



#### **Outline**



- Modelling principle
- The Real Exchange Rate
- Equation and Variable counts
- Market clearing
- Macroeconomic Closures
  - Numéraire
  - Foreign exchange market closure
  - Investment-Savings closure
  - Government account closure
    - Tax accounts
    - Government expenditures



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# **Modelling Principle**



Different applications and users require different closure settings. Therefore, the model should allow

- Multiple different closure settings
- Sensitivity testing of closure choices
- Acknowledgment of the tensions between (Walrasian) Microeconomic and Macroeconomic 'visions'
- Be simple to change



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The Real Exchange Rate

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# Exchange Rate in CGE Models



- Nominal Exchange rate, ER = localcurrency/foreign currency
- Uses in the model code
  - Current account balance denominated in foreign currency in the model

```
KAPEQUIL..
KAPWOR =E= SUM(cm, PWM(cm) *OM(cm))
            - SUM (ce, PWE (ce) *QE (ce)) ;
```

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### Exchange Rate in CGE Models



- Uses in the model code
  - Domestic prices of imports and exports report the prices in local currency units, using ER

```
PMDEF(c)$cm(c)..
 PM(c) = E = (PWM(c) * (1 + (TMADJ * tm(c)))) * ER
                         + [TMSADJ * tms(c)];
PEDEF(c) ce(c)..
  PE(c) = E = PWE(c) * ER * (1 - (TEADJ * te(c))) ;
TOTSAVEQ..
  TOTSAV =E= SUM(h,YH(h) * (1-(TYHADJ*tyh(h)))
                     *(SADJ*shh(h)))
               + SUM(f, deprec(f) *YF(f))
               + KAPGOV + (KAPWOR*ER) ;
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```







# Exchange Rate in CGE Models



- Real Exchange Rate =  $P_{tradable} / P_{nontradable}$
- Armington assumption → imports and domestic goods are imperfect substitutes, so 'semi-tradable' goods rather than a pure non-traded good
- Price (index) of the 'non-traded'/'semi-traded' goods is a weighted average of the price of domestically produced goods sold on the domestic market, i.e., PPI

$$\therefore RER = \frac{ER}{PPI}$$

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# Exchange Rate in CGE Models

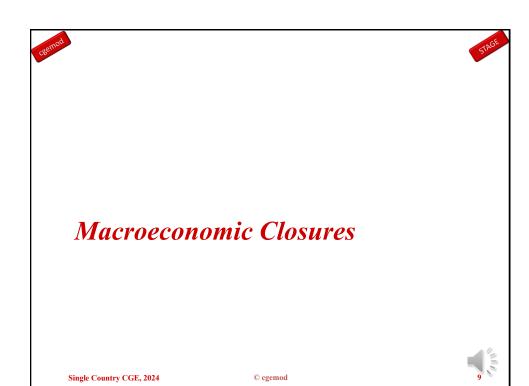


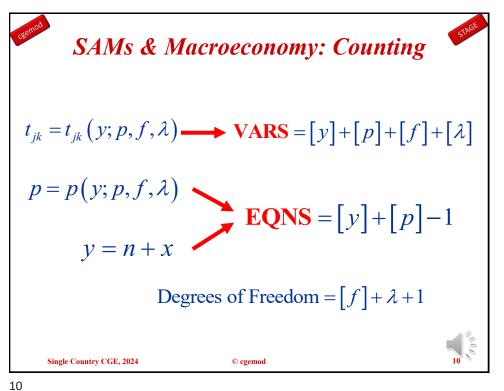
- The (nominal and real) exchange rates are not financial variables
  - -No financial assets in the model
  - -No inter-temporal equilibrium concept
- The (nominal and real) exchanges rate are determined by the prices of tradable and non/semi tradable goods and services

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#### Numéraire



$$CPI = \overline{CPI}$$
OR

$$PPI = \overline{PPI}$$

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#### Numéraire



