Project Description:
Provincial Decision-Making Enabling (PROVIDE) Project

Purpose of this Document

To obtain formal approval of and to provide the basic guidelines for a collaborative research project on the development of a sound quantitative base for agricultural policy decision-making at national and inter- as well as intra-provincial level in the Republic of South Africa.

Introduction

The forces of globalisation have led to rapidly increasing international flows of goods, services, capital and new technologies between countries, and consequently to a reduction in the degree of independence in the determination of economic policies. These forces are largely a direct consequence of liberalisation of trade and external capital flows at a world level. South Africa has actively participated in the process of liberalisation, which, combined with the relative isolation of the economy before the economic and political reforms of the last decade, means the pace of change in South Africa has been particularly rapid. The liberalisation of world markets offers potentially large benefits; but only if a country is able to take advantage of the opportunities. However, globalisation carries with it the potential for appreciable adverse impacts and a threat of increased vulnerability to external factors. South Africa is not immune to the effects of these forces, as demonstrated by the recent history of economic policy in South Africa. Consequently, the positions adopted by South Africa in bilateral and multilateral negotiations, and how the economy responds to the forces of globalisation, will be important determinants of the extent to which economic policy decisions contribute to the development goals of South Africa.

While the processes of liberalisation and globalisation may produce growth and development at a macroeconomic level, inevitably they have distributional implications, i.e., there are winners and losers. Changes in prices associated with these processes mean that some production sectors of the economy will need to expand while others remains relatively static or even shrink. Consequently, there will be associated changes in household incomes that will influence the patterns of well being throughout the economy. Although it is well known that policy, and particularly trade, reforms will have both macroeconomic and distributional implications, there is relatively little evidence as to the magnitude of these implications, and even less analysis of how governments may structure reforms to offset the worst implications.

The overall objective of this research is to provide a comprehensive and sound quantitative base for the analysis of the implications of liberalisation and globalisation for the agricultural sectors and rural populations in South Africa, and it regions, within the context of the macroeconomy. This focus is important for 5 reasons. First, agriculture is, and is likely to remain, a major component of South Africa's multilateral and bilateral trade negotiations. Second, it is now well recognised that macroeconomic relationships are important to an understanding of the well being of agricultural sectors, and that the sector can have appreciable macroeconomic effects. Third, poverty is heavily concentrated in the rural populations of South Africa. Fourth, there are appreciable regional differences in South Africa. And fifth, policy reforms are likely to have appreciable environmental consequences, in terms of the need for natural resources, e.g., water.

The specific objectives of the project are:

1. to provide a set of comprehensive Social Accounting Matrices that can be used for quantitative policy analysis;
2. to produce a generic general equilibrium model that can be used to provide *ex ante* evaluations of alternative policy scenarios, and thereby inform both decision-making and negotiating positions;
3. to carry out a series of case studies that address contemporary policy concerns in the regions of South Africa, within South Africa and on the international stage;
4. to build domestic capacity that is capable of carrying forward and developing the research initiated by this project.

Policy relevance

Motivation

Decision-makers in agriculture are normally faced with a multitude of options, problems and opportunities. In this regard South Africa is not unique, and the situation has been compounded since the elections in 1994. These problems and opportunities include the typical global themes of international competitiveness, environmental quality, market deregulation and trade liberalisation. In addition themes, such as food security, tradability, efficiency and equity, need to be addressed, while attention must also be given to typical South African themes, for instance land redistribution and tenure, structural transformation and small farmer development.

In order to solve these problems and realise the opportunities, it is necessary to focus on issues at an appropriate level. At a macro-level, choices are between different policy instruments. At a meso-level, decisions relating to spatial development and equity, comparative advantages, etc., are necessary, albeit not necessarily by the same decision-makers. Although these choices are made within a political framework, they are in pursuit of normative goals. It can further be argued that better choices will be made if these are based on systematic quantitative analyses. Analysis, within this context, can be described as a process of identifying, and quantifying, the costs and benefits of alternative choices, i.e., "what if" scenario analysis.

In the current economic environment there are a large number of policy questions susceptible to this form of economic analysis. South Africa is engaged in a wide range of trade policy negotiations: in particular SACU, Mercosur, World Trade Organisation (WTO), SADC and the Lomé Convention. Fiscal policies remain an on-going concern, e.g., how changes in trade taxes will impact upon the government's budget, and optimal tax regimes subject to given constraints. Particular concerns are how different tax instruments impact upon (production) incentives, and hence structural transformation, and on consumer prices and hence on the incidence of poverty. A major concern is the operation of labour markets and the absorption of unemployed labour. The legacy of constraints on the availability of skilled labour is likely to impose limits upon the rate of structural transformation and the creation of job opportunities. These constraints will be made more binding by the premature loss of skilled labour in critical sectors, e.g., mining, due to the escalating HIV/AIDS epidemic. These macro/meso policy issues can be analysed using Computable General Equilibrium (CGE) models.

CGE models are a class of flex-price multi-sector models that have come to prominence with the increasing emphasis on policy reforms that entail changes in prices, e.g., trade liberalisation, tax reform etc., and the growing forces of globalisation. These models are primarily used to analyse policy options that entail changes in relative prices, as a consequence of domestic policy decisions and/or exogenous shocks/forces. CGE models have concentrated therefore on changes in trade, sectoral and fiscal policies. In all cases the analysis is carried out within a multi-sector framework

and therefore can provide substantial amounts of information about the macroeconomic, sectoral and income distribution implications of policy options.

The implementation of a CGE model requires the compilation of a complete and consistent set of disaggregated national accounts. There are substantial benefits from presenting such national accounts in the form of a Social Accounting Matrix (SAM). As such a prior requirement of any CGE model is an appropriately structured SAM.

Background (SM3)

During 1996 the Sub-Directorate: Agricultural Economics and Finance of the Western Cape Department of Agriculture (WCDOA), in conjunction with the Impact Analysis Unit of the Agricultural Research Council (ARC) embarked on a Strategic Micro and Macro Modelling (SM3) project. The aim of the SM3 project was to develop the necessary enabling framework for systematic quantitative decision making. In the development phase of this framework expertise from the Universities of Pretoria, Western Cape, Stellenbosch, Cape Town (South Africa) and Colorado (USA) and other institutions, such as the Development Bank of Southern Africa, INRA, CIRAD (France) and LEI-DLO (Netherlands), was utilised.

An important output of the SM3 project was a SAM for the Western Cape that emphasised the agricultural and rural sectors (see Eckert *et al*., 1997a). Eckert *et al*., (1997b) and Eckert and Liebenberg (1997) presented the first research results using this SAM. Subsequent research applications can be found in Berning *et al*., (1999) and Berning and McDonald (2000). In the former, some implications of the next round of the WTO negotiations on the economy of the Western Cape were evaluated with the aid of a number of scenarios, while in the latter implications of supply side constraints on agriculture in the Western Cape were quantified.

