

South Africa

Cecilia Punt

1. Introduction

This report discusses the treatment of data for South Africa submitted to the Global Trade Analysis Project (GTAP) for inclusion in the version 7 GTAP Data Base. The data for South Africa is for the base year 2005. The final input-output (I-O) table contains 40 sectors, which represents an aggregation of the 57 GTAP sectors. The input-output table was derived from a preliminary aggregated version of the Social Accounting Matrix (SAM) for South Africa for 2005. The most recent supply and use tables published by Statistics South Africa are for 2002 and these were used together with additional data sources for 2005 to derive the I-O table for 2005.

The next section discusses the data sources. Section 3 gives an overview of the disaggregation of selected accounts. Section 4 discusses the method of estimating missing information and balancing in order to derive a consistent SAM with equal row and column totals. The process to transform the SAM into the relevant data tables required by GTAP is discussed in section 5, while the treatment of re-exports is discussed in the final section. The final sectors of the South African data and the mappings between different account sets are presented in the appendix.

2. Main Data Sources

The input-output tables were derived from a preliminary aggregated version of a supply and use SAM for South Africa for 2005 (PROVIDE, 2008). The control totals for 2005 were taken from the South African Reserve Bank (SARB, 2008). The supply and use tables published by Statistics South Africa for 2002 (SSAa, 2006) were used as base for the SAM. The use table contains 94 industries and 95 commodities, while the supply table, which assumes that industries produce multiple products, contain 94 industries and 153 commodities and a mapping is provided by Statistics South Africa to map the 153 commodities to the 95 commodities contained in the use table. The 153 commodities in the supply table were mapped to the 95 commodities in the use table. The aggregated supply table and the original use table were used as base in the SAM. The first set of accounts in Table 2 in the appendix gives an indication of the list of 95 commodities¹. Data for 2005 on imports, exports and import tariffs on traded goods were obtained from the South African Revenue Service (SARS, 2006). The nine sector supply and use tables for 2005 published by Statistics South Africa (SSA, 2007) were also used to provide additional updated information on each of the nine economic sectors.

The sector for dwellings was not disaggregated in the submitted I-O table, but the relevant value reported in the Income and Expenditure Survey for 2005 for South Africa (SSA, 2008) was submitted to GTAP.

¹ Commodity C96 for Domestic Services is not included in the supply and use tables of Statistics South, but is added for purposes of the SAM for South Africa.

3. Disaggregation of Selected Accounts

The supply and use tables for 2002 from Statistics South Africa contain a single account for agriculture, forestry and fishing, but one of the mandatory splits required by GTAP is separate accounts for agriculture on the one hand and forestry and fishing on the other. Another mandatory split is to separate minerals from energy related mining. In the supply and use tables the account for 'other mining products' includes minerals, crude oil and natural gas. GTAP also requires that import tariffs are separated from domestic commodity taxes. The account for net taxes on products contained in the supply and use table was therefore disaggregated into import tariffs and other net taxes on products. Import tariffs for 2005 were obtained from the South African Revenue Service.

For the disaggregation of the data for 'agriculture, forestry and fishing' into three separate accounts, two data sources were used. The gross domestic product (GDP) figures for 2005 published by Statistics South Africa (SSA, 2007) were used to separate the original account into three separate accounts. The 2002 Census of Agriculture (SSAb, 2006) also provided some information on production of forestry and fishing products. Forestry and fishing comprise only 0.5 per cent of GDP of South Africa.

