Static Open Economy Computable General Equilibrium Model: User Guide

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In this document we describe how to implement the GAMS code of the static small open economy (SOE) model. A detailed description of the model can be found in Lofgren and Cicowiez (2018). The model can be run through the ISIM interface (see Cicowiez et al., 2013).

GAMS Code Organization

In Figure 1, we show how the GAMS files of the model are organized. As can be seen, we use a "modular" approach where some parts of the code are re-utilized.

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Figure 1: organization of GAMS files

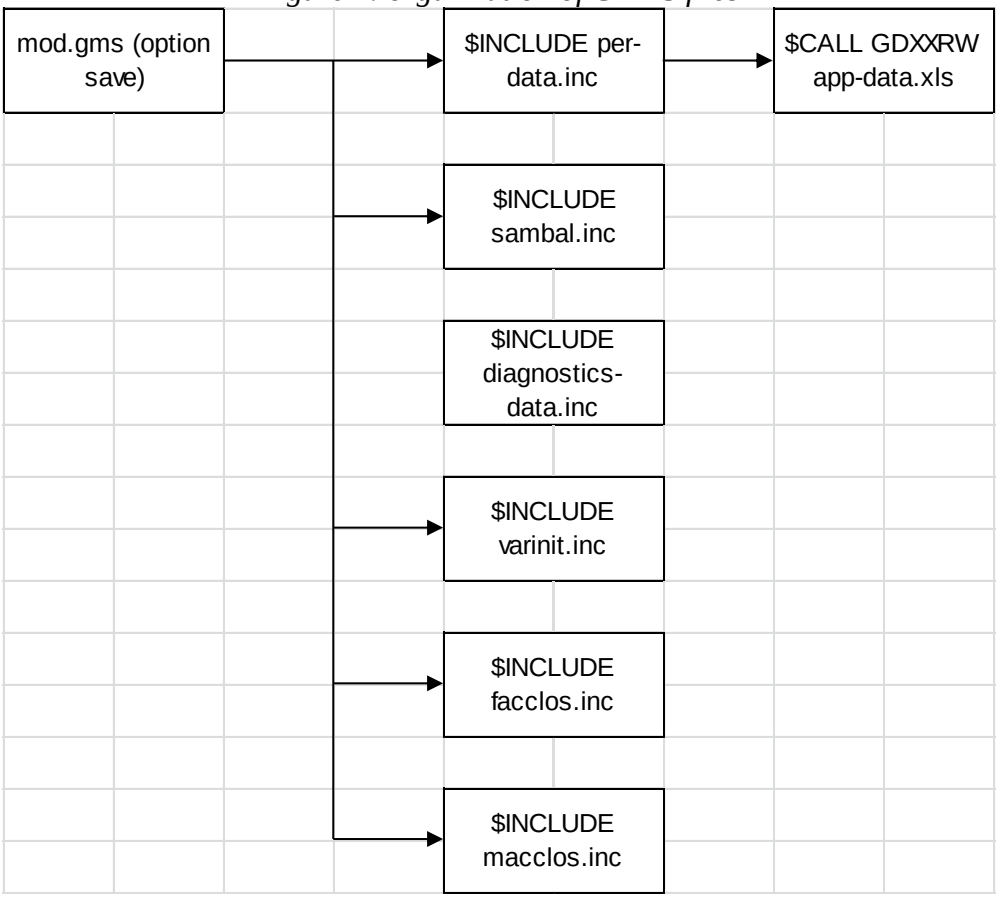
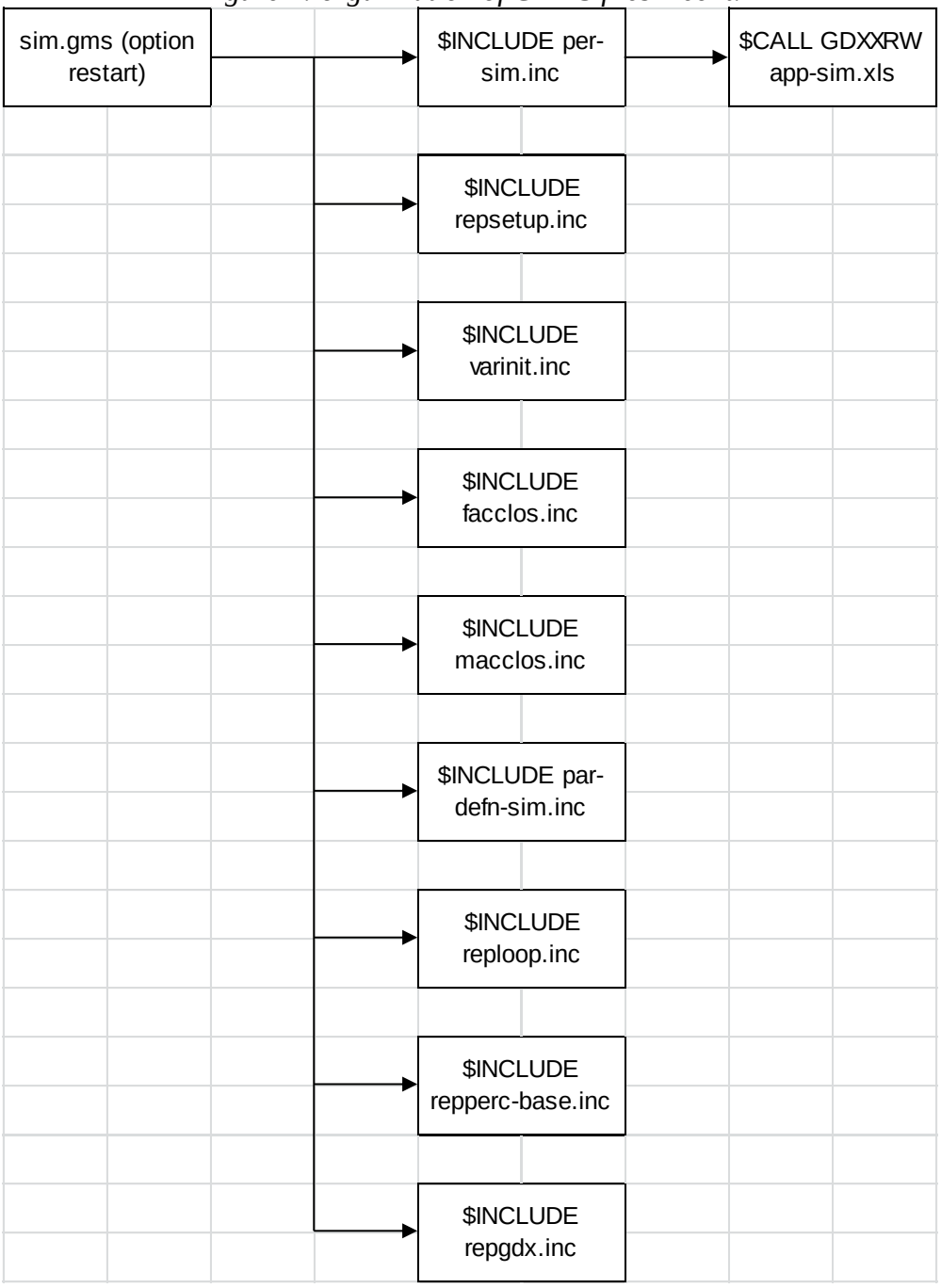


