Table 4.1

Competitive CGE Model Equations

	Equation	Description Equations	No. of Equations	Endogenous Variables	Exogenous Variables	Parameters
0.	$Z = \sum_i (SLACK_i + SLACK2_i)$	*Objective function*	*1*	Z $SLACK_i$ $SLACK2_i$		
	PRODUCTION SYSTEM					
1.	$LAB_i = \frac{\alpha_i^L PN_i X_i}{PL}$	*Labor demand*	*n*	LAB_i PN_i PL X_i		α_i^L
2a.	$CAP_i = \frac{\alpha_i^K PN_i X_i}{PK_i}$	*Capital demand SR*	*n*	CAP_i PN_i PK_i X_i		α_i^K
2b.	$CAP_i = \frac{\alpha_i^K PN_i X_i}{PK}$	*Capital demand LR*	*n*	CAP_I PN_i PK X_i		α_i^K
3.	$LAND_{ag} = \frac{\alpha_{ag}^T PN_{ag} X_{ag}}{PT_{ag}}$	*Land demand*	*n*	$LAND_{ag}$ PN_{ag} PT_{ag} X_{ag}		α_i^T
4.	$VA_i = a_{0i} X_i$	*Composite factor demand*	*n*	VA_i X_i		a_{0i}
5.	$V_{ji} = a_{ji} X_i$	*Intermediate input demand*	*n* x *n*	V_{ji} X_i		a_{ji}

Table 4.1 (Continued)

	Equation	Description Equations	No. of Equations	Endogenous Variables	Exogenous Variables	Parameters
6a.	$VA_{ag} = \phi_{ag}^{VA} LAB_{ag}^{\alpha_{ag}^{L}} CAP_{ag}^{\alpha_{ag}^{K}} LAND_{ag}^{\alpha_{ag}^{T}}$	*Net product production function sector with land*	*1*	$VA_{ag}\ LAB_{ag}\ CAP_{ag}\ LAND_{ag}$		$\phi_{ag}^{VA}\ \alpha_{ag}^{L}\ \alpha_{ag}^{K}\ \alpha_{ag}^{T}$
6b.	$VA_{nag} = \phi_{nag}^{VA} LAB_{nag}^{\alpha_{nag}^{L}} CAP_{nag}^{\alpha_{nag}^{K}}$	*Net product production function sector without land*	*n-1*	$VA_{nag}\ LAB_{nag}\ CAP_{nag}$		$\phi_{nag}^{VA}\ \alpha_{nag}^{L}\ \alpha_{nag}^{K}$
7.	$V_{ji} = \phi_{ji}^{V}\left[\delta_{ji}^{V} VM_{ji}^{\rho_j^V} + (1-\delta_{ji}^{V}) VR_{ji}^{\rho_j^V}\right]^{\frac{1}{\rho_j^V}},\ \sigma_j^V = \frac{1}{1-\rho_j^v}$	*CES for intermediate input demand*	*n* x *n*	$V_{ji}\ VM_{ji}\ VR_{ji}$		$\phi_{ji}^{V}\ \delta_{ji}^{V}\ \rho_j^V\ \sigma_j^V$
8.	$TV_i = \sum_j V_{ij}$	*Total composite intermediate demand*	*n*	$TV_i\ V_{ij}$		
9.	$VR_{ji} = VM_{ji}\left[\left(\frac{1-\delta_{ji}^{V}}{\delta_{ji}^{V}}\right)\left(\frac{PM0_j}{PR_j}\right)\right]^{\sigma_j^V}$	*Regional produced intermediate input demand*	n^2	$VM_{ji}\ VR_{ji}\ PR_j$	$PM0_j$	$\delta_{ji}^{V}\ \sigma_j^V$
10.	$TVR_i = \sum_j VR_{ji}$	*Total intermediate regional demand*	*n*	$TVR_i\ VR_{ji}$		
11.	$TVM_i = \sum_j VM_{ji}$	*Total intermediate imported demand*	*n*	$TVM_i\ VM_{ji}$		

Table 4.1 (Continued)