For the disaggregation of the 'other mining' sector into 'crude oil', 'gas' and 'other mining' crude oil was disaggregated first, using additional data from the South Africa Petroleum Industry Association (SAPIA, 2006) and the South African Revenue Service (SARS, 2006). In the supply and use tables for 2002, crude oil is included in the 'other mining' category. However, this category also includes many other economically important but very different commodities, including iron ore, diamonds and mining of chemical substances. However, in the case of crude oil virtually all of the imported crude oil is used solely by the petroleum refineries. Data from South African Revenue Service on import tariffs indicate that there are no import tariffs on crude oil before it reaches the refineries. It is therefore assumed that the value of imported crude oil should equal the difference between the total use of crude oil by the petroleum activity and domestic production of crude oil. The portion of the aggregate 'other mining' imports that relate to crude oil was reported as 81% or R41.68bn in 2005 (SARS, 2006). South Africa does not export crude oil. Domestic crude oil production in 2005 was reported to be 3.3% of total crude oil used (SAPIA, 2006). The entire supply of crude oil is used by the petroleum industry. The SASOL facilities produce oil from coal, the PetroSA facility produces oil from gas and the remainder are conventional crude refineries. The (strong) assumption is made that the values of primary inputs to these facilities are proportional to the volumes of primary outputs. Therefore coal and gas usage is set in order that coal represents 22.5% of primary inputs and gas 6.8%. As gas is still included in the remaining 'other mining' category (after crude oil has been removed), an additional allowance is added for the non-gas inputs in this category for use of the remaining 'other mining' by the petroleum activity.

For the disaggregation of gas from the remaining 'other mining' additional data from the Department of Minerals and Energy (DME) were used. The contribution of natural gas to the primary energy supply was estimated at 3.3 per cent in 2005 (DME, 2008). According to the Department of Minerals and Energy (DME, 2006) 100% of the natural gas production from PetroSA is converted into liquid fuels, supplying about 7 per cent of liquid fuel requirements. For purposes of including values in the supply and use tables, natural gas production and imports were calculated as a share of the respective values for coal and was found to be 2.35 per cent for production and 2.57 per cent for imports. Import tariff and other sales tax rates for gas were assumed to be same as for the 'other mining' category.

4. *Balancing the SAM*

The process of compiling the prior SAM results in a matrix of priors for transactions values in the national SAM, which does not meet the necessary accounting constraints that each account must balance, i.e. receipts and expenditures must equal. The generalised cross entropy method (GCE) (Golan, et al., 1996), which forms the basis of the method applied to the South African data, explicitly assumes the estimation of some data for which there exist measurements, but the measurements are subject to various kinds of (unspecified) measurement error. The GCE method makes use not only of a prior for each magnitude being estimated, but also for characteristics of the measurement error generating process, so as to explain the existing measurements against the estimates. The estimation process then proceeds by estimating error distributions that can explain the measured values against the estimated “actual” values, which are implicitly determined in the process. A benefit of this method is that detailed prior information regarding the measurement process can be incorporated into the estimates, allowing the data base builder not only to specify the magnitude in the SAM, but also influence how these are treated by the estimation procedure. Typically, this functionality is utilised to incorporate a measure of accuracy of the prior data in the process, so that better quality data are given more weight than lower quality data.

A method of top-down SAM estimation and accompanying software for implementing it that were developed as part of the PROVIDE Project (PROVIDE, 2006) was used. A balanced NAM is used as a starting point, and the problem is divided into phases that each effect a degree of disaggregation. Each subsequent phase introduces additional prior data, which cannot affect any estimations from previous phases. The first phase entails balancing a nine-sector SAM, the second phase balances the SAM with 95 commodities and 94 activities, and the third and final phase balances the SAM after disaggregation of forestry and fishing from the main agricultural account, and disaggregation of crude oil and gas from the main ‘other mining’ account. After disaggregation there are 100 commodities in the SAM.

5. *Deriving the GTAP Data Tables from the SAM*

The national accounts matrix (NAM) and the detailed input-output SAM are initially developed according to supply and use principles and after balancing of the SAM the detailed SAM is reduced to an input-output SAM for purposes of deriving the relevant data tables for submission to GTAP. This process is discussed here.

The reduced form input-output SAM was derived following the method of apportionment discussed in Pyatt (2001), following a commodity by commodity production structure as recommended by GTAP. The method proposed by Pyatt appears to give the same results as the programme prepared by GTAP² to be used if there is a non-diagonal make matrix, e.g. when there is production of multiple products by industries and when industry and commodity sets differ. The domestic trade and transport margins were absorbed into the production block of the supply and use SAM before creating the input-output SAM.

The accounts were re-labelled and re-ordered to be consistent with the GTAP specifications. The rows of the I-O table therefore included the accounts for the 100 sectors of the SAM, and accounts for labour, capital, land (zero account), production tax and commodity tax. The column accounts also contained the 100 sector accounts, and accounts

² Used during the GTAP training course on Contributing I-O Tables to the GTAP Data Base that was presented in June 2008 in Helsinki, Finland.

for investment, consumption, government, stock changes, exports, imports, import tax (zero account) and import tariffs.

