

Appendix A: Mathematical Summary Statement for the Standard Static CGE Model

Sets	$a \in A$ $a \in ACES (\subset A)$ $a \in ALEO (\subset A)$ $a \in ACCES (\subset A)$ $c \in C$ $c \in CD (\subset C)$ $c \in CDN (\subset C)$ $c \in CE (\subset C)$ $c \in CEN (\subset C)$ $c \in CM (\subset C)$ $c \in CMN (\subset C)$ $c \in CT (\subset C)$ $c \in CX (\subset C)$ $f \in F$ $i \in INS$ $i \in INSD (\subset INS)$ $i \in INSDNG (\subset INSD)$ $h \in H (\subset INSDNG)$	activities activities with a CES function at the top of the technology nest activities with a Leontief function at the top of the technology nest activities with CES domestic activity aggregation function commodities commodities with domestic sales of domestic output commodities not in CD exported commodities commodities not in CE imported commodities commodities not in CM transactions services commodities commodities with domestic production factors institutions (domestic and rest of the world) domestic institutions domestic non-government institutions households
Parameters	$cwts_c$ $dwtsc$ ica_{ca} $icd_{cc'}$ $ice_{cc'}$ $icm_{cc'}$ $inta_a$ iva_a $mps01_i$ \overline{mps}_i pop_h pwe_c pwm_c \overline{qg}_c $qdst_c$ \overline{qinv}_c $shif_{if}$ $shii_{i'}$ $ta01_a$ \overline{ta}_a $te01_c$ \overline{te}_c $tf01_f$ \overline{tf}_c $ti01_i$ \overline{tl}_i $tm01_c$ \overline{tm}_c	weight of commodity c in the CPI weight of commodity c in the producer price index quantity of c as intermediate input per unit of activity a quantity of commodity c as trade input per unit of c produced and sold domestically quantity of commodity c as trade input per exported unit of c' quantity of commodity c as trade input per imported unit of c' quantity of aggregate intermediate input per activity unit quantity of value-added per activity unit 0-1 parameter for institutions without/with flexible savings rates base savings rate for domestic institution i population of representative household h export price (foreign currency) import price (foreign currency) base-year quantity of government demand quantity of stock change base-year quantity of private investment demand share for domestic institution i in income of factor f share of net income of institution i' to institution i 0-1 parameter for activities without/with flexible activity tax rates exogenous activity tax rate for activity a 0-1 parameter for commodities without/with flexible export tax rates exogenous export tax rate for commodity c 0-1 parameter for factors without/with flexible factor tax rates exogenous factor tax rate for factor f 0-1 parameter for institutions without/with flexible direct tax rates exogenous direct tax rate for domestic institution i 0-1 parameter for commodities without/with flexible import tariff rates exogenous import tariff rate for commodity c

	$trnsf_{fi}$	exogenous transfer from institution i to factor f
	$trnsi_{ii'}$	exogenous transfer from institution i' to institution i
	$tq01_c$	0-1 parameter for commodities without/with flexible sales tax rates
	$\bar{t}q_c$	exogenous sales tax rate for commodity c
	$tv01_a$	0-1 parameter for activities without/with flexible value-added tax rates
	$\bar{t}v_a$	exogenous value-added tax rate for activity a
Greek letters	α_a^a	efficiency parameter in the CES activity function
	α_c^{ac}	shift parameter for domestic commodity aggregation function
	α_a^{ca}	shift parameter for domestic activity aggregation function
	α_{fa}^f	factor efficiency parameter in the CES activity function
	α_c^q	Armington function shift parameter
	α_c^t	CET function shift parameter
	α_a^{va}	efficiency parameter in the CES value-added function
	β_{ah}^h	marginal home consumption spending share for activity output a for household h
	β_{ch}^m	marginal market consumption spending share for commodity c for household h
	δ_a^a	CES activity function share parameter
	δ_{ac}^{ac}	share parameter for domestic commodity aggregation function
	δ_{ac}^{ca}	share parameter for domestic activity aggregation function
	δ_c^q	Armington function share parameter
	δ_c^t	CET function share parameter
	δ_{fa}^{va}	CES value-added function share parameter for factor f in activity a
	γ_{ah}^h	subsistence home consumption of activity output a by household h
	γ_{ch}^m	subsistence market consumption of commodity c by household h
	ρ_a^a	CES production function exponent
	ρ_c^{ac}	domestic commodity aggregation function exponent
	ρ_a^{ca}	domestic activity aggregation function exponent
	ρ_c^q	Armington function exponent
	ρ_c^t	CET function exponent
	ρ_a^{va}	CES value-added function exponent
	θ_{ac}	yield of output c per unit of activity a
Variables (* indicates exogenous in base model)	<i>CPI</i>	consumer price index
	<i>DMPS</i>	* change in domestic institution savings rates (0 in base)
	<i>DPI</i>	producer price index for domestically marketed output
	<i>DTA</i>	* change in activity tax rates (0 in base)
	<i>DTE</i>	* change in export tax rates (0 in base)
	<i>DTF</i>	* change in factor tax rates (0 in base)
	<i>DTI</i>	* change in direct institution tax rates (0 in base)
	<i>DTM</i>	* change in import tariff rates (0 in base)
	<i>DTQ</i>	* change in sales tax rates (0 in base)
	<i>DTV</i>	* change in value-added tax rates (0 in base)
	<i>EG</i>	government expenditures
	<i>EH_h</i>	total household consumption spending
	<i>EXR</i>	exchange rate (LCU per unit of FCU)
	<i>FSAV</i>	* foreign savings (FCU)
	<i>GADJ</i>	* government consumption adjustment factor

