## Appendix 1

|  |  |  |  |
| --- | --- | --- | --- |
| **Regions Included in Liberty Link Contamination Analysis** | | | |
| Afghanistan | Egypt | Kuwait | Russia |
| Algeria | El Salvador | Liberia | Sierra Leone |
| Angola | EU27 | Saudi Arabia | Singapore |
| Argentina | Gambia | Senegal | Suriname |
| Australia | Ghana | Libya | Somalia |
| Bangladesh | Guatemala | Madagascar | South Africa |
| Benin | Guinea | Malaysia | Switzerland |
| Brazil | Guyana | Mali | Syria |
| Bolivia | Haiti | Mauritius | Taiwan |
| Burkina Faso | Honduras | Mexico | Tanzania |
| Myanmar | Hong Kong | Mozambique | Thailand |
| Cambodia | India | Nepal | Togo |
| Cameroon | Indonesia | Nicaragua | Turkey |
| Canada | Iran | Niger | Ukraine |
| Chile | Iraq | Nigeria | UAE |
| China | Israel | Oman | USA |
| Colombia | Jamaica | Pakistan | Uruguay |
| Costa Rica | Japan | Panama | Venezuela |
| Cote D’Ivoire | Jordan | Papua | Vietnam |
| Cuba | Kenya | Paraguay | Yemen |
| Dominican Republic | Korea, North | Peru |  |
| Ecuador | Korea, South | Philippines |  |

