imposed to reduce consumption of certain goods (Black *et al.*, 2007: 201).

Table 3. Different types of taxes (2002) (Rand millions)

	Different types of taxes (additional data)					SUT	
	VAT	**Customs and excise tax**	**Fuel levy**	**Other taxes**	**Total taxes on products**	**Taxes less subsidies**	**Subsidies**
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
(1)Agriculture	1,953	16	-	-	1,969	1,839	130
(2)Coal	13	-	-	-	13	13	-
(3)Gold	-	-	-	-	-	-	-
(4)OthMining	35	4	-	-	39	40	-1
(5)Food	8,953	10,129	-	-	19,082	18,896	186
(6)Textiles	2,826	1,219	-	-	4,044	3,293	752
(7)Footwear	1,201	135	-	-	1,336	717	619
(8)Petroleum	5,730	3,026	15,227	-	23,983	23,641	342
(9)OthNonMet	239	186	-	-	425	420	5
(10)BasIronStl	3,696	1,215	-	-	4,911	4,682	229
(11)ElecMach	522	1,250	-	-	1,772	1,757	15
(12)Radio	2,258	1,665	-	-	3,923	3,917	6
(13)TransEquip	4,916	2,725	-	-	7,640	7,578	63
(14)OthManuf	1,812	373	-	-	2,185	3,419	-1,234
(15)Electricity	1,026	-	-	-	1,026	1,026	-
(16)Water	390	-	-	-	390	390	-
(17)Construction	3,895	-	-	-	3,895	3,895	-
(18)Trade	1,543	-	-	-	1,534	1,534	-
(19)HotelRestaur	1,554	-	-	-	1,554	1,554	-
(20)TransServ	2,588	-	-	-	2,588	-579	3,167
(21)Communic	2,935	-	-	-	2,935	2,452	483
(22)Financial	5,313	-	-	-	5,313	5,313	-
(23)RealEstate	4,814	-	-	-	4,814	4,814	-
(24)BusinessAct	2,145	-	-	-	2,145	2,145	-
(25)Government	1,483	-	-	-	2,145	1,483	-
(26)HealthSoc	2,854	-	-	-	4,337	2,854	-
(27)OthAct	3,821	-	-	3,984	7,805	7,805	-
(28)OwnerDwel	-	-	-	-	-	-	-
Total	68,507	21,942	15,227	3,984	109,660	104,898	4,762
% contribution	62%	20%	14%	4%	100%		

Source: Statistics South Africa, 2007.

Levies on fuel is an indirect tax on fuel, which consists of five components:

- The general fuel levy, which accrues to the National Revenue Fund;
- The Road Accident Fund levy, which is dedicated to meeting claims from victims of road accidents;
- A customs and excise levy, which forms part of the SACU customs pool;

[12] When levied on imported goods, they are known as customs duties or tariffs.

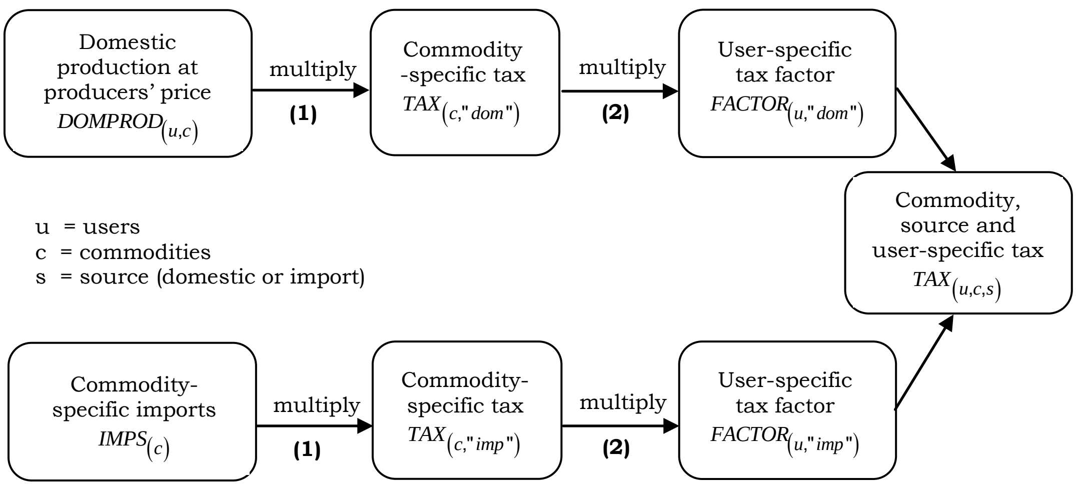
- An equalisation fund levy, the proceeds of which have been used in the past to smooth the monthly fluctuations in the domestic fuel price due to changes in international crude oil prices; and
- A small levy has been imposed as of 2001, on diesel sales to fund the marking and dyeing of illuminating paraffin to combat the illegal mixing of diesel and illuminating paraffin.

Other taxes include registration fees on housing, charges and levies on financial transaction, air departure tax and social security tax charges. In 2002 the air passenger departure tax was introduced at R50 per fee-paying passenger travelling to SACU countries[13] and R100 per fee-paying passenger travelling to all other countries.

3.9.2. Creating indirect tax matrices for all users

Although commodity-specific taxes are known, user-specific taxes are unknown, that is, no information is available on who pays the taxes. To determine user-specific taxes, commodity-specific taxes are multiplied with a tax factor. This tax factor assigns a weight to each user, indicating who will pay most of the tax.

Figure 8. Creating a source dimension for the tax matrices



A tax factor of 1 is assigned to producers and investment, and 3 to households. The implication of the tax factor is that households carry most of the tax burden. Commodity-specific tariff revenues are not explicitly given in the SUTs. Instead they are included in net taxes. However, the aggregate tariff revenue[14] is known. Commodity-specific tariffs are

[13] Southern African Customs Union (SACU) includes Botswana, Lesotho, Namibia and Swaziland.
[14] Aggregate tariff revenue including subsidies are R8,429 million. Tariff revenue excluding subsidies are R8,218 million.

determined by calculating the share of each commodity in the total *Customs and excise taxes* paid (column 3 in Table 3) and multiplying this share by the total tariff revenue.

3.9.3. Taxes on production

Taxes on production consist mainly of taxes on the ownership or use of land, buildings or other assets used in production or on the labour employed, or compensation of employees employed. Examples of taxes on production include taxes payable by producers for business licences, payroll taxes, stamp duties. These taxes are not proportional to the value of goods and services produced (United Nations, 1999: 26). The industry-specific production taxes are captured in the Use table. The production taxes, summed across industry, are consistent with the SARB data (South African Reserve Bank, 2005: S-136). Hence, no further adjustments are required. Taxes on production were R25,028 million and subsidies on production R3,485 million. Therefore, net production taxes are R21,543 million. At the end of this step, the V1TAX to V5TAX and V0TAR matrices have been created.

3.10. Step 10: Creating matrices for the basic flows

The aim of this step is to create the domestic flow values of the BAS1 to BAS6 matrices. These flows are illustrated in the first row of Figure 1. The flows at purchasers' price include the basic value plus the margin costs plus taxes. The imported flows at basic prices are calculated in Step 6, margin flows in Step 8 and tax matrices in Step 10. Based on the outcomes of these steps, the domestic flows valued at basic prices are determined.

To calculate the domestic basic flows, I subtract the imports, margin and tax flows from the total purchases values:

$$BAS_{(u,c,dom)} = \sum_{s \in SRC} VPUR_{(u,c,s)} - BAS_{(u,c,imp)} - \sum_{s \in SRC} \sum_{m \in MAR} MAR_{(u,c,s,m)} - \sum_{s \in SRC} TAX_{(u,c,s)} \quad \text{(E4.5)}$$

At the end of this step the domestic flows of the V1BAS to V6BAS matrices are created.