Figure 1: organization of GAMS files – cont.



The GAMS file mod.gms is used to calibrate the model and replicate the information in the SAM (i.e., the "replication check"). In turn, the file sim.gms is used to define the simulation scenarios. Finally, the results are saved in the file report.gdx, that can be inspected from within ISIM. The sequence to run the model without the interface is the following:

mod.gms with the command line option s=save\mod

sim.gms with the command line option r=save\mod s=save\sim

However, the model can also be executed using ISIM, so that the direct interaction with GAMS is not needed. In any case, even when using ISIM, the user has no restriction to alter the GAMS model code; it is located in the "folder model" (see below).

The model is coded to facilitate its use with different datasets. In other words, the model theory is separated from the data that is used for the calibration process. The distributed version of the model contains three sets of data files: (1) demo which is for a non-existent country, (2) nic2010v2 which contains information for Nicaragua in the year 2010, and (3) uga0910 which contains information for Uganda in the fiscal year 2009/10. Of course, the three datasets can be use as the starting point (i.e., a template) to develop a new dataset for the model.

As said before, each dataset contains two components, one for calibration data and another that is used to define simulation scenarios. As we will see, certain model characteristics will be active or not depending on the information contained in the data file. After running simulations, the model code generates a report file (rep1-disp-gdx.gdx) in GDX format, which is a GAMS format. Besides, selected reports are also shown in Excel. In case of using the model through ISIM, the simulation file is created through the interface. On the other hand, the data file has to be developed without the aim of ISIM.

Data File

In what follows we describe the content of each of the sheets in the Excel that contains the information used to calibrate the model. Typically, this file would be called app-data.xlsx, where app represents a specific application of the model.

Sets

In this sheet the sets of the model are defined. In addition, the model has other sets (e.g., acnt) that are automatically defined in the GAMS model code. In this model we have minimized the number of mandatory names for SAM accounts. For example, the name of the SAM account that refers to direct taxes can be chosen arbitrarily, provided it complies with GAMS restrictions for set elements. Then, that name should be introduced in the set taxdir(actax). On the other hand, an account named “total” is mandatory, as it is explicitly referenced (i.e., it is hard-coded) in the GAMS model code (see file mod.gms).

Table 1: sets

set	description
ac	global set (SAM accounts and other items)
a(ac)	activities
c(ac)	commodities
tacd(ac)	domestic trade and transport margin account
tacm(ac)	import trade and transport margin account
tace(ac)	export trade and transport margin account
f(ac)	factors
flab(f)	factors labor
fcap(f)	factors capital
ins(ac)	institutions
insd(ins)	domestic institutions
insdng(insd)	domestic non-government institutions
h(insdng)	households
insgov(insd)	government
insrow(ins)	rest of the world
actax(ac)	all taxes
taxvat(itax)	value-added
taxcom(actax)	sales tax
taxact(actax)	tax on producer gross output value
taxdir(actax)	direct tax on dom inst ins
taximp(actax)	import tariff
taxexp(actax)	export tax
taxfac(actax)	direct tax on factors (soc sec tax)
savinv(ac)	savings-investment account
dstk(ac)	changes in inventories

sam – SAM(ac,acp)

In this sheet, the social accounting matrix that will be used to calibrate the model is stored. Generally speaking, it advisable that no large differences exist between the maximum and the minimum values in the SAM. In addition, it is preferable that values in the SAM do not exceed the number 99999. Doing this, the SOLVE performance when searching for a model solution is improved.

mapaggreg – mapaggreg(ac,acp)

In this sheet the user can aggregate accounts of the social accounting matrix. For example, Figure 1 shows how the tax-vat account can be excluded from the model by aggregating its content with the tax-com account.

Figure 1: mapaggreg

mapaggreg(ac,acp)	
	tax-com
tax-vat	YES

prodelas – prodelas(a)

In this sheet the elasticities of substitution between factors are introduced. Note that the value added production function is a CES function. The user must introduce an elasticity value for each activity in the SAM. Figure 2 shows an example.

Figure 2: prodelas

prodelas(a)	
a-agric	0.25
a-ganad	0.25
a-forestal	0.20
a-pesca	0.20
a-mineria	0.20
a-carne	1.15
a-aceites	1.15
a-otralim	1.15

tradelas – tradelas(c,ac)

In this sheet values for the trade-related elasticities are introduced. Specifically, in column sigma_q (sigma_x) Armington (CET) elasticities are introduced. As can be seen, elasticities can be different among commodities. Figure 3 shows an example.

Figure 3: tradelas

tradeas(c,ac)		
	sigma_Q	sigma_X
c-agric	0.9	1.5
c-ganad	0.9	1.5
c-forestal	0.9	1.5
c-pesca	0.9	1.5
c-mineria	0.9	1.5
c-carne	0.9	1.5
c-aceites	0.9	1.5
c-otralim	0.9	1.5

facclos0 – facclos(f)

In this sheet, the user selects the closure rule (i.e., the mechanism to equilibrate supply and demand) for the factor markets; this model provides three pre-programmed alternatives:

- facclos0(f) = 1 factor is fully employed and perfectly mobile among sectors;
- facclos0(f) = 2 factor is fully employed and sector specific (i.e., immobile); and
- facclos0(f) = 3 factor is unemployed with an horizontal supply curve and mobile among sectors.