<i>GOVSHR</i>	government consumption share in nominal absorption
<i>GSAV</i>	government savings
<i>IADJ</i>	investment adjustment factor
<i>INVSHR</i>	investment share in nominal absorption
<i>MPS_i</i>	marginal propensity to save for domestic non-government institution
<i>MPSADJ</i>	* savings rate scaling factor (0 in base)
<i>PA_a</i>	activity price (unit gross revenue)
<i>PDD_c</i>	demand price for commodity produced and sold domestically
<i>PDS_c</i>	supply price for commodity produced and sold domestically
<i>PE_c</i>	export price (domestic currency)
<i>PINTA_a</i>	aggregate intermediate input price for activity a
<i>PM_c</i>	import price (domestic currency)
<i>PQ_c</i>	composite commodity price
<i>FSAV</i>	* foreign savings (FCU)
<i>PVA_a</i>	value-added price (factor income per unit of activity)
<i>PX_c</i>	aggregate producer price for commodity
<i>PXAC_{a c}</i>	producer price of commodity c for activity a
<i>QA_a</i>	quantity (level) of activity
<i>QD_c</i>	quantity sold domestically of domestic output
<i>QE_c</i>	quantity of exports
<i>QF_{f a}</i>	quantity demanded of factor f from activity a
<i>QFS_f</i>	* quantity supplied of factor
<i>QG_c</i>	government consumption demand for commodity
<i>QH_{c h}</i>	quantity consumed of commodity c by household h
<i>QHA_{a h}</i>	quantity of household home consumption of activity output a by household h
<i>QINT_{c a}</i>	quantity of commodity c as intermediate input to activity a
<i>QINTA_a</i>	quantity of aggregate intermediate input
<i>QINV_c</i>	quantity of investment demand for commodity
<i>QM_c</i>	quantity of imports of commodity
<i>QQ_c</i>	quantity of goods supplied to domestic market (composite supply)
<i>QT_c</i>	quantity of commodity demanded as trade input
<i>QVA_a</i>	quantity of (aggregate) value-added
<i>QX_c</i>	aggregated marketed quantity of domestic output of commodity
<i>QXAC_{a c}</i>	quantity of marketed output of commodity c from activity a
<i>TA_a</i>	activity tax rate for activity a
<i>TAADJ</i>	* activity tax rate scaling factor (0 in base)
<i>TABS</i>	total nominal absorption
<i>TE_c</i>	export tax rate for commodity c
<i>TEADJ</i>	* export tax rate scaling factor (0 in base)
<i>TF_f</i>	factor tax rate for factor f
<i>TFADJ</i>	* factor tax rate scaling factor (0 in base)
<i>TI_i</i>	direct institution tax rate for institution i
<i>TIADJ</i>	* direct institution tax rate scaling factor (0 in base)
<i>TM_c</i>	import tariff rate for commodity c
<i>TMADJ</i>	* import tariff rate scaling factor (0 in base)
<i>TRII_{i i'}</i>	transfers from institution i' to i
<i>TQ_c</i>	sales tax rate for commodity c
<i>TQADJ</i>	* sales tax rate scaling factor (0 in base)
<i>TV_a</i>	value-added tax rate for activity a
<i>TVADJ</i>	* value-added tax rate scaling factor (0 in base)

WF_f		average price of factor f
$WFDIST_{f\ a}$	*	wage distortion factor for factor f in activity a
YF_f		income of factor f
YG		government revenue
YI_i		income of domestic nongovernment institution
$YIF_{i\ f}$		income to domestic institution i from factor f

Static Model Equations

Price Block

Import price

$$PM_c = pwm_c \cdot (1 + TM_c) \cdot EXR + \sum_{c' \in CT} PQ_{c'} \cdot icm_{c'c} \quad c \in CM \quad (1)$$

$$\begin{bmatrix} \text{import price} \\ \text{(LCU)} \end{bmatrix} = \begin{bmatrix} \text{import price} \\ \text{(FCU)} \end{bmatrix} \cdot \begin{bmatrix} \text{tariff} \\ \text{adjustment} \end{bmatrix} \cdot \begin{bmatrix} \text{exchange rate} \\ \text{(LCU per FCU)} \end{bmatrix} + \begin{bmatrix} \text{cost of trade} \\ \text{inputs per import unit} \end{bmatrix}$$

Export price

$$PE_c = pwe_c \cdot (1 - TE_c) \cdot EXR - \sum_{c' \in CT} PQ_{c'} \cdot ice_{c'c} \quad c \in CE \quad (2)$$

$$\begin{bmatrix} \text{export price} \\ \text{(LCU)} \end{bmatrix} = \begin{bmatrix} \text{export price} \\ \text{(FCU)} \end{bmatrix} \cdot \begin{bmatrix} \text{tax} \\ \text{adjustment} \end{bmatrix} \cdot \begin{bmatrix} \text{exchange rate} \\ \text{(LCU per FCU)} \end{bmatrix} - \begin{bmatrix} \text{cost of trade} \\ \text{inputs per export unit} \end{bmatrix}$$

Demand price of domestic nontraded goods

$$PDD_c = PDS_c + \sum_{c' \in CT} PQ_{c'} \cdot icd_{c'c} \quad c \in CD \quad (3)$$

$$\begin{bmatrix} \text{domestic demand price} \end{bmatrix} = \begin{bmatrix} \text{domestic supply price} \end{bmatrix} + \begin{bmatrix} \text{cost of trade} \\ \text{inputs per unit of domestic sales} \end{bmatrix}$$

