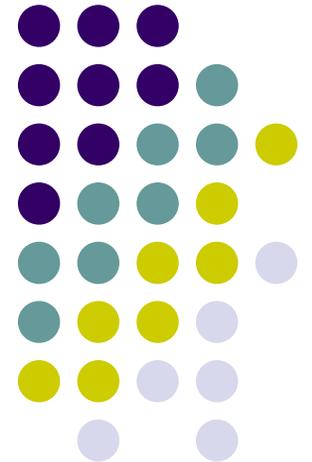
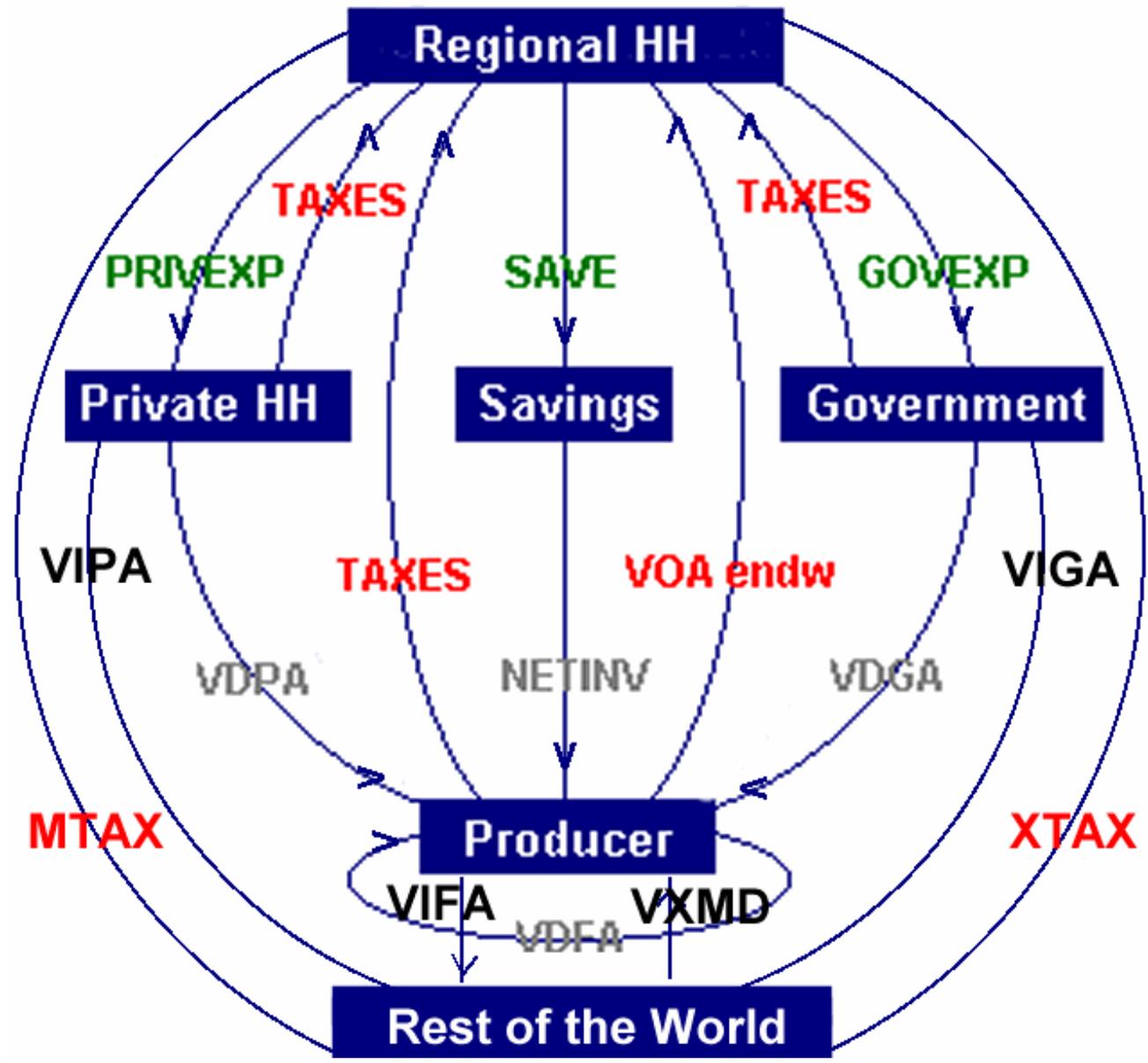