This SAM for the Western Cape has provided valuable information for decision-makers. However, it followed the structure used by earlier SAMs for South Africa, and consequently has certain structural characteristics that preclude its use as a database for CGE models. It was decided therefore to produce a revised (agriculture) SAM for the Western Cape whose structural characteristics were consistent with the requirements of CGE models. This research is conducted in conjunction with the University of Pretoria and the University of Sheffield, UK. The first results are expected shortly. The Chief Directorate of Agriculture in the Western Cape has therefore established the capacity to maintain the SAM and to use the database to calibrate simple (linear) economic models. A project to develop the capacity to implement flex-price economic models, for example CGE models, at the Chief Directorate has been undertaken for 2001. The specific objectives of the project are a) to produce a standard type of flex-price model b) to carry out a series of case studies that address contemporary policy concerns and c) to build domestic capacity in CGE modelling.

In recent years the Chief Directorate of Agriculture in the Western Cape has made considerable investments in building the capacity for analytical research, especially relating to agricultural issues. This capacity, which is located at Elsenburg, is the origin of the initiative in this collaborative project and a core around which the project can be developed. While the policy analysis focus has previously been the agricultural sector, the current research programme on the Western Cape will provide a database, Social Accounting Matrix, suitable for policy analyses relating to all economic sectors.

Objectives

General Objective

To develop an enabling framework for systematic quantitative assessment of policy options at macro- and meso-level in the agricultural and agribusiness sectors of the provinces of South Africa.

Specific objectives

The following specific objectives will be achieved by the project.

a) *Development of an enabling framework*: Data are essential for quantitative policy analyses. This project will produce Regional SAM databases that are integrated into a SAM database for South Africa, and which are fully documented. The resultant SAMs can be used to calibrate general equilibrium models.

b) *Case studies*: A generic CGE model will be used to analyse some current policy issues. The results of the preliminary analyses will be presented in workshops, and other forums, during the period of the project: the feedback will ensure that the policy issues addressed are responsive to the concerns of practitioners. The policy options analysed for the final reports will be determined by responses to dissemination activities during the project and by consultation with the National and Provincial Departments of Agriculture, industry and the academic community.

c) *Capacity building*: This is a core objective. As the analytical framework will be developed, applied and the results interpreted by local people, a core of expertise will be developed in South Africa. This body of expertise will be available to extend and further develop the indigenous capacity for economic policy analysis, ensuring the long-term sustainability of the project.

Additional Benefits

The project will produce a number of additional benefits. In the main these are by-products of the specific objectives. These benefits include the following.

(a) The analytical framework constructed for the regions will include all sectors of the economy. Consequently the SAMs will provide databases that can be used to evaluate macro-economic implications of trade, fiscal and other policies for all sectors of the economy. Adaptations of the policy models can also be used to examine the regional and national implications of such diverse issues as the HIV/AIDS, mega-projects, etc. The project will provide therefore a versatile tool for macroeconomic analysis for the Provinces.

(b) The classification of commodities will be consistent with the classification scheme used by the Global Trade Analysis Project (GTAP). Therefore the project will contribute to, and be able to benefit from, research activities stemming from GTAP.

(c) The integration of the SAMs for the Regions into an overall SAM for South Africa will facilitate evaluation of the impact of national macro-economic decisions on South Africa and the Provinces and vice versa.

(d) The SAMs will contribute to the creation of integrated economic databases that encompass the member states of SADC. As such the SAMs will enhance the development of research into economic policy analyses and formation in Southern Africa.

(e) The availability of well-structured SAMs will attract domestic and international researchers interested in macro-economic issues. The databases will generate research activities, over and above those of the project. Hence there will be additional value added from the investment.

(f) There are appreciable economies of scale in this type of project. Hence a single program will lead to considerable savings in terms of time and money.

Methods

Social Accounting Matrices

All whole economy models require data that can be presented in the form of a Social Accounting Matrix (SAM). While the construction of a SAM may be a lengthy and complex process, the presentation of the national accounts in a SAM framework has numerous benefits. This has been recognized through the inclusion of Social Accounting Matrices within the Revised (1993) System of National Accounts (SNA). First, a SAM is a complete and consistent set of economic and social accounts for a nation and/or a region. Hence, a SAM can be used as a framework to impose completeness and consistency on the economic and social data for a country and/or region. Second, a SAM provides a large amount of descriptive information about the economic and social structures and state of development of an economy: as such it is a source of information that can inform the policy formation process. And third, a SNA consistent SAM provides the data required for all whole economy models.

A SAM is therefore a valuable accounting and descriptive tool, which provides consistent information about a region, e.g., the structure of production, distribution of income, trade relationships etc., and can be used to guide policy making. In recent years the use of SAMs as a basis for more wide-ranging economic models has increased substantially. Early models, e.g., multiplier models, precluded detailed analysis of the effects of changes in prices, whereas more recent models, i.e., CGE models, have emphasised price changes.

A core requirement of this project is therefore the construction of a series of integrated SAMs for South Africa and its regions. The benchmark is a SAM for South Africa. This project will start from a SAM for 1993 developed at the Universities of Pretoria and Sheffield (McDonald, 2000a). This SAM, *inter alia*, uses data from the recently revised national accounts (SARB, 1999), the 1993 supply and use tables (SSA, 1999), and the 1995 Income and Expenditure and October Household Surveys (CSS, 1997a and 1997b). For the regional disaggregation it could be argued that a SAM should be developed for each of the provinces. However, a number of general considerations argue against this approach.

a) Within a nation state political and economic boundaries are not necessarily synonymous. Where economic regions encompass more than one political region it is difficult to justify independent economic models since the determinants of price formation are common.
b) Province specific concerns can often be captured by the choice of accounts in the SAMs.
c) The economic characteristics of some of the provinces are similar, and therefore the marginal benefits of dissagregation will be minimal.
d) There is a necessary compromise between detail and costs. The costs of integrating Regional and National SAM will escalate exponentially as number of SAMs is increased.

With reference to (d) above, an understanding of the scale of the extra cost of moving to a structure with nine province specific SAMs can be gained from a schematic representation of the data base (Figure 1). The components on the principal diagonal, in bold type, are the intra-regional transactions for each region, which will be captured in matrices that contain about 290 rows and

columns[1]. The other submatrices, except for those in the final row and column are of the same dimensions and record the transactions between regions. The final row and column of submatrices record transactions with the rest of the world and will contain between 4 and 10 rows and columns respectively. Consequently the envisaged database would contain approximately 1.3m datapoints, although many of these will be zeros. Extending the database to cover all nine provinces would increase the number of datapoints to approximately 6.8 m. Since many of the datapoints referring to inter regional transactions will be zeros these numbers overstate the scale of the problem, but data on inter regional transactions are very limited and therefore the most challenging part of the data estimation problem.

It is realistic to expect that extending the database to cover all nine provinces would very substantially increase the cost of the project – at least by a factor of two – while increasing the risk of the project failing to fully deliver the planned outputs, and reducing the degree of detail available for each region/province.

Figure 1 Schematic Representation of SAM Database for 4 Regions

	Region 1	Region 2	Region 3	Region 4	Rest of World
Region 1	**R1:R1**	R1:R2	R1:R3	R1:R4	R1:W
Region 2	R2:R1	**R2:R2**	R2:R3	R2:R4	R2:W
Region 3	R3:R1	R3:R2	**R3:R3**	R3:R4	R3:W
Region 4	R4:R1	R4:R2	R4:R3	**R4:R4**	R4:W
Rest of World	W:R1	W:R2	W:R3	W:R4	

Nevertheless it is recognised that there are province level concerns that are important and that the project should seek to address. It is therefore proposed that opportunities offered through the choice of accounts for each region will be exploited. These possibilities relate specifically to the household, regional government and activity/industry accounts.