Absorption

$$PQ_c \cdot (1 - TQ_c) \cdot QQ_c = PDD_c \cdot QD_c + PM_c \cdot QM_c \quad c \in (CD \cup CM) \quad (4)$$

$$\begin{bmatrix} \text{absorption} \\ \text{(at demand prices net of sales tax)} \end{bmatrix} = \begin{bmatrix} \text{domestic demand price} \\ \text{times domestic sales quantity} \end{bmatrix} + \begin{bmatrix} \text{import price} \\ \text{times import quantity} \end{bmatrix}$$

Marketed output value

$$PX_c \cdot QX_c = PDS_c \cdot QD_c + PE_c \cdot QE_c \quad c \in CX \quad (5)$$

$$\begin{bmatrix} \text{producer price} \\ \text{times marketed output quantity} \end{bmatrix} = \begin{bmatrix} \text{domestic supply price} \\ \text{time domestic sales quantity} \end{bmatrix} + \begin{bmatrix} \text{import price} \\ \text{times import quantity} \end{bmatrix}$$

Activity output
price

$$PA_a = \sum_{c \in C} PXAC_{ac} \cdot \theta_{ac} \quad a \in A \quad (6)$$

$$\left[\begin{array}{c} \text{activity} \\ \text{price} \end{array} \right] = \left[\begin{array}{c} \text{producer prices} \\ \text{times yields} \end{array} \right]$$

Aggregate
intermediate
input price

$$PINTA_a = \sum_{c \in C} PQ_{ac} \cdot \theta_{ac} \quad a \in A \quad (7)$$

$$\left[\begin{array}{c} \text{aggregate} \\ \text{intermediate} \\ \text{input price} \end{array} \right] = \left[\begin{array}{c} \text{intermediate input cost} \\ \text{per unit of aggregate} \\ \text{intermediate input} \end{array} \right]$$

Value-added price

$$PVA_a \cdot QVA_a = PA_a \cdot (1 - TA_a) \cdot QA_a - PINTA_a \cdot QINTA_a \quad a \in A \quad (8)$$

$$\left[\begin{array}{c} \text{value-added} \\ \text{price times} \\ \text{quantity} \end{array} \right] = \left[\begin{array}{c} \text{activity price} \\ \text{(net of taxes)} \\ \text{times activity level} \end{array} \right] - \left[\begin{array}{c} \text{aggregate} \\ \text{intermediate input} \\ \text{price times quantity} \end{array} \right]$$

Consumer price index

$$CPI = \sum_{c \in C} PQ_c \cdot cwts_c \quad (9)$$

$$\left[\begin{array}{c} \text{consumer} \\ \text{price index} \end{array} \right] = \left[\begin{array}{c} \text{prices times} \\ \text{weights} \end{array} \right]$$

Producer price index
for nontraded
market output

$$DPI = \sum_{c \in C} PDS_c \cdot dwts_c \quad (10)$$

$$\left[\begin{array}{c} \text{domestic price} \\ \text{price index} \end{array} \right] = \left[\begin{array}{c} \text{prices times} \\ \text{weights} \end{array} \right]$$

Production and Trade Block

Activity production
function
(CES technology)

$$QA_a = \alpha_a^a \cdot \left(\delta_a^a \cdot QVA_a^{-\rho_a^a} + (1 - \delta_a^a) \cdot QINTA_a^{-\rho_a^a} \right)^{-\frac{1}{\rho_a^a}} \quad a \in ACES \quad (11)$$

$$\left[\begin{array}{c} \text{activity} \\ \text{level} \end{array} \right] = CES \left[\begin{array}{c} \text{quantity of aggregate value added,} \\ \text{quantity of aggregate intermediate input} \end{array} \right]$$

Value-added
intermediate-input
quantity ratio
(CES technology)

$$\frac{QVA_a}{QINTA_a} = \left(\frac{PINTA_a}{PVA_a} \cdot \frac{\delta_a^a}{1 - \delta_a^a} \right)^{\frac{1}{1 + \rho_a^a}} \quad a \in ACES \quad (12)$$

$$\left[\begin{array}{c} \text{value-added :} \\ \text{intermediate input} \\ \text{quantity ratio} \end{array} \right] = f \left[\begin{array}{c} \text{intermediate input :} \\ \text{value-added} \\ \text{price ratio} \end{array} \right]$$

Activity production
function
(Leontief technology)

$$QVA_a = iva_a \cdot QA_a \quad a \in ALEO \quad (13)$$

$$\left[\begin{array}{c} \text{demand for aggregate} \\ \text{intermediate input} \end{array} \right] = f \left[\begin{array}{c} \text{activity} \\ \text{level} \end{array} \right]$$

Value-added
intermediate-input
quantity ratio
(Leontief technology)

$$QINTA_a = inta_a \cdot QA_a \quad a \in ALEO \quad (14)$$

$$\left[\begin{array}{c} \text{demand for aggregate} \\ \text{intermediate input} \end{array} \right] = f \left[\begin{array}{c} \text{activity} \\ \text{level} \end{array} \right]$$

Value-added and
factor demands

$$QVA_a = \alpha_a^{va} \cdot \left(\sum_{f \in F} \delta_{fa}^{va} \cdot (\alpha_{fa}^f \cdot QF_{fa})^{-\rho_{fa}^{va}} \right)^{-\frac{1}{\rho_a^{va}}} \quad a \in A \quad (15)$$

$$\left[\begin{array}{c} \text{quantity of aggregate} \\ \text{value added} \end{array} \right] = CES \left[\begin{array}{c} \text{factor} \\ \text{inputs} \end{array} \right]$$