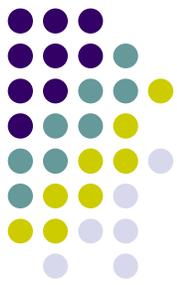
Producer behaviour and technical change



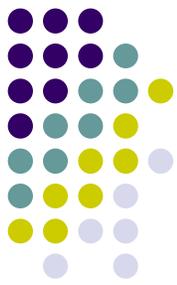
Multi Region Open Economy -



Supply side

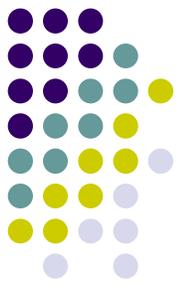


- Sectors use up to 5 primary factors of production: farm land, natural resources, capital, unskilled labour, skilled labour
- Producers choose inputs that minimise costs subject to separable, constant returns to scale technologies
 - CES functions describe substitution possibilities between primary factors
 - Supply = demand for each factor
 - For intermediate inputs, a Leontief function implies no substitution between intermediate inputs
 - Elasticity of substitution between any primary factor & intermediates is constant (usually zero)
 - Can be relaxed if full matrix of substitution elasticities is known...
 - ..as in the GTAP-AGR model
- Another CES function describes substitution between domestically-produced intermediate inputs & imported inputs

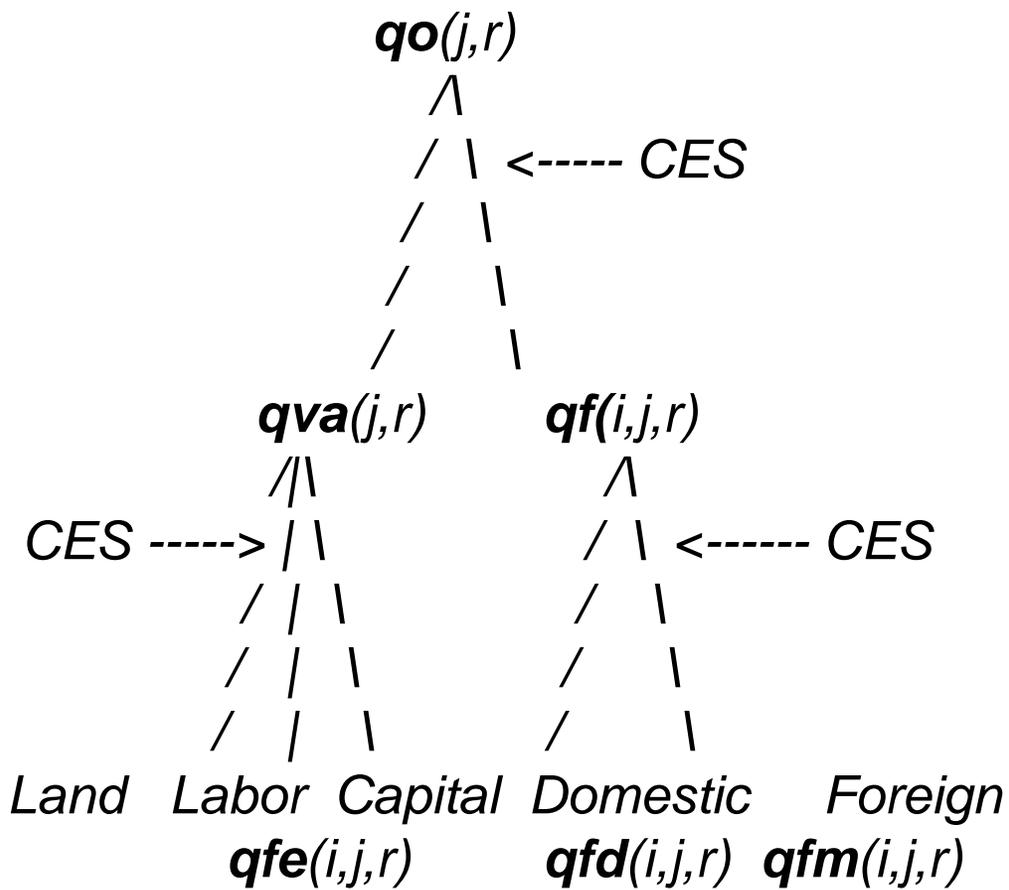


Separability means that:

- Optimal mix of land, labor & capital is independent of the price of intermediate inputs
- Zero substitution between any primary factor and intermediates may be too restrictive - consider for example:
 - Substitution of fertiliser for land
 - Substitution of capital for energy
- Can change if have the data!