The remaining steps to produce the relevant data tables consisted of running in GEMPACK the sequence of programmes prepared by GTAP as part of the training course on Contributing I-O Tables to the GTAP Data Base that was presented in June 2008. After loading the initial data and set mappings into HAR files, the programmes do the following: a) check and reorder the initial data, b) split imports, c) split taxes, d) aggregate sectors, and e) convert the data into the final format.

After running the programmes, there is also a set of programmes for checking the data with regard to expected signs, table balances, plausible tax rates and entropy to ensure no unusual shares. These programmes were run and two errors of re-exports were identified. The data adjustments are discussed in the next section. After the original data were adjusted in the Excel file the data was reloaded into the HAR file and all the programmes were run again as a final check.

See Table 2 in the appendix for the set mappings that was used to aggregate the 100 sectors to the 40 sectors in the common set of accounts, i.e. a set of accounts that also represent an aggregation of the GTAP sectors. The mapping from the GTAP sectors to the common set of sectors is presented in Table 3 of the appendix.

6. Dealing with Re-Exports

In the initial category for 'C59 general machinery' there were re-exports. Imports and exports were each decreased by R5 billion (R - South African Rand) to get rid of the re-exports. There were also re-exports of 'C3 gold and uranium', in which case there are no imports, but all re-exports were accounted for by stock changes. In this case stock changes of R1 2 billion (R - South African Rand) were set to zero, in order for exports to equal production.

References

- DME. 2006. Digest of South African Energy Statistics. Pretoria: Department of Minerals and Energy.
- DME. 2008. SA Yearbook 2007/08, Chapter 15 Minerals, Energy and Geology. Pretoria: Department of Minerals and Energy.
- Golan, A., Judge, G. and Miller, D. 1996. Maximum Entropy Econometrics: Robust Estimation with Limited Data. New York: John Wiley & Sons.
- Pyatt, G. 2001. Some Early Multiplier Models of the Relationship between Income Distribution and Production Structure. Economic Systems Research, Vol. 13, No. 2.
- PROVIDE. 2006. Compiling National, Multiregional and Regional Social Accounting Matrices for South Africa. Elsenburg: Western Cape Department of Agriculture.
- PROVIDE. 2008. Compiling a Social Accounting Matrix for South Africa for 2005. Elsenburg: Western Cape Department of Agriculture. Forthcoming.
- SAPIA. 2006. South African Petroleum Industry Association Annual Report 2006. Cape Town: South African Petroleum Industry Association.
- SARB. 2008. South Africa Reserve Bank Quarterly Bulletin: June 2008. Pretoria: South African Reserve Bank.
- SARS. 2006. Import and Export data for 2005. Pretoria: South African Revenue Service.
- SSA. 2006a. Supply and Use Tables 2002. Report no. 04-04-01(2002). Pretoria: Statistics South Africa.
- SSA. 2006b. Census of Commercial Agriculture for 2002. Report no. 11-02-01(2002). Pretoria: Statistics South Africa.
- SSA. 2007. Statistical Release P0441. Gross Domestic Product, Annual Estimates 1993 – 2006, Annual estimates per region 1995 – 2006. Third Quarter 2007. November 2007. Pretoria: Statistics South Africa.
- SSA. 2008. Income and Expenditure Survey for 2005. Pretoria: Statistics South Africa.