Factor demand

$$WF_f \cdot WFDIST_{fa} = PVA_a \cdot (1 - TV_a) \cdot QVA_a \cdot \left(\sum_{f' \in F} \delta_{f'a}^{va} \cdot (\alpha_{f'a}^f \cdot QF_{f'a})^{-\rho_a^{va}} \right)^{-1} \cdot \delta_{fa}^{va} \cdot QF_{fa}^{-\rho_a^{va}-1} \quad \begin{matrix} a \in A \\ f \in F \end{matrix} \quad (16)$$

$$\left[\begin{array}{c} \text{marginal cost of} \\ \text{factor } f \text{ in activity } a \end{array} \right] = \left[\begin{array}{c} \text{marginal revenue product} \\ \text{of factor } f \text{ in activity } a \end{array} \right]$$

Disaggregated intermediate input demand

$$QINT_{ca} = ica_{ca} \cdot QINTA_a \quad \begin{matrix} a \in A \\ c \in C \end{matrix} \quad (17)$$

$$\left[\begin{array}{c} \text{intermediate demand} \\ \text{for commodity } c \\ \text{from activity } a \end{array} \right] = f \left[\begin{array}{c} \text{aggregate intermediate} \\ \text{input quantity} \\ \text{for activity } a \end{array} \right]$$

Commodity production (Leontief)

$$QXAC_{ac} = \theta_{ac} \cdot QA_a - \sum_{h \in H} QHA_{ah} \quad \begin{matrix} a \notin ACCES \\ c \in CX \end{matrix} \quad (18)$$

$$\left[\begin{array}{c} \text{marketed quantity} \\ \text{of commodity } c \\ \text{from activity } a \end{array} \right] = \left[\begin{array}{c} \text{production} \\ \text{of commodity } c \\ \text{from activity } a \end{array} \right] - \left[\begin{array}{c} \text{household home} \\ \text{consumption of commodity } c \\ \text{from activity } a \end{array} \right]$$

Commodity production (CET)

$$QXAC_{ac} = \left(QA_a - \sum_{h \in H} QHA_{ah} \right) \cdot \left(\frac{PXAC_{ac}}{PA_a \cdot \delta_{ac}^{ca} \cdot (\alpha_a^{ca})^{\rho_a^{ca}}} \right)^{\frac{1}{\rho_a^{ca}-1}} \quad \begin{matrix} a \in ACCES \\ c \in CX \end{matrix} \quad (19)$$

$$\left[\begin{array}{c} \text{marketed quantity} \\ \text{of commodity } c \\ \text{from activity } a \end{array} \right] = \left[\begin{array}{c} \text{production of commodity } c \text{ from} \\ \text{activity } a \text{ less home consumption} \\ \text{of commodity } c \text{ from activity } a \end{array} \right] - \left[\begin{array}{c} \text{household home} \\ \text{consumption of commodity } c \\ \text{from activity } a \end{array} \right]$$

Output aggregation function

$$QX_c = \alpha_c^{ac} \cdot \left(\sum_{a \in A} \delta_{ac}^{ac} \cdot QXAC_{ac}^{-\rho_c^{ac}} \right)^{-\frac{1}{\rho_c^{ac}}} \quad c \in CX \quad (20)$$

$$\left[\begin{array}{c} \text{aggregate marketed} \\ \text{production of} \\ \text{commodity } c \end{array} \right] = CES \left[\begin{array}{c} \text{activity-specific} \\ \text{marketed production} \\ \text{of commodity } c \end{array} \right]$$

First-order condition
for output aggregation
function

$$PXAC_{ac} = PX_c \cdot QX_c \cdot \left(\sum_{a \in A} \delta_{ac}^{ac} \cdot QXAC_{ac}^{-\rho_c^{ac}} \right)^{-1} \cdot \delta_{ac}^{ac} \cdot QXAC_{ac}^{-\rho_c^{ac}-1} \quad \begin{matrix} a \in A \\ c \in CX \end{matrix} \quad (21)$$

$$\left[\begin{matrix} \text{marginal cost of commodity } c \\ \text{from activity } a \end{matrix} \right] = \left[\begin{matrix} \text{marginal revenue product} \\ \text{of commodity } c \text{ from activity } a \end{matrix} \right]$$

Output transformation
(CET) function

$$QX_c = \alpha_c^t \cdot \left(\delta_c^t \cdot QE_c^{\rho_c^t} + (1 - \delta_c^t) \cdot QD_c^{\rho_c^t} \right)^{\frac{1}{\rho_c^t}} \quad \begin{matrix} c \in \\ (CE \cap CD) \end{matrix} \quad (22)$$

$$\left[\begin{matrix} \text{aggregate marketed} \\ \text{domestic output} \end{matrix} \right] = CET \left[\begin{matrix} \text{export quantity, domestic} \\ \text{sales of domestic output} \end{matrix} \right]$$

Export-domestic
supply ratio

$$\frac{QE_c}{QD_c} = \left(\frac{PE_c}{PDS_c} \cdot \frac{1 - \delta_c^t}{\delta_c^t} \right)^{\frac{1}{\rho_c^t - 1}} \quad \begin{matrix} c \in \\ (CE \cap CD) \end{matrix} \quad (23)$$

$$\left[\begin{matrix} \text{export-domestic} \\ \text{supply ratio} \end{matrix} \right] = f \left[\begin{matrix} \text{export-domestic} \\ \text{price ratio} \end{matrix} \right]$$