3.11. Step 11: Creating an industry dimension for the investor column

Currently, the matrices pertaining to investors (user 2) are vector matrices implying that there is only one representative investor. This is consistent with the investment data included in the SUT. However, we know that investors buy commodities to construct capital in each industry. The aim in this step is two-fold. Firstly, the amount of investment undertaken by each industry is calculated. The sum of all the industry investment should be consistent with the economy-wide investment. Secondly, for each industry the commodity-composition is determined. The total use of each commodity for investment purposes summed across all industries, should add up to the value of the commodity-specific investment as it appears in the official data. To determine the required investment data, I follow the work by Giesecke and Tran (2007). They use the Capital Asset Pricing Model (CAPM) theory to create the necessary data for a dynamic model for Vietnam. The next section relies heavily on their description of determining the required investment data (Giesecke & Tran, 2007).

3.11.1. Calculating industry-specific investment

No official industry-specific investment data are available to split the aggregate investment column into 28 columns. Instead, industry-specific investment is determined from assumed capital growth rates, depreciation rates and rates of return.

Capital accumulates over time according to the following formula:

$$K1_{(i)} = K0_{(i)}\left(1 - d_{(i)}\right) + I_{(i)} \qquad \text{(E4.6)}$$

where

- $K0_{(i)}$ and $K1_{(i)}$ are the industry-specific capital stock at the beginning and the end of the year;
- $I_{(i)}$ is investment undertaken by industry during the year; and
- $d_{(i)}$ is the industry-specific depreciation rate.

Rewriting (E4.6) yields:

$$I_{(i)} = K0_{(i)}\left(k_{(i)} + d_{(i)}\right) \qquad \text{(E4.7)}$$

where k is the growth rate of capital stock in an industry:

$$k_{(i)} = \frac{K1_{(i)} - K0_{(i)}}{K0_{(i)}} \qquad \text{(E4.8)}$$

If the values of K_0, k and d were known, I could be calculated via (E4.7). However, no industry-specific data are available for these variables. There is, however, data on industry-specific gross operating surplus (V1CAP). The industry-specific V1CAP can be used to infer industry-specific investment via the rate of return on capital. The net rate of returns on capital is:

$$R_{(i)} = \frac{V1CAP_{(i)}}{P2tot_{(i)} * K0_{(i)}} - d_{(i)} \quad \Rightarrow \quad \frac{P1cap_{(i)}K0_{(i)}}{P2tot_{(i)}K0_{(i)}} - d_{(i)} \qquad \text{(E4.9)}$$

where

- $R_{(i)}$ is the net rate of return on industry-specific capital;
- $V1CAP$ is the industry-specific gross operating surplus (capital rentals);
- $P2tot_{(i)}$ is the cost of building a new unit of capital; and
- $P1cap_{(i)}$ is the industry-specific gross return per unit of capital.

From (E4.7) and (E4.9) we have:

$$I_{(i)} = \frac{V1CAP_{(i)}\left(k_{(i)} + d_{(i)}\right)}{R_{(i)} + d_{(i)}} \qquad \text{(E4.10)}$$

Equation (E4.10) shows that to calculate industry-specific investments, the following information is required:

- $V1CAP$, which is known from the Use table;
- $k_{(i)}$ is the industry-specific capital growth rates;
- $d_{(i)}$ is the industry-specific depreciation rates; and
- $R_{(i)}$ is the industry-specific rates of return on capital.

The remainder of this subsection describes the method of calculating d, k and R.

3.11.1.1. Calculating industry-specific depreciation rates (d)

As a first guess, the economy-wide average depreciation rate for 2002 can easily be calculated from data published by the SARB. The economy-wide depreciation rate, based on SARB published data, is calculated via (E4.11) at 7.2 per cent:

$$d = \frac{D}{VCAP} * 100 \qquad \text{(E4.11)}$$

where
- d is the economy-wide depreciation rate;
- D is the published total depreciation value at current price; and
- $VCAP$ is the published total capital stock.

The SARB does not publish data on industry-specific depreciation rates and capital stocks. I therefore use a second data source, QUANTEC. QUANTEC publishes data on capital stocks and consumption of fixed capital for selected industries. To determine the industry-specific depreciation values, net fixed investment is calculated as:

$$K1_{(i)} - K0_{(i)} = I_{(i)} - D_{(i)} \qquad \text{(E4.12)}$$

where
- $K0_{(i)}$ and $K1_{(i)}$ are the capital stock at the beginning and the end the year ;
- $I_{(i)}$ is gross domestic fixed investment undertaken during the year; and
- $D_{(i)}$ is the depreciation value and calculated as $d_{(i)} * K0_{(i)}$ where $d_{(i)}$ is the depreciation rate.

From (E4.12) *net* domestic fixed investment $(I_t - D_t)$ is calculated as the difference between the start $(K1)$ and the end $(K0)$ capital stock data. The depreciation value at constant price can now be calculated as the difference between *gross* domestic fixed investment and *net* domestic fixed investment. This can then be transformed into a depreciation value at replacement cost by multiplying by the appropriate investment deflator. These rates vary across industries. Reasons for the differences in depreciation rates include: (1) different economic lives for the different assets used by industries and (2) industries using different combinations of capital assets. The current estimate of economic lifetimes for the different types of assets in South Africa varies between a maximum of 80 years for construction works and eight years for the transport equipment (SAICA, 2007). For *Owner Dwellings* the depreciation rate is set at 2 per cent.

The dispersion among the industry-specific depreciation rates is adjusted according to (E4.13):

$$d_{(adj,i)} = d_{(ave)} * \left(\frac{d_{(i)}}{d_{(ave)}} \right)^{\xi} \qquad \text{(E4.13)}$$

where
- $d_{(i)}$ and $d_{(adj,i)}$ are the depreciation rates of industry $i's$ capital stock

before and after the adjustment;

- $d_{(ave)}$ is the average economy-wide depreciation rate at 6 per cent; and
- ξ us the adjustment coefficient, which is set at 0.5.

The final depreciation rates vary between 6 and 10 per cent for manufacturing industries and 4 and 9 per cent for service industries. The weighted average depreciation rate for the economy is 6.1 per cent.

3.11.1.2. Calculating industry-specific capital growth rates (k)

The economy-wide capital growth rate, based on the SARB data, is calculated as the percentage change in capital stock from 2001 to 2002. The capital growth rate is 1.09 per cent (South African Reserve Bank, 2005: S-129). As with the depreciation rate, the SARB does not publish industry-specific capital growth rates. Based on data from QUANTEC, the industry-specific capital growth rates are calculated. Capital growth rates vary across industries. *Other mining*, *Health and Social work*, *Owner dwelling* and *Communications* all indicate strong positive capital growth while *Coal*, *Food*, *Textiles*, *Electricity* and *Water* all indicate negative growth rates. For all the negative capital growth rates, I assigned a small positive default value of 0.002. The dispersion of the capital growth rates across all industries was reduced via:

$$k_{(adj,i)} = k_{(ave)} * \left(\frac{k_{(i)}}{k_{(ave)}} \right)^{\aleph} \qquad \text{(E4.14)}$$

where
- $k_{(i)}$ and $k_{(adj,i)}$ are the capital growth rate before and after the adjustment for year t;
- $k_{(ave)}$ is the average economy-wide capital growth rate at 3.2 per cent period t; and
- $\aleph$ is the adjustment coefficient which is set at 0.5.