**Appendix 2**

**Relevant Sets, Coefficients, and Variables Used in Riceflow Model**

|  |  |  |
| --- | --- | --- |
| Set Name | Description | |
| ACT | Activities | |
| ACT\_P | Primary Activities | |
| COM | Commodities | |
| COM\_E | Commodities with Endogenous Production | |
| COM\_CE | Commodities with Exogenous Production | |
| COM\_FC | Commodities Suitable for Final Consumption | |
| COM\_ECFC | Endogenous Comm. Complement of FC | |
| COM\_CFC | Commodities Complement of FC | |
| COM\_P | Primary Commodities | |
| COM\_ECP | Endogenous Comm. Complement of P [COM\_E - COM\_P] | |
| FAC | Factors of Production | |
| FS | Sluggish Factors of Production [FAC - FM] | |
| REG | Regions or Foreign Institutions | |
| Coefficients | Description | |
| ESUBA(a,r) | Elast. of substitution between value-added and intermediate composites | |
| ESUBVA(a,r) | Elast. of substitution among factors used by activity a in region r | |
| ESUBIN(a,r) | Elast. of substitution among intermediates used by activity a in region r | |
| ESUPC(c,r) | Own-price supply elasticity for exogenous commodity c | |
| ESUBM(c,r) | Armington elasticity of substitution for bilateral imports of commodity c | |
| ESUBQ(c,r) | Elast. of subst. in the production of composite commodity c in region r | |
| ESUPF(f,r) | Own-price supply elasticity for factor f | |
| ETRAF(f,r) | Elast. of transformation for factor of production f in region r | |
| INCPAR(c,r) | CDE income parameter by commodity and region | |
| SUBPAR(c,r) | CDE substitution parameter by commodity and region | |
| VCAM(c,a,r) | Market value of commodity c produced by activity a in region r | |
| VEA(f,a,r) | Value of demand of endowment f by activity and region | |
| VICA(c,a,r) | Value of intermediate demand of commodity c by activity and region | |
| VKC(c,r) | Value of change in stock by commodity and region | |
| VBXM(c,r,s) | Value of bilateral exports of commodity c at market price | |
| VBXB(c,r,s) | Value of bilateral exports of commodity c at border price | |
| VBXW(c,r,s) | Value of bilateral exports of commodity c at world price | |
| VBYW(c,r,s) | Value of bilateral import of commodity c at world price | |
| VBYM(c,r,s) | Value of bilateral imports of commodity c at market price | |
| VFC(c,r) | Bulk value of final consumption by commodity and region | |
| VFCW(c,r) | Wholesale value of final consumption by commodity and region | |
| VFCR(c,r) | Retail value of final consumption by commodity and region | |
| VEAM(f,a,r) | Market value of demand of endowment f by activity and region | |
| VICAM(c,a,r) | Market value of intermediate demand of commodity c by activity and region | |
| Quantity Variables | | Description |
| qa(a,r) | | Level of activity a in region r |
| qva(a,r) | | Derived demand for the value-added composite by activity and region |
| qfa(f,a,r) | | Derived demand for specific factors of production by activity and region |
| qi(a,r) | | Derived demand for the intermediate composite by activity and region |
| qin(c,a,r) | | Derived demand for specific intermediate inputs by activity and region |
| qca(c,a,r) | | Production of specific commodities by activity and region |
| qc(c,r) | | Volume of commercialization by commodity and region |
| delqk(c,r) | | Change in the volume of stock by commodity and region |
| qd(c,r) | | Volume commercialized domestically by commodity and region |
| qms(c,r,s) | | Bilateral volume of imports by commodity |
| qm(c,r) | | Volume of imports by commodity and region |
| qq(c,r) | | Production by composite commodity and region |
| qz(c,r) | | Supply by exogenous commodity and region |
| qdfc(c,r) | | Demand for final consumption by composite commodity and region |
| qfs(f,r) | | Total supply by factor of production and region |
| qfsa(f,a,r) | | Sectoral supply by sluggish factor of production and region |
| Price Variables | | Description |
| pam(a,r) | | Unitary market revenue by activity and region |
| pap(a,r) | | Unitary production cost by activity and region |
| pva(a,r) | | Unitary cost of value-added composite by activity and region |
| pfa(f,a,r) | | Price of factors of production by activity and region |
| pf(f,r) | | Market price of factors of production by region |
| pfas(f,a,r) | | Price of sluggish factors of production by activity and region |
| pi(a,r) | | Unitary cost of intermediate composite by activity and region |
| pc(c,r) | | Price of domestically-produced commodities by region |
| pxbd(c,r,s) | | Border price of bilateral exports by commodity |
| pxwd(c,r,s) | | World price of bilateral exports by commodity |
| pmws(c,r,s) | | World price of bilateral imports by commodity |
| pmms(c,r,s) | | Market price of bilateral imports by commodity |
| pmm(c,r) | | Market price of imports by commodity and region |
| pq(c,r) | | Price of composite commodities by region |
| pwh(c,r) | | Wholesale price of final consumption commodities by region |
| pr(c,r) | | Retail price of final consumption commodities by region |
| pza(c,a,r) | | Price of exogenous commodities by activity and region |
| pz(c,r) | | Market price of exogenous commodities by region |
|  | |  |
| Technology Variables | | Description |
| ao(a,r) | | Augmenting technical change of output by activity and region |
| ava(a,r) | | Augmenting technical change for value-added composite by activity and region |
| ain(a,r) | | Augmenting technical change for intermediate composite by activity and region |
| afe(f,a,r) | | Augmenting technological change for primary factor f by activity and region |
| aie(c,a,r) | | Augmenting technical change for intermediate comm. c by activity and region |
| Policy Variables | | Description |
| to(a,r) | | Production tax by activity and region |
| tfa(f,a,r) | | Tax/subsidy on factor f by activity and region |
| tia(c,a,r) | | Tax/subsidy on input c by activity and region |
| txd(c,r,s) | | Bilateral export tax by commodity |
| tms(c,r,s) | | Bilateral import tariffs by commodity |
| Other Variables | | Description |
| delvk(c,r) | | Change in the value of stock by commodity and region |
| stockslack(c,r) | | Slack variable for stocks by commodity and region |
| zpactslack(a,r) | | Slack variable for zero profits by activity and region |
| excomslack(c,r) | | Slack variable for market clearing by exogenous commodity and region |
| qmsint(c,r,s) | | Shift in bilateral import demand intercept by commodity |
| qfsint(f,r) | | Shift in supply intercept by factor and region |
| qzint(c,r) | | Shift in supply intercept by exogenous commodity and region |
| xmrg(c,r,s) | | Bilateral export margin by commodity and region |
| wmrg(c,r) | | Wholesale margin by final consumption commodities and region |
| rmrg(c,r) | | Retail margin by final consumption commodities by region |
| tc(c,r,s) | | Bilateral transportation cost by commodity and region |
| expn(r) | | Expenditure on final consumption by region |
| pop(r) | | Rate of population growth by region |

**Appendix 3**

**RICEFLOW Relevant Equations for Behavior, Price Linkages, System Constraints and Secondary Estimations**

*1. BEHAVIORAL EQUATIONS*

*1.1 PRODUCTION*

*1.1.1 ACTIVITY LEVEL NEST*

**Equation** DEF\_QVA (**all**,a,ACT)(**all**,r,REG) *#Derived demand for the value-added composite by activity and region#*

qva(a,r) = qa(a,r) - ava(a,r) - ao(a,r) + ESUBA(a,r) \* **{**pap(a,r) + ava(a,r) + ao(a,r) - pva(a,r)**}**;

**Equation** DEF\_QI (**all**,a,ACT)(**all**,r,REG) *#Derived demand for the intermediate composite by activity and region#*

qi(a,r) = qa(a,r) - ain(a,r) - ao(a,r) + ESUBA(a,r) \* **{**pap(a,r) + ain(a,r) + ao(a,r) - pi(a,r)**}**;