For the household accounts it is proposed that the household groups distinguish between households on the basis of racial group, income level and residential location both within and between provinces, i.e., province specific household groups will be identified. This will ensure the results of policy analyses can provide information on the income distribution implications for each province. Province specific government accounts can be identified for each province.

The activity accounts can also take account of province specific concerns. For agriculture it was already proposed to estimate transactions for agricultural activities based on agronomic regions. This will be retained. For other production sectors it is proposed that the disaggregation of industries by province be limited to industries of strategic importance. The details of the sectoral/activity disaggregation should be agreed BEFORE the commencement of the project. This additional detail can be used to extend the scope of viable sectoral analyses, and thereby extend the depth of analyses for agriculture to other sectors.

It is therefore recommended that four Regional SAMs are developed, and these are integrated with a National SAM for South Africa. The nine provinces of South Africa can be divided into two main groups; the four coastal provinces with commercial ports and the five central provinces. The coastal provinces can be further subdivided into the two west coast provinces and the two east coast provinces. And the five central provinces can also be subdivided into two groups; the two most

[1] This estimate is based on the dimensions of the current SAM for the Western Cape.

northern border provinces and the three central provinces. The proposed Regional SAMs are identified below with brief reasons for the proposed groupings.

1) *Western Cape and Northern Cape*
   - Coastal provinces that include winter rainfall areas, large tracts of semi-arid grazing and irrigated long-term crops of high importance.
   - The only two provinces where Africans are not in the majority, but more than half of the population consist of Coloureds.
   - Relatively high per capita income compared to other provinces (ranking second and third respectively).
   - Limited natural resources, with small industrial base but substantial financial centre.
2) *Eastern Cape and KwaZulu-Natal*
   - Coastal areas with summer rainfall and subtropical climate.
   - Large previously disadvantaged agricultural communities.
   - Relatively low per capita income compared to other provinces (ranking eighth and sixth respectively).
   - Limited natural resources, but substantial industrial base.
3) *Northern Province and North-West*
   - Border provinces with summer rainfall and large previously disadvantaged agricultural communities.
   - Two of the poorest provinces in the country in terms of per capita income.
   - Significant contributors to the gross geographic product of the mining and quarrying industry and the electricity, water and gas industry, but minimal industrial base.
4) *Gauteng, Mpumalanga and Free State*
   - Central provinces with summer rainfall and the main market in the Gauteng area.
   - Significant contributors to the gross geographic product of the mining and quarrying industry.
   - Substantial industrial base and main financial centre.

The Regional SAMs will be developments of the SAM for the Western Cape, which was compiled at the Chief Directorate of Agriculture in the Western Cape, and the SAM for South Africa compiled at the Universities of Sheffield and Pretoria. Details of the SAM structure and the methodology are provided in the appendix.

Generic Computable General Equilibrium Model

The generic CGE model will be a derivative of an earlier model for South Africa (McDonald and Kirsten, 1999; McDonald, 2000b). The most notable feature of the model will be the allowance for secondary production, i.e., activities (industries) are allowed to produce more than one commodity. This feature will permit the model to draw directly upon SAMs produced in accordance with the SNA, and ensures the model will be a more realistic representation of real economies. This will be particularly relevant when modelling agriculture and the food system since they are typically characterised by multi-product industries. It also means that exports will be from the commodity accounts rather than the activity accounts. These features will distinguish the model from the large majority of CGE models that have followed Dervis *et al*., (1982).

Other notable features of the CGE model will be the following. The model will be specified as a mixed complementarity problem (see Rutherford, 1995, and Lofgren and Robinson, 1997), allow for the modelling of transport and marketing margins, and include provision for modelling the effects of 'own-production for own-consumption' upon the economy.

The model will be in the general class of neoclassical models, although this will not necessarily limit the degree of generality. Hence, full employment will not be assumed in the

general case; the model will allow factor specific assumptions about the extent of employment, one of which is full employment. Similarly the model will allow for varying degrees of imperfect competition.

Further details about the model are given in the appendices.

Outputs

This project will produce outputs that can be classified under three headings.

Databases

The primary data outputs will be a series of SAMs and their accompanying documentation. These SAMs will provide all the data needed to construct general equilibrium models for general economic and agricultural policy analyses at the level of the regions and the nation. The databases will initially be benchmarked to the National Accounts for 1997. If the requisite data are forthcoming from Statistics South Africa and South African Reserve Bank during the first two years of the project, the SAMs will be updated. Provisional supply and use tables are planned for 2001, which may allow provisional updating of the SAMs, but full updating must await final supply and use tables and the publication of a new Income and Expenditure Survey. Specifically the following will be published.

a) Two Supply and Use SAMs for each of the four Regions and South Africa will be produced. These SAMs will follow the structures detailed in the appendix. The first (General) SAM will contain single commodity and activity accounts for agriculture, whereas the second (Agriculture) SAM will contain multiple commodity and activity accounts for agriculture.
b) Two four-region SAMs for South Africa will be produced. These will integrate the data for the whole economy and the Regions, and quantify the inter-region transactions.
c) Input-output SAMs for the four Regions and South Africa will be produced. These SAMs will be organised for use in SAM-Leontief models.
d) A series of SAM-Leontief multipliers and their decompositions will be produced using a range of aggregations of the input-output SAMs.
e) All the SAMs will be available in electronic form.
f) Data manuals will be produced for each Region and South Africa. The manuals will contain details about the methods used, data sources, definitions and conventions used. The computer programmes used to develop the databases will also be made available to ensure the databases are replicable and/or can be updated at least cost.

The databases will be made available free to the funding agencies. Use of the databases for profit will be subject to payment of the economic cost; the revenue will be used to support the research project.

Capacity Building

Capacity building is a fundamental component of the project. An important aspect of the capacity building programme will be close links with Universities. The research assistants for the project will be required to register for a research Master's Degree or a research postgraduate degree (PhD) at a cooperating university department.

The dissertations or theses of the research assistants will constitute an output of the project, while the examination process will provide quality control. The requirement for originality in research theses will ensure additional, but *a priori* unquantifiable, outputs from the project.

Policy Analyses

A generic CGE model will be developed and calibrated for each of the Regions. These models will be used to carry out a series of policy experiments. Full documentation of models will be included in the final report along with core code for the computer model.

Policy Experiments

The three-year life cycle of the project means it is difficult to provide precise specifications of the policy experiments that will be conducted, e.g., policy experiments related to trade negotiations will be calibrated to proposals emanating from the negotiations. The policy experiments below are therefore general rather than specific. The final report for the project will contain five policy experiments for each of the Regions. The precise experiments will be determined by discussion with the Steering Committee and by feedback received from the workshops.

The results from the policy experiments will typically emphasise the implications of the 'policy' changes for the internal and external balances of South Africa, the implications for income distribution, the implied changes in the structure of industry, and employment. The weight given to each dimension of the result will depend upon the specific policy issues under examination.

