

APPENDIX A: MATHEMATICAL SUMMARY STATEMENT FOR THE STANDARD CGE MODEL

SETS	$\alpha \in A$	activities
	$\alpha \in ACES(\subset A)$	activities with a CES function at the top of the technology nest
	$\alpha \in ALEO(\subset A)$	activities with a Leontief function at the top of the technology nest
	$c \in C$	commodities
	$c \in CD(\subset C)$	commodities with domestic sales of domestic output
	$c \in CDN(\subset C)$	commodities not in CD
	$c \in CE(\subset C)$	exported commodities
	$c \in CEN(\subset C)$	commodities not in CE
	$c \in CM(\subset C)$	imported commodities
	$c \in CMN(\subset C)$	commodities not in CM
	$c \in CT(\subset C)$	transactions service commodities
	$c \in CX(\subset C)$	commodities with domestic production
	$f \in F$	factors
	$i \in INS$	institutions (domestic and rest of the world)
	$i \in INSD(\subset INS)$	domestic institutions
	$i \in INSDNG$	
	$(\subset INSD)$	domestic nongovernment institutions
	$h \in H(\subset INSDNG)$	households

PARAMETERS

Latin Letters

$cwts_c$	weight of commodity c in the <i>CPI</i>
$dwtsc$	weight of commodity c in the producer price index
ica_{ca}	quantity of c as intermediate input per unit of activity a
$icd_{cc'}$	quantity of commodity c as trade input per unit of c' produced and sold domestically
$ice_{cc'}$	quantity of commodity c as trade input per exported unit of c'
$icm_{cc'}$	quantity of commodity c as trade input per imported unit of c'
$inta_a$	quantity of aggregate intermediate input per activity unit

	iva_a	quantity of value-added per activity unit
	\overline{mps}_i	base savings rate for domestic institution i
	$mps01_c$	0-1 parameter with 1 for institutions with potentially flexed direct tax rates
	pwe_c	export price (foreign currency)
	pwm_c	import price (foreign currency)
	$qdst_c$	quantity of stock change
	$\overline{qg_c}$	base-year quantity of government demand
	\overline{qinv}_c	base-year quantity of private investment demand
	$shif_{if}$	share for domestic institution i in income of factor f
	$shii_{ii'}$	share of net income of i' to i ($i' \in INSDNG'$; $i \in INSDNG$)
	$t\alpha_a$	tax rate for activity a
	te_c	export tax rate
	tj_f	direct tax rate for factor f
	\overline{tins}_i	exogenous direct tax rate for domestic institution i
	$tins01_i$	0-1 parameter with 1 for institutions with potentially flexed direct tax rates
	tm_c	import tariff rate
	tq_c	rate of sales tax
	$trnsfr_{if}$	transfer from factor f to institution i
	tva_a	rate of value-added tax for activity a
Greek Letters	α_a^a	efficiency parameter in the CES activity function
	α_a^{va}	efficiency parameter in the CES value-added function
	α_a^{ac}	shift parameter for domestic commodity aggregation function
	α_c^q	Armington function shift parameter
	α_c^t	CET function shift parameter
	β_{ach}^h	marginal share of consumption spending on home commodity c from activity a for household h
	β_{ch}^m	marginal share of consumption spending on marketed commodity c for household h
	δ_a^a	CES activity function share parameter
	δ_{ac}^{ac}	share parameter for domestic commodity 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_{ch}^m	subsistence consumption of marketed commodity c for household h
	γ_{ach}^h	subsistence consumption of home commodity c from activity a for household h

