

# **GAMS MIRO CGE Model Interface User Guide**

*November 2023*



**TABLE OF CONTENTS**

**A. Overview ..... 2**

**B. Data and models..... 2**

**C. Navigating the interface ..... 3**

**D. References..... 12**

**E. Annex: SAM accounts ..... 14**

## A. Overview

---

There is an increasing demand to evaluate impacts of domestic policies and changes in world economic conditions. However, the models used to assess these impacts are often complex; requiring substantial training to use. A user-friendly interface enables users to run their own (simple) policy scenarios & visualise results using the same type of models used for in-depth impact assessment. The interface described in this user guide is an example of how GAMS MIRO can be used to deploy a user-friendly interface for a national CGE model.

The interface uses a national Computable General Equilibrium (CGE) model, STAGE 1 (McDonald, 2007), calibrated to a Social Accounting Matrix (SAM) for South Africa, deployed via GAMS MIRO (Model Interface with Rapid Orchestration) software (GAMS Software GmbH, 2023).

A user-friendly interface offers several benefits. First, it allows users to interact with complex models with a lower training requirement. This improves transparency builds trust by demystifying the modelling 'black box'. Second, users can explore a wider range of scenarios beyond those that can be included in a written impact assessment report, thereby enriching the research offering. Third, it provides an accessible entry point to CGE simulations for users interested in investing in models or undertaking more advanced training.

Several assumptions underlie the modelling interface. First, that the underlying data and model are of good quality. Second, that the policy instruments and results indicators in the interface cover relevant policies and outcomes. Furthermore, while the user interface provides an accessible entry-point for using complex models, a basic understanding of the underlying models is required to interpret the results and to construct logically consistent scenarios. It should be noted that the interface offers a 'window' into CGE models rather than replacing the direct use of such models for policy analysis. In depth analysis using the underlying models should accompany the implementation of any real-world policy.

This user guide continues with a brief overview of the data and models used, followed by a guide to navigating the interface. For enquiries related to the content of the user interface, contact Lindsay Shutes at Elevate Economics ([lindsayshutes@gmail.com](mailto:lindsayshutes@gmail.com)). For MIRO specific and technical questions contact GAMS Software GmbH ([support@gams.com](mailto:support@gams.com)). For detailed background information about the model and online training in the model see [www.cgemod.org.uk](http://www.cgemod.org.uk).

*Disclaimer: The material and information contained in the user interface is for general information purposes only. The proprietors accept no liability for consequences arising from the use of the interface or data and models therein. Any reliance placed on such material is therefore strictly at the user's own risk.*

## B. Data and models

---

The interface uses a national Computable General Equilibrium (CGE) model, STAGE 1 (McDonald, 2007), calibrated to a Social Accounting Matrix (SAM) for South Africa. A CGE model is a whole economy model based on economic theory, populated with real economic data which depicts an economy in a given year. The model is a deterministic system of equations which represents the behaviour of firms, households, and the government. The model used here is run in comparative static mode, allowing for a comparison of the state of the economy before and after a policy change or change in world economic

conditions. The comparative static mode is selected as the interface is a 'sandbox' environment in which users can quickly explore a wide range of scenarios.

The interface includes policy levers to examine the impact of changes in global economic conditions and domestic tax policies. The interface is tailored to an economy wide CGE model of South Africa based on 2000 data in billion South African rand, (Punt *et al.*, 2023). The representation of the economy includes 13 commodities and activities, 8 factors (land, labour and capital), and 10 household groups. Of the 8 factors included, there are 6 labour types grouped by ethnicity and skill level. Households are disaggregated into 10 representative groups by ethnicity and income group and, for African households, male- or female-headed. The remaining accounts consist of an (incorporated business) enterprise account, the government account and sixteen tax accounts, the capital account (savings and investments) and the rest of the world (RoW) account. Details of the model aggregation are available in the annex.

The model and user interface are licensed under Creative Commons BY<sup>1</sup>.