Output transformation
for non-exported
commodities

$$QX_c = QD_c + QE_c \quad \begin{matrix} c \in \\ (CD \cap CEN) \\ \cup \\ (CE \cap CDN) \end{matrix} \quad (24)$$

$$\left[\begin{matrix} \text{aggregate} \\ \text{marketed} \\ \text{domestic output} \end{matrix} \right] = \left[\begin{matrix} \text{domestic market} \\ \text{sales of domestic output} \\ [\text{for } c \in (CD \cap CEN)] \end{matrix} \right] - \left[\begin{matrix} \text{exports} \\ [\text{for } c \in \\ (CE \cap CDN)] \end{matrix} \right]$$

Composite supply
(Armington) function

$$QQ_c = \alpha_c^q \cdot \left(\delta_c^q \cdot QM_c^{-\rho_c^q} + (1 - \delta_c^q) \cdot QD_c^{-\rho_c^q} \right)^{-\frac{1}{\rho_c^q}} \quad \begin{matrix} c \in \\ (CM \cap CD) \end{matrix} \quad (25)$$

$$\left[\begin{matrix} \text{composite} \\ \text{supply} \end{matrix} \right] = CES \left[\begin{matrix} \text{import quantity, domestic} \\ \text{use of domestic output} \end{matrix} \right]$$

Import-domestic
demand ratio

$$\frac{QM_c}{QD_c} = \left(\frac{PDD_c}{PM_c} \cdot \frac{\delta_c^q}{1 - \delta_c^q} \right)^{\frac{1}{1+\rho_c^q}} \quad \begin{matrix} c \in \\ (CM \cap CD) \end{matrix} \quad (26)$$

$$\left[\begin{matrix} \text{import-domestic} \\ \text{demand ratio} \end{matrix} \right] = f \left[\begin{matrix} \text{domestic-import} \\ \text{price ratio} \end{matrix} \right]$$

Composite supply
for non-imported
outputs and non-
produced imports

$$QQ_c = QD_c + QM_c \quad \begin{matrix} c \in \\ (CD \cap CMN) \\ \cup \\ (CM \cap CDN) \end{matrix} \quad (27)$$

$$\left[\begin{matrix} \text{composite} \\ \text{supply} \end{matrix} \right] = \left[\begin{matrix} \text{domestic use of} \\ \text{marketed domestic output} \\ [\text{for } c \in (CD \cap CMN)] \end{matrix} \right] - \left[\begin{matrix} \text{imports} \\ [\text{for } c \in \\ (CM \cap CDN)] \end{matrix} \right]$$

Demand for
transaction
services

$$QT_c = \sum_{c' \in C} (icm_{cc'} \cdot QM_{c'} + ice_{cc'} \cdot QE_{c'} + icd_{cc'} \cdot QD_{c'}) \quad c \in CT \quad (28)$$

$$\left[\begin{matrix} \text{demand for} \\ \text{transaction services} \end{matrix} \right] = \left[\begin{matrix} \text{sum of demands for imports,} \\ \text{exports, and domestic sales} \end{matrix} \right]$$

Institution Block

Factor income

$$YF_f = \sum_{a \in A} WF_f \cdot WFDIST_{fa} \cdot QF_{fa} + trnsfr_{f_{gv}} \cdot CPI + trnsfr_{f_{rw}} \cdot EXR \quad f \in F \quad (29)$$

$$\left[\begin{matrix} \text{income of} \\ \text{factor } f \end{matrix} \right] = \left[\begin{matrix} \text{sum of activity payments (activity-} \\ \text{specific wages times employment levels} \end{matrix} \right] + \left[\begin{matrix} \text{income of factor } f \\ \text{from government} \end{matrix} \right] + \left[\begin{matrix} \text{income of factor } f \\ \text{from rest of world} \end{matrix} \right]$$

Institutional factor
incomes

$$YIF_{if} = shif_{if} \cdot YF_f \cdot (1 - TF_f) \quad \begin{matrix} i \in INS \\ f \in F \end{matrix} \quad (30)$$

$$\left[\begin{matrix} \text{income of} \\ \text{institution } i \\ \text{from factor } f \end{matrix} \right] = \left[\begin{matrix} \text{share of income} \\ \text{of factor } f \text{ to} \\ \text{institution } i \end{matrix} \right] \cdot \left[\begin{matrix} \text{income of} \\ \text{factor } f \\ \text{(net of taxes)} \end{matrix} \right]$$

Income of domestic,
non-government
institutions

$$YI_i = \sum_{f \in F} YIF_{if} + \sum_{i' \in INSDNG} TRII_{ii'} + trnsfr_{i_{gv}} \cdot CPI + trnsfr_{i_{rw}} \cdot EXR \quad i \in INSDNG \quad (31)$$

$$\begin{bmatrix} \text{income of} \\ \text{institution } i \end{bmatrix} = \begin{bmatrix} \text{factor} \\ \text{income} \end{bmatrix} + \begin{bmatrix} \text{transfers from other} \\ \text{domestic non-} \\ \text{government institutions} \end{bmatrix} + \begin{bmatrix} \text{transfer income for} \\ \text{institution } i \text{ from} \\ \text{government} \end{bmatrix} + \begin{bmatrix} \text{transfer income for} \\ \text{institution } i \text{ from} \\ \text{rest of world} \end{bmatrix}$$