	θ_{ac}	yield of output c per unit of activity a
	ρ_a^a	CES production function exponent
	ρ_a^{va}	CES value-added function exponent
	ρ_c^{ac}	domestic commodity aggregation function exponent
	ρ_c^q	Armington function exponent
	ρ_c^t	CET function exponent
EXOGENOUS VARIABLES	\overline{CPI}	consumer price index
	\overline{DTINS}	change in domestic institution tax share (= 0 for base; exogenous variable)
	\overline{FSAV}	foreign savings (FCU)
	\overline{GADJ}	government consumption adjustment factor
	\overline{IADJ}	investment adjustment factor
	\overline{MPSADJ}	savings rate scaling factor (= 0 for base)
	\overline{QFS}_f	quantity supplied of factor
	$\overline{TINSADJ}$	direct tax scaling factor (= 0 for base; exogenous variable)
	\overline{WFDIST}_{fa}	wage distortion factor for factor f in activity a
ENDOGENOUS VARIABLES	$DMPS$	change in domestic institution savings rates (= 0 for base; exogenous variable)
	DPI	producer price index for domestically marketed output
	EG	government expenditures
	EH_h	consumption spending for household
	EXR	exchange rate (LCU per unit of FCU)
	$GOVSHR$	government consumption share in nominal absorption
	$GSAV$	government savings
	$INVSHR$	investment share in nominal absorption
	MPS_i	marginal propensity to save for domestic non-government institution (exogenous variable)
	PA_a	activity price (unit gross revenue)
	PDD_c	demand price for commodity produced and sold domestically
	PDS_c	supply price for commodity produced and sold domestically
	PE_c	export price (domestic currency)
	$PINTA_a$	aggregate intermediate input price for activity a
	PM_c	import price (domestic currency)
	PQ_c	composite commodity price
	PVA_a	value-added price (factor income per unit of activity)
	PX_c	aggregate producer price for commodity
	$PXAC_{ac}$	producer price of commodity c for activity a
	QA_a	quantity (level) of activity
	QD_c	quantity sold domestically of domestic output

QE_c	quantity of exports
QF_{fa}	quantity demanded of factor f from activity a
QG_c	government consumption demand for commodity
QH_{ch}	quantity consumed of commodity c by household h
QHA_{ach}	quantity of household home consumption of commodity c from activity a for household h
$QINTA_a$	quantity of aggregate intermediate input
$QINT_{ca}$	quantity of commodity c as intermediate input to activity a
$QINV_c$	quantity of investment demand for commodity
QM_c	quantity of imports of commodity
QQ_c	quantity of goods supplied to domestic market (composite supply)
QT_c	quantity of commodity demanded as trade input
QVA_a	quantity of (aggregate) value-added
QX_c	aggregated marketed quantity of domestic output of commodity
$QXAC_{ac}$	quantity of marketed output of commodity c from activity a
$TABS$	total nominal absorption
$TINS_i$	direct tax rate for institution i ($i \in INSDNG$)
$TRII_{i'}$	transfers from institution i' to i (both in the set $INSDNG$)
WF_f	average price of factor f
YF_f	income of factor f
YG	government revenue
YI_i	income of domestic nongovernment institution
YIF_{if}	income to domestic institution i from factor f

EQUATIONS

Price Block

Import price

$$PM_c = pwm_c \cdot (1 + tm_c) \cdot EXR + \sum_{c \in CT} P\bar{Q}_c \cdot icm_c \quad (1)$$

$$\left[\begin{array}{c} \text{import} \\ \text{price} \\ (LCU) \end{array} \right] = \left[\begin{array}{c} \text{import} \\ \text{price} \\ (FCU) \end{array} \right] \cdot \left[\begin{array}{c} \text{tariff} \\ \text{adjust-} \\ \text{ment} \end{array} \right] \cdot \left[\begin{array}{c} \text{exchange rate} \\ (LCU \text{ per} \\ \text{FCU}) \end{array} \right] + \left[\begin{array}{c} \text{cost of trade} \\ \text{inputs per} \\ \text{import unit} \end{array} \right]$$

Export price

$$PE_c = pwe_c \cdot (1 - te_c) \cdot EXR - \sum_{c \in CT} P\bar{Q}_c \cdot ice_c \quad (2)$$

$$\left[\begin{array}{c} \text{export} \\ \text{price} \\ (LCU) \end{array} \right] = \left[\begin{array}{c} \text{export} \\ \text{price} \\ (FCU) \end{array} \right] \cdot \left[\begin{array}{c} \text{tariff} \\ \text{adjust-} \\ \text{ment} \end{array} \right] \cdot \left[\begin{array}{c} \text{exchange rate} \\ (LCU \text{ per} \\ \text{FCU}) \end{array} \right] - \left[\begin{array}{c} \text{cost of trade} \\ \text{inputs per} \\ \text{export unit} \end{array} \right]$$