## C. Navigating the interface

The structure of the interface follows *Input*, *Output*, *GAMS interaction*, *Load scenarios*, and *Compare scenarios*. The interface is navigated via the menu bar on the left-hand side of the screen. Documentation of the GAMS MIRO software is available at <https://www.gams.com/miro/start.html> and complements this user guide.

### C.1.1. Input

The input section is comprised of an introduction screen including the glossary of terms, scenario levers and data related tabs.

**Table C-1 Inputs in the national modelling interface**

Tab name	Description	Type
Introduction	Introduction to the CGE modelling interface and glossary of terms.	Information
World prices	Scenario: changes in world prices and exchange rate.	Scenario levers
Tax policy	Scenario: tax policy instruments	Scenario levers
Closure	Applies to whichever scenarios are specified. User selects how the government raises additional revenue to meet fixed spending commitments. Options are via increasing borrowing or raising the income tax rate.	Model closure

<sup>1</sup> <http://creativecommons.org/licenses/by/4.0/>

South Africa SAM	Social Accounting Matrix for 2000 in billion South African rand.	Data
South Africa SAM expenditure shares	Expenditure shares of the SAM to show spending pattern in 2000 e.g., household consumption, export demand etc.	Data
South Africa SAM income shares	Income shares of the SAM to show income pattern in 2000 e.g., household income, government income etc.	Data

### Navigating the data tabs

The modelling interface input screen includes three data tabs which can be consulted for information about the structure of the South African economy: the Social Accounting Matrix for 2000 in billion South African rand, a matrix of income (row) shares and a matrix of expenditure (column) shares of the SAM.

The accounts of the SAM matrices follow the syntax format shown in Introduction screen:

## Social Accounting Matrix

### Abbreviation Definition

c_	Commodity accounts	SALTAX	Sales taxes
m_	Margin accounts	INDTAX	Production taxes
a_	Activity accounts	FACTTAX	Factor taxes
h_	Household accounts	DIRTAX	Direct income taxes
f_	Factor tax accounts	GOVT	Government
VATTAX	Value added taxes	ENT	Enterprises
IMPTAX	Import duties	KAP	Savings/Investment
EXPTAX	Export taxes	DSTOC	Stock Changes
ECTAX	Excise duty	ROW	Rest of World

In addition to scrolling through the matrices, users can search for the data of specific accounts using the search box (see the full list of SAM accounts in the annex). As each matrix is large, the interface also includes a set of predefined views that display sub-matrices of each matrix. The views are accessed via the *Load view* drop down menu:



### Scenario levers: World prices

Two types of scenario levers are included in the user interface: world prices and tax policy. The *World prices* tab is used to capture changes in import and export prices and the exchange rate. The *Tax policy* tab includes policy levers that may be used to explore the impact of changing tax rates.

Scenarios to examine the impact of changes in world prices are implemented in the interface via the *World prices* tab. The user can vary the world prices of 5 import and export commodity groups as shown below, the membership of which is shown in Table C-2.



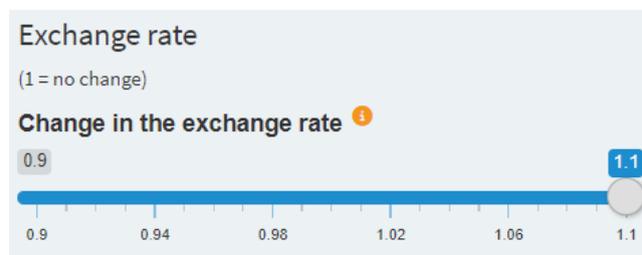
**Table C-2 Commodity groups for world price scenarios**

Commodity group	Commodities
Agriculture	Agriculture
Minerals	Minerals
Food	Food products
Industry	Textiles, Petrol, Chemicals, Metal and mineral products, Machinery, Vehicles and Other manufacturing
Utilities	Utilities
Construction	Construction
Services	Trade and transportation, Services

The user defines a scenario by changing the world prices of one or more import and/or export commodity groups. The size and sign of the change is informed by the user’s expectation of the impact of the change in global economic conditions on world prices. The magnitude of the price changes is set via the levers e.g., for a 10% increase in the world price of agricultural imports, move the slider below to 1.1:



The user can also change the exchange rate via the slider below. A 10% increase corresponds to a 10% depreciation of the currency as the exchange rate is defined as domestic currency units per unit of world currency.

