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Manual in English to the Suryamodel, the Macroabc model of Suriname

Paramaribo/The Hague, January 2016, by Dr. Marein van Schaaijk

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Introduction to this Manual

The Suryamodel is the fruit of the collaboration (1991 up to present) between Surinamese Planning Office and Stuseco, and collaboration with IGSR from 2010 till present.

This Manual is strongly based on documentation to Macmic, Mamiabc and Suryamodel, and on manuals to other macroabc models.

The Suryamodel is a well documented model, but in Dutch. The Suryamodel is based on the Macmic model of February 1991 documented in the PH.D. thesis of Marein van Schaaijk. An English translation is available "A macro model of a small economy" and can be downloaded on www.stuseco.org (at the bottom of the website).

The Suryamodel can be downloaded as shareware from www.stuseco.org and from www.planningofficesuriname.com (The 8 January 2016 version)

See in the (hidden) column A in sheet Model the names of variables in English and in column B in Dutch.

This Manual is based on the Dutch Manuals to the Suryamodel and on the text of the Manual to the Country X model. If you want an English Manual for a macroabc model, you might read the one that MMC has built in assignment for United Nations. It is as shareware on UN homepage and on http://www.micromacroconsultants.com/Engels/Projects/United%20Nations/United%20Nations.html

The Suryamodel in a nutshell:

The MACMIC model, the predecessor of the Suryamodel was developed by Dr. Marein van Schaaijk in early 1991. During the nineties of last century the model was used intensively by the Surinamese Planning Bureau; see on the bottom right on www.stuseco.org for an overview by ir. Christine de Rooy former vice Director of SPS: Surinammodelworkshop.ppt. It is available as shareware on www.stuseco.org currently it is used in collaboration by SPS, IGSR (University of Suriname) and Stuseco. Dr. Marein van Schaaijk is chairman of Stuseco.

The Suryamodel is a structural, empirical macroeconomic model, familiar to the macro model of Centraal Planbureau Netherlands and for 20 countries (mainly running in Curaçao, Sint Maarten, Aruba, Indonesia, Kenya, Rwanda, Zambia, Namibia, Country X and Bhutan) see www.micromacroconsultants.com

The Suryamodel consists of time series 1954- 2030 for revenues and expenditures, as well as the difference of total revenues and expenditures for the sectors: Real, Fiscal, External, and

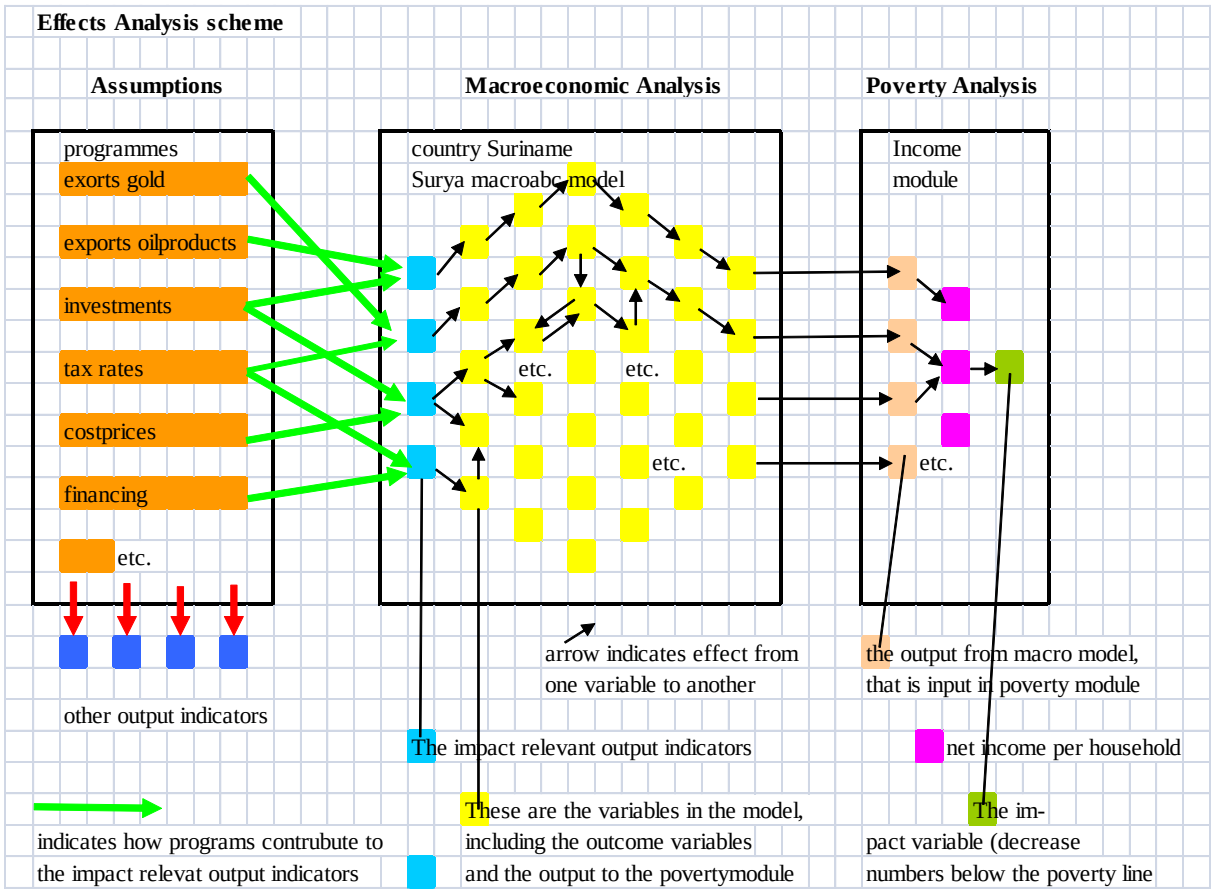
Monetary. This is familiar to the Financial Programming of the IMF. In addition, the Suryamodel also has a Household block and a Poverty module. The model also includes behavioural equations and statistical discrepancy variables. It also comprises a micro block for the export sector: a breakdown of exports in main products like gold, oil, rice etc. And for each individual product the volume, price and value of investments are included per annum.

