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Impacts of Changes in Exchange Rate and International Prices on Agriculture and Economy of the Sudan: Computable General Equilibrium Analysis

Omer Elgaili Elsheikh[1], Azharia Abdelbagi Elbushra[2] & Ali A. A. Salih[3]

[1] The Economic and Social Research Bureau, Ministry of Science and Technology, Khartoum, Sudan

[2] The University of Bahri- College of Agriculture, Department of Agricultural Economics, Khartoum, Sudan

[3] The University of Khartoum, Department of Agricultural Economics, Faculty of Agriculture, Shambat, Khartoum Bahri, Sudan

Correspondence: Omer Elgaili Elsheikh, Economic and Social Research Bureau, Ministry of Science and Technology, Khartoum, Sudan. Tel: 249-9124-93924. E-mail: omerii@yahoo.com

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Abstract

Changes in exchange rate and international prices greatly affect food availability, the agricultural sector, and Gross Domestic Product (GDP). This study quantifies the effects of change in exchange rate and world prices on Sudan's agricultural production, imports, exports, and GDP. Special emphasis has been placed on sorghum and wheat, the main food grains. A Standard Computable General Equilibrium model has been developed and used for the analysis. The main objective is to contribute to policy-making process for enhancing food security and social welfare in the Sudan**.**

Currency depreciation would reduce wheat imports and increase its domestic production, increase sorghum export, increase domestic output and export of sesame and cotton, and improves GDP; and vice versa for appreciation. Appreciation favors urban (wheat) consumers, whereas depreciation favors rural (sorghum) consumers.

Increasing world price of wheat would decrease its imports, whereas that of sorghum would encourage its production and export, and increase domestic food prices. GDP decreases due to investment reduction **.**

It is recommended that wheat import should be conditioned on hard currency availability and food gap, while maintaining stable exchange rate that strike a balance between encouraging sorghum exports and wheat imports. It is also recommended to encourage innovation of fast food from traditional grains to curb the shift to wheat consumption.

Keywords: Sudan, computable general equilibrium model, exchange rate, world prices, agriculture

1. Introduction

The level and changes in international prices and exchange rate have great influence on food supply and Gross Domestic Product (GDP), whereas the volume and diversity of international trade is increasing over time. The Sudan has submitted a request to join the World Trade Organization in 1994, and is currently an observer member, a matter that will further enhance the influence of international linkages with the national economy, especially the agricultural sector. This study quantifies the effects of changes in exchange rate and world prices on domestic production of sorghum and wheat (the main food grains), agricultural imports and exports, and GDP as an aggregate. The main objective of the study is to contribute to policy-making process for enhancing food security and development in the Sudan. Disaggregation of the agricultural sector and tracing the effects of changes of the variables of interest on each component are the main additions to previous research effort such as that provided by Elbushra (2007).

2. Analytical Method

One of the main tools of tracing the anticipated impacts of changes in policy and other variables is the use of econometric modeling. The study uses a Standard Computable General Equilibrium (CGE) model, designed by

the International Food Policy Research Institute (Löfgren et al., 2002). The model is a set of simultaneous nonlinear equations defining the behavior of different actors, and includes a set of constraints. The CGE covers markets (for factors and commodities), balances for saving-investment, government, and the rest of the world accounts. Thus, the model provides detailed description of the Sudanese economy, with special emphasis on agriculture.

Different scenarios has been postulated and simulated. The model has been implemented using General Algebraic Modeling System software. SAM has been calibrated using elasticity values from literature for estimating the shift and share parameters of the constant elasticity of substitution (CES) and constant elasticity of transformation (CET) functions. This validates the model by reproducing the simulated benchmark data set as equilibrium solution.

The model is written as a set of simultaneous equations (Appendix 1), many of which are nonlinear, without objective function. The equations define the behavior of different actors and include a set of constraints that should be satisfied by the system as a whole. These constraints cover markets (for factors and commodities) and macroeconomic aggregates including the balances of saving- investment, government, and current account of the rest of the world. The macro constraints **(**model closures) are specified as follows: in the factor market balance, all demand variables are flexible while the supply variables are fixed, whereas the factor wage is the equilibrating variable. In the government balance, the government savings is flexible while all tax rates are fixed. Regarding the current account balance, foreign savings is fixed and the real exchange rate is the equilibrating variable. For the saving- investment balance, investment is fixed while saving is a flexible variable (investment-driven model).