Trade Policy Experiments

Trade policy experiments would encompass the main bilateral and multilateral trade agreements that involve South Africa with special reference to external balances. They might include

1. WTO scenarios – evaluations of changes in agricultural trade policy instruments and regimes implied by the on-going negotiations;
2. EU SA FTA scenarios – evaluations of the impact of changes in EU policies on agriculture consequent upon the EU SA FTA;
3. SADC/SACU scenarios – evaluations of the implications of Southern African integration on agriculture.
4. MERCOSUR SA scenarios – evaluations of the implications of South Africa entering into a trade agreement with the MERCOSUR trade block.

Fiscal Policy Experiments

Experiments under this heading would encompass concerns about the internal balances. They might include

1. the implications of changes in trade taxes driven by international agreements;
2. the implications of VAT and income taxes changes.

Sectoral Policy Experiments

Sectoral policy experiments would concentrate upon how changes in the structures of production would impact upon welfare. They might include

1. supply responses consequent upon liberalization of world trade in agricultural products;
2. impact of labour legislation on employment in agriculture;
3. impact of natural resource (e.g. water) availability on agricultural production;

4. impact of HIV/AIDS on the availability of labour to the agricultural industries and consequently the impact on the supply of agricultural products.

Dissemination Activities

Dissemination activities will be an important dimension of the project. Various ways of disseminating information will be implemented. In particular

- biannual workshops will be used to formalise dialogue between the researchers, stakeholders, academics and industry;
- conference presentations and publications will be used to disseminate information about the project to wider audiences;
- discussion/working papers will disseminate both detailed technical information and the results of policy on an on-going basis;
- a web site will reduce the cost of dissemination both for the project and recipients.

Underpinning the dissemination activities is recognition of the importance of networking. While the project will gather together and develop technical expertise, only a subset of the skills required for expert quantitative policy analyses will be available to the team on a daily basis. To ensure policy relevance the project will approach various institutions and experts, both within and outside South Africa, with regard to the policy analysis. Such experts will be invited to the project specific workshops, while conference contributions will be used to extend and develop the circle of experts.

Management Arrangements

Programme and Costs

Programme of Research

In order to ensure effective management and control, the project will be divided into a number of distinct phases. These phases will nevertheless, where possible, be completed in unison and not successively.

Phase 1

The first or preliminary phase of the project starts with securing of funding for the project, securing co-ownership for the project from the provinces and the national government, finding appropriate researchers for the project, the initial training of these researchers and finalising the management structure of the project. Due to considerations such as the financial and academic years as well as the rigorous recruitment and selection process that is foreseen, this phase will start in October 2001 and conclude in March 2002.

Criteria for the evaluation of the successful completion of this phase include:

a) The management structure of the project is in place.
b) The infrastructure for the support of the project is in place.
c) The researchers successfully complete their initial training.

Phase 2

During the second or development phase the emphasis will be placed on the development of the analytical framework. This will include securing data, developing the SAMs for the provinces and developing a prototype CGE model. Training of the research assistants with regard to GAMS and CGE modelling will take place at the University of Sheffield during February and March 2003

using part of an established postgraduate training programme. On-going technical training in SAMs, CGE models and GAMS software will be provided by the resource person. In the main this will take place in South Africa, with, if necessary, additional training for the project leader at the University of Sheffield. This phase of the project will take approximately 18 months to complete, i.e., by September 2003. However, the databases will be continuously revised as, and when, new data become available.

Criteria for the evaluation of the successful completion of this phase include:

a) Supply and Use SAMs for each provincial group.
b) Input-output SAMs for each provincial group.
c) Multipliers for each provincial group.
d) Structure of a generic CGE model completed.

Phase 3

The third (analytical) phase of the project will start with a workshop in June 2003. The objective of this workshop will be to determine and prioritise specific questions to be analysed with the CGE models. These questions could include *inter alia* trade and development policies and structural issues at an international, national and/or provincial level. Results will be made available in a series of research reports. The questions, results, and priorities will be evaluated on a six-monthly basis. Depending on the results of phase 4, the project will conclude by the end of March 2005.

Criteria for the evaluation of the successful completion of this phase include:

a) The relevance of the questions being answered by the project.
b) The content and relevance of the research reports.

Phase 4

The final (evaluation) phase will shift the emphasis to the evaluation of the project.

Criteria to be used include:

a) Did the project provide useful results?
b) Should the project be extended for another fixed term?

<u>Research Infrastructure</u>

It is proposed that a research unit be established at a specific geographic location. The reasons include:

a) The natural synergy and interactive problem solving capacity of a group of people located at a specific location is higher than if those same people are geographically dispersed.
b) Although modern communication technology increases the possibility of interaction over distance, it still cannot replace regular face-to-face interaction.
c) People in geographically dispersed locations tend to become distracted from their work by priorities of those around them.

Since the capacity that is located at Elsenburg is the origin of the initiative in this collaborative project and a core around which the project can be developed, it is proposed that the research unit be established at Elsenburg. The Chief Directorate: Agriculture of the Western Cape Province is prepared to provide physical infrastructure, such as office space, for the purposes of this project. Researchers will have access to the library resources of the University of Stellenbosch. Other research requirements, such as computers, acquisition of data, etc., will be budgeted for.

Research Team

A group of six persons will be required for this project. The group will consist of four research assistants; each of whom will be responsible for a specific region and a junior researcher responsible for providing assistance to the project's researchers during the first half of the project with regard to data collection. The sixth person will be the project leader. S/he will coordinate the research project and provide leadership and technical guidance to the research assistants on a daily basis.

The criteria for selecting the research assistants include:

a) South African citizenship;
b) an Honors or Masters degree in Economics, Agricultural Economics or related subject;
c) a strong record of achievement in mathematical, quantitative and computing skills;
d) an interest in a career in economics/agricultural economics research;
e) a determination to study for a Master's Degree or a PhD.

At least two members of the research team, and preferably more, should be drawn from previously disadvantaged groups. Every effort will be made to attract candidates from such groups, and allowance must be made in the budget to provide additional training to aid recruitment of persons from previously disadvantaged groups.

Technical skills currently not available in South Africa will be provided by an external resource person. Dr Scott McDonald of the University of Sheffield, UK, and the University of Pretoria has indicated a willingness to act as resource person for the project. This arrangement would involve the appointment of an assistant to work on the project at the University of Sheffield. This will release Dr McDonald from other duties, provide additional technical support for the research time and generate additional research outputs. The involvement of an external academic will also facilitate post-graduate studies by the research assistants.

Management

The day to day management of the project will be the responsibility of the project leader who will act in consultation with the Assistant Director: Agricultural Economics. A steering committee consisting of nine provincial representatives and one representative from the National Department of Agriculture, will be responsible for the following:

- Brief ITCA
- Finalise the workplan
- Finalise the budget in accordance with proposed adjustments to the proposal
- Set the terms of reference for other Parties involved in the project
- Finalise the commitment agreements
- Identify feasible case studies and priorities of the project
- Decide on capacity building training program for project committee
- Decide on the form of research infrastructure that will be established in all nine provinces.
- Decide on province specific concerns that need to be captured by the choice of accounts in the SAMs.

Each member of the steering committee will appoint a provincial member to serve on the project committee. The main function of the project committee will be to assist the research team in data collection, organising workshops, interpretation of results, etc. The Steering Committee will also be responsible for selecting a technical advisory committee consisting of experts, both from South Africa and abroad, in the field of SAM and CGE modelling. The main function of the technical advisory committee will be to evaluate the technical accuracy of the research outputs.