The time series are divided in exogenous variables, definitions and behavioural equations. The variables are related through the traditional macroeconomic definition and behavioural equations. So if one might add one factor or more factors into one or more of the exogenous or behavioural equations, all variables except the exogenous ones can change. So one can compare the results you obtain using the additional factors with the original baseline figures. The model includes time series running from 1954-2030.

Overview Suryamodel

Here we start with a brief description of the Suryamodel, including underlining of the fact that macroeconomic models incorporate several inaccurate coefficients, so they cannot be used to proof something, but can be helpful for better understanding of the economic processes (for more information about uncertainty and other models please see the box on page 6).

To be able to do macroeconomic impact analysis we need a calculation framework consisting of assumptions that go as input into a macro model. The model contains the relations within and between the fiscal sector, external sector, real sector, monetary sector and household sector. The household contain a breakdown of the numbers of income earners to classes of income and into main categories as wage earners, self-subsistence agricultural sector, informal sector etc. Then the growth of numbers and incomes of the several groups has to be translated into an income module, to calculate the change in the numbers below the poverty line. The scheme on the next page provides an idea what we have in mind.



The scheme above shows how we can use a macro model in combination with the income module to estimate the effects of change in assumptions on the poverty indicators and other relevant indicators.

The scheme should be read from left to right, starting with a (set of) policy measures (orange rectangulars) on the left. On the basis of these policy measures we calculate two types of indicators:

- The dark blue (lower part of the left block) squares below the red arrows indicate the "other output indicators". These are the indicators that are important to measure the results of the programs, but are not relevant to calculate the impact of the programs on poverty. An example of this type of output indicator is the construction of a railway track. The track will not have any impact on poverty, unless it leads to an increase in the capacity to export. The impact relevant indicator is therefore the "x% additional exports" transported by rail.

- The light blue squares in the middle part of the scheme indicate the impact relevant output of the programs: extra export, higher agricultural productivity, etc. that is inserted as input into the macro model.

The light blue squares together with the yellow squares make up the macromodel. The model (the block in the middle of the scheme) contains the relations within and between the

fiscal sector, external sector, real sector, monetary sector and household sector. For example, wages influence prices and prices the wage rates. Government deficit affects money supply and the same for deficit on BoP. A crucial variable is the cost price: if the domestic cost price is lower then the export price, which will stimulate volume growth of exports. And a lower domestic cost price compared to import price will stimulate domestic production. So, the lower cost price results in higher GDP. The cost price is the result of import costs, indirect taxes, plus wage rate minus productivity growth. The household sector includes a breakdown of the number of households and average household incomes into the main socio-economic categories such as wage earners, self-subsistence farmers and other self-employed (traders, etc.). The growth rate in the number of households and average household income of the socio-economic categories is output from the macro model.

This output from the macromodel is input into the poverty module. These are indicated by the pink squares in the right block of the scheme. The pink squares affect the purple squares in the poverty module, i.e. the net incomes of the groups, which in turn affect the number of households below the poverty line indicated by the green coloured squares (the impact variable).

The most difficult, but most important step in the quantification of the policy measures, is to identify the effects of the programs on the impact relevant output indicators. This is indicated by the bold green arrows in the scheme (→). To do this we need the expertise of the sector, fiscal and other experts. For instance, we need agricultural experts to tell us what the effects are of government programs that invest in e.g. higher quality seeds, irrigation or fertilizer support. We need to know to what extend these programs raise the productivity of the small farms. Once we know this we can insert this increase in agricultural productivity in the macro model. The latter then, in combination with the sectoral module and poverty module, simulates the effects on the outcome and impact relevant variables (such as poverty reduction).

Should we have such a combination of policy assumptions, macro model and poverty module, loaded with the accurate data and the accurate coefficients in behavioural relations, then we are able to answer the question as how to accelerate economic growth, how to reduce poverty and how to maintain monetary stability.

However, economic science is not developed so far that we know exactly how the economy works and the data are estimates. So there is no model to proof exactly how policy measures via several channels at the end will affect poverty.
But one can try to construct a model and poverty module that reflects the Surinamese economy as good as possible to get an idea of how policies affect poverty.
Actually that is what we have done.

First a data consistency framework was made, including all needed variables and definition relations. Then we injected row by row the behavioral equations. In the third stage the model was tested by running many baselines and also scenarios.
This model is close to the Financial Programming of the IMF, but with three additional things:

a) A breakdown of exports into the ten main exports products
b) a household sector with income data,
c) behavioral equations including the role of incentives (cost price, productivity) in the exports block

Once the model was tested, first a technical baseline was made based on trend assumptions, Then we ran several combinations of scenarios. This exercise demonstrates that productivity growth is the main road to poverty reduction. Higher savings, higher direct taxes and/or depreciation of the exchange rate are needed to prevent the foreign reserve stock to become negative.

Please realize that the assumptions are input to the model. Thanks to the what-if simulations we found what levels of productivity growth etc. are needed to decrease poverty. Next question is how to realize that. The answer to this question requires other specific knowledge than macroeconomic expertise. So other experts need to be invited too.
One might think of a mixture of policy measures like:

- ✓ Enabling business environment
- ✓ All Government activities reshuffled from viewpoint how they contribute to higher productivity in private sector (better roads, better-educated employees, high speed in providing licenses to starting firms etc.)
- ✓ Decrease of other Government activities, resulting in lower taxes without increase of Government deficit
- ✓ Promote foreign direct investments, and make sure that technology transfers take place

Box 1: Uncertainty and other models

This box is based on text by Dr. Free Huizinga in other manual.