The major blocks of the model include producers, factor markets, commodity markets, households, the government, and the rest of the world. Producers are assumed to maximize profit subject to the level of technology. A CES production functions rather than a Cobb-Douglas function has been used because it does not impose any prior restriction on the value of elasticity of substitution (σ) between factors, whereas the latter imposes a unitary value.

Producers earn their income from domestic sales and exports reflecting the assumption of imperfect transformability between these uses. Allocation of output between these two markets is determined by the relative prices received in domestic and foreign markets. The received income is allocated to purchases of intermediate inputs and payments for production factors. For the domestic product markets, the demand side consists of investment, private and government consumption, and intermediate input demands. The supplies come from domestic sale and imports depending on their relative prices. Flexible prices clear the market segments for products of domestic origin.

For the model's consistency, most of the model's parameters are set endogenously in a manner that assures the base solution would exactly reproduce the values of SAM (calibration process). For the remaining parameters, elasticity values are set exogenously. The consistency of the model was checked by equality of total savings and total investment at equilibrium, and the balance of SAM before and after running the model.

3. Data

The Sudan's Social Accounting Matrix (SAM) for the year 2004 disaggregated for agriculture, has been developed as a core database (Table 1). The year 2004 was chosen as a base year because it is a normal year for the Sudanese economy, and that it is the most recent date with comprehensive data, specifically for capital formation.

In this SAM, the activity and commodity accounts are disaggregated into agriculture, industry and service accounts. The agriculture account is further disaggregated into sesame, sorghum, cotton, wheat, and other-agriculture (mainly livestock) accounts. This disaggregation is based on their relative economic importance.

The "factors of production" account is disaggregated into "labor" and "capital" accounts. The "saving-investment" account is disaggregated into "fixed capital formation" and "change in stocks" accounts. Lastly, taxes and tariffs are disaggregated into "income tax", "activity tax" which refers to indirect taxes on production, "import tariff", and "value added tax" accounts.

The data sources for SAM are the Central Bureau of Statistics, Central Bank of Sudan, Sudan Customs Authority, Ministry of Agriculture and Forestry, and Ministry of Finance and National Economy.

Table 1. Sudan disaggregate social accounting matrix for year 2004 (SDG Million)

		Prod. Factor		Current acc		Capital acc		Agric activity					aind	aser
		lab	Cap	hh	gov	S-I	Dstk	Asesa	asorg	acott	awhea	aother		
Prod. factor	Lab							88.9	140.2	23.7	20.2	3168.3	1656.4	12683.9
	Cap							503.6	794.7	134.1	114.7	17957.8	8466.9	19502.4
current acc.	Hh	17780.5	41392.4		2669.7									
	Gov		6081.8											
capital acc.	S-I			9737.0	1222.3									
	Dstk					1845.0								
Agric. act.	Asesa													
	Asorg													
	Acott													
	Awhea													
	Aother													
Aind														
Aser														
Agric. comm	Csesa			175.7	0.6		3.5	95.4	4.6				108.4	114.0
	Csorg			471.1	1.6		9.3		135.3			25.9	21.7	681.6
	Ccott			14.4	0.0		0.3		0.1	0.3	0.0		4.3	21.7
	Cwhea			322.1	1.1	0.0	6.4		2.7		22.7		158.0	403.2
	Cother			11064.7	697.9	105.5	1676.5					1839.0	3924.2	6099.2
Cind				4450.5	119.5	3635.9	68.3	6.4	1.4	1.4	2.7	259.4	2138.9	3383.8
Cser				35554.1	4916.2	7483.2	80.8	183.9	195.0	78.4	43.0	2246.2	4059.0	7444.1
Taxes and tariff	Ytax			760.7										
	Atax							42.0	44.6	30.6	15.0	12.8	990.1	414.7
	Tar													
	Vtax							34.0	34.0	9.8	8.3	192.1	159.9	289.6
Row		1.1			679.3									
Total		17781.5	47474.2	62550.3	10308.2	13069.6	1845.0	954.2	1352.5	278.2	226.7	25701.5	21687.9	51038.3

Cont. Table 1

		agic commodity					cind	cser	Taxes and tariff				row	Total
		csesa	csorg	ccott	cwhea	cother			Ytax	atax	tar	vtax		
Prod. factor	Lab													17781.5
	Cap													47474.2
current acc.	Hh												707.8	62550.3
	Gov								760.7	1549.8	1188.0	727.8		10308.2
capital ac.	S-I												2110.4	13069.6
	DSTK													1845.0
Agic. act.	Asesa	954.2												954.2
	Asorg		1352.5											1352.5
	Acott			278.2										278.2
	Awhea				226.7									226.7