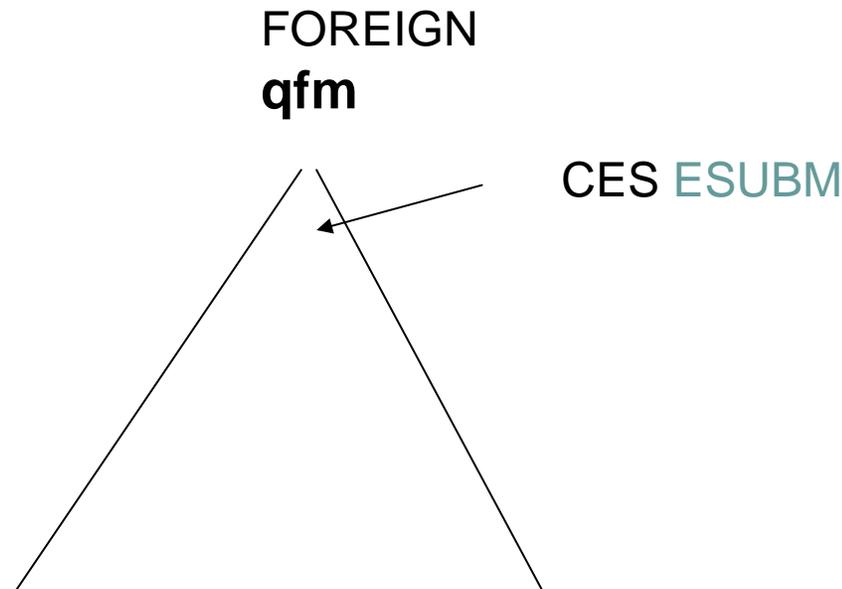
- Open **GTAP.TAB**
- Search for ‘**Production structure**’
- **QO** is sector output
- It is a function of the value added composite (**QVA**) and the composite of intermediate inputs (**QF**)
- Intermediate inputs can be purchased domestically (**QFD**) or imported (**QFM**)



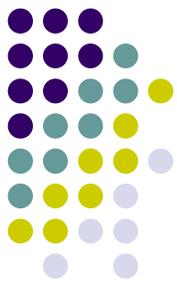
Industry choice of source of imported intermediate inputs:

this is independent of (separable from) the price of domestic goods

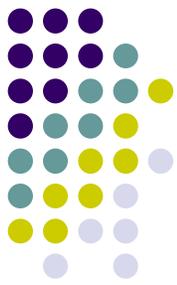
depends on aggregate import price index & import prices by source



Regional sources of imported intermediate inputs



- Intermediate inputs combined in fixed proportions
 - No substitution allowed
- Land, labor & capital substitution permitted with the CES parameter **ESUBVA** which varies across sectors (not regions)
- Fixed substitution (usually zero) between intermediates and value-added composites (parameter **ESUBT**)
- Can find these on the parameter file



- Substitution allowed between domestic and imported intermediate inputs (parameter is **ESUBD**)
- Substitution also permitted between various regional sources of imports of intermediate inputs (parameter is **ESUBM**)
- All these parameters can be found :
 - **View|Parameters**

Firms' demands for composite primary factors



sector demands for primary factor composite

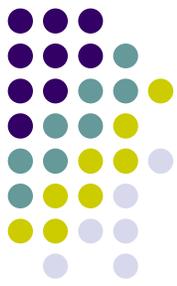
(all,j,PROD_COMM)(all,r,REG)

$qva(j,r)$

$= -ava(j,r) + qo(j,r) - ao(j,r)$

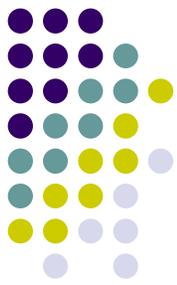
$- E_{SUBT}(j) * [pva(j,r) - ava(j,r) - ps(j,r) - ao(j,r)]$

Firms' demands for the primary factors



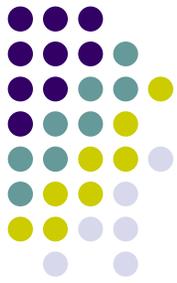
- *# demands for endowment commodities (HT 34) #*
- $(\mathbf{all}, i, \text{ENDW_COMM})(\mathbf{all}, j, \text{PROD_COMM})(\mathbf{all}, r, \text{REG})$
- $$qfe(i, j, r) = -afe(i, j, r) + qva(j, r) - \text{ESUBVA}(j) * [pfe(i, j, r) - afe(i, j, r) - pva(j, r)];$$

Firms' demand for composite intermediate inputs



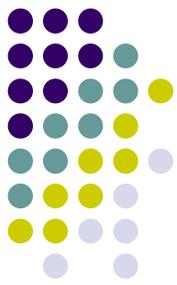
- *# industry demands for intermediate inputs, including cgds #*
- $(\mathbf{all}, i, \text{TRAD_COMM})(\mathbf{all}, j, \text{PROD_COMM})(\mathbf{all}, r, \text{REG})$
- $qf(i, j, r)$
 - = - $af(i, j, r) + qo(j, r) - ao(j, r)$
 - $\text{ESUBT}(j) * [pf(i, j, r) - af(i, j, r) - ps(j, r) - ao(j, r)]$