Demand price of
domestic nontraded goods

$$PDD_c = PDS_c + \sum_{c \in CT} P\bar{Q}_c \cdot icd_c \quad (3)$$

$$\left[\begin{array}{c} \text{domestic} \\ \text{demand} \\ \text{price} \end{array} \right] = \left[\begin{array}{c} \text{domestic} \\ \text{supply} \\ \text{price} \end{array} \right] + \left[\begin{array}{c} \text{cost of trade} \\ \text{inputs per} \\ \text{unit of} \\ \text{domestic sales} \end{array} \right]$$

Absorption

$$P\bar{Q}_c \cdot (1 - tq_c) \cdot \bar{Q}\bar{Q}_c = PDD_c \cdot \bar{Q}D_c + PM_c \cdot \bar{Q}M_c \quad (4)$$

$$c \in (CD \cup CM)$$

Marketed output value

$$PX_c \cdot \bar{Q}X_c = PDS_c \cdot \bar{Q}D_c + PE_c \cdot \bar{Q}E_c \quad (5)$$

$$\left[\begin{array}{c} \text{producer price} \\ \text{times marketed} \\ \text{output quantity} \end{array} \right] = \left[\begin{array}{c} \text{domestic supply price} \\ \text{times} \\ \text{domestic sales quantity} \end{array} \right] + \left[\begin{array}{c} \text{export price} \\ \text{times} \\ \text{export quantity} \end{array} \right]$$

Activity price

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

$a \in A$

Aggregate intermediate
input price

$$PINTA_a = \sum_{c \in C} PQ_c \cdot ica_{ca} \quad (7)$$

$a \in A$

Activity revenue
and costs

$$PA_a \cdot (1 - ta_a) \cdot QA_a = PVA_a \cdot QVA_a + PINTA_a \cdot QINTA_a \quad (8)$$

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

$a \in A$

Consumer price index

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

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

Producer price index for
nontraded market output

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

$$\left[\begin{array}{c} \text{producer price index} \\ \text{for non-traded outputs} \end{array} \right] = \left[\begin{array}{c} \text{prices times} \\ \text{weights} \end{array} \right]$$

Production and Trade Block

CES technology: Activity
production function

$$\underline{QA}_a = \alpha_a^a \cdot \left(\delta_a^a \cdot \underline{QVA}_a^{-\rho_a^a} + (1 - \delta_a^a) \cdot \underline{QINTA}_a^{-\rho_a^a} \right)^{\frac{1}{1+\rho_a^a}} \quad (11)$$

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

$a \in ACES$

CES technology: Value-added
intermediate-input
quantity ratio

$$\frac{\underline{QVA}_a}{\underline{QINTA}_a} = \left(\frac{\underline{PINTA}_a}{\underline{PVA}_a} \cdot \frac{\delta_a^a}{1 - \delta_a^a} \right)^{\frac{1}{1+\rho_a^a}} \quad (12)$$

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

$a \in ACES$

Leontief technology:
Demand for aggregate
value-added

$$\underline{QVA}_a = iva_a \cdot \underline{QA}_a \quad (13)$$

$$\left[\begin{array}{c} \text{demand for} \\ \text{value added} \end{array} \right] = f \left[\begin{array}{c} \text{activity} \\ \text{level} \end{array} \right]$$

$a \in ALEO$

Leontief technology:
Demand for aggregate
intermediate input

$$\underline{QINTA}_a = inta_a \cdot \underline{QA}_a \quad (14)$$

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

$a \in ALEO$

Value-added and
factor demands

$$\underline{QVA}_a = \alpha_a^{va} \cdot \left(\sum_{f \in F} \delta_{fa}^{va} \cdot \underline{QF}_{fa}^{-\rho_a^{va}} \right)^{\frac{1}{1+\rho_a^{va}}} \quad (15)$$

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

$a \in A$

$$WF_f \cdot \overline{WFDIST}_{f\ a} = PVA_a \cdot (1 - tva_a) \cdot \underline{QVA}_a \cdot \left(\sum_{f \in F'} \delta_{f\ a}^{va} \cdot \underline{QF}_{f\ a}^{-\rho_a^{va}} \right)^{-1} \cdot \delta_{f\ a}^{va} \cdot \underline{QF}_{f\ a}^{-\rho_a^{va}-1} \quad (16)$$