*1.1.2 VALUE-ADDED NEST*

**Equation** DEF\_QFA (**all**,f,FAC)(**all**,a,ACT)(**all**,r,REG) *#Derived demand for factors of production by activity and region#*

qfa(f,a,r) = -afe(f,a,r) + qva(a,r) + ESUBVA(a,r) \* **{**pva(a,r) - **[**pfa(f,a,r) - afe(f,a,r)**]}**;

**Formula** (**all**,f,FAC)(**all**,a,ACT)(**all**,r,REG) SFVA(f,a,r) = VEA(f,a,r) / **sum{**g,FAC, VEA(g,a,r)**}** ;

*#Share of factors in value-added cost by activity and region#*

**Equation** DEF\_PVA (**all**,a,ACT)(**all**,r,REG) *#Unitary cost of value-added composite by activity and region#*

pva(a,r) = **sum{**f,FAC, SFVA(f,a,r) \* **[**pfa(f,a,r)-afe(f,a,r)**]}**;

*1.1.3 INTERMEDIATES NEST*

**Equation** DEF\_QIN\_END (**all**,c,COM\_ECFC)(**all**,a,ACT)(**all**,r,REG) *#Derived demand for endogenous intermediate inputs by activity and region#*

qin(c,a,r) = -aie(c,a,r) + qi(a,r) + ESUBIN(a,r) \* **{**pi(a,r)-**[**pq(c,r)-aie(c,a,r)**]}**;

**Equation** DEF\_QIN\_EXO (**all**,c,COM\_CE)(**all**,a,ACT)(**all**,r,REG) *#Derived demand for exogenous intermediate inputs by activity and region#*

qin(c,a,r) = -aie(c,a,r) + qi(a,r) + ESUBIN(a,r) \* **{**pi(a,r)-**[**pza(c,a,r)-aie(c,a,r)**]}**;

**Formula** (**all**,c,COM\_CFC)(**all**,a,ACT)(**all**,r,REG) SIIN(c,a,r) = VICA(c,a,r) / **sum{**p,COM\_CFC, VICA(p,a,r)**}** ;

*#Share of inputs in intermediates cost by activity and region#*

**Equation** DEF\_PI (**all**,a,ACT)(**all**,r,REG) *#Unitary cost of intermediate composite by activity and region#*

pi(a,r) = **sum{**c,COM\_ECFC, SIIN(c,a,r) \* **[**pq(c,r) - aie(c,a,r)**]}** + **sum{**c,COM\_CE, SIIN(c,a,r) \* **[**pza(c,a,r) - aie(c,a,r)**]}**;

*1.1.4 COMMODITY BY ACTIVITY*

**Equation** DEF\_QCA (**all**,a,ACT)(**all**,c,COM\_E)(**all**,r,REG) *#Production of specific commodities by activity and region#*

qca(c,a,r) = qa(a,r);

**Formula** (**all**,c,COM\_E)(**all**,a,ACT)(**all**,r,REG) SCOA(c,a,r) = VCAM(c,a,r) / **sum{**p,COM\_E, VCAM(p,a,r)**}** ;

*#Share of commodity output by activity and region#*

**Equation** DEF\_PAM (**all**,a,ACT)(**all**,r,REG) *#Unitary market revenue by activity and region#*

pam(a,r) = **sum{**c,COM\_E, SCOA(c,a,r) \* pc(c,r)**}**;

*1.1.5 STOCKS*

**Formula** (**initial**)(**all**,c,COM\_E)(**all**,r,REG) LEVPC(c,r) = 1;

**Update** (**all**,c,COM\_E)(**all**,r,REG) LEVPC(c,r) = pc(c,r);

*#Level price of domestically-produced commodities by region#*

**Equation** DEF\_DELQK (**all**,c,COM\_P)(**all**,r,REG) *#Change in the volume of stock by commodity and region#*

100\*LEVPC(c,r)\*delqk(c,r) = VKC(c,r)\***sum[**a,ACT, VCAM(c,a,r)\*qca(c,a,r)**]** + stockslack(c,r);

**Equation** DEF\_DELVK (**all**,c,COM\_P)(**all**,r,REG) *#Change in the value of stock by commodity and region#*

delvk(c,r) = 0.01 \* VKC(c,r) \* pc(c,r) + LEVPC(c,r) \* delqk(c,r);