Macroeconomic models appear to have high uncertainties: the actual values may differ from the model forecasts. Research of CPB Netherlands (by Dr. Free Huizinga) shows four reasons for uncertainty:

- As starting values for the forecast preliminary data of statistical office are used, that differ from the actual values (5%)
- Model coefficients are inaccurate (15%)
- Exogenous variables like world trade growth and world inflation (calculated by IMF, OECD, WB etc.) appears wrong. 50% of the uncertainty comes from this factor.
- Shocks in individual equations (30%).

Actually as long as the World Bank, the IMF and other institutes are unable to produce accurate forecasts of world trade and world inflation, we are unable to make accurate forecasts with a macro model for individual countries. So an important part of the uncertainty cannot be improved by improving the model. This means that we have to explicitly take these uncertainties into account. For this reason the importance of macroeconomic models lies more in the use as instrument for policy simulation and scenario building than in forecasting.

Besides the empirical macroeconomic models two other approaches exits: ARIMA and Applied General Equilibrium (AGE) models (including Stochastic Dynamic General equilibrium Models, SDGM). In case of an Arima model the forecast of a variable is based on its path, it is like an extrapolation. The disadvantages are that forecasts of several variables made by ARIMA models have no connection, so there is no internal consistency. No economic linkages are included, so the models cannot be used for economic impact analysis. Furthermore these models have the same kind of inaccuracy as macroeconomic models

Applied General Equilibrium (AGE) models can be used for long term analysis, but they are very complex. And they have no dynamics: they give you an end result but give no information about the way how to realize that. It is like a night train that brings you from A to B but you cannot have a look where you travel.

Stochastic Dynamic General Equilibrium Models are rather complicated. Actually at CPB in Netherlands we have developed, within one year, a Stochastic Dynamic Micro Simulation model, but it appeared too complicated to be used in practice, also because we had no empirical based coefficients for crucial equations.

Summarizing, the Macroabc Suryamodel starts from a consistent database taken into account

figures from several institutes (like Central Bureau of Statistics, Central Bank and Ministry of Finance). It gives a consistent set of figures for key variables for the next as well as the following years. It can help to do alternative policy simulations to see the effect of measures on a complete set of key variables. It can be used for scenario building as well as historical analysis. It can be complemented with expert opinion that can be inserted by add factors in a consistent way. So it is a helpful tool for macroeconomic and fiscal analysis, if one takes into account that the baseline always will be inaccurate.

The underpinning of the assumptions

In this section we give the underpinning of the block "Programs", the block most left of the three blocks in the scheme.

To run a growth & poverty reduction scenario, we need several assumptions, like: X % additional growth of productivity in general and Y% in certain sectors, with costs for Government Z mln. V % growth of non-traditional exports; W mln. Cash transfers to the poor, etc. These V, W, X, Y and Z are not output from the model, but input, coming from sectoral experts that have to be injected.

This section is written to bridge between macro and sectoral experts. It is also based on our experiences in other countries like Curaçao and Zambia.

A crucial factor to decrease poverty is to increase productivity. Actually many government activities are important to realize that. For example better education will increase productivity, once the young people have finalized their schooling and enter the labour market. You can see the importance of education for schooling, because the wages of highly educated workers are on average higher then low educated persons. So the activities of the Ministry of Education are very important to increase productivity in the medium to long-term. Furthermore, education financed by the Government gives a lower burden to the poor: many of them would not even be able to go to school if the teachers and schools are not paid by the Government. Not only education of young people at school is important, but also education of older people. Think of education in modern agricultural technology, communication technology etc.

Also a good health is important for productivity. So the spending by Ministry of health is important for productivity as well.

See the sectors in the following scheme row by row: Also infrastructure is very important: without roads the production made in the rural areas cannot be sold in urban areas or exported. Access to water is also important.

Then access to energy like electricity will improve productivity.

Agriculture has a special line in the scheme because such an important part of the economy of Suriname is in agriculture. Actually, improvement of productivity in agriculture seems the most important factor to decrease poverty in most developing countries. So the activities of the Ministry of Agriculture are very important to take into account when constructing a growth and poverty reduction scenario.

Actually all sectors, all Ministries of Government can contribute to productivity growth.

So far productivity growth through spending of several Ministries, but not only spending by investments in education, infrastructure etc. is important. Some activities are not that expensive, but require organisation. We think of all government activities that create together an enabling business environment: security, low interest rates for producers, access to credit, stable exchange rates and prices; ease to get licenses etc.

Another important factor is foreign direct investments and aid.

See the following scheme on the next page for an overview:

How sector of government expenditures & policies can contribute to impact relevant output indicators

			Impact relevant output indicators						
Nr	Sector	Summary	Labor Productivity	Agricultural productivity	Exports diversification	Taxes, transfers, grants	Exchange rate	capital costs	other
		mainly spending to increase productivity							
1	Education	Access of poor to secondary and tertiary education	•	•				•	•
2	Health	health is needed for productivity	•	•					•
3	Infrastructure (Transport)	Road network (rural-urban)	•	•					
		Acces to water (peri-urban and rural areas)	•	•					
4	Energy	Electricity generation capacity	•						
5	Agriculture	education in new technologies		•					
		Fertilizers, irrigation etc.		•					
		Access to markets and information		•				•	
6	Tourism	marketing, hotels			•				
7	Manufacturing	new technology like ICT							
8	other secors								
		Mainly activities for enabling business environment							
9	Security	stable environment							•
10	Finance	Access to financial services	•	•					
		Broadening the tax base on profit and income tax				•			
		Reducing the interest rate spread (overhead costs)			•			•	•
11	monetairy policy	Prudential macroeconomic and monetary policy			•		•		•
12	Commerce & Trade	Enabling business environment	•		•				•
		other:							
13	FDI, Aid	financing of investments				•	•		

It might be an idea to present a draft growth scenario to sectoral experts, based on preliminary assumptions. That will show them what kind of sectoral assumptions we need and how important they are in scenario building. Once the sectoral experts understand better what information we need from them from the macro point of view, they will be in a better position to deliver those assumptions, or at least start to comment which level of assumptions are feasible and what it might costs to realize such assumptions.