Typically, the second alternative is used for the capital factor in the context of a short run/medium run simulation, where it is assumed that installed capital cannot move between productive sectors. The third alternative assumes that factor supply is horizontal; in other words, factor supply is perfectly elastic. In model terms, the Table 2 shows the endogenous and exogenous variables in each of the three alternatives.

Table 2: facclos(f)

#	workings of factor markets	WFDIST(f,a)	WF(f)	QF(f,a)	QFS(f)
1	full employment; mobile factor	fix	flex	flex	fix
2	full employment; specific factor	flex	fix	fix	flex
3	unemployment; mobile factor	fix	fix	flex	flex

numeraire0 – numeraire0

In this sheet the user selects the model numeraire; two pre-programmed alternatives are available: (1) the model numeraire is the consumer price index, and (2) the model numeraire is the index for domestic producer prices. In Table 3 we show the endogenous and exogenous variables in each case.

Table 3: numeraire

#	numeraire	CPI	DPI
1	consumer price index	fix	flex
2	producer price index	flex	fix

govclos0 – govclos0

In this sheet the user can select one of the three available (pre-programmed) closures to balance the government budget. If govclos0 = 1, the variable that clears the government budget is direct (income) tax collection (TYADJ). If govclos0 = 2, the variable that clears the government budget is government savings (GSAV). If govclos0 = 3, the variable that clears the government budget is government consumption (GADJ). If govclos0 = 4, the variable that clears the government budget is government (marginal) foreign financing. In the four cases, all indirect tax rates are assumed constant. Table 4 shows the endogenous and exogenous variables in each case. As an extension, additional closure rules could be considered, where both government savings and government consumption are exogenous at the same time that one (or more) tax rate is endogenously modified to balance the government budget.

Table 4: govclos

#	**variable that clears the government budget**	**GSAV**	**GADJ**	**TYADJ**	**GMFF**
1	direct (income) tax rate	fix	fix	flex	fix
2	government savings	flex	fix	fix	fix
3	government consumption	fix	flex	fix	fix
4	foreign financing	fix	fiex	fix	flex

siclos0 – siclos0

In this sheet the user can select the clearing variable for the savings-investment balance. The model provides two alternatives:

- siclos0 = 1 implies that the model is savings-driven (i.e., the household savings rate(s) are exogenous and investment is the adjustment variable); and
- siclos0 = 2 implies that the model is investment-driven (i.., investment is exogenous and the household savings rate(s) are the adjustment variable).[1]

In the first case, MPSADJ is exogenous and IADJ is endogenous. In the second case, it is the opposite (see Table 5).

[1] In case more than one household are present in the SAM, all savings rates are scaled up or down to the same extent.

Table 5: siclos

#	variable that clears the savings-investment balance	IADJ	MPSADJ
1	investment	flex	fix
2	savings rate of households	fix	flex

rowclos0 – rowclos0

In this sheet the user can select the clearing variable for the current account of the balance of payments. In other words, the mechanism for balancing inflows and outflows of foreign exchange is selected. In the first case, the real exchange rate is the clearing variables that drives exports and imports to be consistent with the exogenous current account balance (i.e., minus FSAV). In the second case, the real exchange rate is assumed exogenous at the same time that the foreign savings are the clearing variable. Table 6 shows the endogenous and exogenous variables in each case.

Table 6: rowclos

#	variable that clears the current account BoP	FSAV	REXR
1	real exchange rate	fix	flex
2	rest of the world savings	flex	fix

scaling

In this sheet the user can introduce scaling values for the SAM; one means that no scaling is made.

layout

In this sheet, we define how the information in the Excel file is organized. In general, the user should not modify this sheet.