I then scale the industry-specific capital growth rates so that their rental-weighted average is equal to the growth rate of the aggregate capital stock of 1.2 per cent.

3.11.1.3. Calculate industry-specific rates of return (R)

I do not have any plausible independent data that can be used to determine R in (E4.10). Following Giesecke and Tran (2007), I use the following steps to determine R :

Firstly, the industry-specific normal rate of return to equity is calculated by the CAPM equation:

$$R_{(i)}^{(equity)} = R^{(f)} + \beta_{(i)}\left(R^{(m)} - R^{(f)}\right) \qquad \text{(E4.15)}$$

where
- $R_{(i)}^{(equity)}$ is the return on industry $i's$ equity;
- $R^{(f)}$ is the return on a risk-free investment. The interest rate on government 10 year bond as a proxy;
- $R^{(m)}$ is the average market equity rate of return; and
- $\beta_{(i)}\left(R^{(m)} - R^{(f)}\right)$ is the risk premium on equity capital in industry i.

Secondly, I assume that the normal rate of return on capital $\left(R_{(i)}^{(nor)}\right)$ in industry i is the weighted average cost of capital:

$$R_{(i)}^{(nor)} = S_{(i)}^{(equity)} R_{(i)}^{(equity)} + \left(1 - S_{(i)}^{(equity)}\right)\left(R^{(f)} + \varphi_{(i)}\right) \qquad \text{(E4.16)}$$

where
- $\varphi_{(i)}$ is the premium above the risk-free rate that an industry will pay on debt finance; and
- $S_{(i)}^{(equity)}$ is the share of equity in industry $i's$ capital financing structure.

Thirdly, I assume that fast-growing industries will have actual rates of return that exceed $R_{(i)}^{(nor)}$:

$$R_{(i)} = R_{(i)}^{(nor)} + \alpha\left(k_{(adj,i)} - k\_trend_{(adj,i)}\right) \qquad \text{(E4.17)}$$

where
- $k\_trend_{(adj,i)}$ is the trend growth rate of capital stock in industry i over a historical period of time and scaled to the economy-wide average.

❖ *Calculating the rate of return on industry equity*

To calculate the rate of return on industry equity, $R_{(i)}^{(equity)}$, in (E4.15), the following assumptions are made:

- The risk-free return, $R^{(f)}$, is set at 10.4 per cent. This was the nominal fixed interest rate on the South African government 10-year bond (SARB S-29).
- The market rate of return, $R^{(m)}$, is set at 15.1 per cent.
- Independent industry-specific values for Beta were not available for South Africa. Assumed values for Beta were calculated as follows. First, I assign a risk index to each industry based on informal knowledge about the volatility and profitability of these industries. The risk index varies from 1 to 11, with 6 the average (Table 4.5). With each risk level, I assign a value to link the risk level with the $\beta_{(i)}$ values. The values are listed in Table 4.5. Low-risk industries (risk index of 1–3) include Owner Dwellings, Electricity, Water, General Government, Health and social work and Other activities and services. High-risk industries (risk index of 8–11) include Real Estate and Business Activities, Mining, Petroleum, and Hotels and Restaurants. Appendix 4H, columns (4), lists the assigned values for the industry-specific $\beta_{(i)}$.

Table 4. The values assigned to the risk index

Risk index	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
$\beta_{(i)}$	0.50	0.63	0.78	0.88	0.95	1.00	1.05	1.12	1.22	1.37	1.50

Source: Adapted from Giesecke and Tran, 2007: 40.

Given all the above information, $R_{(i)}^{(equity)}$ is calculated via (E4.15).

❖ *Calculating the normal rate of return on industry capital stock*

Calculating the normal rate of return on industry capital stock, $R_{(i)}^{(nor)}$, via (E4.16), requires information on the shares of equity and debt in total assets in each industry. This is calculated from data on the capital resources of enterprises (Statistics South Africa, 2006a). Assuming that the corporate debt premium is 3 per cent, $R_{(i)}^{(nor)}$ is calculated via (E4.16). This procedure determines an economy-wide rental-weighted average cost of capital of 15.1 per cent.

❖ *Calculating trend capital growth rates*

To adjust $R_{(i)}^{(nor)}$ via (E4.17), I require industry-specific trend capital growth rates. Given that target trend growth rate, k_tot, is set at 1.1 per cent, the dispersion in the trend rates is reduced via:

$$k\_trend_{(adj,i)} = k\_trend_{(i)} * \left(\frac{\sum_{i \in IND} V1CAP_{(i)} * k\_tot}{\sum_{i \in IND} V1CAP_{(i)} * k\_trend_{(i)}} \right) \qquad \text{(E4.18)}$$

Finally, industry-specific investments are calculated by substituting (E4.17) with (E4.10):

$$I_{(i)} = \frac{V1CAP_{(i)}\left(k_{(i)} + d_{(i)}\right)}{\left(R_{(i)}^{(nor)} + \alpha\left(k_{(adj,i)} - k\_\ trend_{(adj,i)}\right)\right) + d_{(i)}} \qquad \text{(E4.19)}$$

3.11.2. Completing the investment matrix

The process described above determines the value of investment by each SAGE industry. Combined with commodity-specific investments (row totals), the task now is to complete the investment matrix by calculating the share of each commodity used by the different industries. Every industry has a unique input requirement. This requirement depends on the nature of the industry. For example, the transport services industry will mainly invest in transport equipment.

No data are available on industry use of commodities. I therefore adopt the industry-specific input requirements, that is, the share of commodities used by each industry for investment purposes, from the Australian dynamic CGE model (MONASH). The MONASH commodity and industries are mapped to the 28 SAGE commodities and industries. I then calculate the share of commodity inputs to each industry's capital formation. These shares are then multiplied with the aggregate industry-specific investment calculated via (E4.19). The final step is to balance the investment matrix.

3.11.3. Determining industry-specific capital stocks

With known values for, $I_{(i)}, k_{(i)}$ and $d_{(i)}$, industry-specific capital stocks $K_{(i)}$ can be calculated via (E4.7). The aggregate value of capital stock is estimated to be R2,547,110 million. This implies an investment-capital ratio of 0.7 and a capital-output ratio of 2.18.[15] These ratios are plausible values for a developing country like South Africa.

3.12. Step 12: Final balancing of the SAGE database

The database created using Steps 1–11, creates minor distortions. For the SAGE database to be balanced, two conditions have to be satisfied.

3.12.1. Condition 1: industry costs should equal industry output

We assume that no pure economic profits are made by the industries and therefore the first condition states that industry costs should equal industry output. This means that when considering Figure 1, the column totals for each industry in the producer column (column 1), should be equal to the domestic output of each industry:

$$IND\_COSTS_{(i)} = IND\_OUTPUT_{(i)} \qquad \text{(E4.20)}$$

where

$$IND\_COSTS_{(i)} = \sum_{c \in COM} \sum_{s \in SRC} V1PUR_{(c,s,i)} + \sum_{c \in COM} \sum_{s \in SRC} \sum_{m \in MAR} V1MAR_{(c,s,i,m)}$$
$$+ \sum_{c \in COM} \sum_{s \in SRC} V1TAX_{(c,s,i)} + \sum_{o \in OCC} V1LAB_{(i,o)} \qquad \text{(E4.21)}$$
$$+ V1CAP_{(i)} + V1LAND_{(i)} + TAX0_{(i)} + V1OCT_{(i)}$$

and

$$IND\_OUTPUT_{(i)} = \sum_{c \in COM} MAKE_{(i,c)} \qquad \text{(E4.22)}$$

where
- $IND\_COST_{(i)}$ is total cost of each industry;
- $\sum_{c \in COM} \sum_{s \in SRC} V1PUR_{(c,s,i)}$ is the basic intermediate flows to all industries summed across all commodities and sources;
- $\sum_{c \in COM} \sum_{s \in SRC} \sum_{m \in MAR} V1MAR_{(c,s,i,m)}$ is the total margins used to facilitate flows to industries, summed across commodities, sources and types of margins;
- $\sum_{o \in OCC} V1LAB_{(i,o)}$ is the compensation of employees summed across all

[15] GDP is R1,168,778 million.

occupations;

- $V1CAP_{(i)}$ is the industry-specific gross operating surplus;
- $V1LAND_{(i)}$ is the rental value of land for the agricultural and mining industries;
- $TAX0_{(i)}$ is the industry-specific production taxes;
- $V1OCT_{(i)}$ is industry-specific other cost tickets;
- $IND\_OUTPUT_{(i)}$ is the total industry output; and
- $\sum_{c \in COM} MAKE_{(i,c)}$ is the total industry output summed across commodities.