Outline of Suryamodel, Suriname's macroabc model

The model is bi-lingual: variable names are given in English as well as in Dutch. The model file contains a sheet MANUAL with description of this macroeconomic model in Dutch and this file in English. (In most countries a Handbook to Macroabc model contains around 500 pages and a USB stick or CDROM with all the text and model files). More information in English of macroabc models can be found in www.micromacroconsultants.com

The model consists of a database, using data from National Accounts of General Bureau of Statistics, Government revenues and expenditures from Ministry of Finance and Balance of Payments and Monetary Survey of Central Bank. These data are brought into a consistency framework. The coefficients in the behavioural equations initially were originally calibrated, using the time series 1954-1987 and later several coefficients have been improved in many workshop discussions.

Macroabc Methodology

The methodology of *Macroabc* consists of constructing a combined instrument: a macroeconomic database and an analytical framework that uses the data from the database. The construction of this combined instrument is in most projects achieved through close co-operation of local staff expertise of local institutions (Ministries, Central Bureau of Statistics, and Central Bank) and international consultants' expertise of data and instruments for economic analyses in a market economy.

The macroabc model uses also the experience of the Netherlands. The Central Planning Bureau of the Netherlands (CPB) is an independent government agency established 70 years ago by Dr. Tinbergen. The CPB's charter is to formulate, analyze, monitor and forecast different policy scenarios in a well-developed market economy. It has played a central and rather unique role in the Dutch economic policy formation. In particular, it contributed to the building of a consensus about economic policy between the government and the main social

institutions (e.g., labour unions and employers' organisations). In the Macroabc approach we borrow a lot from the Dutch best practice.

Macroabc is a methodology to construct an integrated data, forecasting, and simulation model based on the core of the macro models of the CPB and the experience to combine that knowledge with the needs of other countries (like Curaçao, Poland, Kenya, Ethiopia, Indonesia, Namibia, Macedonia, Zambia, Ukraine, Rwanda, Bhutan, Suriname etc.). In this section we use the name for the methodology as well as for the resulting model. It is a so-called aggregate demand, aggregate supply model (AD-AS model), or ‘’structural model’’ that combines modern macroeconomic theory with pragmatic modelling. It is easily adapted to fit the institutional and behavioural relationships in other countries. The macro models of Surinam 'Macmic' and ‘Suryamodel’, of Curaçao 'Curalyse' of the European Union 'Euralyse', of Poland 'M98D', Kenya ‘KTMM’, Indonesia ‘MODFI’, Aruba ‘Maruba’, Zambia ‘ZAMMOD’, Rwanda ‘Marumo’, Namibia ‘!Namtrimo’ and Bhutan ‘DrukMac model’, have been based on this *Macroabc* methodology. These models run in Excel or in solution programs like MicroTSP, EVIEWS or SIMPC. The ability to run a model in a standard spreadsheet increases a model’s accessibility. In particular, because the spreadsheet models do not require multi-year specialized training in detailed computer programming languages, policy experts can participate more in model construction and execution. And nowadays also simultaneous models like Macroabc can run in Excel.

The methodology of *Macroabc* is similar to, but more advanced then the Financial Programming of IMF and the Reduced Minimum Standard Model (RMSM-X) of the World Bank. The Macroabc models include a special block concerning the labour market. From a theoretical point of view, Macroabc is closely related to the models of the Dutch CPB.