*1.1.6 MARKETED COMMODITY OUTPUT*

**Formula**(**all**,c,COM\_P)(**all**,r,REG) VTOC(c,r) = **sum{**a,ACT, VCAM(c,a,r)**}** - VKC(c,r);

**Formula**(**all**,c,COM\_ECP)(**all**,r,REG) VTOC(c,r) = **sum{**a,ACT, VCAM(c,a,r)**}**;

*#Volume of commercialization by commodity and region#*

**Formula** (**all**,c,COM\_E)(**all**,a,ACT)(**all**,r,REG) SCATCO(c,a,r) = VCAM(c,a,r) / **sum{**s,ACT, VCAM(c,s,r)**}** ;

*#Share of comm by activity in total comm output by region#*

**Equation** DEF\_QC\_P (**all**,c,COM\_P)(**all**,r,REG) *#Volume of commercialization by commodity and region#*

**[**VTOC(c,r) + TINY**]** \* qc(c,r) = **sum[**a,ACT, VCAM(c,a,r) \* qca(c,a,r)**]** - 100 \* LEVPC(c,r) \* delqk(c,r);

*!In levels, this clearing equation is qc = SUM{ACT, QCA} - DELQK. In producer values, PC\*qc = SUM{ACT, PC\*QCA} - PC\*DELQK ==> VTOC = SUM{ACT, VCAM} - VKC. In percentage-change, it becomes VTOC\*qc = SUM{ACT, VCAM\*qca} - VKC\*qk. However, there is no percentage-change variable qk, but rather the change*

*variable delqk. The relationship between delqk and qk is qk = delqk/DELQK\*100. Replacing we get VTOC\*qc = SUM{ACT, VCAM\*qca} - VKC\*(delqk/DELQK\*100). Simplifying we finally get VTOC\*qc = SUM{ACT, VCAM\*qca} - 100\*LEVPC\*delqk.!*

**Equation** DEF\_QC\_ECP (**all**,c,COM\_ECP)(**all**,r,REG) *#Volume of commercialization by commodity and region#*

qc(c,r) = **sum{**a,ACT, SCATCO(c,a,r) \* qca(c,a,r)**}**;

*1.2 EXOGENOUS COMMODITY SUPPLY*

**Equation** DEF\_QZ (**all**,c,COM\_CE)(**all**,r,REG)  *Supply by exogenous commodity and region#*

qz(c,r) = qzint(c,r) + ESUPC(c,r) \* pz(c,r);

*1.3 FACTOR SUPPLY*

**Equation** DEF\_QFS (**all**,f,FAC)(**all**,r,REG) *#Total supply by factor of production and region#*

qfs(f,r) = qfsint(f,r) + ESUPF(f,r) \* pf(f,r);

**Equation** DEF\_QFSA (**all**,f,FS)(**all**,a,ACT)(**all**,r,REG) *#Sectoral supply by sluggish factor of production and region#*

qfsa(f,a,r) = qfs(f,r) + ETRAF(f,r) \* **[**pf(f,r) - pfas(f,a,r)**]**;

**Formula** (**all**,f,FS)(**all**,a,ACT)(**all**,r,REG) SATFS(f,a,r) = VEA(f,a,r) / **sum{**s,ACT, VEA(f,s,r)**}** ;

*#Share of sectoral to total endowment of sluggish factors by region#*

**Equation** DEF\_PF (**all**,f,FS)(**all**,r,REG) *#Price of factors of production by region#*

pf(f,r) = **sum{**a,ACT, SATFS(f,a,r) \* pfas(f,a,r)**}**;

*1.4 IMPORT ALLOCATION*

**Equation** DEF\_QMS (**all**,c,COM\_E)(**all**,r,REG)(**all**,s,REG) *#Bilateral volume of imports by commodity#*

qms(c,r,s) = qmsint(c,r,s) + qm(c,s)+ ESUBM(c,s)\***[**pmm(c,s) - pmms(c,r,s)**]**;

**Formula** (**all**,c,COM\_E)(**all**,r,REG)(**all**,s,REG) SBTYC(c,r,s) = VBYM(c,r,s) / **sum{**p,REG, VBYM(c,p,s)**}** ;

*#Share of bilateral to total imports by commodity by region#*

**Equation** DEF\_PMM (**all**,c,COM\_E)(**all**,r,REG) *#Market price of imports by commodity and region#*

pmm(c,r) = **sum{**s,REG, SBTYC(c,s,r) \* pmms(c,s,r)**}**;

*1.5 COMPOSITE COMMODITY*

**Equation** DEF\_QD (**all**,c,COM\_E)(**all**,r,REG) *#Volume of domestic commodity traded domestically by region#*

qd(c,r) = qq(c,r) + ESUBQ(c,r) \* **[**pq(c,r) - pc(c,r)**]**;