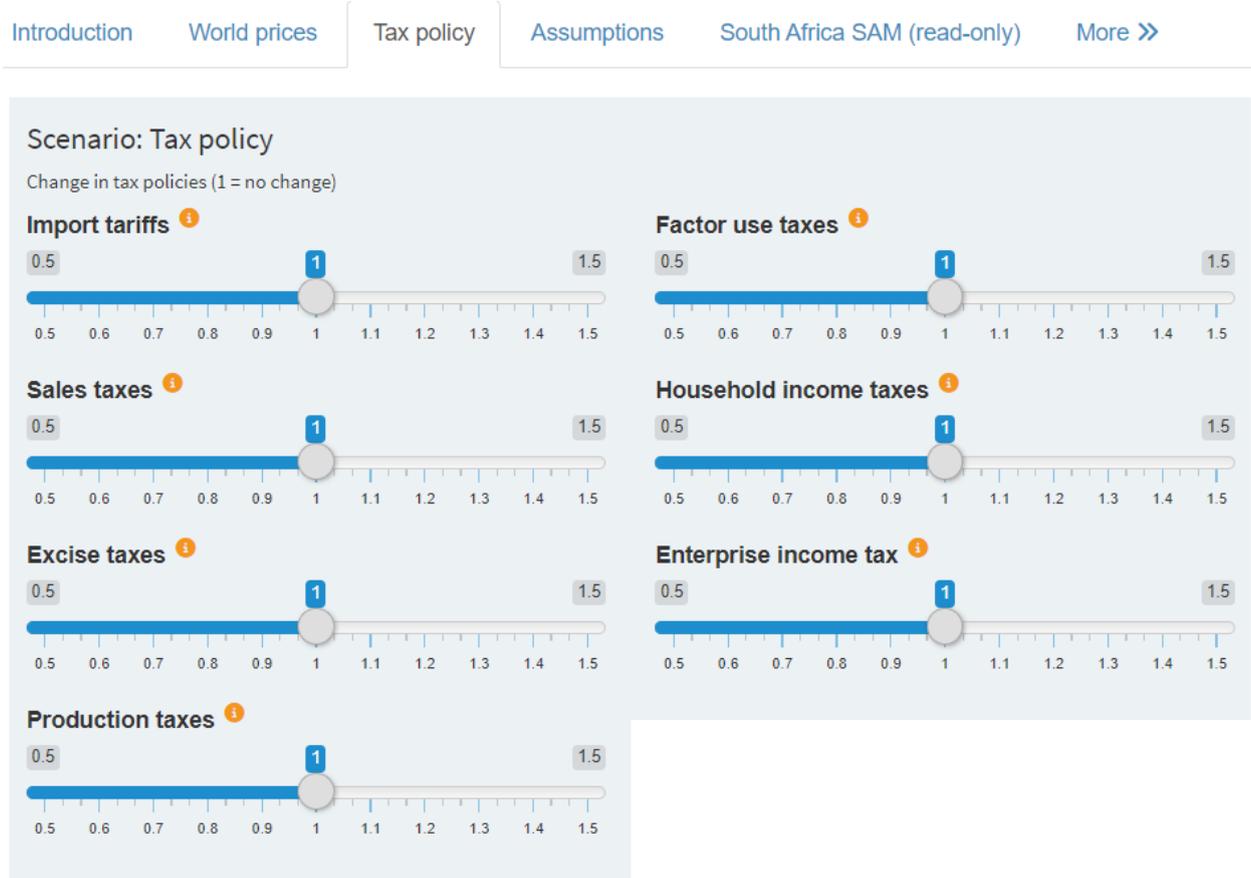


Save the scenario by selecting *Scenario*>*Save as* via the drop-down menu on the top right-hand side. Choose a name for the scenario and add tags if you would like, e.g., for the above example, *imports* and *agricultural* are suitable tags. The tags can be used to filter for similar scenarios in the results database.