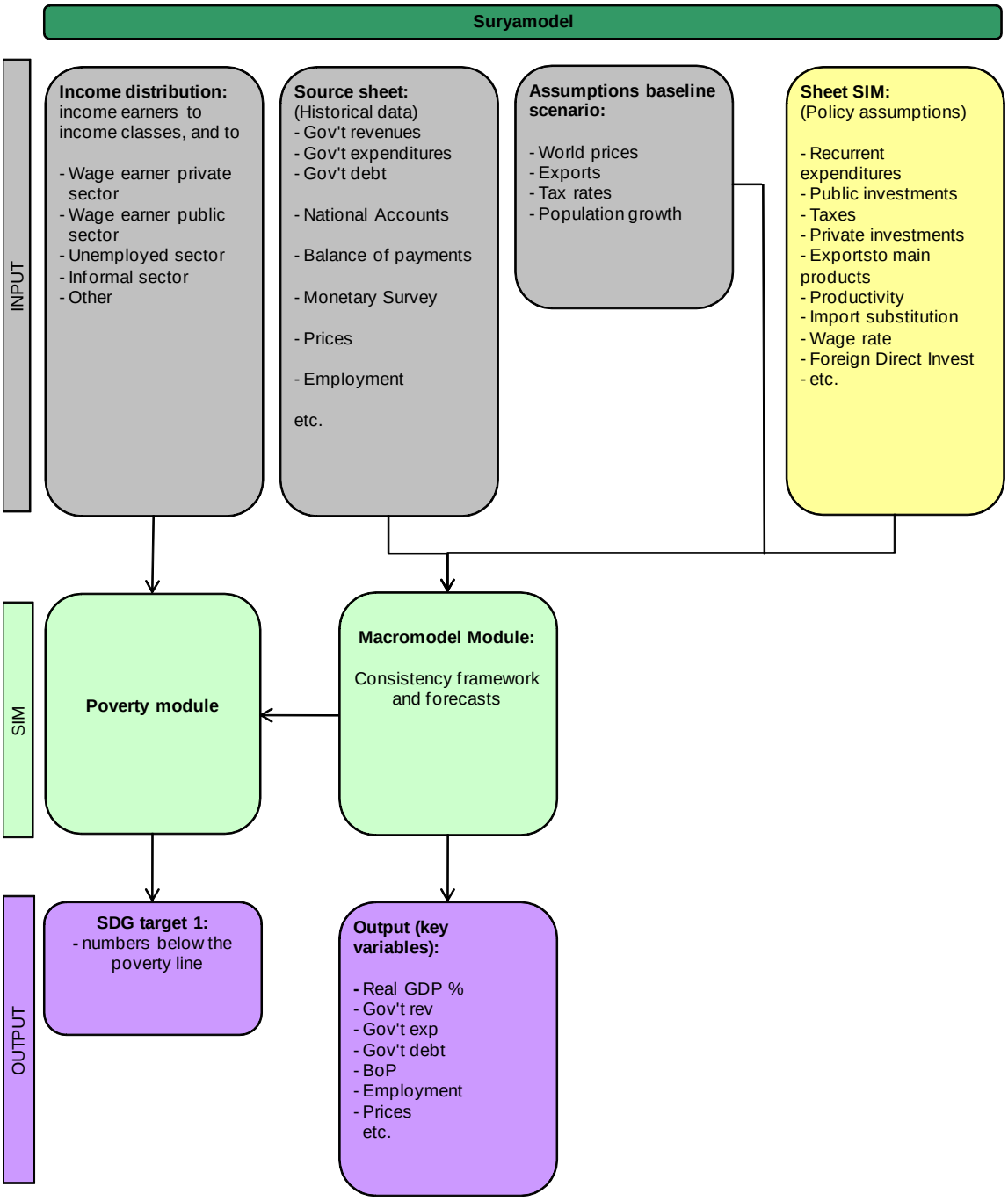
The main sheets of the Suryamodel

The Suryamodel file contains several sheets for which we will give some short explanations:

Logbook – Documentation for the changes and the improvements to the model;

- **Datainput** - Contains all data. The sheet is organised in such a way that the figures from different sources are in the same block;

A schematic overview of the model is presented below:



Colours and columns - Throughout this model the variable names are given in English in column A, and in Dutch in column B. Other columns are used to give the unit and source of different variables. For the rest of the worksheets every column presents a different year as is shown in row 2. The different colours of the different cells in this model also have a role:

1. Grey: These figures are directly obtained from sheet Data.

2. Yellow: Estimates made using certain assumptions.

3. Green: Behavioural or exogenous equations.

4. White (no colour): Definition equation.

➢ **Model** – This sheet is the heart of the Suryamodel. In this sheet the calculations take place, starting with data from sheet Datainput

➢ **Manual** – Explanations about the Suryamodel;

➢ **SIM -** The user can insert figures that are automatically incorporated into the model forecasts. In this way it is easy to run simulation in the model.

➢ **FINSIM –** input to bring the model in line with fiscal policy measures

➢ **Mamiabc -** time series 1954-2000 from the –now sleeping- old Mamiabc model

➢ **Rice block –** analysis rice sector, including price/cost ratio development

➢ **Decomposition –** Break down of results of behavioural equations in components

Features of the Suryamodel

The Suryamodel is an integrated data, forecasting, and simulation model designed to run also in Microsoft Excel. The data-model of the Suryamodel produces a comprehensive and consistent survey of the macro economy in the form of the National Accounts (SNA 1993) of a country, not only the National Accounts in a narrow sense, but and consistent with that, prices, an overview of the labour market, the monetary sector, and the public sector. Specifically the data model produces information on the following:

- Real Sector (GDP expenditure approach);
- External Sector (Balance of Payments);
- Fiscal Sector (Government expenses and revenues and deficit);
- Monetary Sector (Monetary Survey and Prices);
- Household Sector (Disposable income, Labour market);
- Sectors of industry

The consistency of the data is assured through a set of internal definitions and statistical discrepancy variables that compensate for data irregularities and therefore produce consistent results. This makes the Suryamodel a powerful and easy tool for the integration of data from different sources, for discussing the consistency requirements between these data sources, and for getting a quick overview of the current state of affairs in the overall economy. In addition to being a data model, the Suryamodel is also a forecasting and simulation model. As such, it can make simulations, forecasts and medium- and long-term scenarios. These calculations

may serve as a base for forecasting the budget and for discussing macro economic policy issues.

Clearly, using the *Macroabc* methodology the Suryamodel had to be adapted to the Surinamese economy because data, institutional development, and economic progress vary by country. For this reason the local staff participation is very important, because they have the best knowledge of the local conditions. Involving local staff also serves the overall goal of involving more people in the discussions about how the economy operates and how it may be directly or indirectly influenced by policy. Our experience suggests that this overall goal is achieved naturally in the *Macroabc* approach, because the use of a spreadsheet allows for an immediate and transparent relationship between the verbal discussions, the modelled equations and the modelling output.

Suryamodel operations

As stressed above, the Suryamodel runs in a spreadsheet. Every row has information about one variable, and every column concerns one year, except for the first columns, which contain the names of the variables and the unit and the source. The Suryamodel distinguishes between primary variables and secondary variables. *Primary variables have the colour grey, green or yellow. Secondary variables which are calculated by definition equations have no colour.*

Primary variables form the core set of variables: once these variables are given a value, the remaining variables (the secondary variables) can all be calculated through simple definitions. Primary variables may be exogenous or endogenous. Endogenous variables may be further subdivided into behavioural and semi-behavioural (institutional) variables. Equations for behavioural variables are mostly based on a theoretical foundation, while institutional variables reflect the institutional context of the country. Secondary variables are all endogenous, as their equations are identity relationships linking these secondary variables to the primary variables.