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

$a \in A$
 $f \in F$

$$\underline{QINT}_{c\ a} = ica_{c\ a} \cdot \underline{QINT}_a$$

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

$a \in A$
 $c \in C$

$$\underline{QXAC}_{a\ c} + \sum_{h \in H} \underline{QHA}_{a\ c\ h} = \theta_{a\ c} \cdot \underline{QA}_a$$

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

$a \in A$
 $a \in CX$

$$\underline{QX}_c = \alpha_c^{ac} \cdot \left(\sum_{a \in A} \delta_{a\ c}^{ac} \cdot \underline{QXAC}_{a\ c}^{-\rho_c^{ac}} \right)^{\frac{1}{-\rho_c^{ac}-1}}$$

$c \in CX$

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

$$PXAC_{a\ c} = PX_c \cdot \underline{QX}_c \cdot \left(\sum_{a \in A'} \delta_{a\ c}^{ac} \cdot \underline{QXAC}_{a\ c}^{-\rho_c^{ac}} \right)^{-1} \cdot \delta_{a\ c}^{ac} \cdot \underline{QXAC}_{a\ c}^{-\rho_c^{ac}-1}$$

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

$a \in A$
 $c \in CX$

First-order condition for
output aggregation function

**Production and
Trade Block
(continued)**

Output transformation
(CET) function

$$\bar{Q}X_c = \alpha_c^t \cdot (\delta_c^t \cdot \bar{Q}E_c^{\rho_c^t} + (1 - \delta_c^t) \cdot \bar{Q}D_c^{\rho_c^t})^{\frac{1}{\rho_c^t}} \quad (21)$$

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

Export-domestic supply ratio

$$\frac{\bar{Q}E_c}{\bar{Q}D_c} = \left(\frac{PE_c}{PDS_c} \cdot \frac{1 - \delta_c^t}{\delta_c^t} \right)^{\frac{1}{\rho_c^t - 1}} \quad (22)$$

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

Output transformation for
non-exported commodities

$$\bar{Q}X_c = \bar{Q}D_c + \bar{Q}E_c$$

$$\left[\begin{array}{c} \text{aggregate} \\ \text{marketed} \\ \text{domestic output} \end{array} \right] = \left[\begin{array}{c} \text{domestic market} \\ \text{sales of domestic} \\ \text{output [for} \\ c \in (CD \cap CEN)] \end{array} \right] + \left[\begin{array}{c} \text{exports [for} \\ c \in (CE \cap CDN)] \end{array} \right] \quad (23)$$

Composite supply
(Armington) function

$$\bar{Q}Q_c = \alpha_c^q \cdot (\delta_c^q \cdot \bar{Q}M_c^{\rho_c^q} + (1 - \delta_c^q) \cdot \bar{Q}D_c^{\rho_c^q})^{\frac{1}{\rho_c^q}} \quad (24)$$

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

Import-domestic demand ratio

$$\frac{\bar{Q}M_c}{\bar{Q}D_c} = \left(\frac{PDD_c}{PM_c} \cdot \frac{\delta_c^q}{1 - \delta_c^q} \right)^{\frac{1}{1 + \rho_c^q}} \quad (25)$$

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

Composite supply for
non-imported outputs
and nonproduced imports

$$\underline{Q}\underline{Q}_c = \underline{Q}D_c + \underline{Q}M_c \quad (26)$$

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

Demand for
transactions services

$$\underline{Q}T_c = \sum_{c' \in C'} (icm_{c,c'} \cdot \underline{Q}M_{c'} + ice_{c,c'} \cdot \underline{Q}E_{c'} + icd_{c,c'} \cdot \underline{Q}D_{c'}) \quad (27)$$

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

Institution Block
Factor income

$$YF_f = \sum_{a \in A} WF_f \cdot \overline{WFDIST}_f \cdot \underline{Q}F_{f,a} \quad (28)$$

$$\left[\begin{array}{c} \text{income of} \\ \text{factor } f \end{array} \right] = \left[\begin{array}{c} \text{sum of activity payments} \\ \text{(activity-specific wages} \\ \text{times employment levels)} \end{array} \right]$$