Timetable

Period	Dates	Elsenburg	Sheffield	Output
1	Oct -March 2002	Selection of Researchers, basic IO and Computer training	SAM Structures	
2	April - March 2003	SAM data collection	RSA CGE model	Provisional Regional SAMs, National CGE model results
3	April-Sept 2003	SAM-Leontief models	Regional CGE model structure	Final Regional SAMs, Regional SAM-Leontief model results
4	Oct-March 2004	Regional CGE models	Multi-region CGE model structure	National and Regional CGE model results
5	April-Sept 2004	Multi-region CGE model	Model refinements	Multi regional Model results
6	Oct-March 2005	Final report	Final report	Closing workshop

Training

Period	Dates	Staff	Research	Training	Location	Students	Staff
1	Oct - March 2002	PL + SRA	Orientation	Intro to Excel	Elsenburg	RAs	6 wks
2	April - Sept 2002	PL + SRA	Preliminary Data Collection	Intro to IO & SAMs	Elsenburg	RAs	3 wks
3	Oct - March 2003	PL	Data Classification	Intro to GAMS	Elsenburg	RAs	6 wks
		SMcD + SRA		Intro to CGE Models	Sheffield	RAs	6 wks
4	April - Sept 2003	SMcD	Regional SAM Balancing	GAMS & Matrix Balancing	Elsenburg	PL + RAs	2 wks
		SMcD + PL + SRA	Simple CGE Models	Simple CGE Models	Elsenburg	RAs	3 wks
5	Oct - March 2004	SMcD + PL + SRA	CGE Models	CGE Models	Elsenburg	RAs	3 wks
6	April - Sept 2004	SMcD + PL + SRA	Policy Analyses	Problem Solving in GAMS	Elsenburg	RAs	3 wks
7	Oct - March 2005	SMcD + PL	Policy Analyses	Problem Solving in GAMS	Elsenburg	RAs	3 wks

SRA: Sheffield based research assistant
PL: Project leader
RA: Research assistant
SMcD: Dr Scott McDonald

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APPENDICES

Appendix I Social Accounting Matrices

Introduction

The SAMs for the regions will be integrated with a SAM for South Africa. This approach has four major advantages. First, many of the data sources for the national and regional SAMs are common. Second, adopting a common structure for the SAMs means that computer programmes written for the national SAM can be transformed for use with the regional SAMs. Third, integrating the SAMs allows the use of the SAMs to analyse the economic relationships between a region and the rest of South Africa. And fourth, a consistent SAM for South Africa exists (McDonald, 2000a). The net effect of these advantages is to reduce the cost of constructing the SAMs for the regions while increasing the amount of useful information.

The initial regional SAMs produced by this project will be for 1993; the year of the latest available Census of Manufacturing. However a substantial proportion of the data will relate to 1995. This is the year closest to 1993 for which an Income and Expenditure and Household Surveys were conducted. It also has an additional advantage: a Census of Manufacturing was conducted in 1996 and when its results become available, probably in 2000, updated SAMs can be estimated.

The general method of construction will follow Stone (1962) and the System of National Accounts (UN, 1993). More specifically, the general approach and method follow that of McDonald (2000a) and McDonald and Berning (2000) and incorporate recent developments in information theory and maximum entropy econometrics (see McDonald and Robinson, 1998, for an application). This appendix provides a brief introduction.

Structure of SAMs for South Africa and the Regions

The structure for the regional SAMs will be the same as that adopted for South Africa, see Figure 1 for an overview and Tables A1 to A4 for details about the accounts. The most distinctive feature of this SAM, in contrast to previous SAMs for South Africa, is the separate identification of commodity and activity (industry) accounts. At the core of the SAM are the supply and use matrices for 1993, which have recently been released by Statistics South Africa; these contain the latest available structural data on production in South Africa. As more later production data becomes available the SAMs can be revised. The separation of commodity and activity accounts ensures that trade relationships are recorded in a manner amenable to CGE models: the types of SAMs previously developed for South Africa are one of a number of reduced form SAMs that can be produced from this more general form of SAM.

There are a number of other developments in the structure of the SAM. The classification of households adopted for the SAM is different from that previously used for South Africa. In addition

to distinguishing between households on the basis of racial group and income, these SAMs also identify households by their location (urban/rural). Moreover, the number of household groups for each racial group is not the same. The household groups have been determined by reference to household characteristics identified from data in the Income and Expenditure and October Household Survey. The household groups identified necessarily involve degrees of compromise. Not only must the choice of household groups reflect population structure, it must also reflect the distribution of income. The net effect is a set of household groups that more closely reflect the structure of the South African population than the traditional race and quintile structure.

The other major difference is the inclusion of an account for Corporations. This was an important omission because substantial proportions of household incomes are remitted via Corporations rather than form direct sales of factor services.

The final development is the disaggregation of the agricultural accounts. The initial SAMs will be produced with a single account for agricultural commodities and activities: these SAMs can be used immediately for economic analysis relevant to the Province. The agriculture accounts will then be disaggregated in two ways. First, different farm types, defined by agronomic areas, will be identified as separate activities. The farm types will therefore be region specific. Second, a range of agricultural commodities will be identified, e.g., wheat, maize, wine, deciduous fruits, beef, etc. The commodity accounts will be the same for all regions. In part because of the need to map inter-regional trade flows, but also to facilitate inter-regional comparisons of the implications for households. The classification of commodities will be reducible to the commodity account structure used by the Global Trade Analysis Project (GTAP). This will allow the project to benefit immediately from the results stemming from GTAP.

A full listing of the (proposed) accounts is given in Tables A1 to A4. These tables are based on the existing SAMs for South Africa and Western Cape, but only include single commodity and activity accounts for agriculture. Table A4 details the commodity and activity accounts for used in the Western Cape SAM; hence these accounts are only illustrative, the final accounts will depend upon the specific data available for each region.

Table A1 Commodity and Activity Accounts

No.	Commodity and Activity Accounts	No.	Commodity and Activity Accounts (continued)	No.	Commodity and Activity Accounts (continued)
1	Agricultural products	33	Basic chemical products	65	Household appliances
2	Coal and lignite products	34	Fertilizers	66	Office machinery
3	Gold and uranium ore products	35	Primary plastic products	67	Electric motors
4	Other mining products	36	Pesticides	68	Electricity apparatus
5	Meat products	37	Paints	69	Wire and cable products
6	Fish products	38	Pharmaceutical products	70	Accumulators
7	Fruit and vegetables products	39	Soap products	71	Lighting equipment
8	Oils and fats products	40	Other chemical products	72	Other electrical products
9	Dairy products	41	Rubber tyres	73	Radio and television products
10	Grain mill products	42	Other rubber products	74	Optical instruments
11	Animal feeds	43	Plastic products	75	Motor vehicles
12	Bakery products	44	Glass products	76	Motor vehicles parts
13	Sugar products	45	Ceramicware	77	Other transport products
14	Confectionary products	46	Ceramic products	78	Furniture
15	Other food products	47	Cement	79	Jewellery
16	Beverages and tobacco products	48	Other non-metallic products	80	Other manufacturing
17	Textile products	49	Iron and steel products	81	Electricity
18	Made-up textile products	50	Non-ferrous metals	82	Water
19	Carpets	51	Structural metal products	83	Buildings
20	Other textile products	52	Treated metal products	84	Other constructions
21	Knitting mill products	53	General hardware products	85	Trade services
22	Wearing apparel	54	Other fabricated metal products	86	Accommodation
23	Leather products	55	Engines	87	Transport services
24	Handbags	56	Pumps	88	Communications
25	Footwear	57	Gears	89	FSIM
26	Wood products	58	Lifting equipment	90	Insurance services
27	Paper products	59	General machinery	91	Real estate services
28	Containers of paper	60	Agricultural machinery	92	Other business services
29	Other paper products	61	Machine-tools	93	General Government services
30	Published and printed products	62	Mining machinery	94	Health and social work
31	Recorded media products	63	Food machinery	95	Other services / activities
32	Petroleum products	64	Other special machinery		