To start the model, we first insert historical data for the primary variables. The data-model of the Suryamodel then calculates the secondary variables according to the identities. For future years the values of the endogenous (behavioural and institutional) primary variables are calculated by formulas. The exogenous primary variables are given values based on external sources. Once the set of primary variables for the future is complete, the secondary variables for the future are again calculated through the identity equations.

As explained above, to initialize the model we need only values for the primary variables. In the standard version of the Suryamodel, there are around 70 primary variables.

Based on these around 70 primary input variables only the Suryamodel calculates hundreds of other variables automatically and consistently by definitional relationships. These secondary

variables are generally grouped together according to familiar concepts, and arranged in the form of standard output tables. Some of the standard output tables produced by the Suryamodel are:

- National Accounts (Expenditure approach of GDP in current prices and in constant prices)
- Balance of payments
- Government finance (with separate tables for revenues and expenditures)
- Monetary survey
- Labor market survey
- Overview of key variables

Of course, client specified tables or modules can be added like the Poverty Module, and the tables may be altered further to fit the needs of a particular analysis projects. Using figures from different sources and presenting the results according to the needs and customs of various institutions, the Suryamodel becomes an instrument that offers a complete and consistent survey of the macro economy, budget variables, monetary indicators, and labor market of Suriname.

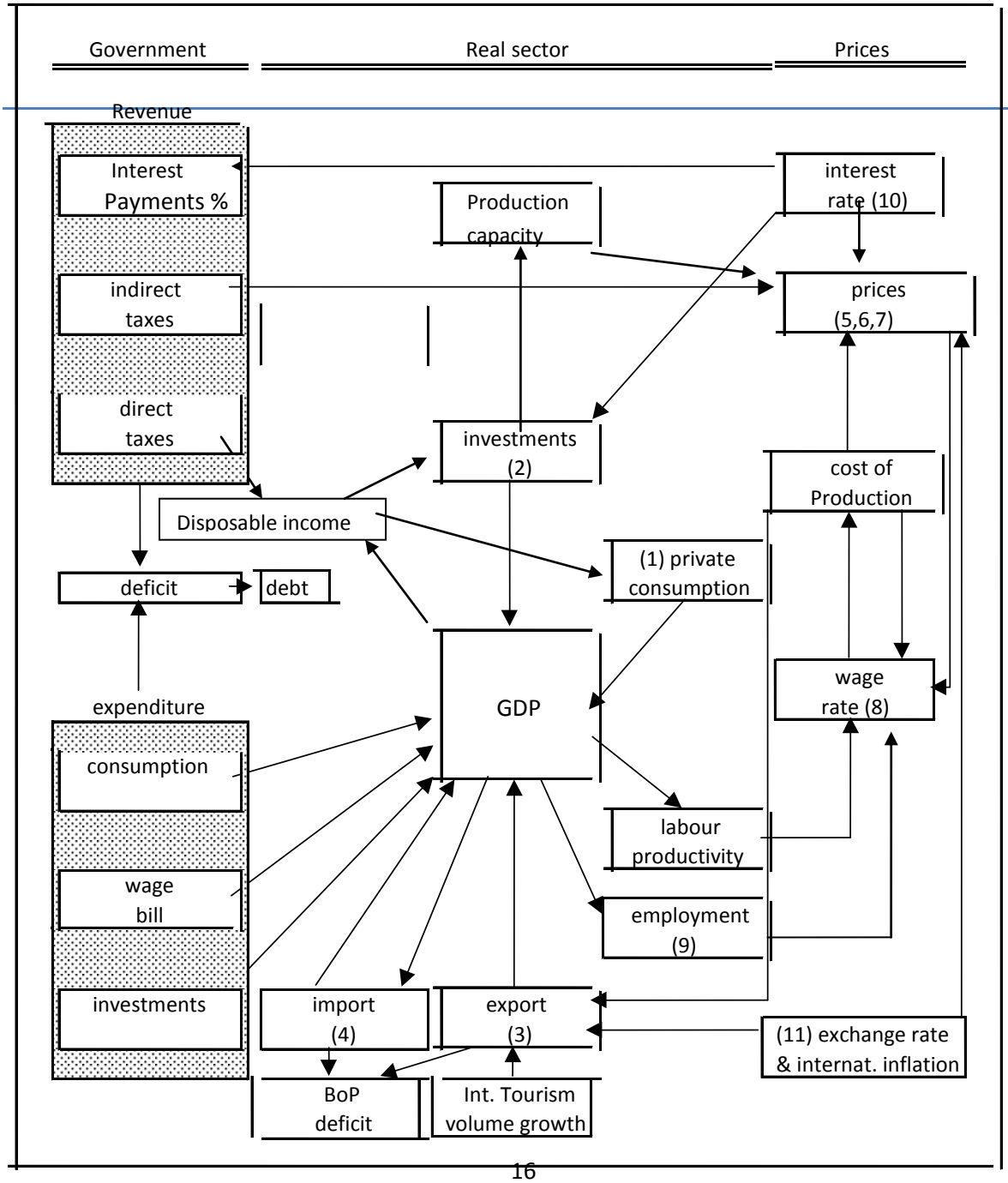
To use the Suryamodel as a tool for forecasting, simulating policy options, and scenario building, we start with the 70 primary historical variables and projected variables. As mentioned above, there are three types of primary variables: exogenous, behavioural, and institutional. Variables concerning **external factors** (e.g. the increase in import prices) are taken as exogenous, and we use the forecasts published by international institutions like IMF and World Bank.