	Aother				25701.5						25701.5
	Aind					21687.9					21687.9
	Aser						51038.3				51038.3
		Csesa								451.9	954.2
		Csorg								6.0	1352.5
Agic. comm		Ccott								237.2	278.2
		Cwhea									916.2
		Cother								814.9	26221.8
	Cind									8250.4	22318.5
	Cser									108.6	62392.6
		Ytax									760.7
		Atax									1549.8
Taxes and tariff		Tar		19.9	11.2	66.9	1090.0				1188.0
		Vtax									727.8
	Row			669.7	509.1	563.6	10264.3				12687.1
	Total	954.2	1352.5	278.2	916.2	26221.8	22318.5	62392.6	760.7	1549.8	1188.0	727.8	12687.1	

The input-output coefficient developed by Elbushra (2007) was used in building the aggregated SAM, while those at the agricultural sector's disaggregated level has been developed and validated based on "Best Educated Guess" (Table 2).

Table 2. Technical coefficients of the Sudan IOT for the year 2004

	Sesame	Sorghum	Cotton	Wheat	Other agric	Industry	Service
Sesame	0.1000	0.0034	0.0000	0.0000	0.0000	0.0050	0.0022
Sorghum	0.0000	0.1000	0.0000	0.0000	0.0010	0.0010	0.0134
Cotton	0.0000	0.0000	0.0010	0.0001	0.0000	0.0002	0.0004
Wheat	0.0000	0.0020	0.0000	0.1000	0.0000	0.0073	0.0079
Other Agric.	0.0000	0.0000	0.0000	0.0000	0.0716	0.1809	0.1195
Industry	0.0067	0.0010	0.0049	0.0120	0.0101	0.2163	0.4149
Service	0.1927	0.1442	0.2818	0.1898	0.0874	0.4105	0.9128

Source: Authors Compilation.

4. Model Simulations

The simulation work is composed of two scenarios: one scenario simulates the effects of changes in the exchange rate, and the other assesses the effects of change in world prices of the Sudanese imports and exports on the levels of domestic output, export, imports, and the GDP.

4.1 Scenario 1: Impact of Exchange Rate Change on the Economy

Exchange rate is a trade policy instruments often used to correct current account deficit. The first scenario has simulated the effect of changes in the exchange rate (depreciation and appreciation) on the economy. Depreciation is a recommended policy of the structural adjustment program packages of the International Monetary Fund for the developing countries. In the Sudan, foreign exchange rate has been devaluated from SDG 2.1/ US$ to SDG 2.7 per US$ during the period from 2007 to 2009. Accordingly, simulations 1a and 1b have been carried out by devaluing the rate by 10% and 7%, respectively. However, in 2005/06 the currency appreciated due to oil export, thus, scenario 1c simulates the effect of a 5% appreciation. The chosen rate of appreciation is the maximum limit of the model's design. It may be relevant here to mention that hypothetical

rates of change in exchange rate could also be used. However, the used rates are realistic; thus, using those rates would provide estimates of the impacts of those changes given the postulated CGE with its 2004-SAM as a base year.

4.2 Scenario 2: Impact of World Prices Change on the Economy

Recent studies of Word Bank, IFPRI and FAO have stated that since late 2007 food prices had been increasing, and would continue to increase for a number of years. Based on these findings the second scenario is done to assess the effect of rising world prices of the Sudanese imports and exports on the economy. Wheat is the major imported agricultural commodity for the country. Recently, its world price witnessed an increase of 80%. In addition, the international prices of sesame, sorghum cotton and live animals have increased by 2%, 6%, 1% and 8%, respectively (Ministry of Agriculture and Natural Resources, 2008). Moreover, the "Cotton Initiative", which was, raised by the four leading African exporters of cotton, if approved, would lead to higher world cotton prices. Based on these rates, simulations 2a to 2e have been conducted. As the case of the exchange rate, hypothetical rates of change in international prices could be used as well.

5. Results

The result of implementing the proposed simulation scenarios could be summarized in the following sub-sections.