Intra-institutional
transfers

$$TRII_{ii'} = shii_{ii'} \cdot YI_{i'} \cdot (1 - MPS_{i'}) \cdot (1 - TI_{i'}) \quad \begin{matrix} i \in INS \\ i' \in INSDNG \end{matrix} \quad (32)$$

$$\begin{bmatrix} \text{transfer from} \\ \text{institution } i \\ \text{to institution } i' \end{bmatrix} = \begin{bmatrix} \text{share of net income} \\ \text{of institution } i' \\ \text{transferred to } i \end{bmatrix} \cdot \begin{bmatrix} \text{income of institution } i' \\ \text{(net of savings and} \\ \text{direct taxes)} \end{bmatrix}$$

Household
consumption
expenditure

$$EH_h = \left(1 - \sum_{i \in INSDNG} shii_{ih}\right) \cdot YI_h \cdot (1 - MPS_h) \cdot (1 - TI_h) \quad h \in H \quad (33)$$

$$\begin{bmatrix} \text{household income} \\ \text{disposable for} \\ \text{consumption} \end{bmatrix} = \begin{bmatrix} \text{household income (net of savings,} \\ \text{direct taxes, and transfers to other} \\ \text{non-government institutions} \end{bmatrix}$$

Household
consumption demand
for marketed
commodities

$$PQ_c \cdot QH_{ch} = pop_h \cdot \left(PQ_c \cdot \gamma_{ch}^m + \beta_{ch}^m \cdot \left(\frac{EH_h}{pop_h} - \sum_{c' \in C} PQ_{c'} \cdot \gamma_{c'h}^m - \sum_{a \in A} PA_a \cdot \gamma_{ah}^h \right) \right) \quad \begin{matrix} c \in C \\ h \in H \end{matrix} \quad (34)$$

$$\begin{bmatrix} \text{household consumption} \\ \text{spending on market} \\ \text{commodity } c \end{bmatrix} = \begin{bmatrix} \text{population of} \\ \text{household } h \end{bmatrix} \cdot \begin{bmatrix} \text{per capita household consumption} \\ \text{spending, market price of } c, \text{ and other} \\ \text{commodity prices (market and home)} \end{bmatrix}$$

Household
consumption demand
for home
commodities

$$PA_a \cdot QHA_{ah} = pop_h \cdot \left(PA_a \cdot \gamma_{ah}^h + \beta_{ah}^h \cdot \left(\frac{EH_h}{pop_h} - \sum_{c \in C} PQ_c \cdot \gamma_{ch}^m - \sum_{a' \in A} PA_{a'} \cdot \gamma_{a'h}^h \right) \right) \quad \begin{matrix} a \in A \\ h \in H \end{matrix} \quad (35)$$

$$\begin{bmatrix} \text{household consumption} \\ \text{spending on home output} \\ \text{from activity } a \end{bmatrix} = \begin{bmatrix} \text{population of} \\ \text{household } h \end{bmatrix} \cdot \begin{bmatrix} \text{per capita household consumption} \\ \text{spending, producer price of } a, \text{ and other} \\ \text{commodity prices (market and home)} \end{bmatrix}$$

Investment
demand

$$QINV_c = IADJ \cdot qinv_c \quad c \in \mathcal{C} \quad (36)$$

$$\left[\begin{array}{c} \text{fixed investment demand} \\ \text{for commodity } c \end{array} \right] = \left[\begin{array}{c} \text{adjustment factor times} \\ \text{base-year fixed investment} \end{array} \right]$$

Government
consumption
demand

$$QG_c = GADJ \cdot qg_c \quad c \in \mathcal{C} \quad (37)$$

$$\left[\begin{array}{c} \text{fixed investment demand} \\ \text{for commodity } c \end{array} \right] = \left[\begin{array}{c} \text{adjustment factor times} \\ \text{base-year fixed investment} \end{array} \right]$$

Government
revenue

$$\begin{aligned} YG = & \sum_{a \in A} TA_a \cdot PA_a \cdot QA_a + \sum_{c \in CM} TM_c \cdot pwm_c \cdot QM_c \cdot EXR + \sum_{c \in CE} TE_c \cdot pwe_c \cdot QE_c \cdot EXR \\ & + \sum_{c \in \mathcal{C}} TQ_c \cdot PQ_c \cdot QQ_c + \sum_{a \in A} TV_a \cdot PVA_a \cdot QVA_a + \sum_{f \in F} TF_f \cdot YF_{f\,gv} \\ & + \sum_{i \in INSDNG} TI_i \cdot YI_i + \sum_{i \in INSDNG} TRII_{gv\,i} + trsnfr_{gv\,rw} \cdot EXR \end{aligned} \quad (38)$$

$$\begin{aligned} \left[\begin{array}{c} \text{government} \\ \text{revenue} \end{array} \right] = & \left[\begin{array}{c} \text{activity} \\ \text{taxes} \end{array} \right] + \left[\begin{array}{c} \text{import} \\ \text{tariffs} \end{array} \right] + \left[\begin{array}{c} \text{export} \\ \text{taxes} \end{array} \right] + \left[\begin{array}{c} \text{sales} \\ \text{taxes} \end{array} \right] + \left[\begin{array}{c} \text{value-added} \\ \text{taxes} \end{array} \right] + \left[\begin{array}{c} \text{direct taxes} \\ \text{from factors} \end{array} \right] \\ & + \left[\begin{array}{c} \text{direct taxes} \\ \text{from institutions} \end{array} \right] + \left[\begin{array}{c} \text{transfers from} \\ \text{institutions} \end{array} \right] + \left[\begin{array}{c} \text{transfers from} \\ \text{rest of world} \end{array} \right] \end{aligned}$$