3.12.2. Condition 2: domestic commodity output equals total use

We assume that all markets clear and therefore the second condition states that domestic commodity output should equal total use:

$$COM\_OUTPUT_{(c)} = COM\_USE_{(c)} \qquad \text{(E4.23)}$$

where

$$COM\_OUTPUT_{(c)} = \sum_{i \in IND} MAKE_{(i,c)} \qquad \text{(E4.24)}$$

For non-margin commodities the $COM\_USE_{(c)}$ is:

$$\begin{aligned} COM\_USE_{(c)} = & \sum_{i \in IND} V1BAS_{(c,"dom",i)} + \sum_{i \in IND} V2BAS_{(c,"dom",i)} \\ & + V3BAS_{(c,"dom")} + V4BAS_{(c)} + V5BAS_{(c,"dom")} \qquad \text{(E4.25)} \\ & + V6BAS_{(c,"dom")} \end{aligned}$$

For margin commodities the $COM\_USE_{(c)}$ is:

$$\begin{aligned} COM\_USE_{(m)} = & \sum_{i \in IND} V1BAS_{(m,"dom",i)} + \sum_{i \in IND} V2BAS_{(m,"dom",i)} \\ & + V3BAS_{(m,"dom")} + V4BAS_{(m)} + V5BAS_{(m,"dom")} \qquad \text{(E4.26)} \\ & + \sum_{c \in COM} \sum_{u \in USER} \sum_{s \in SRC} \sum_{i \in IND} VMAR_{(u,c,s,i,m)} \end{aligned}$$

where • $COM\_OUTPUT_{(c)}$ is the commodity output summed across all industries;

- $COM\_USE_{(c)}$ is the commodity use valued at basic price summed across all users;
- $\sum_{i \in IND} MAKE_{(i,c)}$ is the total commodity output summed across all industries; and
- $\sum_{i \in IND} V1BAS_{(c,"dom",i)}$ to $V6BAS_{(c,"dom")}$ is the basic value of all commodities used by all users; and
- $\sum_{c \in COM} \sum_{u \in USER} \sum_{s \in SRC} \sum_{i \in IND} VMAR_{(u,c,s,i,m)}$ is the value of all margin commodities.

After completion of all the data adjustments procedures explained in the previous steps, it is likely that the above conditions are not satisfied. The RAS procedure is used to balance the database. Table 5 organises the targets set for all the variables in the database. The expenditure and income components, as well as the labour and production taxes, are set to national accounts. The targets for land and capital were calculated in Step 5, and their aggregate value is equal to the gross operating surplus in the national accounts. The tariff target was set in Step 10 and adding it to indirect taxes will set the target for taxes on commodities and imports, which is equal to National Accounts data.

Table 5. Targets set for variables in the SAGE database

GDP expenditure	***Value R millions***	***Share (%)***
Consumption	722,091	61.8
Investment	175,594	15.0
Inventories	13,034	1.1
Government	215,301	18.4
Exports	382,290	32.7
Imports	339,532	-29.1
Total	1,168,778	100

GDP income	***Value R millions***	***Share (%)***
Labour	520,501	44.5
Land	22,178	1.9
Capital	499,658	42.8
Indirect taxes	96,680	8.3
Tariff revenue	8,218	0.7
Production taxes	21,543	1.8
Total	1,168,778	100

Source: South African Reserve Bank, December 2005: S-112.

4. PARAMETERS AND ELASTICITIES

This section describes the elasticities listed in Part 3 of Table 2. Where possible, values for the various elasticities are taken from sources where they are empirically estimated for the South African environment. In the absence of empirical estimates, elasticities are adopted from the MONASH model.

In reviewing the elasticities adopted in this study, I focus on two econometric studies. Van Heerden and Van der Merwe (1997) estimated elasticities that were adopted in IDCGEM, the Industrial Development Corporation's (IDC) CGE model. Before their estimations, elasticities in IDCGEM were adopted from the MONASH model. In their study, the estimations are based on annual data for 25 manufacturing sectors for the period 1973–1993. For the majority of the manufacturing sectors, the results were statistically significant with the expected sign. Most of the elasticities were found to be similar in magnitude to other elasticities estimated by different econometric methods elsewhere (Van Heerden & Van der Merwe, 1997). The second set of estimations was conducted by De Wet (2003). His elasticities were adopted for a CGE model used to evaluate environmental policy (double dividend hypothesis). He used a combination of microeconometric and econometric methods to estimate several elasticities for 45 industries. The elasticities adopted in this study are summarised in Appendix 2.

4.1. The substitution parameter between primary factors

The substitution parameter between primary factors indicates the ease with which an industry can substitute away from primary input a toward primary input b, if primary input a becomes more expensive relative to the other primary inputs. The CES specification implies that the substitution elasticity is constant for all pair-wise substitution possibilities. This means that the substitution elasticity between labour and capital, for all non-land using industries, and the pairwise substitution elasticities between labour, land and capital in each of the land-using industries are similar.

Van Heerden and Van der Merwe (1997) estimated the capital-labour substitution elasticity for 25 manufacturing industries. The highest elasticity of substitution is 0.61 for the *Other Non-Metallic Mineral Products* sector and the lowest value is 0.086 for the *Basic Iron and Steel Products* sector.

De Wet estimated the substitution elasticities between capital and labour for 40 South African industries. The average elasticity of substitution is 0.66. The elasticities vary between the lowest value of 0.17 for *Water Supply* and highest value of 1.45 for the *Communications* industry. De Wet assigns the average elasticity of 0.66 to industries for which significant results could not be estimated. The elasticities indicate that most of South Africa's industries function at an elasticity of substitution of less than one (De Wet, 2003). For this study, the substitution elasticity of 0.4 is adopted.

4.1. The CES substitution elasticities between labour occupations

The labour substitution elasticity determines the sensitivity of industry $i's$ demand for a specific occupation when there are changes in the relative price of occupations. It is very difficult to estimate the substitution elasticities between different occupation types due to lack of data. Dixon *et al.* (1982) cite a study by Ryland and Parham (1978) where the pairwise substitution elasticities for five types of labour are estimated. Although the overall results were not satisfactory, a value of 0.2 was obtained for the labour-labour substitution elasticity where occupational labour inputs were combined by a CES function to generate the overall labour input (Dixon *et al.*, 1982: 190).

Due to institutional and structural factors that characterise the South African labour market, one should not expect a high degree of substitution between the different types of labour. Therefore De Wet (2003) also adopts a labour-substitution value of 0.2. The UPGEM[16] model adopts the ORANI-G[17] labour-substitution elasticity of 0.5. For this study, the MONASH value of 0.35 is adopted for the elasticity of substitution between occupations. The elasticities are summarised in Appendix 2, column 2.