**Equation** DEF\_QM (**all**,c,COM\_E)(**all**,r,REG) *#Volume of imports by commodity and region#*

qm(c,r) = qq(c,r) + ESUBQ(c,r) \* **[**pq(c,r) - pmm(c,r)**]**;

*1.6 FINAL CONSUMPTION*

*CDE functional form*

**Formula**(**all**,c,COM\_FC)(**all**,r,REG) SFCC(c,r) = VFC(c,r) / **sum{**p,COM\_FC, VFC(p,r)**}**;

*#Share of commodity to total expenditure for final consumption by region#*

**Formula** (**all**,c,COM\_FC)(**all**,r,REG) ALPHA(c,r) = (1 - SUBPAR(c,r));

*#CDE substitution parameter#*

**Formula** (**all**,c,COM\_FC)(**all**,g,COM\_FC)(**all**,r,REG) APE(c,g,r) = ALPHA(c,r) + ALPHA(g,r)- **sum[**p,COM\_FC, SFCC(p,r) \* ALPHA(p,r)**]**;

**Formula** (**all**,c,COM\_FC)(**all**,r,REG) APE(c,c,r) = 2 \* ALPHA(c,r) - **sum[**p,COM\_FC, SFCC(p,r) \* ALPHA(p,r)**]** - ALPHA(c,r) / **[**SFCC(c,r) + TINY**]**;

*#Allen partial elasticity of subst. btwn rice types c and g by region#*

**Formula** (**all**,c,COM\_FC)(**all**,r,REG) EY(c,r) = 1 / **sum[**p,COM\_FC, SFCC(p,r) \* INCPAR(p,r)**]** \* **{**INCPAR(c,r) \* **[**1 - ALPHA(c,r)**]** + **sum[**p,COM\_FC, SFCC(p,r) \* INCPAR(p,r) \* ALPHA(p,r)**]}** + **{**ALPHA(c,r) - **sum[**p,COM\_FC, SFCC(p,r) \* ALPHA(p,r)**]}** ;

*#income elasticity of demand for tradable commodity c by region#*

**Formula** (**all**,c,COM\_FC)(**all**,g,COM\_FC)(**all**,r,REG) EP(c,g,r) = 0;

**Formula** (**all**,c,COM\_FC)(**all**,g,COM\_FC)(**all**,r,REG) EP(c,g,r) = **[**APE(c,g,r) - EY(c,r)**]** \* SFCC(g,r);

*#Uncompensated demand elasticity by commodity and region#*

**Equation** DEF\_QDFC (**all**,c,COM\_FC)(**all**,r,REG) *#Demand for final consumption by composite commodity and region#*

qdfc(c,r) - pop(r) = **sum[**g,COM\_FC, EP(c,g,r) \* pr(g,r)**]** + EY(c,r) \* **[**expn(r) - pop(r)**]**;

*2. PRICE LINKAGE EQUATIONS*

**Equation** PL\_ACTIVITY (**all**,a,ACT)(**all**,r,REG) *#linkage between producer and market price by activity and region#*

pap(a,r) = pam(a,r) + **to**(a,r);

**Equation** PL\_FM (**all**,f,FM)(**all**,a,ACT)(**all**,r,REG) *#linkage between the market and activity price of factors by region#*

pfa(f,a,r) = pf(f,r) + tfa(f,a,r);

**Equation** PL\_FS (**all**,f,FS)(**all**,a,ACT)(**all**,r,REG) *#linkage between the market and activity price of factors by region#*

pfa(f,a,r) = pfas(f,a,r) + tfa(f,a,r);

**Equation** PL\_INPUT (**all**,c,COM\_CE)(**all**,a,ACT)(**all**,r,REG)  *linkage between the market and activity price of exogenous inputs by region#*

pza(c,a,r) = pz(c,r) + tia(c,a,r);

**Equation** PL\_EXP1 (**all**,c,COM\_E)(**all**,r,REG)(**all**,s,REG) *#Linkage between market and world price of bilateral exports by commodity#*

pxbd(c,r,s) = pc(c,r) + xmrg(c,r,s);

**Equation** PL\_EXP2 (**all**,c,COM\_E)(**all**,r,REG)(**all**,s,REG) #*Linkage between market and world price of bilateral exports by commodity#*

pxwd(c,r,s) = pxbd(c,r,s) + txd(c,r,s);

**Formula**(**all**,c,COM\_E)(**all**,r,REG)(**all**,s,REG) SFOBCIF(c,r,s) = VBXW(c,r,s) / **[**VBYW(c,r,s)**]**;

*#Share of fob to cif value of imports by region#*

**Equation** PL\_FOBCIF (**all**,c,COM\_E)(**all**,r,REG)(**all**,s,REG) #*Linkage between world price of bilateral exports and imports by commodity#*

pmws(c,r,s) = SFOBCIF(c,r,s) \* pxwd(c,r,s) + **[**1-SFOBCIF(c,r,s)**]** \* tc(c,r,s);