5.1 Impact of Changes in Exchange Rate on the Sudanese Economy

Table 3. Impact of exchange rate changes on the Sudanese economy

Sectors	Base value (Million SDG)	Percentage change from the base		
		scen 1a	scen 1b	scen 1c
Macroeconomic indicators				
Private consumption	52053	-3.09	-2.15	1.49
Investment	13070	0.84	0.59	17.89
GDP	68721	1.03	0.70	-0.45
Balance of Trade	-3326	-63.40	-45.01	34.19
Imports				
Wheat	689.5	-3.506	-2.508	1.971
Other agric	520.3	-9.197	-6.592	5.210
Industry	630.6	-5.448	-3.909	3.113
Service	11354.3	-8.556	-6.123	4.813
Total	13194.7	-8.169	-5.847	4.599
Exports				
Sesame	451.9	6.07	4.30	-3.25
Sorghum	6.0	29.34	19.90	-12.56
Cotton	237.2	3.70	2.62	-1.97
Wheat	0.0	0.00	0.00	0.000
Other agric	814.9	22.95	15.81	-10.56
Industry	8250.4	9.49	6.71	-5.01
Service	108.6	21.14	14.59	-9.81
Total	9869	10.44	7.35	-5.37
Domestic output				
Sesame	954	2.1761	1.5340	-1.1270
Sorghum	1353	-0.9796	-0.6780	0.4618
Cotton	278	2.8079	1.9849	-1.4782
Wheat	227	0.9205	0.6518	-0.4865
Other agric.	25701	-0.1832	-0.1309	0.1001
Industry	21688	2.8083	1.9759	-1.4379
Service	51038	-0.8552	-0.5874	0.3874
Total	101239	0.1412	0.1062	-0.0969

Source: Model results

Simulation of the impacts of changes in the exchange rate on the Sudanese economy (given in table 3 below)

reveals that depreciation of the Sudanese currency would increase domestic output and export of sesame and cotton. Wheat, being an importable good, witnessed a reduction in its imports, while sorghum would experience rapid increase in its export. This can be justified by the increase in wheat output as a substitute food grain for sorghum, ceteris paribus. The other agricultural commodities would respond to lucrative market prospects, and hence would switch its resources towards producing more for export and import substitution. The aggregate effects of depreciation would improve GDP due to improvement in the balance of trade and investment.

On the other side, appreciation of the currency would decrease domestic output and export of sesame and cotton. Wheat output would decrease, while its import increases. Regarding sorghum, its output increases, while its export decrease due to implicit reduction in world price. With respect to the other agricultural commodities, its output level would decline, resulting in reduced exports and increased imports. This could be attributed to cheaper imports. The overall effect of the appreciation would be a decline in GDP due to increased deficit in the balance of trade despite an expected improvement in the private consumption and investment levels.

5.2 Impact of Change of World Prices on the Sudanese Economy

Table 4. Impact of world prices changes on the Sudanese economy

Sectors	Base value	Percentage change from the base				
	(Million SDG)	scen 2a	scen 2b	scen 2c	scen 2d	scen 2e
Macroeconomic indicators						
Private consumption	52053	0.087	-0.014	-0.003	-0.002	-0.36
Investment	13070	-0.046	-0.008	-0.002	0.000	0.15
GDP	68721	-0.500	0.011	-0.00003	0.004	0.06
Balance of Trade	-3326	-2.680	-0.204	-0.036	-0.030	-5.16
Imports						
Wheat	689.5	-11.61	-0.009	-0.001	-0.001	-0.226
Other agric	520.3	-0.280	-0.016	-0.003	-0.002	0.112
Industry	630.6	-0.045	-0.008	-0.002	-0.001	-0.221
Service	11354.3	-0.045	-0.009	-0.002	-0.001	-0.292
Total	13194.7	-0.658	-0.009	-0.002	-0.001	-0.269
Exports						
Sesame	451.9	0.269	1.146	0.001	0.000	0.190
Sorghum	6	0.747	0.026	12.082	0.003	0.989
Cotton	237.2	0.165	0.001	0.001	0.373	0.081
Wheat	0	0.000	0.000	0.000	0.000	0.000
Other agric	814.9	0.800	0.026	0.006	0.002	15.151
Industry	8250.4	-0.070	0.002	0.002	0.000	0.135
Service	108.6	-0.114	0.003	0.001	-0.001	0.251
Total	9869	0.023	0.056	0.010	0.009	1.378
Domestic output						
Sesame	954	0.1213	0.4646	0.0003	-0.0004	0.0228
Sorghum	1353	0.0041	-0.0052	0.0378	-0.0008	-0.099
Cotton	278	0.1339	0.0002	0.0004	0.2994	0.0434
Wheat	227	8.9364	-0.0022	-0.0001	-0.0006	-0.031
Other agric.	25701	0.0521	-0.0033	-0.0004	-0.0006	0.221
Industry	21688	-0.059	-0.0025	0.0004	-0.0004	-0.023
Service	51038	-0.065	-0.0055	-0.0010	-0.0009	-0.136
Total	101239	-0.011	0.0001	0.0000	0.0001	-0.019

Source: Model results.