4.2. The elasticities of substitution between domestic and foreign sources of supply

Trade theory often assumes that domestic and imported commodities are perfect substitutes, implying that the elasticity is infinite. This, however, does not explain why there is a demand for a specific commodity from both domestic and imported sources. This led to the Armington assumption. The Armington assumption allows for similar commodities produced by different countries to be imperfect substitutes, with the degree of substitutability governed by the Armington elastisity. A high Armington elasticity implies that an industry is more sensitive to changes in domestic and foreign prices and therefore there is a high degree of substitution. Low elasticities imply that industries are not sensitive to changes in relative prices and therefore there is not a very high degree of substitution between imported and domestic commodities.

Following Dixon *et al.* (1982), it is further assumed that the Armington elasticity is the same for all users, that is: $\sigma^{(1)}_{(c,i)} = \sigma^{(2)}_{(c,i)} = \sigma^{(3)}_{(c)}$ for $c \in COM$ and $i \in IND$. The numbers refer to the users: (1) refers to producers, (2) investors and (3) households. Dixon *et al.* (1982) defend

[16] UPGEM is a static CGE model for South Africa and hosted at the Department of Economics at the University of Pretoria.

[17] ORANI-G is a static CGE model for Australia (Dixon *et al.*, 1982).

this assumption by pointing out that most of Australia's major imports are used predominantly in one end-use category only (Dixon *et al.*, 1982: 182).

For most trade policy models in South Africa, the Armington elasticities estimated by Van Heerden and Van der Merwe (1997) are adopted. The lowest estimated elasticity is 0.57 for the *Other Non-Ferrous Metal Products* sector and the highest elasticity is 4.41 for the *Leather and Leather Products* sector. For some sectors the elasticity is insignificant from zero and where elasticities are not estimated, the elasticities from the Monash model are adopted. The high elasticity values may be attributed to the level of disaggregation of the *Manufacturing* sector. The more disaggregated the sectors, the easier it is to substitute away (towards) from domestic (imported) commodities.

De Wet (2003) estimates the Armington elasticities for 45 South African industries. For industries where the elasticities are either not significant or do not exhibit a cointegrating relationship, the average Armington elasticity of 0.94 is assigned. With the exception of a few industries, most elasticities are less than 1, implying that there is not a very high degree of substitution between imported and domestically produced commodities. De Wet argued that the low elasticities can be attributed to the level of industry aggregation. The 45 industries can be disaggregated further, which may increase the ease of substitution between domestic and imported commodities. The most sensitive industries are the *Civil Engineering* (2.84), *Leather* (1.83), *Building and Construction* industries (1.57). The least sensitive industries are the *Glass* (0.35) and *Coke* (0.47) (De Wet, 2003).

The final South African study under consideration is that of Gibson (2003) where Armington elasticities for 42 industries are estimated. Out of the total, 32 exhibit positive and significant short-term Armington elasticities. The most sensitive sectors are the *Coal Mining* (2.771), *Footwear* (2.04), *Beverages* (1.57), *Leather and Leather* products (1.474). The least sensitive sectors are the *Catering and Accommodation* services (0.42), *Basic Chemicals* (0.677) and *Coke and Refined Petroleum* products (0.73) (Gibson, 2003: 17).

The GTAP database, version 6.0, includes Armington elasticities for South Africa for 57 sectors (Dimaranan, 2006). The highest elasticity is 17.20 for the *Gas* sector and the lowest elasticity is 0.9 for the *Other Non-Metal* sectors.

Comparing the results from the above-mentioned four sources, shows that no obvious pattern can be observed. The only observation is that the GTAP elasticities seem to be higher than the South African estimated elasticities. The implication is that careful consideration should be given if elasticities are adopted from international studies. The reason is that economic structure and policy may differ between countries. In addition to international comparisons, estimates from South African studies yield very different results.

Some of the reasons Gibson (2003) cites are (1) the IDC report estimates Armington elasticities for only intermediate goods while the Gibson study uses data for total production; (2) data may be unreliable and inconsistent; and (3) different econometric methodologies may be used. For further discussion on this topic, see Gibson (2003), Section 6.2. The Armington elasticites used in this study are adopted from Gibson and reported in Appendix 2, column 4.

4.3. The Constant Elasticity of Transformation (CET elasticity)

SAGE allows for industries to produce more than one product. For these industries, a CET product transformation elasticity has to be specified. In a study by Pauw and Edwards (2006), where they evaluate the effects of a wage subsidy scheme for South Africa, a CET of 2 is adopted. The UPGEM model adopts a CET of 0.5 and GTAP reports an elasticity of 0.4. For the purpose of this study, a CET elasticity of 0.5 is adopted. These elasticities are summarised in Appendix 2, column 3.

4.4. Export demand elasticities

The export demand elasticities are important in determining the sensitivity of exports to a change in relative prices. A change in the price of exports $\left(p4_{(c)}\right)$ will not only affect the value of exports $\left(w4_{(c)}\right)$ and the balance of trade, but also the terms of trade and the welfare of a country.

In 2008, South Africa's share in world exports was 0.5 per cent (World Trade Organisation, 2010). Therefore, South Africa is considered to be a small open economy and lacks pricing power in international markets. For this reason, De Wet (2003) did not estimate export elasticities and assumed a value of -4 for all common export commodities. The export elasticities estimated by Van Heerden and Van der Merwe (1997) show the highest elasticity for *Beverages*, and the lowest for *Machinery and Equipment* products (Van Heerden & Van der Merwe, 1997: 50). For all other non-traditional export commodities a value of -1 is adopted. For all traditional exports, except *Gold Mining*, elasticities of -3 are adopted. For *Gold Mining* an export elasticitiy of -100 is adopted (South Africa has a large share in gold exports). The UPGEM model adopts an elasticity of -5 for all traditional and non-traditional commodities. The GTAP database implies elasticities from -34 for *Gas* to -1.8 for *Other Metal NEC*. In this study, the elasticities for all products, except *Owner Dwellings*, are assumed to be -5. For *Owner Dwellings* the elasticitiy is zero. These elasticities are summarised in Appendix 2, column 5.

4.5. The household expenditure and marginal budget shares

For this study, the household expenditure elasticities estimated by De Wet (2003) are adopted. De Wet estimated elasticities for 39 commodities. For commodities where the elasticities are not significant or do not form a cointegrating relationship, the average elasticity is assigned. The elasticities are then scaled to satisfy the Engel aggregation property of demand systems. This property is one of the conditions in the initial database that should not be violated, and states that the sum of the products of each income elasticity multiplied with its budget share must equal unity. This implies that:

$$\sum_{c \in COM} \alpha_{(c)} EPS_{(c)} = 1 \qquad \text{(E4.27)}$$

with

$$\alpha_{(c)} = \frac{V3PUR_{(c)}}{\sum_{c \in COM} V3PUR_{(c)}} \qquad \text{(E4.28)}$$

where
- $\alpha_{(c)}$ is the average budget share of commodity c consumed by household
- $EPS_{(c)}$ is the commodity-specific expenditure elasticities.

By definition, the expenditure elasticity for commodity c can be calculated as:

$$E_{(c)} = \frac{\partial x_{(c)}}{\partial y}\frac{y}{x_{(c)}} = \frac{\partial x_{(c)} p_{(c)}}{\partial y}\frac{y}{x_{(c)} p_{(c)}} \qquad \text{(E4.29)}$$

where
- $x_{(c)}$ is the demand of commodity c;
- y is the household expenditure; and
- $p_{(c)}$ is the price of the commodity c.