Firms' demand for domestic intermediates



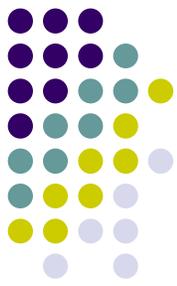
- # industry j demands for domestic good i . (HT 32) #
- $(\mathbf{all}, i, \text{TRAD_COMM})(\mathbf{all}, j, \text{PROD_COMM})(\mathbf{all}, s, \text{REG})$
- $qfd(i, j, s) = qf(i, j, s) - \text{ESUBD}(i) * [\text{pfd}(i, j, s) - \text{pf}(i, j, s)];$

Firms' demand for imported intermediates

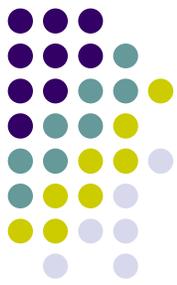


- # industry j demands for composite import i (HT 31) #
- $(\mathbf{all}, i, \text{TRAD_COMM})(\mathbf{all}, j, \text{PROD_COMM})(\mathbf{all}, s, \text{REG})$
- $q_{fm}(i, j, s) = q_f(i, j, s) - \text{ESUBD}(i) * [p_{fm}(i, j, s) - p_f(i, j, s)];$

Firms earn zero profits in equilibrium



- Open **GTAP.TAB**
- Search for **ZEROPROFITS**
- This requires the change in producer price (**ps**) to be equal to a weighted sum of the change in price of factors (**pfe**) and change in the price of intermediate inputs (**pf**)
- Cost shares (**STC**) are the weights



(profitslack is fixed at zero)

Equation ZEROPROFITS

industry zero pure profits condition (HT 6)

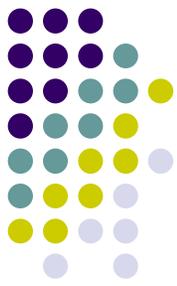
(all,j,PROD_COMM)(all,r,REG)

$$\begin{aligned} & ps(j,r) + ao(j,r) \\ & = \mathbf{sum}(i,ENDW_COMM, STC(i,j,r) * [pfe(i,j,r) - afe(i,j,r) - ava(j,r)]) \\ & + \mathbf{sum}(i,TRAD_COMM, STC(i,j,r) * [pf(i,j,r) - af(i,j,r)]) \\ & + profitslack(j,r) \end{aligned}$$

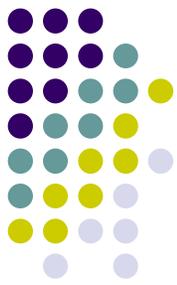
OR

$$VOA(j,s) = \sum_{i \text{ TRAD}} VFA(i,j,s) + \sum_{i \text{ ENDW}} VFA(i,j,s)$$

Factor mobility



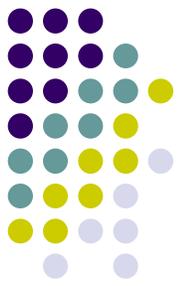
- As prices changes, how easily can factors move between sectors?
- In the standard model, labor & capital are perfectly mobile
- But land is “sluggish”
- Quantity of land allocated to each farm sector depends on difference between aggregate market price of land, & land price in each farm sector.
- The substitution elasticity in **ETRAE**
- User can change these assumptions



Technical change

- Can model the following -
- Hicks-neutral TC: uniformly reduces all input requirements to produce given output
- Primary factor-augmenting TC: makes any primary factor more productive & encourages substitution among factors
- Intermediate factor-augmenting TC: makes the composite intermediate input more productive & encourages substitution between intermediate and primary factors

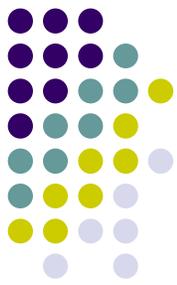
Hicks-neutral Technical change



- Production function:
- $Y = A_0 f(X_1, X_2, \dots, X_n)$
- The GTAP variable is **AOALL**(j,r)
- Percentage change variable is **ao**

- See equations for firms' demands for primary & intermediate inputs

Input-augmenting technical change



- Production function:
- $Y = f(A_1X_1, A_2X_2, \dots, A_nX_n)$
- Input X_i is augmented by the factor A_i
- A_iX_i is the quantity of the *effective* input
- The GTAP percentage change variables are:
 - *avaall* : value-adding TC in sector j
 - *afeall* : primary factor i augmenting TC in sector j
 - *afall* : intermediate input i augmenting TC in sector j
- Look at firms demands for inputs