Behavioural variables are calculated on the basis of other variables in the spreadsheet and predetermined coefficients. For example, consumption may be calculated as a function of disposable income and the share of savings. The values of the behavioural coefficients are based on a combination of time series analysis, economic theory, overall plausibility of the total model results, comparative studies, and –most important- expert opinion. Historical research alone is not adequate because the available time series are not that long and because the developing process affects behavioural relationships. The Suryamodel has, among others, behavioural equations for imports, employment, unemployment, wage formation, investments, consumption prices, money supply, net primary and secondary income transfers from abroad, etc.

Institutional variables (also called semi-behavioural) comprise the last set of data. They include, for instance, government variables such as direct taxes, indirect taxes, government wages, investment, and consumption.

The Suryamodel is based on the *Macroabc* methodology which was originally developed for the Netherlands, but has been implemented successfully for Suriname, Curaçao, the European Union, Poland, Kenya, Indonesia, Ethiopia, Macedonia, Namibia, Aruba, Sint Maarten, Zambia, Ukraine, Rwanda and Bhutan. It is our experience that the *Macroabc* methodology of combining the core of the model components (of CPB model and other Macroabc models) with local expertise produces a practical and user friendly instrument that is very helpful in policy discussions. A first version of MACROABC can already be running in a few months. Later on, the model is expanded step by step in cooperation with local economists and MMC consultants, and because the whole process during the workshops goes through the hands of local economists they master all components of the model.

Flow diagram of the Suryamodel



The Suryamodel in detail

With the framework outlined above, one can use the Suryamodel for:

- historical analysis
- forecasting/prognosis
- policy simulations
- constructing scenarios
- monitoring and updating

National accounts contain a large number of interdependent variables. Most of the macro data show up in the books twice; once as an asset and once as a liability. Also, a number of macro-economic variables are calculated based on other variables. As a result, an enormous volume of data is generated from a select number of key variables. With the use of the Macroabc methodology, the Suryamodel focuses on the key variables.

Taking advantage of practical statistical experience in making National Accounts, a Model Team could construct a primary data set of about 70 primary variables, which gives enough information for the Suryamodel to calculate the other variables needed for the output data and to estimate the behavioral relations. In principle one can make, starting with only 70 variables, 70 factorial other variables. That is nearly infinite. The current Suryamodel contains some few hundred rows, which is enough to support a 70 primary variable model.

The historical data is collected outside of the model. All other cells are secondary variables, and their entries are calculated by definitional relationships based on the primary variables (sometimes indirectly, through an intermediary secondary variable). All of these secondary cells contain formulas.

There are three types of secondary variables. The first types are **balance variables, indices and help variables.** These variables provide validity checks on the primary variables or are used as intermediary steps in the calculations of the formulas for the behavioral relationships later on. The second set of secondary variables is called **key figures** and gives the outcomes for the key figures for the various years. Most of the time these outcomes are presented in percentage growth rates. The last sets of secondary variables are **output tables**.

For the future, we need forecasted values of the primary variables. For the exogenous primary variables, these forecasts are taken from outside the mode. For the endogenous (behavioral or institutional) variables, a formula is used to calculate the forecasted values. As input for these formulas only primary values are needed or variables of the first set of secondary variables. So there is never feedback from the output part back to the core part.

Theory behind the Behavioural equations in brief

As also noted above, behavioural variables are calculated based on presumed relationships with other variables that are present in the model. Which variables are utilized as explanatory variables and the values of the behavioral coefficients is determined based on a combination of time series analysis, economic theory, feasibility of model results and comparative studies.

In the case of developing economies, historical research must be augmented with these latter components because the development process affects behavioral relationships, causing a structural change in the time series. Where possible evidence from other countries is used to calibrate local statistics.

Below is a discussion of the most important behavioral equations, and their significant explanatory variables. See the Flow Diagram for the relations between variables and the box with 12 main behavioral equations for an overview of the formulas and levels of the preliminary coefficients. For a detailed discussion of economic theory, see: 'M. Van Schaaijk: A macro model for a small economy, The Hague, 1991 [This document is available as shareware on www.stuseco.org. At the bottom you will find a section in English were you can download MACMIC EN]

Main behavioural equations

- **Consumer behaviour:**

Consumption is determined by inter-temporal optimization. In that case consumption is determined by the real disposable income, wealth and interest rate. Since data on wealth was not available, we left out wealth and interest rate from the equation, but we make a difference between the consumption rates of income from labour (unlagged) on the one hand and profit income (half year lag) from the other hand. With profits consumption rate 50% of that from labour income.

- **Investment behaviour:**

Many investments theories are available (accelerator theory; neo-classical investment theory; vintage theory; adjustment cost models; Tobin's q; the finance approach; Keynesian approach; supply factors). However in practice it is quite difficult to find a theory with high forecasting capacity. So for the time being we use a rather simple investment function: Investments in industries are a function of gross value added of industries (accelerator) and the investments per export product are exogenous in the micro block of the exports.

- **The export function**:

Exports are split into ten products. Production volumes, prices and investments are exogenous in the baseline. Only for Rice exists a special endogenous block. However, when we use the model, we manually translate price/costs ratios (including productivity) to changes in exports.

- **The demand for imports function:**

For the production of final output of the private sector (Consumption +Investments +several Exports) domestic value added as well as imports is needed. The share of domestic value added to imports will change if domestic inflation differs from international inflation. The direct plus indirect import intensity of different final demand categories (C, I, several E) can differ, and for that reason we use a Cumulated Production Structure (CPS) Matrix of Suriname. This gives the next equation: The change in the quantity of imports is a function of real final output re-weighted to import intensity, and 0,1 * the difference between internal and external inflation.

- **Prices**.

In a market economy with many competing firms the marginal prices will follow marginal costs (the combination of wage costs, import costs and capital costs). However, the export prices of raw materials are set internationally. Concerning the consumer price we take also the change in indirect taxes as one of the costs components: The change in the consumer price is a function of the change in costs and the change in the indirect tax rate.