Table A2 Factor and Household Accounts

No.	Factor accounts	No.	Factor accounts (continued)
1	Gross Operating Surplus		
2	African Legislators, senior officials and managers	24	Asian Legislators, senior officials and managers
3	African Professionals	25	Asian Professionals
4	African Technicians and associate professionals	26	Asian Technicians and associate professionals
5	African Clerks	27	Asian Clerks
6	African Service workers and shop market sales workers	28	Asian Service workers and shop market sales workers
7	African Skilled agricultural and fishery workers	29	Asian Skilled agricultural and fishery workers
8	African Craft and related trades workers	30	Asian Craft and related trades workers
9	African Plant and machine operators and assemblers	31	Asian Plant and machine operators and assemblers
10	African Elementary occupations	32	Asian Elementary occupations
11	African Unspecified	33	Asian Unspecified
12	African Armed forces	34	Asian Armed forces
13	Coloured Legislators, senior officials and managers	35	White Legislators, senior officials and managers
14	Coloured Professionals	36	White Professionals
15	Coloured Technicians and associate professionals	37	White Technicians and associate professionals
16	Coloured Clerks	38	White Clerks
17	Coloured Service workers and shop market sales workers	39	White Service workers and shop market sales workers
18	Coloured Skilled agricultural and fishery workers	40	White Skilled agricultural and fishery workers
19	Coloured Craft and related trades workers	41	White Craft and related trades workers
20	Coloured Plant and machine operators and assemblers	42	White Plant and machine operators and assemblers
21	Coloured Elementary occupations	43	White Elementary occupations
22	Coloured Unspecified	44	White Unspecified
23	Coloured Armed forces	45	White Armed forces

Table A2 Factor and Household Accounts (continued)

No.	Household accounts	No.	Household accounts (continued)
1	African Urban Quintile 1	16	Coloured Urban Quintile 3b
2	African Urban Quintile 2	17	Coloured Rural Quintile 1
3	African Urban Quintile 3	18	Coloured Rural Quintile 2a
4	African Urban Quintile 4	19	Coloured Rural Quintile 2b
5	African Urban Quintile 5a	20	Asian Quintile 1
6	African Urban Quintile 5b	21	Asian Quintile 2a
7	African Rural Quintile 1	22	Asian Quintile 2b
8	African Rural Quintile 2	23	White Urban Quintile 1
9	African Rural Quintile 3	24	White Urban Quintile 2
10	African Rural Quintile 4	25	White Urban Quintile 3
11	African Rural Quintile 5a	26	White Urban Quintile 4a
12	African Rural Quintile 5b	27	White Urban Quintile 4b
13	Coloured Urban Quintile 1	28	White Rural Quintile 1
14	Coloured Urban Quintile 2	29	White Rural Quintile 2a
15	Coloured Urban Quintile 3a	30	White Rural Quintile 2b

Table A3 Other Accounts

No.	Other Accounts	No.	Other Accounts (continued)
1	Business Enterprises	11	Government Consolidated
2	Commodity Taxes	12	Provincial Government
3	Import Duties	13	Savings
4	Export Taxes	14	Stock Changes
5	Production Taxes	15	Other Capital
6	Income Taxes	16	Rest of South Africa Commodities
7	Commodity Subsidies	17	Other Rest of South Africa
8	Production Subsidies	18	Rest of World Commodities
9	Province Taxes 1	19	Other Rest of World
10	Province Taxes 2		

Table A4 Agricultural Commodity and Activity Accounts for Western Cape

No.	Agricultural Commodity Accounts	No.	Agricultural Commodity Accounts (continued)
1	Maize	16	Deciduous Fruit (excluding grapes)
2	Wheat	17	Rooibos tea
3	Rice	18	Flowers
4	Other grains	19	Other horticultural
5	Oilseeds (includes canola)	20	Cattle (dairy and beef)
6	Legumes and fodder crops	21	Sheep
7	Sugarcane	22	Pigs
8	Cotton	23	Poultry
9	Other field crops (including tobacco)	24	Other livestock
10	Potatoes	25	Game
11	Vegetables (excluding potatoes)	26	Dairy (milk and cream)
12	Citrus	27	Animal fibres
13	Subtropical Fruit	28	Fisheries
14	Viticulture	29	Forestry
15	Table Grapes		

No.	Agricultural Activity Accounts	Corresponding Statistical Region
1	Metropolitan Area	Statistical region 1
2	Boland	Statistical region 2
3	Ruens / Grabouw	Statistical region 3
4	Southern Cape	Statistical region 4
5	Little Karoo	Statistical region 5
6	Breede River / Witzenberg	Statistical region 6
7	Swartland	Statistical region 7
8	Olifants River	Statistical region 8
9	Great Karoo	Statistical region 9

Figure 1: Structure of South Africa and Provincial SAMs

	Commodities	Activities	Factor Payments	Households	Corporations	Government	Capital Account	Rest of World	Total Incomes
Commodities		Combined Use Matrix		Household Consumption Expenditure		Government Consumption Expenditure	Investment & Inventory Expenditures	Export Revenue incl of Subsidies	Commodity demand
Activities	Domestic Supply Matrix								
Factors		Value Added		Domestic employment		Government employment		Factor Income from Abroad	Factor incomes
Households			Labour incomes and distributed profits	Inter-household transfers	Transfers & Payments to Households	Government Transfers to Households		Remittances to Households from Abroad	Household incomes
Corporations			Undistributed profits			Government Transfers to Corporations			Corporation Income
Government	Tariff revenue	Indirect tax revenue less subsidies	Taxes on labour and profits	Tax Revenue from Households	Tax Revenue from Corporations		Tax Revenue from Capital Account	Government Income from World	Government revenue
Capital Account				Household Saving	Savings by Corporations	Government Saving		Current Account BoP	Total savings
Rest of World	Imports		Factor payments abroad	Imports and Transfers	Net Transfer Abroad	Imports and Transfers	Imports and Transfers		Total imports
Total Expenditures	Commodity Supply	Production	Factor outlay	Household expenditure	Corporation Expenditure	Government expenditure	Capital expenditure	Total exports	

Integration of SAMs

Integration of the SAMs allows analyses of economic relationships between the regions and the rest of South Africa. By combining the processes of constructing SAMs for the Regions and South Africa, and adopting common structures, the development of a multi-regional SAM for South Africa is made less difficult. Figure 2 illustrates how the SAMs can be combined to produce a multi-regional SAM.