An option to reset all sliders to the default position is included to the right of the screen.

## Scenario levers: Tax policy

A range of domestic policy instruments aimed at exploring the impact of different tax policies:



The sliders allow for an increase and reduction of up to 50% in the starting tax rates, the ranges of which are shown in Table C-3. Note that all tax rates are scaled by the value entered e.g., a 50% increase in the excise tax rate increases the rate from 0%-10% to 0%-15%. Exact tax rates can be computed from the SAM.

**Table C-3 Initial tax rates**

Tax	Initial tax rate range
Import tariffs	0-23%
Sales taxes	2-9%
Excise taxes	0-10%
Production taxes	-0.1-0.7%
Factor use taxes	-146-25%
Household income taxes	3-20%
Enterprise income tax	18%

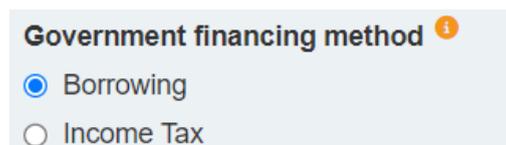
An option to reset all sliders to the default position is included to the right of the screen.

### Closure

The closure of the model has economic and operational purposes. From an economic perspective, the closure defines the functioning of the economy. Operationally, the closure addresses the requirement that the number of variables must equal the number of equations in the model. The 'fixing' of excess variables to equate the number of variables and equations is the process of model closure.

Choices made under the Closure tab apply to whichever changes have been made in the scenario levers tabs. The user can specify how government maintains fixed spending commitments when government revenues and should revise the choice made for each scenario to check that it is appropriate.

Two government financing methods are available: borrowing and income tax. Under the *borrowing* closure, any decrease (increase) in government revenue is compensated for by an increase (decrease) in government borrowing.



Under the *Income tax* closure, any decrease (increase) in government revenue is compensated for by an increase (decrease) in the income tax rate.

It is useful to save scenarios using suffixes or tags that reflect the closures made e.g., *\_B* for borrowing or *\_YT* for income tax.

The closure rules for the showcase model are comprised of the following fixed variables:

- i. Exchange rate
- ii. World prices reflecting the assumption that South Africa is a price taker on world markets
- iii. Share of investment in domestic final demand
- iv. Enterprise demand in volume terms and enterprise transfers to households
- v. All tax rates (unless swapped with government savings in the Closure tab of the interface), government transfers and the value of government demand
- vi. Supply of factors (fully employed factors) and inter-activity wage differences (fully mobile factors)
- vii. Productivity growth
- viii. Consumer Price Index (CPI) as the numéraire against which changes in prices are benchmarked

All, or a selection of, the closure rules may be added to the Closure tab to extend the options available to the users of the interface.

## C.1.2. Output

The output section contains a dashboard of results arising from the last scenario run in – or loaded into – the interface.

### *Navigating the dashboard*

The dashboard is navigated via the ‘tiles’ on the right-hand side of the screen. The tiles show headline results for the current scenario. More detailed results are accessed by clicking on each tile.

**Table C-4 Outputs in the national modelling interface dashboard**

Indicator	Description	Type
Macroeconomic indicators	Percentage change in real macroeconomic indicators GDP, absorption, production, exports and imports in the scenario compared to the base.	Graph, table
GDP (percentage change)	Percentage change in real Gross Domestic Product (GDP) in the scenario compared to the base.	Tile
Composition of GDP (percentage change)	Percentage change in the components of nominal and real GDP in the scenario compared to the base. The structure follows the equation for GDP from the expenditure side: $GDP = C$ (private consumption) + $I$ (investment) + $G$ (government consumption) + $(X$ (exports) – $M$ (imports)).	Graphs, table
Absorption (percentage change)	Percentage change in real absorption in the scenario compared to the base.	Tile
Composition of absorption (percentage change)	Percentage change in the components of nominal and real absorption in the scenario compared to the base. The structure follows the equation for absorption: $Absorption = C$ (private consumption) + $I$ (investment) + $G$ (government consumption). Absorption can be used as measure of whether welfare has increased or decreased in the country.	Graphs, table
Production (percentage change)	Percentage change in real production in the scenario compared to the base.	Tile