By rewriting the above equation it is clear that the expenditure elasticity is equal to the ratio between the marginal budget share $\frac{\partial x_{(c)} p_{(c)}}{\partial y}$ and average budget share, $\frac{x_{(c)} p_{(c)}}{y}$. In SAGE, elasticities are calculated during simulations by taking the average budget shares from the household data and by reading in the marginal budget shares. Hence, it is the marginal budget shares and not the elasticities that form part of the dataset. However, literature only reports income elasticities and not marginal budget shares. Since I know the elasticities and the average budget shares, the marginal budget shares can be calculated as:

$$\Delta_{(c)} = \frac{\partial x_{(c)} p_{(c)}}{\partial y} = E_{(c)} * S_{(c)} \qquad \text{(E4.30)}$$

4.6. Frisch parameter

The linear expenditure system distinguishes between luxury and subsistence demand. It is therefore necessary to determine the ratio of household luxury expenditure to total expenditure. The Frisch parameter is the negative of the ratio between total final household expenditure and luxury expenditure. We can expect that if household income increases, the proportion spent on subsistence will decrease and luxury spending should increase. As a result, we expect that the Frisch parameter for:

- high-income countries to be low; and
- low-income countries to be high.

Both De Wet (2003) and the UPGEM model adopt a value of -1.82 for the Frisch parameter. The Frisch parameter reported in the GTAP database is -3.25.

For SAGE, I estimate the Frisch parameter for South Africa at -2.8. To derive the parameter, household expenditure data from the Income and Expenditure Survey (IES) (Statistics South Africa, 2008b) are used. The Engel law states that as income increases, the proportion of income spent on food declines. At the same time, the proportion of income spent on subsistence commodities will decline, that is, as income increases more income is spent on luxury items.

Given the income and expenditure data, I assign a percentage that each expenditure group will spend on necessities and luxuries. On this basis I calculate the average share of subsistence expenditure in total expenditure to be 64.3 per cent and the share of luxury spending to be 35.7 per cent. From this, the average Frisch parameter for the household expenditure groups can be calculated as -2.80.[18]

[18] The Frisch parameter is calculated as $-\frac{100}{\%luxury\ epending}$, which is $-\frac{100}{35.73} = 2.80$.

5. ADDITIONAL DATA REQUIRED FOR THE DYNAMIC EQUATIONS

5.1. Investment and capital stock

The data estimated for industry-specific capital stock, depreciation rates and trend growth rates of capital are discussed in Section 2.4.11. This section describes additional information, not yet discussed, on how capital adjusts over time. This includes the difference between maximum and trend growth rates of capital, the average sensitivity of capital growth to changes in expected rates on capital, industry asset price of capital, the level of CPI and the real interest rate.

5.1.1. Difference between maximum and trend growth rates of capital

The difference between maximum and trend growth rates of capital is set equal to a fixed 10 per cent for all industries.

5.1.2. Real interest rate

The real interest rate is needed to calculate the expected rates of return on industry capital. The real interest rate for 2002 is 5 per cent.

5.1.3. Asset price of capital

The level of capital asset prices for all industries is normalised at 1 in the base year.

5.1.4. The average sensitivity of capital growth to changes in expected rates of return

The average sensitivity of capital growth to changes in expected rates of return is set at 1.0. This value is adopted from the MONASH database.

5.1.5. CPI and lagged CPI

The SARB provides information on the nominal and real data for private household expenditure. The private consumption price deflators serve as a proxy for the CPI and the lagged CPI. The CPI and lagged CPI are obtained from the *Quarterly Bulletin* and set to 1 and 0.939 (South African Reserve Bank, 2005: S–144).

5.2. Government accounts

The South African public sector comprises different spheres. At the core we have the *central government*, which includes the governmental departments (national government), extra-budgetary agencies and social security funds. The next sphere is the *general government*, which includes the departments of the provincial and local governments to the central government. The final sphere is the *public sector*, which includes the general government and all public corporations. The largest sphere is the general government and therefore the data for the general government, as listed in the SARB *Quarterly Bulletin*, are used for this study.

5.2.1. Revenue and expenditure items

Government revenue and expenditure for 2002 are set out in Table 6. There are three main sources of data. Firstly, Statistics South Africa publishes a detailed account of the total consolidated expenditure by the general government but not the consolidated income[19] (Statistics South Africa, 2004). They also construct the SUT and SAMs (Statistics South Africa, 2006b & 2006c). Secondly, information on the consolidated account of the general government is published by Treasury in the Budget Review (National Treasury, 2004: 69). Finally, the *Quarterly Bulletin*, published by the SARB, includes data on public consumption, net taxes on products and production taxes. It should be noted that there are discrepancies between the different data sources. I therefore use, as the main source for the income and expenditure data, the *Quarterly Bulletin* (South African Reserve Bank, 2005: S–136), as it was the most consistent with the data in the SUTs.

Revenues include indirect taxes, direct taxes and other government revenue. Indirect taxes include all taxes on commodities and imports as well as production tax. This information is in the SUTs and *Quarterly Bulletin*, and the tax flows were constructed in Step 9. Direct taxes include taxes on income and wealth and refer to tax collected from labour and capital income. Other government revenues include income from property, that is, interest and rent receipts as well as other revenues from households, business and the rest of the world. Expenditures include public consumption, public investment and transfers. Transfers consist of benefits and net interest payment. Benefits refer to social benefits paid and other miscellaneous current transfers. Public investment is calculated as the residual as no data is available. The following section includes explanations of more specific items in the government account. The government deficit is 1 per cent of GDP.

[19] Until 2006 only the consolidated expenditures of the general government were published in Statistical release number P9119. As of 2006, both the consolidated expenditures and income are published.

Table 6. Consolidated account of general government (2002) (Rand million)

Revenue		**310,251**
Indirect taxes (V0TAX_CSI)		
consist of:		
Intermediate inputs (V1TAX)	38,954	
Inputs to investment (V2TAX)	5,480	
Consumption (V3TAX)	52,246	
Exports (V4TAX)	0	
Public expenditures (V5TAX)	0	
Imports (V0TAR)	8,218	
Production (V1PTX)	21,543	
Direct taxes (INCTAX)		
consist of:		
Labour (TAX_LAB)	95,972	
Capital (TAX_CAP)	68,807	
Other government revenue		
consists of:		
Other revenue (OTHGOVREV)	19,031	
Expenditure		**326,734**
Public consumption (V5TOT)	215,301	
Public investment (AGGINVG)	29,574	
Transfers (TRANS)		
consist of:		
Transfers and subsidies (BENEFITS)	34,491	
Net interest payments (NETINT_G)	47,368	
Deficit (GOV_DEF)		**-16,483**
GDP as it appears in the SUT (million)		1,168,778
% of GDP		-1.0%

Source: SAGE database.

5.2.2. Tax rates on labour and capital incomes

In SAGE, direct taxes refer to taxes on income and wealth, and are paid by households and business. The tax rates on labour and capital incomes are the average tax rates and are calculated as the tax income across the relevant income category.

Both the *Quarterly Bulletin* (South African Reserve Bank, 2005: S–133) and SUTs publish data on net operating surplus, depreciation and compensation of employees. SAGE records capital rentals as a gross value (gross operating surplus) and therefore the tax rate on capital income is calculated as the ratio of corporate income tax to gross operating surplus. Revenues from corporate taxes for 2002 amounted to R68,807 million, implying that the capital tax rate is 14.3 per cent. Similarly, the tax rate on labour is calculated as the ratio of personal income tax to the compensation of employees. Government revenue from personal income tax was R95,972 million, implying a tax rate of 18.4 per cent. Total current taxes on income and wealth is R164,779 million.