On the main diagonal of the matrix in Figure 2 are the SAMs for South Africa and a Region excluding the accounts for the rest of the world. The rest of the world accounts for South Africa come directly from the SAM for South Africa. The 'trade' accounts from the Regional SAM have to be separated according to whether they relate to trade with South Africa or the rest of the world. The most difficult parts are the identification of trade flows within the nation state, and, in particular, the adjustments required to the South Africa SAM. However a substantial part of this task needs to be undertaken in constructing the Regional SAM; namely the separation of trade flows between the Region and South Africa; and the Region and the rest of the world.

Table 2: Multi-Regional SAM for One Region and South Africa

	Region	South Africa	Rest of World	Total
Region	Regional SAM	Exports to S Africa from Region	Exports from Region	Incomes to Region
South Africa	Imports to Region from S Africa	S Africa SAM	Exports from S Africa	Incomes to S Africa
Rest of World	Imports to Region	Imports to S Africa		
Total	Expenditures by Region	Expenditures by S Africa		

Data Requirements

Five major data sources are required for the SAM

1. National/Regional Aggregate Accounts.
2. Supply and Use Matrices for South Africa.
3. Censuses of Manufacturing, Mining and Other Activities.
4. Agricultural Accounts.
5. Income and Expenditure and October Household Surveys.

The SAMs for South Africa and the Western Cape have used these data sources. Many of the costs associated with learning about the structure, content and idiosyncrasies of these data sources have already been borne; hence there will be economies in the subsequent development of regional SAMs.

SAM Estimation and Reconciliation

The construction of a SAM requires the use of data from a range of different sources, many of which are surveys. National account statisticians therefore face a substantial task in reconciling these data. Many early SAMs and input-output tables relied heavily upon the knowledge and judgement of the statisticians. Concerns about the unscientific nature of this approach led authorities to advocate the adoption of more formal methods of reconciling accounts. With on-going developments in computer technology the range of practical methods for reconciling SAM accounts has increased. The development of these methods has produced a number of benefits; not only can a SAM be constructed more rapidly, statisticians can make use of a wider range of information and a SAM can be progressively improved as more information becomes available.

The most commonly applied method for reconciling SAMs and inter-industry (matrix) databases is the RAS method (see Stone *et al*., 1963). This method relies upon known and certain row and column (or control) totals and a series of best estimates of the unknown elements of the matrix. The method achieves reconciliation by adjusting the elements of a matrix by means of row and column multipliers such that the row and column totals are made consistent with the control totals; the biproportional adjustment method. Variants of the RAS method allow for the inclusion of known elements of the matrix. However, the RAS method cannot be used in situations where the control totals are not known or are subject to a degree of uncertainty: a situation typically encountered when constructing a regional SAM. Moreover, the RAS method requires the imposition of a large number of implicit restrictions/constraints, which cannot be readily justified and are often quasi-arbitrary.

An alternative method is the Stone-Byron method (Stone, 1974; Byron, 1976 and 1996). For this method the knowledge and judgement of the statisticians enters at the second order level by the imposition of tolerances upon the estimates rather than through the estimates themselves. More recently a method of estimating and balancing SAMs based on information theory and entropy econometrics has been developed (see Golan *et al*., 1994; Robinson and McDonald, 1998, for applications). Among the advantages of this method is the minimisation of the inclusion of information based upon judgement rather than knowledge, the avoidance of the need to know account totals with certainty, and the speed with which new and/or additional information can be incorporated into a SAM. This is the method that would be used to estimate and balance the SAMs for the Regions.

Entropy Difference Method

The guiding principal of the entropy difference method is to use only the known information, and then to seek the most probable distribution of other elements consistent with the known data. As new information becomes available so the estimated SAM can be rapidly revised. A variety of

related Bayesian estimation techniques, known as "maximum entropy econometrics" have recently been developed (Golan *et al*., 1996). Golan *et al*., (1994) applied these techniques to the estimation of an inter-industry table with known row and column totals, i.e., the classical RAS problem. This methodology has been extended to situations where there are different kinds of prior information than row and column totals (Robinson *et al*., 1998).

The deterministic version of the cross entropy method is a generalisation of the RAS method. The objective is to estimate a SAM in which the entropy distance between a prior and new SAM is minimised and is consistent with the available information. As such the procedure is a non-liner constrained optimisation problem based on probability distributions.

However the compilation of a SAM typically requires the compilation of a consistent data series from data with noise, e.g., commodity and activity account totals from SUPPLY and USE matrices may differ; total expenditures/incomes for households are disaggregates derived from partial (survey) data, etc. The cross entropy method can be generalised to incorporate row and column sums that are not fixed parameters but involve errors in measurement, and to use initial estimates that are not fully consistent. In this context the standard assumptions in regression analysis, e.g., the error is distributed with zero mean and constant variance, the independent variables are non-stochastic and there is no prior information about the parameters, are very restrictive. A SAM is a framework for organising data, not a model, but there is the potential for substantial amounts of missing information. The issue therefore is not the specification of an error generating process, but a problem of error measurement.

Robinson *et al*., (1998) have extended the Cross Entropy criterion to include an "errors in variables" formulation where the independent variables are measured with noise as opposed to the "errors in equations" approach of classical econometrics where the process is assumed to include random noise. This variant does not require the best/initial estimates of the SAM to be balanced: indeed there is good reason to believe that balanced initial estimates will be the exception rather than the rule. If the initial SAM is not balanced it implies that a cross entropy measure of zero is not possible because the prior is not feasible. The idea is to find a new feasible SAM that is entropy-close to the infeasible prior. Very importantly, cross-entropy methods allow the inclusion of other types of information, including the knowledge and judgement of national accounts statisticians. These include moment constraints, and linear aggregation equalities and/or inequalities, e.g., macroeconomic aggregates and sub-matrix control totals from a macro SAM. When deriving the regional SAMs and important constraint will be that they a fully consistent with the National SAM.

Summary

The major benefit from using the entropy difference method is the parsimonious use of information. This has five important potential benefits for statisticians. First, it enables the statistician to begin