**Equation** PL\_IMP (**all**,c,COM\_E)(**all**,r,REG)(**all**,s,REG) *#Linkage between market and world price of bilateral imports by commodity#*

pmms(c,r,s) = pmws(c,r,s) + tms(c,r,s);

**Equation** PL\_FC1 (**all**,c,COM\_FC)(**all**,r,REG) *#Linkage between bulk and wholesale price of final consumption#*

pwh(c,r) = pq(c,r) + wmrg(c,r);

**Equation** PL\_FC2 (**all**,c,COM\_FC)(**all**,r,REG) *#Linkage between wholesale and retail price of final consumption#*

pr(c,r) = pwh(c,r) + rmrg(c,r);

*3. SYSTEM CONSTRAINTS*

*3.1 ZERO PROFIT CONDITIONS*

**Formula**(**all**,f,FAC)(**all**,a,ACT)(**all**,r,REG) SFTAC(f,a,r) = VEA(f,a,r) / **[sum{**g,FAC,VEA(g,a,r)**}** + **sum{**c,COM\_CFC,VICA(c,a,r)**}]**;

*#Share of factor in total activity cost by region#*

**Formula**(**all**,c,COM\_CFC)(**all**,a,ACT)(**all**,r,REG) SITAC(c,a,r) = VICA(c,a,r) / **[sum{**f,FAC,VEA(f,a,r)**}** + **sum{**p,COM\_CFC,VICA(p,a,r)**}]**;

*#Share of input in total activity cost by region#*

**Formula**(**all**,c,COM\_E)(**all**,r,REG) VOQ(c,r) = VTOC(c,r) - **sum{**s,REG, VBXM(c,r,s)**}** + **sum{**s,REG, VBYM(c,s,r)**}**;

*#Output value of composite commodity c by region#*

**Formula**(**all**,c,COM\_E)(**all**,r,REG) SYQO(c,r) = **sum{**s,REG, VBYM(c,s,r)**}** / VOQ(c,r);

*#Share of imports in total value of composite commodity c by region#*

**Equation** ZP\_PRODUCTION (**all**,a,ACT)(**all**,r,REG) #*zero profits condition by activity and region#*

**[**pap(a,r)+ao(a,r)**]** = **sum{**f,FAC, SFTAC(f,a,r) \* **[**pfa(f,a,r)-afe(f,a,r)-ava(a,r)**]}** + **sum{**c,COM\_ECFC, SITAC(c,a,r) \* **[**pq(c,r)-aie(c,a,r)-ain(a,r)**]}** + **sum{**c,COM\_CE, SITAC(c,a,r) \* **[**pza(c,a,r)-aie(c,a,r)-ain(a,r)**]}** + zpactslack(a,r);

**Equation** ZP\_COMPOSITE (**all**,c,COM\_E)(**all**,r,REG) *#zero profits condition in the production of composite commodity c#*

pq(c,r) = SYQO(c,r) \* pmm(c,r) + **[**1 - SYQO(c,r)**]** \* pc(c,r);

*3.2 MARKET CLEARING CONDITIONS*

**Equation** MKTCLR\_FC (**all**,c,COM\_FC)(**all**,r,REG) *#market clearing in final consumption of composite commodity c by region#*

qq(c,r) = qdfc(c,r);

**Formula** (**all**,c,COM\_ECFC)(**all**,a,ACT)(**all**,r,REG) SAIN(c,a,r) = VICA(c,a,r) / **sum{**s,ACT, VICA(c,s,r)**}** ;

*#Share of activity to total use of inputs by region#*

**Equation** MKTCLR\_INTERM (**all**,c,COM\_ECFC)(**all**,r,REG) *# market clearing in intermediate consumption of composite commodity #*

qq(c,r) = **sum{**a,ACT, SAIN(c,a,r) \* qin(c,a,r)**}**;

**Formula**(**all**,c,COM\_E)(**all**,r,REG)(**all**,s,REG) SBXDO(c,r,s) = VBXM(c,r,s) / VTOC(c,r);

*#Share of bilateral imports in total traded value of domestic comm c#*

**Equation** MKTCLR\_DOMCOM (**all**,c,COM\_E)(**all**,r,REG) *#market clearing for domestic commodities by region#*

qc(c,r) = **sum{**s,REG, SBXDO(c,r,s) \* qms(c,r,s)**}** + **[**1 - **sum{**s,REG,SBXDO(c,r,s)**}]** \* qd(c,r);