Institutional factor incomes

$$YIF_{i,f} = shif_{i,f} \cdot \left[(1 - tf_f) \cdot YF_f - transfr_{row,f} \cdot EXR \right] \quad (29)$$

$$\left[\begin{array}{c} \text{income of} \\ \text{institution } i \\ \text{from factor } f \end{array} \right] = \left[\begin{array}{c} \text{share of income} \\ \text{of factor } f \text{ to} \\ \text{institution } i \end{array} \right] \cdot \left[\begin{array}{c} \text{income of factor } f \\ \text{(net of tax and} \\ \text{transfer to RoW)} \end{array} \right]$$

Income of domestic,
nongovernment institutions

$$YI_i = \sum_{f \in F} YIF_{i,f} + \sum_{i' \in \overline{INSNDNG}} TRII_{i,i'} + transfr_{i,gov} \cdot \overline{CPI} + transfr_{i,row} \cdot EXR \quad (30)$$

$$\left[\begin{array}{c} \text{income of} \\ \text{institution } i \end{array} \right] = \left[\begin{array}{c} \text{factor} \\ \text{income} \end{array} \right] + \left[\begin{array}{c} \text{transfers} \\ \text{from other domestic} \\ \text{non-government} \\ \text{institutions} \end{array} \right] + \left[\begin{array}{c} \text{transfers} \\ \text{from} \\ \text{government} \end{array} \right] + \left[\begin{array}{c} \text{transfers} \\ \text{from} \\ \text{RoW} \end{array} \right]$$

Institution Block (continued)

Intra-institutional
transfers

$$TRI_{i' i'} = shii_{i' i'} \cdot (1 - MPS_{i'}) \cdot (1 - TINS_{i'}) \cdot YI_{i'} \quad (31)$$

$$\left[\begin{array}{c} \text{transfer from} \\ \text{institution } i' \text{ to } i \end{array} \right] = \left[\begin{array}{c} \text{share of net income} \\ \text{of institution } i' \\ \text{transferred to } i \end{array} \right] \cdot \left[\begin{array}{c} \text{income of institution} \\ i', \text{ net of savings and} \\ \text{direct taxes} \end{array} \right]$$

$i \in INSDNG$
 $i' \in INSDNG$

Household consumption
expenditure

$$EH_h = \left(1 - \sum_{i \in INSDNG} shii_{i h} \right) \cdot (1 - MPS_h) \cdot (1 - TINS_h) \cdot YI_h \quad (32)$$

$$\left[\begin{array}{c} \text{household income} \\ \text{disposable for} \\ \text{consumption} \end{array} \right] = \left[\begin{array}{c} \text{household income, net of direct} \\ \text{taxes, savings, and transfers to} \\ \text{other non-government institutions} \end{array} \right]$$

$h \in H$

Household consumption
demand for marketed
commodities

$$PQ_c \cdot QH_{c h} = PQ_c \cdot \gamma_{c h}^m + \beta_{c h}^m \cdot \left(EH_h - \sum_{c' \in C} PQ_{c'} \cdot \gamma_{c' h}^m - \sum_{a \in A} \sum_{c' \in C} PXAC_{a c'} \cdot \gamma_{a c' h}^h \right) \quad (33)$$

$$\left[\begin{array}{c} \text{household consumption} \\ \text{spending on market} \\ \text{commodity } c \end{array} \right] = f \left[\begin{array}{c} \text{total household consumption} \\ \text{spending, market price of } c, \text{ and other} \\ \text{commodity prices (market and home)} \end{array} \right]$$

$c \in C$
 $h \in H$

Household consumption
demand for home
commodities

$$PXAC_{a c} \cdot QHA_{a c h} = PXAC_{a c} \cdot \gamma_{a c h}^h + \beta_{a c h}^h \cdot \left(EH_h - \sum_{c' \in C} PQ_{c'} \cdot \gamma_{c' h}^m - \sum_{a \in A} \sum_{c' \in C} PXAC_{a c'} \cdot \gamma_{a c' h}^h \right) \quad (34)$$

$$\left[\begin{array}{c} \text{household consumption} \\ \text{spending on home commodity} \\ c \text{ from activity } a \end{array} \right] = f \left[\begin{array}{c} \text{total household consumption spending,} \\ \text{producer price, and other} \\ \text{commodity prices (market and home)} \end{array} \right]$$