5.2.3. Transfers

Transfers include net payments to households and the rest of the world as well as interest paid on public debt. Net payments to households mainly consist of social benefit payments. For 2002 the value amounts to R34,491 million. Interest payments on public debt amounts to R47,368 million (South African Reserve Bank, 2005: S–55).

5.2.4. Public sector debt and interest paid on public sector debt

Both the South African Reserve Bank and Treasury, as part of the Budget Review, publish data on public sector debt. For 2002 the total government debt amounted to R460,199 million. Domestic debt consists of various marketable and non-marketable bills and bonds (South African Reserve Bank, 2005: S–59). Other debts are a very small part of total debt and include liabilities assumed by national government from the former TBVC (Transkei, Bophuthatswana, Venda and Ciskei) countries, self-governing territories and former regional authorities (South African Reserve Bank, 2005: S–59). Interest paid on public sector debt amounted to R47,368 million, which was 4.5 per cent of the GDP (South African Reserve Bank, 2005: S–55).

5.2.5. Government investment

Government capital investments mainly consist of the acquisition of infrastructure. Due to the lack of detailed government investment per industry, I used the MONASH shares for government investment to distribute aggregate capital investments. As in previous steps, the SAGE industries are mapped to the MONASH industries. The share for 28 SAGE industries is then calculated and used to distribute government investment across all industries. Government investments are highest in government activities such as health (27 per cent), electricity (13.4 per cent), transport (12.8 per cent) and telecommunications (8 per cent).

5.3. Accounts with the rest of the world

The South African Reserve bank published data on the balance of payments (BOP), which corresponds with the data published in the SUT and SAM (2002). The BOP is made up of receipts and payments with the main components being (1) imports and exports of goods and services, (2) net income, (3) net current transfers and (4) net capital transfers. Net income is calculated as compensation of employees, investment income and non-direct investment. Net current transfers and net capital transfers are made to and from the central government and other sources.

5.3.1. Gross national product (GNP)

Nominal GNP is defined as the difference between GDP and the interest paid on foreign debt. In 2002 the value was R1,133,534 million, which is 97 per cent of GDP.

5.3.2. Foreign debt and the interest rate on foreign debt in the base year

Total foreign debt for 2002 was given as R375,409 million (South African Reserve Bank, 2005: S-106). The South African *Quarterly Bulletin* provides data on net investment income, which includes information on dividends and interest on foreign investment. The average interest rate on foreign debt is calculated as the ratio between the interest payments and total stock of foreign debt. The interest was calculated as 5.3 per cent.

5.3.3. Exchange rate

The nominal exchange rate is used in SAGE to convert coefficients valued in foreign currency to South African Rand. In the base year the exchange rate is set at 1.

6. TESTS FOR MODEL VALIDITY

Since SAGE consists of a large number of linearised equations, which have been calibrated by a large database, it is possible that errors may occur. Errors may occur in the database, the equations in the model or in the specification of the model closure. Following Horridge, a number of tests are performed each time the model equations or data are changed (Horridge, 2006: 71).

6.1. Test 1: Real and nominal homogeneity tests

After the database has been created it is useful to test the model theory with the data. One characteristic of SAGE is that economic agents respond to changes in the relative prices and not the absolute price level. This implies that if all exogenous nominal variables, such as the consumer price ($p3tot$), increase by 1 per cent, all endogenous nominal variables will increase by 1 per cent while real variables remain unchanged.

A second characteristic is that SAGE displays constant returns to scale. This implies that if all exogenous real variables are shocked by 1 per cent, all endogenous real variables will increase by 1 per cent. All prices should remain unchanged.

The theory of the model is represented in a number of equations. Most of the equations are written in percentage-change form. Percentage-change equations make it easier to conduct the homogeneity tests because the exogenous percentage-change variables can directly be shocked with 1 per cent. Other equations can be written in ordinary-change form or include ordinary-change variables like ∂Y. These variables are denoted by *del* or the letter $d\_$ followed by the variable name. The correct shock must now be calculated. For example, inventory changes are denoted by *d_x6cs.* The correct shock is 1 per cent of the basic value of inventories, that is, 0.01*BAS6.

6.2. Test 2: GDP from the income and expenditure side should be equal

This test checks that the percentage changes in GDP from the income side and expenditure side are the same. For this test, real household consumption is shocked with 10 per cent. Errors in the database or in the equations may cause GDP from the income and expenditure side to be unequal. In addition to the solution file, the simulation generates an updated database. This updated database is used in Test 3 as the initial solution to a simulation.

6.3. Test 3: Updated database should be balanced

In this test, this updated database, produced in Test 2, is used as the initial database. By using the updated database as the initial solution, Tests 1 and 2 are repeated. The results should be similar to those explained in Tests 1 and 2. If not, there might be an error with the Update statements.

6.4. Test 4: Repeat the above steps using a multistep solution method

Tests 1–3 can be repeated by breaking each simulation into a number of steps. By doing this, more subtle errors can be identified, such as a percentage change variable that is passing through zero or formulae are used to alter data after they have been read in.

6.5. Test 5: Explain the results

It is possible that even if the above tests were successfully performed, errors may still occur. For example, if the export-demand elasticities in the database had the wrong sign, the model would still pass the tests. These types of errors are only detected by careful inspection of the results.

7. CONCLUDING REMARKS

This paper described the structure of the core CGE database developed for a CGE model for South Africa. I explained how the published data was transformed, in 12 steps, into the required format. These steps include creating industry, source and margin flows as well as an *Owner Dwelling* commodity and industry. The final database was scaled as to adhere to the conditions set for a balanced database as well as the national accounts. In addition to the flows, parameters were specified. Together the core database and the parameters are sufficient for static simulations. However, SAGE is a dynamic model and requires additional information regarding capital, rates of return and government accounts. Together, the core database, parameters and additional data form the database required for this study. The database also passed several tests to check the validity of both the model and database.

REFERENCES

Black, A.B., Calitz, E., Steenekamp, T. & Associates. (2007). *Public Economics* (3rd ed.). Oxford University Press.

De Wet, T.J. (2003). *A CGE Model for South Africa: The Database and Elasticities*. Doctoral thesis, Chapter 8, University of Pretoria, Pretoria, South Africa. [http://upetd.up.ac.za/thesis/available/etd-06302004-143319/unrestricted/08chapter8.pdf. Accessed in May 2006]

Dimaranan, B.V. (2006) *Global trade and assistance, and production. The GTAP 6 Data Base*. Center for Global Trade Analysis, Purdue University, West Lafayette.

Dixon, P.B., Parmenter, B.R., Sutton, J. & Vincent, D.P. (1982). *ORANI: A Multisectoral Model of the Australian Economy*. North-Holland, Amsterdam.

Gibson, K.L. (2003). *Armington elasticities for South Africa: Long and short run industry level estimates*. TIPS Working Paper, 12–2003. [http://www.tips.org.za/node/341. Accessed in March 2008]

Giesecke J.A. & Tran, N. (2007). Tax liberalisation for Vietnam, Chapter 2. *A dynamic CGE model for Vietnam*. Centre of Policy Studies, Monash University, Melbourne, Australia.

Harrison, WJ. & Pearson, R.K. (1996). *Computing solutions for large General Equilibrium Models using GEMPACK*. Computational Economics, Volume 9: 83–127.

Horridge, J.M. (2006). *ORANI-G: A Generic Single-Country Computable General Equilibrium Model.* Training document prepared for the Practical GE Modelling Course, Centre of Policy Studies, Monash University, Melbourne.

Pauw, K., and Edwards, L. (2006). *Evaluating the general equilibrium effects of a wage subsidy scheme for South Africa*. South African Journal of Economics, Volume 74(3): 442-462.