**Formula**(**all**,c,COM\_CE)(**all**,a,ACT)(**all**,r,REG) SAZ(c,a,r) = VICA(c,a,r) / **sum{**s,ACT, VICA(c,s,r)**}**;

*#Share of activity to total use of exogenous commodity#*

**Equation** MKTCLR\_EXOCOM (**all**,c,COM\_CE)(**all**,r,REG) *#market clearing for exogenous commodities by region#*

qz(c,r) = **sum{**a,ACT, SAZ(c,a,r) \* qin(c,a,r)**}** + excomslack(c,r);

**Equation** MKTCLR\_FM (**all**,f,FM)(**all**,r,REG) *#clearing in the market for mobile factors by region#*

**[sum{**a,ACT, VEA(f,a,r)**}** + TINY**]** \* qfs(f,r) = **sum{**a,ACT, VEA(f,a,r) \* qfa(f,a,r)**}**;

**Equation** MKTCLR\_FS (**all**,a,ACT)(**all**,f,FS)(**all**,r,REG) *#clearing in the market for sluggish factors by region#*

qfsa(f,a,r) = qfa(f,a,r);

*4 SECONDARY ESTIMATIONS*

*4.1 PRODUCTION AGGREGATES*

*4.1.1 TOTAL PRODUCTION OF PADDY RICE BY REGION*

**Equation** DEF\_QPR (**all**,r,REG) *#regional production of paddy rice#*

**[sum{**c,COM\_P, **sum{**a,ACT, VCAM(c,a,r)**}}** + TINY**]** \* qpr(r) = **sum{**c,COM\_P, **sum{**a,ACT, VCAM(c,a,r) \* qca(c,a,r)**}}**;

*4.1.2 TOTAL PRODUCTION OF BROWN RICE BY REGION*

**Equation** DEF\_QBR (**all**,r,REG) *#regional production of brown rice#*

**[sum{**c,COM\_B, **sum{**a,ACT, VCAM(c,a,r)**}}** + TINY**]** \* qbr(r) = **sum{**c,COM\_B, **sum{**a,ACT, VCAM(c,a,r) \* qca(c,a,r)**}}**;

*4.1.3 TOTAL PRODUCTION OF WHITE RICE BY REGION*

**Equation** DEF\_QWR (**all**,r,REG) *#regional production of white rice#*

**[sum{**c,COM\_FC, **sum{**a,ACT, VCAM(c,a,r)**}}** + TINY**]** \* qwr(r) = **sum{**c,COM\_FC, **sum{**a,ACT, VCAM(c,a,r) \* qca(c,a,r)**}}**;

*4.1.4 WORLDWIDE PRODUCTION OF PADDY RICE BY TYPE*

**Equation** DEF\_QPT (**all**,c,COM\_P) *#worldwide production of paddy rice by type#*

**[sum{**a,ACT, **sum{**r,REG, VCAM(c,a,r)**}}** + TINY**]** \* qpt(c) = **sum{**a,ACT, **sum{**r,REG, VCAM(c,a,r) \* qca(c,a,r)**}}**;

*4.1.5 WORLDWIDE PRODUCTION OF PADDY RICE*

**Equation** DEF\_QP *#worldwide production of paddy rice#*

**[sum{**c,COM\_P, **sum{**a,ACT, **sum{**r,REG, VCAM(c,a,r)**}}}** + TINY**]** \* qp = **sum{**c,COM\_P, **sum{**a,ACT, **sum{**r,REG, VCAM(c,a,r) \* qca(c,a,r)**}}}**;

*4.2 CONSUMPTION AGGREGATES*

*4.2.1 TOTAL CONSUMPTION OF RICE BY REGION*

**Equation** DEF\_QFCR (**all**,r,REG) *#total consumption of rice by region#*

**[sum{**c,COM\_FC, VFC(c,r)**}** + TINY**]** \* qfcr(r) = **sum{**c,COM\_FC,VFC(c,r) \* qdfc(c,r)**}**;

*4.2.2 WORLDWIDE CONSUMPTION OF RICE BY TYPE*

**Equation** DEF\_QFCT (**all**,c,COM\_FC) *#worldwide final consumption of rice by type#*

**[sum{**r,REG, VFC(c,r)**}** + TINY**]** \* qfct(c) = **sum{**r,REG, VFC(c,r) \* qdfc(c,r)**}**;

*4.2.3 WORLDWIDE CONSUMPTION OF RICE*

**Equation** DEF\_QFC *#worldwide consumption of rice#*

**[sum{**r,REG, **sum{**c,COM\_FC, VFC(c,r)**}}** + TINY**]** \* qfc = **sum{**r,REG, **sum{**c,COM\_FC, VFC(c,r) \* qdfc(c,r)**}}**;