Government
expenditures

$$EG = \sum_{c \in \mathcal{C}} PQ_c \cdot QG_c + \sum_{i \in INSDNG} trnsfr_{i\,gv} \cdot CPI + trnsfr_{rw\,gv} \cdot EXR \quad (39)$$

$$\left[\begin{array}{c} \text{government} \\ \text{spending} \end{array} \right] = \left[\begin{array}{c} \text{government} \\ \text{consumption} \end{array} \right] + \left[\begin{array}{c} \text{transfers to domestic} \\ \text{non-government institutions} \end{array} \right] + \left[\begin{array}{c} \text{transfers to} \\ \text{rest of world} \end{array} \right]$$

System Constraint Block

Factor market

$$QFS_f = \sum_{a \in A} QF_{fa} \quad f \in F \quad (40)$$

$$\begin{bmatrix} \text{supply of} \\ \text{factor } f \end{bmatrix} = \begin{bmatrix} \text{demand for} \\ \text{factor } f \end{bmatrix}$$

Composite
commodity
market

$$QQ_c = \sum_{a \in A} QINT_{ca} + \sum_{h \in H} QH_{ch} + QG_c + QINV_c + qdst_c + QT_c \quad c \in C \quad (41)$$

$$\begin{bmatrix} \text{composite} \\ \text{supply} \end{bmatrix} = \begin{bmatrix} \text{intermediate} \\ \text{use} \end{bmatrix} + \begin{bmatrix} \text{household} \\ \text{consumption} \end{bmatrix} + \begin{bmatrix} \text{government} \\ \text{consumption} \end{bmatrix} + \begin{bmatrix} \text{fixed} \\ \text{investment} \end{bmatrix} + \begin{bmatrix} \text{stock} \\ \text{change} \end{bmatrix} + \begin{bmatrix} \text{trade} \\ \text{input use} \end{bmatrix}$$

Current account
balance for rest
of the world
(in foreign currency)

$$\begin{aligned} \sum_{c \in CM} pwm_c \cdot QM_c + \sum_{f \in F} YIF_{rf}/EXR + \sum_{i \in INSDNG} TRII_{ri}/EXR + trnsfr_{rgv} \\ = \sum_{c \in CM} pwe_c \cdot QE_c + \sum_{f \in F} trnsfr_{frw} + \sum_{i \in INSD} trnsfr_{irw} + FSAV \end{aligned} \quad (42)$$

$$\begin{aligned} \begin{bmatrix} \text{import} \\ \text{spending} \end{bmatrix} &= \begin{bmatrix} \text{factor transfers} \\ \text{to rest of world} \end{bmatrix} + \begin{bmatrix} \text{institution transfers} \\ \text{to rest of world} \end{bmatrix} + \begin{bmatrix} \text{government transfers} \\ \text{to rest of world} \end{bmatrix} \\ &= \begin{bmatrix} \text{export} \\ \text{revenue} \end{bmatrix} + \begin{bmatrix} \text{factor transfers} \\ \text{from rest of world} \end{bmatrix} + \begin{bmatrix} \text{institution transfers} \\ \text{from rest of world} \end{bmatrix} + \begin{bmatrix} \text{foreign} \\ \text{savings} \end{bmatrix} \end{aligned}$$

Government
balance

$$YG = EG + GSAV \quad (43)$$

$$\begin{bmatrix} \text{government} \\ \text{revenue} \end{bmatrix} = \begin{bmatrix} \text{government} \\ \text{expenditures} \end{bmatrix} + \begin{bmatrix} \text{government} \\ \text{savings} \end{bmatrix}$$

Private savings

$$PSAV = \sum_{i \in INSDNG} MPS_i \cdot (1 - TI_i) \cdot YI_i \quad (44)$$

$$\left[\begin{array}{c} \text{total private} \\ \text{savings} \end{array} \right] = \left[\begin{array}{c} \text{savings rate times institution} \\ \text{income (net of taxes)} \end{array} \right]$$

Savings-investment
balance

$$PSAV + GSAV + FSAV \cdot EXR = \sum_{c \in C} PQ_c \cdot QINV_c + \sum_{c \in C} PQ_c \cdot qdst_c + WALRAS \quad (45)$$

$$\left[\begin{array}{c} \text{total private} \\ \text{savings} \end{array} \right] + \left[\begin{array}{c} \text{government} \\ \text{savings} \end{array} \right] + \left[\begin{array}{c} \text{foreign} \\ \text{savings} \end{array} \right] = \left[\begin{array}{c} \text{fixed} \\ \text{investment} \end{array} \right] + \left[\begin{array}{c} \text{stock} \\ \text{change} \end{array} \right]$$

Total absorption

$$TABS = \sum_{c \in C} \sum_{h \in H} PQ_c \cdot QH_{c h} + \sum_{a \in A} \sum_{h \in H} PA_c \cdot QHA_{a h} + \sum_{c \in C} PQ_c \cdot QG_c + \sum_{c \in C} PQ_c \cdot QINV_c \sum_{c \in C} PQ_c \cdot qdst_c \quad (46)$$

$$\left[\begin{array}{c} \text{total} \\ \text{absorption} \end{array} \right] = \left[\begin{array}{c} \text{household market} \\ \text{consumption} \end{array} \right] + \left[\begin{array}{c} \text{household home} \\ \text{consumption} \end{array} \right] + \left[\begin{array}{c} \text{government} \\ \text{consumption} \end{array} \right] + \left[\begin{array}{c} \text{fixed} \\ \text{investment} \end{array} \right] + \left[\begin{array}{c} \text{stock} \\ \text{change} \end{array} \right]$$