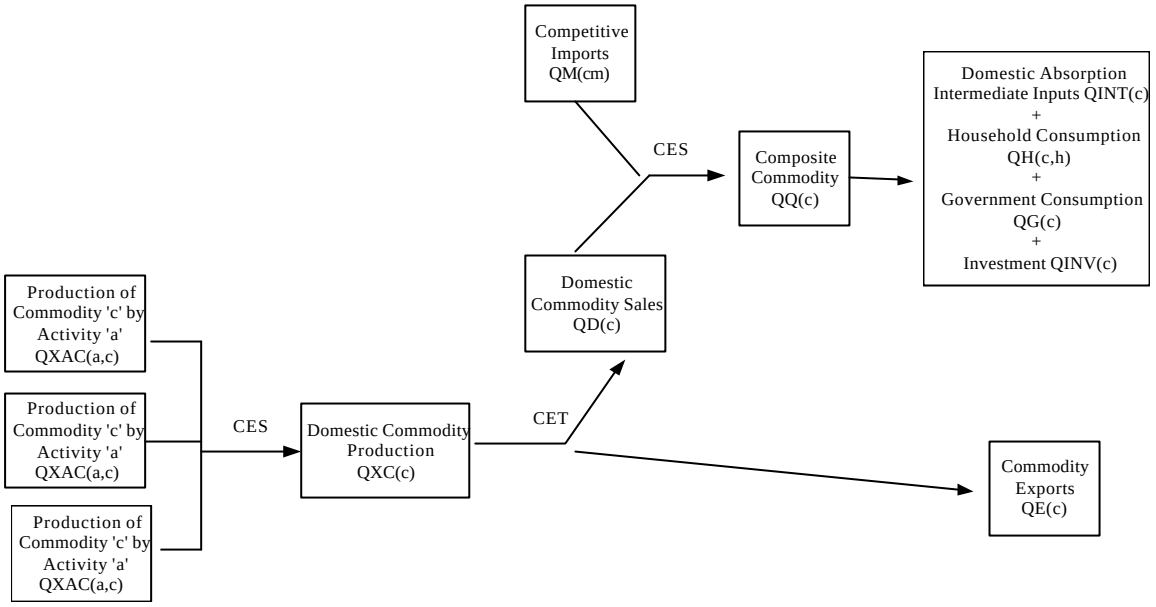
producing SAMs early on in the data compilation process. This facilitates the identification of weaknesses in the current information and thereby can direct the future efforts of the statisticians. Second, as new information becomes available, either in the form of revised initial estimates or additional constraints, so new and balanced SAMs can be produced very rapidly - hours as opposed to days and weeks. Third, the estimation process generates estimates of shadow prices for cells in the matrix. These shadow prices represent the value of extra information relating to that cell, and hence can direct the statistician's effort in the gathering of extra information. Fourth, it provides a means of updating benchmark SAMs to a more recent year. This is particularly important when the year chosen for benchmarking the accounts proves to be atypical. And fifth, provisional versions of a SAM can be incorporated into multi-sector models at an early stage. This allows the synergies between the activities of the national account statisticians and modellers to be exploited so as to direct further the efforts of government statisticians.

Appendix II Generic Computable General Equilibrium Model

The model will be in the general class of neoclassical models. The model will start from an existing CGE model for South Africa, but this will be refined and developed throughout the period of the project. A brief non-technical description follows. More details are available in McDonald (2000b).

The proposed quantity flows are illustrated in Figure 1. The model will make extensive use of the Armington assumption, i.e., imperfect substitution (Armington, 1969). Activities will choose the quantities of different commodities, $QXAC_{a,c}$, to produce on the basis of relative prices and the ease of substitutability. Domestic production, QXC_c, will be sold on either the domestic market, QD_c, or exported, QE_c, on the basis of relative prices and the ease of substitutability. Domestic outputs will then be combined with imported commodities, QM_c, to produce composite commodities, QQ_c, that will be distributed to domestic final demand categories. The proportions of imports and domestic goods will be determined by relative prices and the ease of substitutability. A consequence of using the Armington assumption will be that the impacts of changes in world prices on the economy depend upon the elasticities (degrees) of substitutability and the shares of imports/exports in the composite commodities/domestic production functions. This typically reduces the sensitivity of a model to the specification of unknown parameters.

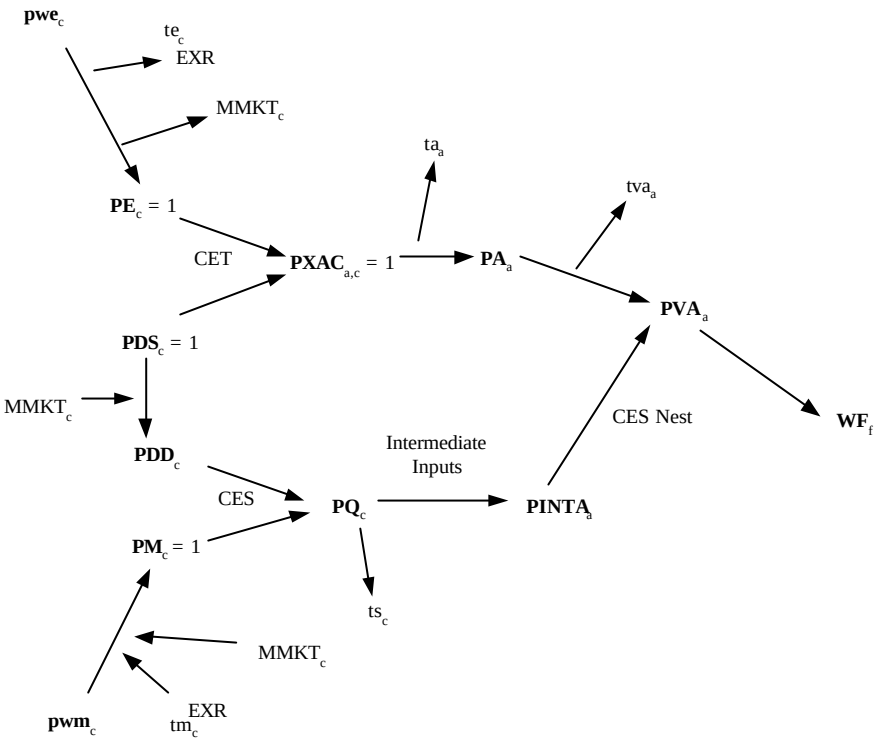
Figure 1 Quantity Flows



Decisions about the quantities of commodities produced by domestic activities, exported, imported and allocated to different categories of final demands will depend upon relative prices. Consequently, the price system will be critical to the operation of the model. Moreover the price system will encompass the governments' price policy instruments. Figure 2 provides a schematic illustration of the price system that is planned for the model. Since governments have a wide range of price/tax instruments the price system will inevitably be moderately complex. Product taxes will have three specifications; tariff rates (tm_c), export tax rates (te_c) and sales tax rates (tq_c). Taxes on production will be of two forms; indirect tax rates on production (ta_a) and value added tax rates (tva_a). Marketing margin rates will be endogenously determined by the efficiency with which marketing services are produced. The other tax instruments will be direct/income tax rates for households and enterprises. This price system will also allow for the possibility of imperfect competition.

The price system will capture the main mechanisms through which the government can influence the operation of the economy. Specifically, government policies will determine the choice and levels of tax instruments. The range of tax instruments included in this model allows for the subsequent analyses of a wide range of tax policy experiments.

Figure 2 Price System



An important dimension of the model will be the modeling of factor markets and household consumption. The modeling of factor markets will exploit the detailed data on employment and income from employment captured by the SAMs. Production relationships will allow for substitutability between factors, i.e., capital for labour, and between different types of labour on the basis of skill and racial classifications. Hence factors of production will be treated, in general, as imperfect substitutes and the elasticity (degree) of substitutability will vary between infinity and zero. Consequently the factor demand functions and incomes will be extensively disaggregated. Full employment will not be assumed in the general case; the model will allow factor specific assumptions about the extent of employment for each type of factor, one of which is full employment.

The disaggregation of the value added accounts in the SAMs will be matched by the disaggregation of the household accounts. Therefore the operations of factor, especially labour markets, will have implications for household incomes and the distribution of income. The basic model will use an extended linear expenditure system. This allows substitutions in consumption patterns after the satisfaction of subsistence requirements, where degrees of substitutability and subsistence requirements differ by household type.

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