	Equation	Description Equations	No. of Equations	Endogenous Variables	Exogenous Variables	Parameters
12.	$X_i = \phi_i^x \left[\delta_i^x EXP_i^{\rho_i^x} + \left(1-\delta_i^x\right) R_i^{\rho_i^x} \right]^{\frac{1}{\rho_i^x}}, \sigma_i^X = \frac{1}{\rho_i^X - 1}$	*CET for regional and export markets*	*n*	$X_i\ EXP_i\ R_i$		$\phi_i^x\ \delta_i^x\ \rho_i^x\ \sigma_i^x$
13.	$R_i = EXP_i \left[\left(\frac{1-\delta_i^x}{\delta_i^x} \right) \left(\frac{PE0_i}{PR_i} \right) \right]^{-\sigma_i^x}$	*Regional supply for regional demand*	*n*	$R_i\ EXP_i\ PR_i$	$PE0_i$	$\phi_i^x\ \delta_i^x\ \sigma_i^x$
	COMMODITY MARKETS					
14.	$Q_i = \left(\frac{\beta_i}{P_i} \cdot AHEXP \right)$	*Composite household demand*	*n*	$Q_i\ P_i\ AHEXP_i$		β_i
15.	$Q_i = \phi_i^Q \left[\delta_i^Q QM_i^{\rho_i^Q} + \left(1-\delta_i^Q\right) QR_i^{\rho_i^Q} \right]^{\frac{1}{\rho_i^Q}}, \sigma_i^Q = \frac{1}{1-\rho_i^Q}$	*CES for household demand*	*n*	$Q_i\ QM_i\ QR_i$		$\phi_i^Q\ \delta_i^Q\ \rho_i^Q\ \sigma_i^Q$
16.	$QR_i = QM_i \left[\left(\frac{1-\delta_i^Q}{\delta_i^Q} \right) \left(\frac{PM0_i}{PR_i} \right) \right]^{\frac{1}{1-\rho_i^Q}}$	*Regionally produced household demand*	*n*	$QR_i\ QM_i\ PR_i$	$PM0_j$	$\delta_i^Q\ \rho_i^Q$
17.	$QGOV_i = QGOV0_i$	*State / Local gov commodity demand*	*n*	$QGOV_i$	$QGOV0_i$	

Table 4.1 (Continued)

	Equation	Description Equations	No. of Equations	Endogenous Variables	Exogenous Variables	Parameters
18.	$QGOV_i = \phi_i^{GOV} * \left(\delta_i^{GOV} QGOVM_i^{\rho_i^{GOV}} + \left(1-\delta_i^{GOV}\right) \cdot QGOVR_i^{\rho_i^{GOV}} \right)^{\frac{1}{\rho_i^{GOV}}}$	*CES for government domestic and import demand*	*n*	$QGOV_i$ $QGOVM_i$ $QGOVR_i$		ϕ_i^{GOV} δ_i^{GOV} ρ_i^{GOV} σ_i^{GOV}
19.	$QGOVR_i = QGOVM_i \left[\left(\frac{1-\delta_i^{GOV}}{\delta_i^{GOV}} \right) \cdot \left(\frac{PM0_i}{PR_i} \right) \right]^{\frac{1}{1-\rho_i^{GOV}}}$	*State / Local government demand for regional good*	*n*	$QGOVR_i$ $QGOVM_i$ PR_i	$PM0_i$	δ_i^{GOV} ρ_i^{GOV}
20.	$QINV_i = QINV0_i$	*Investment demand*	*n*	$QINV_i$	$QINV0_i$	
21.	$QINV_i = \phi_i^{INV} \left[\delta_i^{INV} QINVM_i^{\rho_i^{INV}} + \left(1-\delta_i^{INV}\right) QINVR_i^{\rho_i^{INV}} \right]^{\frac{1}{\rho_i^{INV}}}$	*CES for investment domestic and import demand*	*n*	*QINVi QINVMi QINVRi*		ϕ_i^{INV} δ_i^{INV} ρ_i^{INV} σ_i^{INV}
22.	$QINVR_i = QINVM_i \left[\left(\frac{1-\delta_i^{INV}}{\delta_i^{INV}} \right) \cdot \left(\frac{PM0_i}{PR_i} \right) \right]^{\frac{1}{1-\rho_i^{INV}}}$	*Investment demand for regional good*	*n*	$QINVR_i$ $QINVM_i$ PR_i	$PM0_i$	δ_i^{INV} ρ_i^{INV}

Table 4.1 (Continued)