Production by sector and activity (percentage change)	Percentage change in the output of each activity, grouped by sector in the scenario compared to the base.	Graph, table
Exports (percentage change)	Percentage change in real exports in the scenario compared to the base.	Tile
Imports (percentage change)	Percentage change in real imports in the scenario compared to the base.	Tile
Trade (percentage change)	Percentage change in real imports and exports by commodity group in the scenario compared to the base.	Graph, table, list of commodity groups
Government savings (percentage change)	Percentage change in government savings in the scenario compared to the base.	Tile
Income tax rate (percentage change)	Percentage change in the income tax rate on enterprises in the scenario compared to the base. Note that this percentage change is applied to the initial income tax rates.	Tile
Government indicators (percentage change)	Percentage change in nominal government income, tax revenue, consumption and savings, and real consumption in the scenario compared to the base.	Graph, table
Returns to capital (percentage change)	Percentage change in the average return to capital in the scenario compared to the base.	Tile
Average wage (percentage change)	Percentage change in the average wage in the scenario compared to the base.	Tile
Returns to capital and labour (wages) (percentage change)	Percentage change in returns to capital and labour (wages) by type in the scenario compared to the base.	Graph
Labour demand by sector (real, percentage change)	Percentage change in labour demand by activity groups in the scenario compared to the base.	Graph, list of activity groups
Average household consumption (percentage change)	Percentage change in real average household consumption in the scenario compared to the base.	Tile

Household consumption by product group (percentage change)	Percentage change in real household consumption by commodity group in the scenario compared to the base.	Graph, list of commodity groups
Household consumption by household (percentage change)	Percentage change in real household consumption by household group. The household group definition is included in the glossary on the welcome page.	Radar plot
Average household income (percentage change)	Percentage change in real average household income in the scenario compared to the base.	Tile
Household income by region and household group (percentage change)	Percentage change in real household income by region and household group in the scenario compared to the base. The household group definition is included in the glossary on the welcome page.	Graph, table
Simulation shocks	Shows the shocks applied in the current scenario in terms of world prices, the exchange rate and climate policies, together with the government financing closure.	Table

### **C.1.3. GAMS interaction**

The GAMS interaction section of the interface provides information during and after the solving of the model. The Model Status bar shows the status of the model run while the GAMS output section provides information on the solution of the model.

The user can stop an active model run by pressing the *Stop* button. Further information on this section is available at <https://www.gams.com/miro/start.html> in the *Solve the model* section.

### **C.1.4. Load scenarios**

The *Load scenarios* section allows the user to load scenarios from a database of saved scenarios. Selecting *Fetch results* returns a list of all saved scenarios which can be ordered by time created, tags and all scenario settings.

Alternatively, the user can restrict the scenarios fetched by using conditions to specify tags or lever values. Further information on this section is available at <https://www.gams.com/miro/start.html> in the *Finding and loading scenarios* section.

### C.1.5. Compare scenarios

The *Compare scenarios* section is similar to the *Output* section but with comparisons across multiple scenarios. To load scenarios, select *Compare scenarios* and then *Load*. Choose which scenarios you want to include, click *Choose selected scenarios* and then *Dashboard compare*:

Select action

---

What would you like to do with the selected scenarios?

Select columns for naming scenarios

By default, the scenarios are named according to their saved name. The user can specify other fields to name the scenarios using the *Select columns for naming scenarios* option above.