Appendix

Table 1. Final sectors of contributed I-O table for South Africa

No	Set name	Description	No	Set name	Description
1	AGR	Agricultural products	21	NMM	Mineral products nec
2	FRS	Forestry	22	I_S	Ferrous metals
3	FSH	Fishing	23	NFM	Metals nec
4	COA	Coal	24	FMP	Metal products
5	OIL	Oil	25	ELE	Electronic equipment
6	GAS	Gas	26	OME	Machinery and equipment nec
7	OMN	Minerals nec	27	MVH	Motor vehicles and parts
8	MEAT	Meat products	28	OTN	Transport equipment nec
9	VOL	Vegetable oils and fats	29	OMF	Manufactures nec
10	MIL	Dairy products	30	ELGAS	Electricity and gas
11	SGR	Sugar	31	WTR	Water
12	OFOOD	Other food	32	CNS	Construction
13	B_T	Beverages and tobacco products	33	TRD	Trade
14	TEX	Textiles	34	TRANS	Transport
15	WAP	Wearing apparel	35	CMN	Communication
16	LEA	Leather products	36	OFI	Financial services nec
17	LUM	Wood products	37	ISR	Insurance
18	PPP	Paper products publishing	38	OBSD	Business services dwellings
19	P_C	Petroleum coal products	39	ROS	Recreational and other services
20	CRP	Chemical rubber plastic products	40	OSG	Public Admin Defence Education Health

Table 2. Sectoral mapping between I-O table for South Africa and common set

No	Set	Description	Final no	Set	Description
1	C1ag	Agricultural products	1	AGR	Agricultural products
2	C1for	Forestry products	2	FRS	Forestry
3	C1fsh	Fishing products	3	FSH	Fishing
4	C2	Coal and lignite products	4	COA	Coal
5	C3	Gold and uranium ore products	7	OMN	Minerals nec
6	C4a	Crude oil	5	OIL	Oil
7	C4b	Gas	6	GAS	Gas
8	C4c	Other mining products	7	OMN	Minerals nec
9	C5	Meat products	8	MEAT	Meat products
10	C6	Fish products	12	OFOOD	Other food
11	C7	Fruit and vegetables products	12	OFOOD	Other food
12	C8	Oils and fats products	9	VOL	Vegetable oils and fats
13	C9	Dairy products	10	MIL	Dairy products
14	C10	Grain mill products	12	OFOOD	Other food
15	C11	Animal feeds	12	OFOOD	Other food
16	C12	Bakery products	12	OFOOD	Other food
17	C13	Sugar products	11	SGR	Sugar
18	C14	Confectionery products	12	OFOOD	Other food

No Set	Description	Final no Set	Description
19 C15	Other food products	12 OFOOD	Other food
20 C16	Beverages and tobacco products	13 B_T	Beverages and tobacco products
21 C17	Textile products	14 TEX	Textiles
22 C18	Made-up textile products	14 TEX	Textiles
23 C19	Carpets	14 TEX	Textiles
24 C20	Other textile products	14 TEX	Textiles
25 C21	Knitting mill products	14 TEX	Textiles
26 C22	Wearing apparel	15 WAP	Wearing apparel
27 C23	Leather products	16 LEA	Leather products
28 C24	Handbags	16 LEA	Leather products
29 C25	Footwear	16 LEA	Leather products
30 C26	Wood products	17 LUM	Wood products
31 C27	Paper products	18 PPP	Paper products publishing
32 C28	Containers of paper	18 PPP	Paper products publishing
33 C29	Other paper products	18 PPP	Paper products publishing
34 C30	Published and printed products	18 PPP	Paper products publishing
35 C31	Recorded media products	18 PPP	Paper products publishing
36 C32	Petroleum products	19 P_C	Petroleum coal products
37 C33	Basic chemical products	20 CRP	Chemical rubber plastic products
38 C34	Fertilizers	20 CRP	Chemical rubber plastic products
39 C35	Primary plastic products	20 CRP	Chemical rubber plastic products
40 C36	Pesticides	20 CRP	Chemical rubber plastic products
41 C37	Paints	20 CRP	Chemical rubber plastic products
42 C38	Pharmaceutical products	20 CRP	Chemical rubber plastic products
43 C39	Soap products	20 CRP	Chemical rubber plastic products
44 C40	Other chemical products	20 CRP	Chemical rubber plastic products
45 C41	Rubber tyres	20 CRP	Chemical rubber plastic products
46 C42	Other rubber products	20 CRP	Chemical rubber plastic products
47 C43	Plastic products	20 CRP	Chemical rubber plastic products
48 C44	Glass products	21 NMM	Mineral products nec
49 C45	Ceramic ware	21 NMM	Mineral products nec
50 C46	Ceramic products	21 NMM	Mineral products nec
51 C47	Cement	21 NMM	Mineral products nec
52 C48	Other non-metallic products	21 NMM	Mineral products nec
53 C49	Iron and steel products	22 I_S	Ferrous metals
54 C50	Non-ferrous metals	23 NFM	Metals nec
55 C51	Structural metal products	24 FMP	Metal products
56 C52	Treated metal products	24 FMP	Metal products
57 C53	General hardware products	24 FMP	Metal products
58 C54	Other fabricated metal products	24 FMP	Metal products
59 C55	Engines	26 OME	Machinery and equipment nec
60 C56	Pumps	26 OME	Machinery and equipment nec
61 C57	Gears	26 OME	Machinery and equipment nec
62 C58	Lifting equipment	26 OME	Machinery and equipment nec
63 C59	General machinery	26 OME	Machinery and equipment nec
64 C60	Agricultural machinery	26 OME	Machinery and equipment nec
65 C61	Machine-tools	26 OME	Machinery and equipment nec