Simulation File

In what follows, we describe the content of each element in the ISIM application Excel file; for example, app-sim.xlsx, where app refers to a particular application; for example, demo-sim.xlsx. As we will see, the simulation scenarios can combine different shocks; i.e., the same scenario name can appear in more than one of the simulation parameters that are described next. For example, we can define a scenario that combines

a reduction in the import tariff rate of a specific commodity with an increase in the world import price of that same (or other) commodity.

sim – sim

In this element, defined using the Scenario Manager, the user gives a name to each of the simulation scenarios that will be defined; the "base" simulation should not be deleted – it corresponds to the reference scenario that is used to calibrate the model. Alternatively, it is the starting point for the non-base simulations. If using ISIM, the simulation names should be entered through the Scenario Manager. Figure 4 shows an example; besides the base simulation, we have created the name for the "example" simulation.

Figura 4: sim

sim
base
ejemplo

simcur -- simcur(sim)

In this sheet the user selects which are the simulation scenarios that should be run. Thus, the set of simulations simcur is a subset of the simulations in sim. If using ISIM, the selection is made through the Scenario Manager.

facclossim – facclossim(sim,f)

In this simulation parameter the user can select the closure rule for the factor markets in each of the scenarios; the available alternatives are the same as those presented above for facclos0. By default (i.e., when no selection is made), all simulations assume the same closure rule that was selected in facclos0 (i.e., the value used in the pre-programmed reference scenario). However, that default is overwritten if a selection is made for the base scenario. Table 2 (facclos0) shows the available options.

numerairesim -- numerairesim(sim)

In this simulation parameter the user can select the numeraire for each simulation. The selection made for the calibration/reference scenario is the default for all non-base simulations. In case no selection is made for the base scenario, the value for numeraire0

(i.e., for the reference scenario) is used as the default for all non-base simulations. Table 3 (numeraire0) shows the available (pre-programmed) options.

govclossim – govclossim(sim)

In this sheet the user can select the government closure rule for each scenario. The available options are the same as the ones described for the calibration/reference scenario (see govclos0). This is an optional parameter; by default, it is assumed that all non-base simulations implement the closure selected for the base scenario. In case no selection is made for the base scenario, the selection from the model calibration/setup is used. Table 4 (govclos0) shows the available (pre-programmed) options.

siclossim – siclossim(sim)

In this sheet the user can select the savings-investment closure rule for each scenario. The available options are the same as the ones described for the calibration/reference scenario (see siclos0). This is an optional parameter; by default, it is assumed that all non-base simulations implement the closure selected for the base scenario. In case no selection is made for the base scenario, the selection from the model calibration/setup is used. Table 5 (siclos0) shows the available (pre-programmed) options.

rowclossim – rowclossim(sim)

In this simulation parameter the user can select the variable that balances the inflows and outflows of foreign exchange in each simulation. The selection made for the calibration/reference scenario is the default for all non-base simulations. In case no selection is made for the base scenario, the value for rowclos0 (i.e., for the reference scenario) is used as the default for all non-base simulations. Table 6 (rowclos0) shows the available (pre-programmed) options.

CPISIM – CPISIM(sim)

In this sheet scenarios in which the value of the numeraire is changed can be defined. In our case, the model numeraire is the consumer price index – see variable CPI. In general, this sheet can be used to check that the model is homogenous of degree zero in prices. In other words, if the numeraire is doubled, all nominal variables (i.e., prices and incomes) should be doubled and quantities remain constant. The counterfactual CPI is defined as

CPI = CPI0 if CPISIM(sim) = 0

CPI = CPI0 * CPISIM(sim) if CPISIM(sim) <> 0

That is to say, shocks are introduced as deviations with respect to the base scenario value; for example, 2 implies a 100% increase. Besides, when no values are introduced for cpisim, the values from the reference scenario are used. As we will see, the same applies to the other parameters that are used to define simulation scenarios. Of course, one can only simulate changes in the CPI provided it is considered an exogenous variable. In any case, the model version distributed with ISIM has, as default, the CPI selected as the model numeraire.

tmsim -- tmsim(sim,c)

In this sheet the user can define scenarios in which changes in the import tariff rates are simulated. The counterfactual import tariff rate for commodity c in simulation sim is computed as

tm(c) = tm0(c) if tmsim(sim,c) = 0

tm(c) = tm0(c) * tmsim(sim,c) if tmsim(sim,c) <> 0

Thus, shocks are introduced as deviations relative to the base scenario. For example, 1.25 implies a 25% increase. Figure 5 shows an example; specifically, the tarcut scenario simulates a unilateral 75% reduction of import tariffs for the following heavy manufactures: c-refpet, c-quimic, c-caucho, c-minernometal, c-metal, c-metalestruct, c-maquin, and c-vehic.