*4.3 TRADE AGGREGATES*

*4.3.1 AGGREGATE EXPORTS BY COMMODITY AND REGION*

**Equation** DEF\_PXCR (**all**,c,COM\_E)(**all**,r,REG) *#world export price by comm and region#*

**[sum{**s,REG, VBXW(c,r,s)**}** + TINY**]** \* pxcr(c,r) = **sum{**s,REG, VBXW(c,r,s) \* pxwd(c,r,s)**}**;

**Equation** DEF\_QXCR (**all**,c,COM\_E)(**all**,r,REG) *#volume of export by comm and region#*

**[sum{**s,REG, VBXW(c,r,s)**}** + TINY**]** \* qxcr(c,r) = **sum{**s,REG, VBXW(c,r,s) \* qms(c,r,s)**}**;

*4.3.2 AGGREGATE EXPORTS BY REGION*

**Equation** DEF\_QXR (**all**,r,REG) *#volume of import by region#*

**[sum{**s,REG,**sum{**c,COM\_E, VBYW(c,r,s)**}}** + TINY**]** \* qxr(r) = **sum{**s,REG,**sum{**c,COM\_E, VBYW(c,r,s) \* qms(c,r,s)**}}**;

*4.3.3 AGGREGATE IMPORTS BY COMMODITY AND COUNTRY*

**Equation** DEF\_PMCR (**all**,c,COM\_E)(**all**,r,REG) *#world import price by comm and region#*

**[sum{**s,REG, VBYW(c,s,r)**}** + TINY**]** \* pmcr(c,r) = **sum{**s,REG, VBYW(c,s,r) \* pmws(c,s,r)**}**;

**Equation** DEF\_QMCR (**all**,c,COM\_E)(**all**,r,REG) *#volume of import by comm and region#*

**[sum{**s,REG, VBYW(c,s,r)**}** + TINY**]** \* qmcr(c,r) = **sum{**s,REG, VBYW(c,s,r) \* qms(c,s,r)**}**;

*4.3.4 AGGREGATE IMPORTS BY COUNTRY*

**Equation** DEF\_QMR (**all**,r,REG) *#volume of import by region#*

**[sum{**s,REG,**sum{**c,COM\_E, VBYW(c,s,r)**}}** + TINY**]** \* qmr(r) = **sum{**s,REG,**sum{**c,COM\_E, VBYW(c,s,r) \* qms(c,s,r)**}}**;

*4.3.5 TOTAL BILATERAL RICE TRADE*

**Equation** DEF\_QMST (**all**,s,REG)(**all**,r,REG) *#total volume of bilateral trade#*

**[sum{**c,COM\_E, VBXW(c,s,r)**}** + TINY**]** \* qmst(s,r) = **sum{**c,COM\_E, VBXW(c,s,r) \* qms(c,s,r)**}**;

*4.4 WORLD PRICE & TRADE VOLUME BY COMMODITY*

**Equation** DEF\_PCW (**all**,c,COM\_E) *#World (f.o.b.) price index by commodity#*

**[sum{**r,REG, **sum{**s,REG, VBXW(c,r,s)**}}** + TINY**]** \* pcw(c) = **sum{**r,REG, **sum{**s,REG, VBXW(c,r,s) \* pxwd(c,r,s)**}}**;

**Equation** DEF\_QCWT (**all**,c,COM\_E) *#Volume of world trade by commodity#*

**[sum{**r,REG, **sum{**s,REG, VBXW(c,r,s)**}}** + TINY**]** \* qcwt(c) = **sum{**r,REG, **sum{**s,REG, VBXW(c,r,s) \* qms(c,r,s)**}}**;

*4.5 RICE WORLD PRICE & TRADE INDEX*

**Equation** DEF\_PW *# Rice world price index #*

**[sum{**c,COM\_E, **sum{**r,REG, **sum{**s,REG, VBXW(c,r,s)**}}}** + TINY**]** \* pw = **sum{**c,COM\_E, **sum{**r,REG, **sum{**s,REG, VBXW(c,r,s) \* pxwd(c,r,s)**}}}**;

**Equation** DEF\_QWT *# Rice world trade index #*

**[sum{**c,COM\_E, **sum{**r,REG, **sum{**s,REG, VBXW(c,r,s)**}}}** + TINY**]** \* qwt = **sum{**c,COM\_E, **sum{**r,REG, **sum{**s,REG, VBXW(c,r,s) \* qms(c,r,s)**}}}**;