Equation	Description Equations	No. of Equations	Endogenous Variables	Exogenous Variables	Parameters
FACTOR MARKETS					
23. $LS = LS0$	*Household labor supply*	*1*	*LS*	*LS0*	
24. $TLAB = \sum_i LAB_i$	*Total labor demand*	*1*	*TLAB* LAB_i		
25. $LY = ALY + \text{PLROC0} \cdot \left(\sqrt{\text{LMIG}^2} - \text{LMIG} \right) \cdot 0.5 - PL \cdot \left(\sqrt{\text{LMIG}^2} + \text{LMIG} \right) \cdot 0.5$	*Labor income*	*1*	*ALY PL LMIG*	*PLROC0*	
26. $LMIG = LS0 \cdot log\left(\frac{PL}{PLROC0}\right) \cdot \eta^L$	*Labor migration*	*1*	*LMIG PL*	*LSO PLROC0*	η^L
27. $ALY = PL \cdot \left(\sum_i LAB_i + LHHH0 + LGOV0 \right)$	*Adjusted labor income*	*1*	*AYL, PL,* LAB_i	*LHHH0 LGOV0*	
28. $adjL = \frac{LS0 + LMIG}{LS0}$	*Household adjustment factor*	*1*	*adjL LMIG*	*LS0*	
29. $TCAP = \sum_i CAP_i$	*Total capital demand*	*1*	*TCAP* CAP_i		

Table 4.1 (Continued)

Equation	Description Equations	No. of Equations	Endogenous Variables	Exogenous Variables	Parameters
30a. $KY = \sum_i PK_i \cdot CAP_i$	*Capital income short-run*	*1*	PK_i KY CAP_i		
30b. $KY = \sum_i CAP_i PKL + \text{PKROC0} \cdot \left(\sqrt{\text{KMIG}^2}\text{-KMIG}\right) \cdot 0.5 - PKL \cdot \left(\sqrt{\text{KMIG}^2}+\text{KMIG}\right) \cdot 0.5$	*Capital income long run*	*1*	KY $CAPi$ PKL $KMIG$	$PKROC0$	
31a. $KMIG = 0$	*Capital migration (Short run equilibrium)*	*1*	$KMIG$		
31b. $KMIG = \sum_i KSO_i \cdot \log\left(\frac{\text{PKL}}{PKROC0}\right) \cdot \eta^{\text{K}}$	*Capital migration (long run equilibrium)*	*1*	$KMIG$ PK	$KS0_i$ $PRROC0$	η^K
32. $TY = \sum_{ag} LAND_{ag} PT_{ag}$	*Land income*	*1*	TY $LAND_{ga}$ PT_{ag}		
INSTITUTIONAL ACCOUNTS					
33. $YENT = KY \cdot (1 - Ktax)$	*Enterprise income*	*1*	$YENT$ KY		$ktax$
34. $RETENT = ret \cdot KY$	*Retained earnings*	*1*	$RETENT$ KY		$retr$

Table 4.1 (Continued)

	Equation	Description Equations	No. of Equations	Endogenous Variables	Exogenous Variables	Parameters
35.	$YH = ALY \cdot (1 - sstax) + TY \cdot (1 - ttax) + (YENT - RETENT\text{-}etKY) + REMIT0 + adjL \cdot TRGOV0 - \left(\sqrt{(adjL-1)^2} - (adjL-1)\right) \cdot 0.5 * [TY \cdot (1 - ttax) + (YENT\text{-}RETENT - et \cdot KY) + REMIT0]$	*Household income*	*1*	*YH ALY TY YENT RETENT KY adjL*	*REMIT0 TRGOV0*	*et sstax ttax*
36.	$DYH = YH \cdot (1 - hhtax)$	*Disposable income*	*1*	*DYH YH*		*hhtax*
37.	$HSAV = mps \cdot YH$	*Household saving*	*1*	*HSAV YH*		*mps*
38.	$INV = \sum_i QINV_i P_I$	*Total investment*	*1*	*INV* $QINV_i$ P_I		
39.	$AHEXP = DYH - HSAV\text{-} PL \cdot LHHH0$	*Household expenditure*	*1*	*AHEXP DYH HSAV PL*	*LHHH0*	
40.	$GRP = LY + KY + TY + IBTX$	*Gross regional product*	*1*	*GRP LY KY TY IBTX*		
41.	$IBTX = \sum_i ibtax_i \cdot X_i$	*Indirect business tax*	*1*	*IBTX* X_I		$ibtax_i$
42.	$GOVEXP = \sum_i QGOV_i \cdot P_i + adjL \cdot TRGOV0 + PL \cdot LGOV0 + GOVITR0$	*Government expenditures*	*1*	$QGOV_i$, *GOVEXP* P_i *PL*	*LGOV0 TRGOV0 GOVITR0*	