Figura 5: tmsim

tmsim(sim,c)		tm = tm0 x tmsim	
tarcut	c-refpet	0.25	
tarcut	c-quimic	0.25	
tarcut	c-caucho	0.25	
tarcut	c-minernomet	0.25	
tarcut	c-metal	0.25	
tarcut	c-metalestruc	0.25	
tarcut	c-maquin	0.25	
tarcut	c-vehic	0.25	

tesim -- tesim(sim,c)

In this sheet the user can define scenarios in which changes in (existing) export tax rates are simulated. The counterfactual export tax rate for commodity c in simulation sim is computed as

te(c) = te0(c)	if tesim(sim,c) = 0
te(c) = te0(c) * tesim(sim,c)	if tesim(sim,c) <> 0

te2sim -- tesim(sim,c)

In this sheet the user can also define scenarios in which changes in the export tax rates are simulated. However, in this case the counterfactual export tax rate is introduced as a level, not as deviation relative to the base scenario. Thus, the simulated export tax rate is computed as

te(c) = te0(c)	if te2sim(sim,c) = 0
te(c) = te2sim(sim,c)	if te2sim(sim,c) <> 0

Note that this simulation parameter can be used to introduce export taxes/subsidies in cases where there are no such taxes in the SAM; i.e., the reference scenario does not show the existence of export taxes.

tqsim – tqsim(sim,c)

In this sheet the user can define scenarios in which changes in sales tax rates are simulated. The counterfactual sales tax rates are defined as deviation with respect to the base scenario, as in previous cases.

tasim – tasim(sim,a)

In this sheet the user can define scenarios in which changes in activity tax rates are simulated. The counterfactual activity tax rates are defined as deviation with respect to the base scenario, as in previous cases.

tysim – tysim(sim,insdng)

In this sheet the user can define scenarios in which changes in (direct) income tax rates are simulated. The counterfactual income tax rates are defined as deviation with respect to the base scenario, as in previous cases.

tfpsim -- tfpsim(sim,a)

In this simulation parameter, the user can define scenarios in which the sectoral total factor productivity (TFP) is changed. The counterfactual TFP for activity a is computed as

phi(a) = phi0(a) if tfpsim(sim,a) = 0

phi(a) = phi0(a) * tfpsim(sim,a) if tfpsim(sim,a) <> 0

qgbarsim – qgbarsim(sim,c)

In this sheet scenarios in which the government consumption is changed can be defined. The counterfactual government consumption is defined as

qgbar(c) = qgbar0(c) if qgbarsim(sim,c) = 0

qgbar(c) = qgbar0(c) * qgbarsim(sim,c) if qgbarsim(sim,c) <> 0

Certainly, the impact of simulating changes in qgbar will be different depending of the closure rule that is used to balance the government budget (see govclossim).

qinvbarsim – qinvbarsim(sim,c)

In this sheet the user can define scenarios in which the investment demand for specific commodities is changed. The counterfactual investment demand for commodity c in simulation c is computed as

qinvbar(c) = qinvbar0(c) if qinvbarsim(sim,c) = 0

qinvbar(c) = qinvbar0(c) * qinvbarsim(sim,c) if qinvbarsim(sim,c) <> 0

As shown, the working of this simulation parameter is similar to that described above for the case of qgbarsim. In fact, the implications of changes in qinvbarsim also depend on the value that is assumed to siclossim.

trnsfrsim -- trnsfrsim(sim,ac,ins)

In his sheet the user can define shocks in which the one or more of the following transfers are modified: (a) from the rest of the world to domestic institutions, (b) from the rest of the world to factors, and (c) from the government to the other (non-government) institutions. On the other hand, note that transfers from domestic non-

government institutions are a fixed shared of their respective incomes. The counterfactual transfer from institution ins to institution/factor ac is computed as

trnsfr(ac,ins) = trnsfr0(ac,ins) if trnsfrsim(sim,ac,ins) = 0

trnsfr(ac,ins) = trnsfr0(ac,ins)*trnsfrsim(sim,ac,ins) if trnsfrsim(sim,ac,ins) <> 0

donde ac puede incluir instituciones y/o factores de producción.