Simulation of the impacts of changes in world prices of the commodities under study is provided in table 4 below. Increasing world price of wheat would result in increased output of wheat associated with increased output and export of all crops. This would take place at the expense of releasing resources from the industry and services sectors.

Increasing world prices of sesame, sorghum, cotton and "other agriculture" would result in different effects. In case of sesame, the effect would lead to more output for sesame and cotton, while in case of sorghum the effect would result in more output for the three crops together; and for the "other agriculture" it is expected to increase its output only. Only cotton has shown an increase in its own output at the expense of the other commodities and the other sectors altogether. Cotton is expected to have more competitiveness compared to the other commodities.

Increasing world prices of all crops indicates an expected increase in their exports except for wheat, which is an import substitute crop. Wheat will witness an increase in its domestic production due to the higher import prices. On the other side, the effect on imports is negative for all sectors except for the "other agriculture" with respect to increasing its own price. The net result of increasing world price of import, mainly wheat, would reduce the GDP due, mainly, to investment reduction regardless of improvement in the balance of trade and private consumption. The reduction of investment could be justified by the fact that wheat is the main intermediate commodity for many food processing industries**.**

Regarding export commodities, the overall effect of increased world prices of sesame, cotton and other agriculture is an improvement of the GDP due to improvement of the balance of trade despite the drop in private consumption and investment. However, the expected overall effect of increasing world price of sorghum is a reduction of the GDP due to decline in private consumption and investment, despite the relative improvement of the balance of trade. Thus, the economy seems to be highly sensitive to changes in sorghum prices.

5. Policy Implications

Currency appreciation seems to favor urban consumers whose main food grain is wheat. On the other side, depreciation seems to favor sorghum production, the main staple food in rural areas, and the production and exports of the other agricultural commodities, mainly animal products.

The increase of world prices of sorghum would encourage its production for export at the expense of domestic sales, leading to higher domestic food prices and inflation. Unless the government takes rational decision of allocating land areas for sorghum production for both the domestic and export market, food security of the poor people would worsen. Otherwise, the government will be forced to apply control policies on export of sorghum and to combat its smuggling to neighboring countries.

Based on the results and the aforementioned policy implications, it is recommended that wheat and other food-grains imports should be conditioned to availability of hard currency, and occurrence of domestic food gap. It is also recommended to encourage innovation of fast food from traditional food items that are produced domestically in order to reduce rising wheat-based fast food consumption. In addition, it is recommended to stabilize foreign exchange rate at a level that strikes a balance between agricultural exports and essential food and non food imports, and to increase investment in agriculture and its related industries. This because agriculture is the main source of livelihood, and the country has great potential in increasing agricultural production for export and domestic use.

Finally, it may be relevant to mention that the advantage of this study is the use of CGE model that disaggregates the agricultural sector by commodities, as a comprehensive approach based on Sudan actual data. However, this advantage could be further improved if more disaggregating data is available.

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Appendix 1: Mathematical Model Statement

The model equations are classified into four blocks: prices, production and trade block, institutions block and system constraint block.

Prices Block

$$PM_c = pwm_c * (1 + tm_c) * EXR$$

$$PE_c = pwm_c * (1 - te_c) * EXR$$

$$PX_c = (PDS_c * QD_c + PE_c * QE_c) / QX_c$$

$$PINTA_a = \sum PQ_c * ica_{c\,a}$$

$$CPI = \sum PQ_c * cwts_c$$

Production and Trade Block

$$QA_a = \alpha_a^a * (\delta_a^a * QVA_a^{-\rho_a^a} + (1 - \delta_a^a) * QINTA_a^{-\rho_a^a})^{-1/\rho_a^a}$$

For the CES function

$$\sigma = 1/1 + \rho$$

$$WF_F * WFDIST_{f\,a} = PVA_a(1 - tva_a) * QVA_a * \sum_{f \in F} \delta_{f\,a}^{va} * QF_{fa}^{-\rho_a^{va}})^{-1} * \delta_{fa}^{va} * QF_{f\,a}^{-\rho_a^{va}-1}$$

$$QQ_c = \alpha_c^q * (\delta_c^q * QM_c^{-p_c^q} + (1 - \delta_c^q) * QD_C^{-\rho_c^q})^{-1/\rho_c^q}$$

$$QM_c \div QD_c = \left(PDD_c / PM_c * (\delta_c^q / 1 - \delta_c^q)\right)^{1/1+p_c^q}$$

$$QX_c = \alpha_c^t * (\delta_c^t * QE_c^{p_c^T} + (1 - \delta_c^t) * QD_C^{-\rho_c^t})^{1/\rho_c^t}$$

$$QE_c \div QD_c = \left(PE_c / PDS_c * (1 - \delta_c^t / \delta_c^t)\right)^{1/p_c^t - 1}$$