- **The export price:**

The changes in export prices of Suriname are given international.

- **The investment price**:

The change in the price of investment goods is a function of the change in costs.

- **Wage determination**

The changes in the wage rate can be explained by a process of bargaining. In this process the employers are most interested in gross wage costs and employees (individuals and trade unions) in net real wages. The change in strength of employers versus employees is given by the change in the unemployment. (Phillips curve effect). So the components in the wage

equation are the lagged consumption price, the labour productivity and the level and the change in unemployment. And 50% of the change in direct tax incidence.

- **Employment**:

If we assume that the production of the value added takes place in a CES production function with capital and labour, the employment will follow the production growth minus productivity increase minus the growth of wages cost compared to other costs (with for the time being the consumer price as indicator). So the growth of employment in industries is a function of growth of the final output and the labour productivity and in the future also relative wage costs might be added.

- **Unemployment:**

The change in unemployment rate is the result of changes in supply and demand. The informal sector follows the growth of labour force minus formal employment. And the unemployment is equal to labour force minus formal and informal employment.

- **The exchange rate**

The exchange rate is exogenous, but we can change it manually should the foreign reserve stock come below a certain level (like 3 month imports covered).

- **Money Supply**

Money supply: increases with liquidity creation foreign transactions (surplus BoP) + liquidity creation by government (the deficit) plus exogenous credit to private sector.

Box 2 below summarizes the main behavioural equations of the Suryamodel

Box 2: List main behavioural equations

Elements of GDP (Lags not mentioned):

1. Consumption: changes with the growth of : (net disposable income wage earners (unlagged) + 50% net disposable profit income (half year lag) of the running year)/ (the same of year before)

2. Private investments excluding in exports sector volume growth follows with half year lag real value added growth of private sector. And exports in export sector per product are exogenous.

3. Exports volumes are exogenous in the baseline, given per product: alumina (ended in November 2015), oil, gold, rice, banana, timber, shrimps, fish, and tourism.

4. Import volume % growth follows real final demand growth, reweighted for import intensity, plus 0,1* (domestic – international inflation)

5. Depreciation of capital: 9 % of estimated value of capital stock

Prices:

6. Consumption price % change: 0,39*import price + 0,61* (wage rate minus trend in labour productivity) + change in indirect tax incidence.

7. Export price % change: weighted average of those of the ten export products.

8. Investment price % change: 0,83*import price + 0,17* (wage rate minus trend in labour productivity) + change in indirect tax incidence.

9. Wage rate businesses: average of current consumer price change an that of one year before + 0,3*labour productivity trend + 50% of change in wage tax incidence + 90% of change in unemployment plus 30% of unemployment level actual minus equilibrium employment.

Employment:

10. Employment businesses % change: real production growth -1*change in labour productivity trend

11. Unemployment: increases with population growth -change in formal and informal employment)

12. Net migration: exogenous, in the base line zero

Monetary variables:

13. Money supply: increases with liquidity creation foreign transactions (surplus BoP) + liquidity creation by government (the deficit) plus exogenous credit to private sector.

14. Exchange rate: exogenous. However if the foreign reserve stock would decrease below a certain level (for example 3 months imports) then we depreciate manually, by trial and error in such a way that the foreign reserve stock does not decrease below the given minimum.

15. Interest rate: exogenous

During workshops in both Suriname and in Stuseco's office in the Netherlands, SPS and other Surinamese staff and several experts of MMC have discussed the theory behind these and other equations. Actually the improvement of a macroeconomic model never ends.

Semi-Behavioural equations

The institutional or semi-behavioural equations reflect the current institutional setting of the country. Some of the most important equations of this type are:

- Import duties is equal to (value of import duties / imports year before) * value of imports current year. So in the baseline we assume no change in tax rates.
- Actually the value of all taxes in current year is equal to (value of that tax year before / value of tax base year before) * value of tax base. So in the baseline we assume no change in tax rates. Then add factors in case of changes in tax rates can be added.
- For example: the value of wages tax in current year is equal to (value of wages tax year before / value of wages bill year before) * value of wages in current year.

The behavioural and institutional equations allow us to perform bookkeeping and more economic analysis. The set of these equations in *Macroabc* is normally deliberately limited. Of course, one may expand this set in any direction based on the questions to be addressed by the model, such as a more detailed breakdown of medium term budgetary projections.

Who is STUSECO and CV

The Foundation for stimulating the study of the Surinamese economy is an independent scientific institute founded in 1977. Stuseco generates its revenues partly from gifts of board members and partly from delivering consultancy services to third parties. It provides research and training to Surinamese economists in macroeconomic modelling. See Explanation of history and goals of Stuseco, published on www.stuseco.org. Stuseco supports the Surinamese Planning Office and the Institute for Graduate Studies and Research of the Anton de Kom University Suriname in the use and maintenance of the Suryamodel, the macroeconomic model of Suriname. One can find on www.stuseco.org a lot of studies, starting in 1977. Actual studies include for example "Suriname scenario's 2015-2030", published in October 2015.

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1973-1976 Algemeen Bureau voor de Statistiek Suriname (ABS). He constructed the first National Accounts of Suriname and trained staff of ABS.
1976-1994 Centraal Planbureau Netherlands 1976-1994 several scientific and management jobs
1994-present Director Micromacro Consultants. This bureau has constructed macroabc models for 20 countries (Curaçao, Sint Maarten, Aruba, Netherlands, Poland, Ukraine, Indonesia, Kenya, Ethiopia, Rwanda, Zambia, Namibia, EU15, Bhutan, etc.) see www.micromacroconsultants.com This private firm is owned by Marein van Schaaijk.
1977-present: Chairman of Stichting ter Bevordering Studie van de economie van Suriname (Stuseco). See www.stuseco.org
He has visited Suriname 44 times. The last visit was on 2 till 11 January 2016.