No Set	Description	Final no Set	Description
66 C62	Mining machinery	26 OME	Machinery and equipment nec
67 C63	Food machinery	26 OME	Machinery and equipment nec
68 C64	Other special machinery	26 OME	Machinery and equipment nec
69 C65	Household appliances	26 OME	Machinery and equipment nec
70 C66	Office machinery	25 ELE	Electronic equipment
71 C67	Electric motors	26 OME	Machinery and equipment nec
72 C68	Electricity apparatus	26 OME	Machinery and equipment nec
73 C69	Wire and cable products	26 OME	Machinery and equipment nec
74 C70	Accumulators	26 OME	Machinery and equipment nec
75 C71	Lighting equipment	26 OME	Machinery and equipment nec
76 C72	Other electrical products	26 OME	Machinery and equipment nec
77 C73	Radio and television products	25 ELE	Electronic equipment
78 C74	Optical instruments	26 OME	Machinery and equipment nec
79 C75	Motor vehicles	27 MVH	Motor vehicles and parts
80 C76	Motor vehicles parts	27 MVH	Motor vehicles and parts
81 C77	Other transport products	28 OTN	Transport equipment nec
82 C78	Furniture	29 OMF	Manufactures nec
83 C79	Jewellery	29 OMF	Manufactures nec
84 C80	Other manufacturing	29 OMF	Manufactures nec
85 C81	Electricity and gas	30 ELGAS	Electricity and gas
86 C82	Water	31 WTR	Water
87 C83	Buildings	32 CNS	Construction
88 C84	Other constructions	32 CNS	Construction
89 C85	Trade services	33 TRD	Trade
90 C86	Accommodation	33 TRD	Trade
91 C87	Transport services	34 TRANS	Transport
92 C88	Communications	35 CMN	Communication
93 C89	FSIM	36 OFI	Financial services nec
94 C90	Insurance services	37 ISR	Insurance
95 C91	Real estate services	38 OBSD	Business services Dwellings
96 C92	Other business services	38 OBSD	Business services Dwellings
97 C93	General Government services	40 OSG	Public Administration Defence Education Health
98 C94	Health and social work	40 OSG	Public Administration Defence Education Health
99 C95	Other services and activities	39 ROS	Recreational and other services
100 C96	Domestic services	39 ROS	Recreational and other services

Table 3. Sectoral mapping between GTAP sectors and common set

No Set	Description	Final no Set	Description
1 PDR	Paddy rice	1 AGR	Agricultural products
2 WHT	Wheat	1 AGR	Agricultural products
3 GRO	Cereal grains nec	1 AGR	Agricultural products
4 V_F	Vegetables fruit nuts	1 AGR	Agricultural products
5 OSD	Oil seeds	1 AGR	Agricultural products
6 C_B	Sugar cane sugar beet	1 AGR	Agricultural products
7 PFB	Plant-based fibres	1 AGR	Agricultural products