For CET function

$$\Omega = 1/(1 + \rho)$$

Institutional Block

$$YF_f = \sum WF_f * WFDIST_{f\,a} * QF_{f\,a}$$

$$YIF_{i\,f} = shif_{i\,f} * ((1 - tf_f) * YF_f - trnsfr_{row\,f} * EXR)$$

$$YI_h = \sum YIF_{h\,f} + trnsf_{h\,gov} + trnsfr_{h\,row} * EXR$$

$$EH_h = (1-\sum shii_{ih}) * (1-MPS_i) * (1-TINS_h) * YI_h$$

$$YG = \sum TINS_i * YI_i + \sum tf_f * YF_f + \sum tva_a * PVA_a * QVA_a + \sum ta_a * PA_a * QA_a + \sum tm_c * pwm_c * QM_c * EXR + \sum tq_a * PQ_a * QQ_a + \sum YIF_{gov\,\mathrm{f}} + transf_{gov\,\mathrm{row}} * EXR$$

$$EG = \sum PQ_c * QG_c + \sum trnsfr_{i\,\mathrm{gov}} + GSAV$$

System Constraint Block (Model Closures)

$$\sum QF_{f\,\mathrm{a}} = QFS_f$$

$$\sum pwm_c * QM_c + \sum trnsfr_{row\,\mathrm{f}} = pwe_c * QE_c + \sum trnsfr_{i\,\mathrm{row}} + FSAV$$

$$S = I$$

$$S = \sum S_i + S_g + S_f * EXR$$

So

$$\sum MPS_i * (1-TINS_i) * YI_i + GSAV + EXR * FSAV = \sum PQ_c * QINV_c + \sum PQ_c * qdst_c$$

Where:

ta(A)	rate of tax on producer gross output value	$QXAC_{ac}$	Quantity of output of commodity c from activity a
te(C)	rate of tax on exports	PM_c	import world price (domestic currency)
tf(F)	rate of direct tax on factors	TABS	total nominal absorption
tm(C)	rate of import tariff	PQ_c	composite commodity price
tq(C)	rate of sales tax	$trnsf_{h\,\mathrm{gov}}$	transfers from domestic government institution to household institution
tva(A)	rate of value-added tax	$trnsf_{h\,\mathrm{rov}}$	transfers from domestic rest of the world to household institution
EG	government expenditures	PVA_a	Value-added price
QQ_c	Quantity of exports	WF_F	economy-wide factor wage
EH_h	consumption spending for household	PX_c	aggregate producer price for commodity
$QF_{f\,\mathrm{a}}$	Quantity demanded of factor f from activity a	YIF_{if}	Transfer of income to domestic institution I from factor f
EXR	exchange rate (LCU per unit of FCU)	$PXAC_{ac}$	producer price of commodity c for activity a
QG	government consumption demand for commodity	YG	government revenue
QH_{ch}	Quantity consumed of commodity c by household h	QA_a	Quantity (level) of activity *a*
GSAV	government savings	YI	Income of domestic non-government institution
$QINT_{ac}$	Quantity of commodity c as intermediate input to activity a	QD_c	Quantity sold domestically of domestic output
$QINV_c$	Quantity of investment demand for commodity	FSAV	foreign savings (FCU)
MPS_i	marginal propensity to save for household	$TINS_h$	direct tax rate for domestic institution i or factor f
QM_c	Quantity of imports of commodity	$WFDIST_{fa}$	wage distortion factor for factor f in activity a
PA_a	Activity price (unit gross revenue)	IADJ	investment adjustment factor

QQ_c	Quantity of goods supplied to domestic market (composite supply)	pwm_c	World price of import (in hard currency)
PDD_c	Demand price for commodity produced and sold domestically	pwe_c	World price of export (in hard currency)
PDS_c	supply price for commodity produced and sold domestically	$QXAC_{ac}$	Quantity of output of commodity c from activity a
QX_c	aggregated quantity of domestic output		