Table 4.1 (Continued)

Equation	Description Equations	No. of Equations	Endogenous Variables	Exogenous Variables	Parameters
43. $YGOV = \left(\sum_i ibtax_i PX_i X_i \right) + \left(sstax \cdot ALY \right) + \left(ktax \cdot KY \right) + et \cdot KY + ttax \cdot TY + hhtax \cdot YH + GOVBOR0 + GOVITR0 + ROWGOV0$	*Government revenue*	*1*	$YGOV\ PX_i$ $X_i\ ALY\ KY$ $TY\ \ YH$	*GOVBOR0* *GOVITRO* *ROWGOV0*	$ibtax_i$ *sstax* *ktax* *ttax* *hhtax*
44. $SAV = HSAV + RETENT + ROWSAV0$	*Total Saving*	*1*	*SAV HSAV* *RETENT*	*ROWSAV*0	
EQUILIBRIUM OF MARKETS					
45. $M_i = TVM_i + QM_i + QGOVM_i + QINVM_i$	*Total regional imports*	*n*	$M_i\ TVM_i\ QM_i$ $QGOVM_i\ QINVM_i$		
46. $X_i + M_i = TV_i + Q_i + QGOV_i + QINV_i + EXP_i$	*Commodity market equilibrium*	*n*	$X_i M_i TV_i Q_i$ $\mathrm{QGOV}_i\ \mathrm{QINV}_i\ \mathrm{EXP}_i$		
47. $\sum_i LAB_i + LHHHO + LGOV0 = LS + LMIG$	*Labor market equilibrium*	*l*	$LS\ \ LMIG\ \ LAB_i$	*LHHH0* *LGOV0*	
48a. $CAP_i = KS0_i$	*Capital market equilibrium (short run equilibrium)*	*n*	CAP_i	$KS0_i$	
48b. $\sum_i CAP_i = \sum_i KS0_i + KMIG$	*Capital market equilibrium (long run equilibrium)*	*1*	$CAP_i\ KMIG$	$KS0_i$	

Table 4.1 (Continued)

	Equation	Description Equations	No. of Equations	Endogenous Variables	Exogenous Variables	Parameters
49.	$LAND_i = TS0_i$	*Land market equilibrium*	*1*	$LAND_i$	$TS0_i$	
	EQUILIBRIUM PRICES					
50.	$PN_i = PX_i - \sum_j a_{ji} P_j - ibtax_i PX_i$	*Net price*	*n*	PN_i , PX_i , P_i		a_{ij} , $ibtax_i$
51.	$P_i = \frac{PR_i R_i + PM0_i M_i}{R_i + M_i}$	*Composite commodity price*	*n*	P_i PR_i R_i M_i	$PM0_i$	
52.	$PX_i = \frac{PR_i R_i + PEO_i EXP_i}{R_i + EXP_i}$	*Composite price faced by producer*	*n*	PR PX_i R_i EXP_i	PEO_i	

WELFARE MEASURE

Compensating Variation:

$$CV_h = \left(\frac{1}{1-\beta_{0h}}\right)\left[\left(AHEXP_h - adjL\sum_j PX_j\gamma_{jh}\right) - \left(adjL_h HEXP0_h - adjL\sum_j P0_j\gamma_{jh}\right) \prod_i \left(\frac{PX_i}{P0_i}\right)^{\beta_{ih}}\left(\frac{PL}{PL0}\right)^{\beta_{0h}}\right], \; ij \varepsilon M, NR,$$

Changes in Compensating Variation by Household Income Group h

Equivalent Variation:

$$EV_h = \left(\frac{1}{1-\beta_{0h}}\right)\left[\left(AHEXP_h - adjL\sum_j PX_j\gamma_{jh}\right) \prod_i \left(\frac{P0_i}{PX_i}\right)^{\beta_{ih}}\left(\frac{PL0}{PL}\right)^{\beta_{0h}} - \left(adjL_h HEXP0_h\right) - adjL\sum_j P0_j\gamma_j\right], \; ij \varepsilon M, NR,$$

Changes in Equivalent Variation by Household Income Group h