$a \in A$
 $c \in C$
 $h \in H$

Investment demand

$$QINV_c = \overline{IADJ} \cdot \overline{qinv}_c \quad (35)$$

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

$c \in CINV$

Government
consumption demand

$$\overline{QG}_c = \overline{GADJ} \cdot \overline{qg}_c \quad (36)$$

$$\begin{bmatrix} \text{government} \\ \text{consumption} \\ \text{demand for} \\ \text{commodity } c \end{bmatrix} = \begin{bmatrix} \text{adjustment factor} \\ \text{times} \\ \text{base-year government} \\ \text{consumption} \end{bmatrix}$$

$c \in C$

Government revenue

$$YG = \sum_{i \in \text{INSDNG}} TINS_i \cdot YI_i + \sum_{f \in F} tf_f \cdot YF_f + \sum_{a \in A} tva_a \cdot PVA_a \cdot \overline{QVA}_a \quad (37)$$

$$+ \sum_{a \in A} ta_a \cdot PA_a \cdot \overline{QA}_a + \sum_{\alpha \in CM} tm_\alpha \cdot pwm_\alpha \cdot \overline{QM}_\alpha \cdot EXR + \sum_{\epsilon \in CE} te_\epsilon \cdot pwe_\epsilon \cdot \overline{QE}_\epsilon \cdot EXR$$

$$+ \sum_{c \in C} tq_c \cdot PQ_c \cdot \overline{QQ}_c + \sum_{f \in F} YIF_{\text{gov } f} + \text{trnsfr}_{\text{gov row}} \cdot EXR$$

$$\begin{bmatrix} \text{government} \\ \text{revenue} \end{bmatrix} = \begin{bmatrix} \text{direct taxes} \\ \text{from} \\ \text{institutions} \end{bmatrix} + \begin{bmatrix} \text{direct taxes} \\ \text{from} \\ \text{factors} \end{bmatrix} + \begin{bmatrix} \text{value-} \\ \text{added} \\ \text{tax} \end{bmatrix}$$

$$+ \begin{bmatrix} \text{activity} \\ \text{tax} \end{bmatrix} + \begin{bmatrix} \text{import} \\ \text{tariffs} \end{bmatrix} + \begin{bmatrix} \text{export} \\ \text{taxes} \end{bmatrix} + \begin{bmatrix} \text{sales} \\ \text{tax} \end{bmatrix} + \begin{bmatrix} \text{factor} \\ \text{income} \end{bmatrix} + \begin{bmatrix} \text{transfers} \\ \text{from} \\ \text{RoW} \end{bmatrix}$$

Government expenditures

$$EG = \sum_{c \in C} PQ_c \cdot \overline{QG}_c + \sum_{i \in \text{INSDNG}} \text{trnsfr}_i \cdot \overline{CPI}_{\text{gov}} \cdot \overline{CPI} \quad (38)$$

$$\begin{bmatrix} \text{government} \\ \text{spending} \end{bmatrix} = \begin{bmatrix} \text{government} \\ \text{consumption} \end{bmatrix} + \begin{bmatrix} \text{transfers to domestic} \\ \text{non-government} \\ \text{institutions} \end{bmatrix}$$

System
Constraint Block
Factor market

$$\sum_{a \in A} \overline{QF}_a = \overline{QFS}_f \quad (39)$$

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

$f \in F$

System Constraint Block (continued)

Composite commodity
markets

$$\underline{QQ}_c = \sum_{a \in A} \underline{QINT}_{c\ a} + \sum_{h \in H} \underline{QH}_{c\ h} + \underline{QG}_c + \underline{QINV}_c + \underline{qdst}_c + \underline{QT}_c$$

$$\begin{bmatrix} \text{composite} \\ \text{supply} \end{bmatrix} = \begin{bmatrix} \text{intermediate} \\ \text{use} \end{bmatrix} + \begin{bmatrix} \text{household} \\ \text{consumption} \end{bmatrix} + \begin{bmatrix} \text{government} \\ \text{consumption} \end{bmatrix} + \begin{bmatrix} \text{fixed} \\ \text{investment} \end{bmatrix} + \begin{bmatrix} \text{stock} \\ \text{change} \end{bmatrix} + \begin{bmatrix} \text{trade} \\ \text{input use} \end{bmatrix} \quad c \in C \quad (40)$$