The indicators in the *Compare scenarios* section follow those in the *Output* section. The user can populate the tiles on the right-hand side using the drop-down menu:

Summary indicators (percentage change for selected scenario)

### C.1.6. Explore further

The user interface allows for ‘what-if’ type analysis. Additional scenarios can easily be run to evaluate other scenarios under alternative assumptions such as different magnitudes of tax policy and/or world price changes, and alternative government financing options. Multiple scenarios can also be run to decompose the observed impacts e.g., an initial scenario in which all import prices rise by 10% could be decomposed into a 10% rise in the import price of each commodity group separately, thus identifying the main drivers of the impacts.

The process of specifying alternative scenarios follows the same process as the initial scenario and viewed via the Compare Scenarios screen.

## D. References

---

McDonald, S. (2007). *A Static Applied General Equilibrium Model: Technical Documentation STAGE Version 1*. Available [here](#).

*Punt, Cecilia, van Schoor, Melt & Mcdonald, Scott (2006) 'Compiling National, Multiregional and Regional Social Accounting Matrices for South Africa'. Available [here](#).*

## E. Annex: SAM accounts

Table E-1 SAM accounts, South Africa SAM 2000

SAM account name	Description
c_Agriculture	Agriculture
c_Minerals	Minerals
c_Food	Food products
c_Textiles	Textiles
c_Petrol_chemicals	Petroleum and chemical products
c_Metal_mineral_products	Metal and mineral products
c_Machinery	Machinery
c_Vehicles	Vehicles
c_Other_manufacturing	Other manufacturing
c_Utilities	Utilities
c_Construction	Construction
c_Trade_transport_communications	Trade transport and communications
c_Services	Services
m_Trade	Trade margins
m_Transport	Transport margins
a_Agriculture	Agriculture
a_Minerals	Minerals
a_Food	Food products
a_Textiles	Textiles
a_Petrol_chemicals	Petroleum and chemicals
a_Metal_mineral_products	Mineral and metal products
a_Machinery	Machinery
a_Vehicles	Vehicles
a_Other_manufacturing	Other manufacturing
a_Utilities	Utilities
a_Construction	Construction
a_Trade_transport_communications	Trade transport and communications
a_Services	Services
f_Capital	Capital
f_Land	Land
f_African_unskilled	African unskilled labour
f_African_skilled	African skilled labour
f_Coloured_Asian_unskilled	Coloured and Asian unskilled labour
f_Coloured_Asian_skilled	Coloured and Asian skilled labour
f_White_unskilled	White unskilled labour
f_White_skilled	White skilled labour
h_African_female_low	African female low education
h_African_female_med	African female mid education
h_African_female_high	African female high education
h_African_male_low	African male low education
h_African_male_med	African male mid education
h_African_male_high	African male high education
h_Coloured_Asian_low	Coloured and Asian low education
h_Coloured_Asian_high	Coloured and Asian high education
h_White_low	White low education

<b>h_White_high</b>	White high education
<b>VATTAX</b>	Value added taxes
<b>IMPTAX</b>	Import duties
<b>EXPTAX</b>	Export taxes
<b>ECTAX</b>	Excise duty
<b>SALTAX</b>	Sales taxes
<b>INDTAX</b>	Production taxes
<b>tff_Capital</b>	Capital
<b>tff_Land</b>	Land
<b>tff_African_unskilled</b>	African unskilled labour
<b>tff_African_skilled</b>	African skilled labour
<b>tff_Coloured_Asian_unskilled</b>	Coloured and Asian unskilled labour
<b>tff_Coloured_Asian_skilled</b>	Coloured and Asian skilled labour
<b>tff_White_unskilled</b>	White unskilled labour
<b>tff_White_skilled</b>	White skilled labour
<b>FACTTAX</b>	Factor taxes
<b>DIRTAX</b>	Direct income taxes
<b>GOVT</b>	Government
<b>ENT</b>	Enterprises
<b>KAP</b>	Savings
<b>DSTOC</b>	Stock Changes
<b>ROW</b>	Rest of World