Pearson, R.K. (2002). *Solving nonlinear economic models accurately via a linear representation.* Preliminary Working Paper No. IP-55, Centre of Policy Studies, Monash University, Melbourne.

QUANTEC. Economic data. [http://www.quantec.co.za/. Accessed in February 2008]

South African Institute for Chartered Accountants (SAICA). (2007). *Legislation Handbook 2007/2008*. LexisNexis, South Africa.

South African Reserve Bank. Online statistical query (historical macroeconomic timeseries information).

South African Reserve Bank. (2005). *Quarterly Bulletin*. December 2005. Pretoria, South Africa.

Statistics South Africa. (1993). *Standard Industrial Classification of all economic activities* (5th Ed.). [http://www.statssa.gov.za/additional_services/sic/contents.htm. Accessed in July 2007]

Statistics South Africa. (2006a). *Annual Financial Statistics Survey, 2006*. Statistical Release P0021. Pretoria, South Africa.

Statistics South Africa. (2006b). *Final Social Accounting Matrix, 2002*. Report no. 04-03-02 (2002). Pretoria, South Africa.

Statistics South Africa. (2006c). *Final Supply and Use Tables, 2002*. Report no. 04-04-01 (2002). Pretoria, South Africa.

Statistics South Africa. (2007). *Addressing the needs of users for the future compilation of a Social Accounting Matrix*. Document received via e-mail. Pretoria, South Africa.

Statistics South Africa. (2008). *Income and expenditure of household*, 2005/2006. Statistical Release P0100. Pretoria, South Africa.

United Nations. (1999). *Handbook of Input-Output table compilation and analysis*. Series F, No. 74. Department for Economic and Social Affairs, Statistics Division.

Van Heerden, J. & Van der Merwe, F. (1997). *Empirical Estimation of Elasticities in IDC's General Equilibrium Model*. IDC Research Paper Series, TS2/1997.

Appendix 1. Elements in the sets modelled in SAGE

	Commodities	
	Description	**Short name**
1.	Agriculture	Agriculture
2.	Coal	Coal
3.	Gold	Gold
4.	Other mining	OthMining
5.	Food	Food
6.	Textiles	Textiles
7.	Footwear	Footwear
8.	Petroleum and chemical products	PetrolChem
9.	Other non-metallic mineral products	OthNonMet
10.	Basic iron/steel	BasIronStl
11.	Electrical machinery	ElecMach
12.	Radio	Radio
13.	Transport equipment	TransEquip
14.	Other manufacturing	OthManuf
15.	Electricity	Electricity
16.	Water	Water
17.	Construction	Construction
18.	Trade	Trade
19.	Hotel and restaurants	HotelRestaur
20.	Transport services	TransServ
21.	Communications	Communic
22.	Financial intermediation	Financial
23.	Real estate	RealEstate
24.	Business activities	BusinessAct
25.	General government	Government
26.	Health and social work	HealthSoc
27.	Other activities/services	OthAct
28.	Dwellings	OwnerDwel

	Industries	
	Description	**Short name**
1.	Agriculture	Agriculture
2.	Coal	Coal
3.	Gold	Gold
4.	Other mining	OthMining
5.	Food	Food
6.	Textiles	Textiles
7.	Footwear	Footwear
8.	Petroleum and chemical products	PetrolChem
9.	Other non-metallic mineral products	OthNonMet
10.	Basic iron/steel	BasIronStl
11.	Electrical machinery	ElecMach
12.	Radio	Radio
13.	Transport equipment	TransEquip
14.	Other manufacturing	OthManuf
15.	Electricity	Electricity
16.	Water	Water
17.	Construction	Construction
18.	Trade	Trade
19.	Hotel and restaurants	HotelRestaur
20.	Transport services	TransServ
21.	Communications	Communic
22.	Financial intermediation	Financial
23.	Real estate	RealEstate
24.	Business activities	BusinessAct
25.	General government	Government
26.	Health and social work	HealthSoc
27.	Other activities/services	OthActivity
28.	Dwellings	OwnerDwel

Appendix 1 (continue).

	Occupations	
	Description	**Short name**
1.	Legislators	Legislator
2.	Professionals	Profes
3.	Technicians	Technical
4.	Clerks	Clerks
5.	Service workers	Service
6.	Skilled agricultural workers	SkilledAgr
7.	Craft workers	Craft
8.	Plant and machine operators	PlantMach
9.	Elementary occupations	Elementary
10.	Domestic workers	Domestic
11.	Occupation unspecified	Unspecified

	Margin commodities	
	Description	**Short name**
1.	Trade	Trade
2.	Transport services	TransServ

	Source	
	Description	**Short name**
1.	Domestic	Dom
2.	Imports	Imp

Appendix 2. Summary of parameters adopted in SAGE

Industry	Substitution elasticity between primary factors	Substitution elasticity between labour occupations[20]	Elasticity of transformation
	SIGMA1PRIM	SIGMA1LAB	SCET
	(1)	(2)	(3)
(1)Agriculture	0.4	0.35	0.5
(2)Coal	0.4	0.35	0.5
(3)Gold	0.4	0.35	0.5
(4)OthMining	0.4	0.35	0.5
(5)Food	0.4	0.35	0.5
(6)Textiles	0.4	0.35	0.5
(7)Footwear	0.4	0.35	0.5
(8)PetrolChem	0.4	0.35	0.5
(9)OthNonMet	0.4	0.35	0.5
(10)BasIronStl	0.4	0.35	0.5
(11)ElecMach	0.4	0.35	0.5
(12)Radio	0.4	0.35	0.5
(13)TransEquip	0.4	0.35	0.5
(14)OthManuf	0.4	0.35	0.5
(15)Electricity	0.4	0.35	0.5
(16)Water	0.4	0.35	0.5
(17)Construction	0.4	0.35	0.5
(18)Trade	0.4	0.35	0.5
(19)HotelRestaur	0.4	0.35	0.5
(20)TransServ	0.4	0.35	0.5
(21)Communic	0.4	0.35	0.5
(22)Financial	0.4	0.35	0.5
(23)RealEstate	0.4	0.35	0.5
(24)BusinessAct	0.4	0.35	0.5
(25)Government	0.4	0.35	0.5
(26)HealthSoc	0.4	0.35	0.5
(27)OthAct	0.4	0.35	0.5
(28)OwnerDwel	0.4	0.35	0.5

Commodity	Substitution elasticity between domestic and foreign sources of supply	Export demand elasticities
	SIGMA_ARM	EXP_ELAST
	(4)	(5)
(1)Agriculture	1.273	-5
(2)Coal	2.771	-5
(3)Gold	0	-5
(4)OthMining	2.771	-5
(5)Food	0.937	-5
(6)Textiles	1.262	-5
(7)Footwear	2.040	-5
(8)PetrolChem	0.730	-5
(9)OthNonMet	0.655	-5
(10)BasIronStl	0.447	-5
(11)ElecMach	0.944	-5
(12)Radio	0.441	-5
(13)TransEquip	0.505	-5
(14)OthManuf	0.417	-5
(15)Electricity	1.437	-5
(16)Water	0	-5
(17)Construction	0.584	-5
(18)Trade	0.603	-5
(19)HotelRestaur	0.420	-5
(20)TransServ	0.861	-5
(21)Communic	0.568	-5
(22)Financial	0.616	-5
(23)RealEstate	1.066	-5
(24)BusinessAct	1.066	-5
(25)Government	0	-5
(26)HealthSoc	1.135	-5
(27)OthAct	1.065	-5
(28)OwnerDwel	0	0

[20] The substitution parameter is listed by industry and is the same for all occupations.