$$\sum_{c \in CM} \underline{pwm}_c \cdot \underline{QM}_c + \sum_{f \in F} \underline{tnsfr}_{row\ f} = \sum_{c \in CE} \underline{pwe}_c \cdot \underline{QE}_c + \sum_{i \in INSD} \underline{tnsfr}_{i\ row} + \underline{FSAV}$$

$$\begin{bmatrix} \text{import} \\ \text{spending} \end{bmatrix} + \begin{bmatrix} \text{factor} \\ \text{transfers} \\ \text{to RoW} \end{bmatrix} = \begin{bmatrix} \text{export} \\ \text{revenue} \end{bmatrix} + \begin{bmatrix} \text{institutional} \\ \text{transfers} \\ \text{from RoW} \end{bmatrix} + \begin{bmatrix} \text{foreign} \\ \text{savings} \end{bmatrix} \quad (41)$$

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

$$YG = EG + GSAV$$

$$\begin{bmatrix} \text{government} \\ \text{revenue} \end{bmatrix} = \begin{bmatrix} \text{government} \\ \text{expenditures} \end{bmatrix} + \begin{bmatrix} \text{government} \\ \text{savings} \end{bmatrix} \quad (42)$$

Government balance

$$\overline{TINS}_i = \overline{tins}_i \cdot \left(1 + \overline{TINSADJ} \cdot \overline{tins01}_i\right) + \overline{DTINS} \cdot \overline{tins01}_i$$

$$\begin{bmatrix} \text{direct tax} \\ \text{rate for} \\ \text{institution } i \end{bmatrix} = \begin{bmatrix} \text{base rate adjusted} \\ \text{for scaling for} \\ \text{selected institutions} \end{bmatrix} + \begin{bmatrix} \text{point change} \\ \text{for selected} \\ \text{institutions} \end{bmatrix} \quad i \in INSDNG \quad (43)$$

Direct institutional tax rates

$$\overline{MPS}_i = \overline{mps}_i \cdot \left(1 + \overline{MPSADJ} \cdot \overline{mps01}_i\right) + \overline{DMPS} \cdot \overline{mps01}_i$$

$$\begin{bmatrix} \text{savings} \\ \text{rate for} \\ \text{institution } i \end{bmatrix} = \begin{bmatrix} \text{base rate adjusted} \\ \text{for scaling for} \\ \text{selected institutions} \end{bmatrix} + \begin{bmatrix} \text{point change} \\ \text{for selected} \\ \text{institutions} \end{bmatrix} \quad i \in INSDNG \quad (44)$$

Institutional savings rates

Savings-Investment Balance

$$\sum_{i \in \text{INDNG}} MPS_i \cdot (1 - TINS_i) \cdot YI_i + GSAV + EXR \cdot \overline{FSAV} = \sum_{c \in C} P\bar{Q}_c \cdot \bar{Q}INV_c + \sum_{c \in C} P\bar{Q}_c \cdot qdst_c$$

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

(45)

Total absorption

$$TABS = \sum_{h \in H} \sum_{c \in C} P\bar{Q}_c \cdot \bar{Q}H_{c\ h} + \sum_{a \in A} \sum_{c \in C} \sum_{h \in H} PXAC_{a\ c} \cdot \bar{Q}HA_{a\ c\ h} + \sum_{c \in C} P\bar{Q}_c \cdot \bar{Q}G_c$$

$$+ \sum_{c \in C} P\bar{Q}_c \cdot \bar{Q}INV_c + \sum_{c \in C} P\bar{Q}_c \cdot qdst_c$$

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

(46)

Ratio of investment to absorption

$$INVSHR \cdot TABS = \sum_{c \in C} P\bar{Q}_c \cdot \bar{Q}INV_c + \sum_{c \in C} P\bar{Q}_c \cdot qdst_c$$

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

(47)

Ratio of government consumption to absorption

$$GOVSHR \cdot TABS = \sum_{c \in C} P\bar{Q}_c \cdot \bar{Q}G_c$$

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

(48)