FSAVSIM -- FSAVSIM(sim)

In this sheet the user can define shocks to the savings from the rest of the world. Of course, the information introduced here is only used if, for the same simulation scenario, the value of rowclossim is 1; i.e., FSAV is an exogenous variable. The counterfactual value for SROW is computed as deviation from the base scenario, similar to other simulation parameters.

pwesim -- pwesim(sim,c)

In this sheet the user can define shocks to the world price of exports. The counterfactual value for pwe for commodity c in simulation sim is computed as

pwe(c) = pwe0(c) if pwesim(c,sim) = 0

pwe(c) = pwe0(c)*pwesim(c,sim) if pwesim(c,sim) <> 0

pwmsim -- pwmsim(sim,c)

In this sheet the user can define shocks to the world price of imports. The counterfactual value for pwm for commodity c in simulation sim is computed as

pwm(c) = pwm0(c) if pwmsim(c,sim) = 0

pwm(c) = pwm0(c)*pwmsim(c,sim) if pwmsim(c,sim) <> 0

layout

In this sheet, we define how the information in the Excel file is organized. In general, the user should not modify this sheet.

Report File

The report files (i.e., rep1-disp-gdx.gdx and report.gdx) are generated after executing the file sim.gms. Specifically, the reporting files contain (1) all endogenous variables

(variable name + X), (2) the percentage change relative to the base for all endogenous variables (variable name + XP), (3) parameters used to define counterfactual scenarios (parameter name + X), and (4) additional report parameters computed based on model results that are described next.

- modsolstat(solcol,sim): status of solver and model; given that the model is solved as a CNS (constrained non-linear system) problem, the solver and model status should be 1 and 16, respectively. Otherwise, an error has occurred.
- SIMSAM(ac,acp,sim): is a collection of SAMs defined using results from each of the simulations contained in the simcur set.
- simsambalchk(ac,sim): is a report parameter that allows checking if the SIMSAM accounts are balanced.
- MACROSAM(ac2,ac2p,sim): contains an aggregated (macro) SAM for each of the simulation scenarios.
- macrosambalchk(ac2,sim): is a report parameter that allows checking if the MACROSAM accounts are balanced.
- gdpindic(igdp,kgdp,sim): summary table with GDP and its components, both in nominal and real terms; in absolute values and as shares of GDP.
- gdpindicXP(igdp,kgdp,sim): similar to the previous one but shows percentage changes relative to the base scenario.
- sectorstruc(ac,sectorcol,sim): this report parameter described the sectoral structure of the economy, both in terms of production and foreign trade. For example, it contains the share of each commodity in total exports, the share of each commodity in total, the share of imports in total consumption, and the share of exports in the total output.
- sectorindic(ac,sectorcol2,kgdp,sim): this report parameter also describes the sectoral structure of the economy, both in terms of production and foreign trade; unlike the previous one, it presents information in absolute values. In turn, the sectorindicXP parameter presents the results as percentage changes from the base scenario.

- fiscalindic(fiscalcol,sim): this report parameter shows the government budget. For example, it shows the ratio between government savings and GDP, the ratio between tax collection and GDP, among others.
- taxstruc(ac,taxcol,sim): this report parameter shows information regarding the tax collection, in values, as a share of total tax collection, and as a share of GDP.
- bopindic(bopcol,kgdp,sim): this report parameter shows the current account of the balance of payments, in domestic currency, as a share of GDP, and in foreign currency.
- ev(h,sim): is the equivalent variation.
- cv(h,sim): is the compensatory variation.

The reports that are expressed in the local currency unit are scaled – using the information in the scaling sheet -- to the original units in the SAM. The model can be used through ISIM, in which case some Excel reports are generated.

References

Lofgren, Hans, and Martín Cicowiez (2018). A Static Open Economy Computable General Equilibrium Model. Mimeo.

Cicowiez, Martín, Fernando Consigli, Enrique Gallego and Hans Lofgren (2013). ISIM-MAMS: An Interface for MAMS: User Guide. Mimeo.