No Set	Description	Final no Set	Description
8 OCR	Crops nec	1 AGR	Agricultural products
9 CTL	Bovine cattle sheep and goats horses	1 AGR	Agricultural products
10 OAP	Animal products nec	1 AGR	Agricultural products
11 RMK	Raw milk	1 AGR	Agricultural products
12 WOL	Wool silk-worm cocoons	1 AGR	Agricultural products
13 FRS	Forestry	2 FRS	Forestry
14 FSH	Fishing	3 FSH	Fishing
15 COA	Coal	4 COA	Coal
16 OIL	Oil	5 OIL	Oil
17 GAS	Gas	6 GAS	Gas
18 OMN	Minerals nec	7 OMN	Minerals nec
19 CMT	Bovine meat products	8 MEAT	Meat products
20 OMT	Meat products nec	8 MEAT	Meat products
21 VOL	Vegetable oils and fats	9 VOL	Vegetable oils and fats
22 MIL	Dairy products	10 MIL	Dairy products
23 PCR	Processed rice	12 OFOOD	Other food
24 SGR	Sugar	11 SGR	Sugar
25 OFD	Food products nec	12 OFOOD	Other food
26 B_T	Beverages and tobacco products	13 B_T	Beverages and tobacco products
27 TEX	Textiles	14 TEX	Textiles
28 WAP	Wearing apparel	15 WAP	Wearing apparel
29 LEA	Leather products	16 LEA	Leather products
30 LUM	Wood products	17 LUM	Wood products
31 PPP	Paper products publishing	18 PPP	Paper products publishing
32 P_C	Petroleum coal products	19 P_C	Petroleum coal products
33 CRP	Chemical rubber plastic products	20 CRP	Chemical rubber plastic products
NM			
34 M	Mineral products nec	21 NMM	Mineral products nec
35 I_S	Ferrous metals	22 I_S	Ferrous metals
36 NFM	Metals nec	23 NFM	Metals nec
37 FMP	Metal products	24 FMP	Metal products
38 MVH	Motor vehicles and parts	27 MVH	Motor vehicles and parts
39 OTN	Transport equipment nec	28 OTN	Transport equipment nec
40 ELE	Electronic equipment	25 ELE	Electronic equipment
41 OME	Machinery and equipment nec	26 OME	Machinery and equipment nec
42 OMF	Manufactures nec	29 OMF	Manufactures nec
43 ELY	Electricity	30 ELGAS	Electricity and gas
44 GDT	Gas manufacture distribution	30 ELGAS	Electricity and gas
45 WTR	Water	31 WTR	Water
46 CNS	Construction	32 CNS	Construction
47 TRD	Trade	33 TRD	Trade
48 OTP	Transport nec	34 TRANS	Transport
49 WTP	Water transport	34 TRANS	Transport
50 ATP	Air transport	34 TRANS	Transport
51 CMN	Communication	35 CMN	Communication
52 OFI	Financial services nec	36 OFI	Financial services nec
53 ISR	Insurance	37 ISR	Insurance

No Set	Description	Final no Set	Description
54 OBS	Business services nec	38 OBSD	Business services Dwellings
55 ROS	Recreational and other services	39 ROS	Recreational and other services
56 OSG	Public Administration Defence Education Health	40 OSG	Public Administration Defence Education Health
57 DWE	Dwellings	38 OBSD	Business services Dwellings

Technical Papers in this Series

Number	Title	Date
TP2003:1	Creating a 1995 IES Database in Stata	September 2003
TP2003:2	Creating a 1995 OHS and a combined OHS-IES Database in Stata	September 2003
TP2003:3	A Standard Computable General Equilibrium Model Version 3: Technical Documentation	September 2003
TP2004:1	SeeResults: A spreadsheet Application for the Analysis of CGE Model Results	November 2004
TP2004:2	The Organisation of Trade Data for inclusion in Social Accounting Matrix	December 2004
TP2005:1	Creating a 2000 IES-LFS Database in Stata	February 2005
TP2005:2	Forming Representative Household and Factor Groups in a SAM	March 2005
TP2005:3	The PROVIDE Project Standard Computable General Equilibrium Model, Version 2	July 2005
TP2006:1	Compiling National, Multiregional and Regional Social Accounting Matrices for South Africa	November 2006
TP2007:1	An Input-Output Social Accounting Matrix for South Africa and Labour Use and Time Use Satellite Accounts for 2000	September 2007
TP2008:1	Deriving an input-output table for South Africa for submission to the GTAP Data Base version 7	September 2008

Other PROVIDE Publications

Background Paper Series

Working Papers

Research Reports