Ratio of investment
to absorption

$$INVSHR \cdot TABS = \sum_{c \in C} PQ_c \cdot QINV_c \sum_{c \in C} PQ_c \cdot qdst_c \quad (47)$$

$$\left[\begin{array}{c} \text{investment} \\ \text{absorption ratio} \end{array} \right] \cdot \left[\begin{array}{c} \text{total} \\ \text{absorption} \end{array} \right] = \left[\begin{array}{c} \text{fixed} \\ \text{investment} \end{array} \right] + \left[\begin{array}{c} \text{stock} \\ \text{change} \end{array} \right]$$

Ratio of government
consumption to
absorption

$$GOVSHR \cdot TABS = \sum_{c \in C} PQ_c \cdot QG_c \quad (48)$$

$$\left[\begin{array}{c} \text{government consumption} \\ \text{absorption ratio} \end{array} \right] \cdot \left[\begin{array}{c} \text{total} \\ \text{absorption} \end{array} \right] = \left[\begin{array}{c} \text{government} \\ \text{consumption} \end{array} \right]$$

Savings and Tax Rates Block

Institutional
savings rates

$$MPS_i = \overline{mps}_i \cdot (1 + MPSADJ \cdot mps01_i) + DMPS \cdot mps01_i \quad i \in INSDNG \quad (49)$$

$$\left[\begin{array}{c} \text{savings rate} \\ \text{for institution } i \end{array} \right] = \left[\begin{array}{c} \text{base rate adjusted for scaling} \\ \text{for selected institutions} \end{array} \right] + \left[\begin{array}{c} \text{point change for} \\ \text{selected institutions} \end{array} \right]$$

Activity tax rates

$$TA_a = \overline{ta}_a \cdot (1 + TAADJ \cdot ta01_a) + DTA \cdot ta01_a \quad a \in A \quad (50)$$

$$\left[\begin{array}{c} \text{activity tax rate} \\ \text{for activity } a \end{array} \right] = \left[\begin{array}{c} \text{base rate adjusted for scaling} \\ \text{for selected activities} \end{array} \right] + \left[\begin{array}{c} \text{point change for} \\ \text{selected activities} \end{array} \right]$$

Export tax rates

$$TE_c = \overline{te}_c \cdot (1 + TEADJ \cdot te01_c) + DTE \cdot te01_c \quad c \in CE \quad (51)$$

$$\left[\begin{array}{c} \text{export tax rate} \\ \text{for commodity } c \end{array} \right] = \left[\begin{array}{c} \text{base rate adjusted for scaling} \\ \text{for selected commodities} \end{array} \right] + \left[\begin{array}{c} \text{point change for} \\ \text{selected commodities} \end{array} \right]$$

Direct factor tax rates

$$TF_f = \overline{tf}_f \cdot (1 + TFADJ \cdot tf01_f) + DTF \cdot tf01_f \quad f \in F \quad (52)$$

$$\left[\begin{array}{c} \text{direct factor tax} \\ \text{rate for factor } f \end{array} \right] = \left[\begin{array}{c} \text{base rate adjusted for scaling} \\ \text{for selected factors} \end{array} \right] + \left[\begin{array}{c} \text{point change for} \\ \text{selected factors} \end{array} \right]$$

Direct institutional
tax rates

$$TI_i = \overline{ti}_i \cdot (1 + TIADJ \cdot ti01_i) + DTI \cdot ti01_i \quad i \in INSDNG \quad (53)$$

$$\left[\begin{array}{c} \text{direct tax rate} \\ \text{for institution } i \end{array} \right] = \left[\begin{array}{c} \text{base rate adjusted for scaling} \\ \text{for selected institutions} \end{array} \right] + \left[\begin{array}{c} \text{point change for} \\ \text{selected institutions} \end{array} \right]$$

Import tariff rates

$$TM_c = \overline{tm}_c \cdot (1 + TMADJ \cdot tm01_c) + DTM \cdot tm01_c \quad c \in CM \quad (54)$$

$$\left[\begin{array}{c} \text{import tariff rate} \\ \text{for commodity } c \end{array} \right] = \left[\begin{array}{c} \text{base rate adjusted for scaling} \\ \text{for selected commodities} \end{array} \right] + \left[\begin{array}{c} \text{point change for} \\ \text{selected commodities} \end{array} \right]$$

Sales tax rates

$$TQ_c = \overline{tq}_c \cdot (1 + TQADJ \cdot tq01_c) + DTQ \cdot tq01_c \quad c \in C \quad (55)$$

$$\left[\begin{array}{c} \text{sales tax rate} \\ \text{for commodity } c \end{array} \right] = \left[\begin{array}{c} \text{base rate adjusted for scaling} \\ \text{for selected commodities} \end{array} \right] + \left[\begin{array}{c} \text{point change for} \\ \text{selected commodities} \end{array} \right]$$

Value-added tax rates

$$TV_a = \overline{tv}_a \cdot (1 + TVADJ \cdot tv01_a) + DTV \cdot tv01_a \quad a \in A \quad (56)$$

$$\left[\begin{array}{c} \text{value-added rate} \\ \text{for activity } a \end{array} \right] = \left[\begin{array}{c} \text{base rate adjusted for scaling} \\ \text{for selected activities} \end{array} \right] + \left[\begin{array}{c} \text{point change for} \\ \text{selected activities} \end{array} \right]$$