- \* ## MISCELLANEOUS FIXED VARIABLES
- \* To use CPI as the numeraire fix CPI

CPI.FX = CPI0 \* numerchk;

- \* To fix the real exchange rate fix ER and PPI
- \* PPI.FX = PPI0 \* numerchk;

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# Foreign Exchange Account



$$ER = ER$$
 OR  $CAPWOR = \overline{CAPWOR}$ 

Small country assumption on import demand and selected export commodities (those defined in the set **cedn(c)**)

$$PWM_c = \overline{PWM_c}$$
  $PWE_{cedn} = \overline{PWE_{cedn}}$ 

Export demand curve for selected commodities (those defined in set ced(c)) so  $PWE_{ced}$  is a variable for those commodities

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# Foreign Exchange Account



- \* ## FOREIGN EXCHANGE MARKET CLOSURE
- \* In this MODEL the exchange rate is fixed
- \* and the current account balance is the
- \* equilibrating variable.
- \* ER.FX = ER0 ;
- \* alternatively the external balance is fixed

CAPWOR.FX = CAPWOR0 ;

\* Fixing of world prices

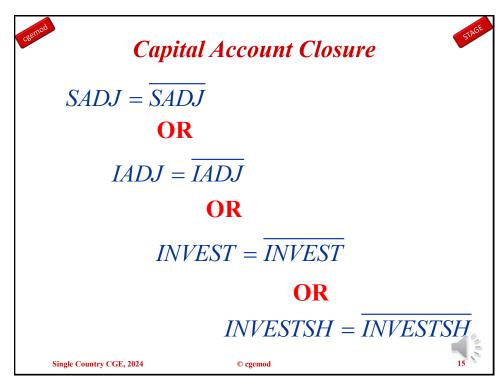
PWM.FX(c) = PWM0(c);

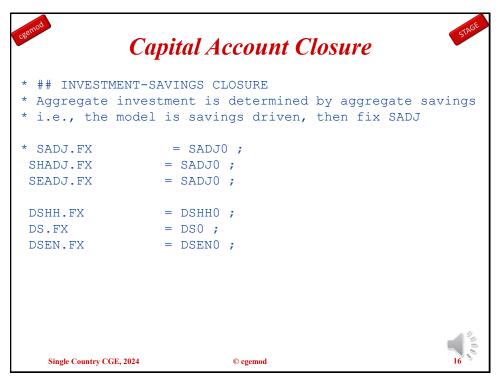
PWE.FX(cedn) = PWE0(cedn);

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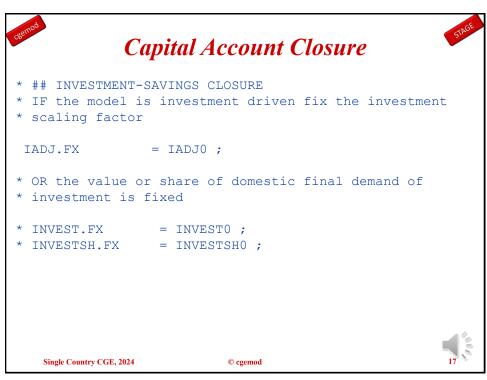


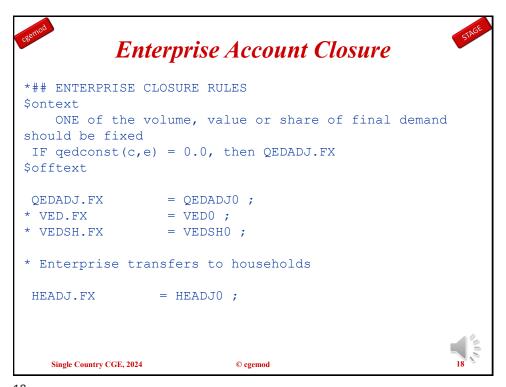


















$$TMADJ = \overline{TMADJ}$$

$$TEADJ = \overline{TEADJ}$$

$$TSADJ = \overline{TSADJ}$$

$$TSSADJ = \overline{TSSADJ}$$

$$TEXADJ = \overline{TEXADJ}$$

$$TVADJ = TVADJ$$

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### Government Closure: Taxes



$$TXADJ = \overline{TXADJ}$$

$$TFADJ = TFADJ$$

$$TYFADJ = \overline{TYFADJ}$$

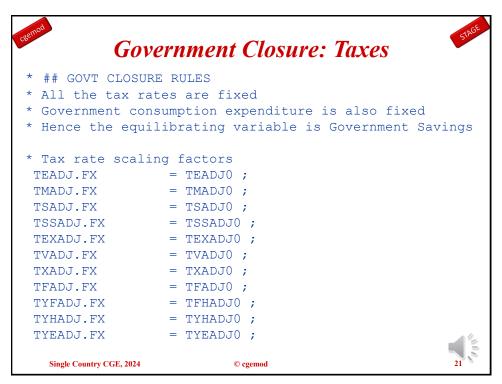
$$TYHADJ = \overline{TYHADJ}$$

$$TYEADJ = \overline{TYEADJ}$$

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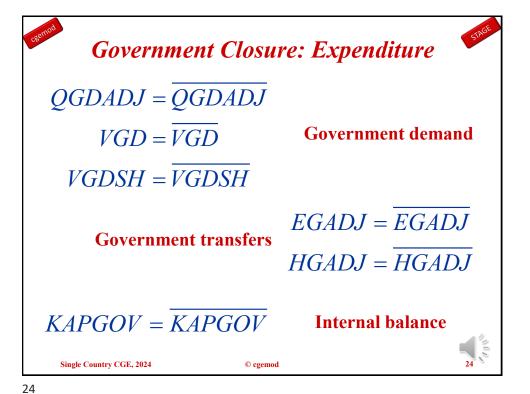
```
Government Closure: Taxes
* ## GOVT CLOSURE RULES
* All the tax rates are fixed
* Government consumption expenditure is also fixed
* Hence the equilibrating variable is Government Savings
* Tax rate scaling factors
DTE.FX
                  = DTE0 ;
DTM.FX
                  = DTM0 ;
DTS.FX
                 = DTS0 ;
DTSS.FX
                  = DTSSO ;
DTV.FX
                  = DTV0 :
DTEX.FX
                 = DTEXO ;
DTX.FX
                 = DTX0 ;
DTF.FX
                  = DTF0 ;
DTYF.FX
                  = DTYF0 ;
DTYH.FX
                 = DTYH0 ;
DTY.FX
                 = DTY0 ;
 DTYE.FX
                 = DTYE0 ;
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```

#### Government Closure: Taxes ## GOVT CLOSURE RULES Tax revenues fixed Tax revenues (real relative to numeraire) \* ETAX.FX = ETAX0 MTAX.FX = MTAX0STAX.FX = STAX0 = SSTAX0 SSTAX.FX EXTAX.FX = EXTAX0= VTAX0 FYTAX.FX = FYTAX0 ITAX.FX = ITAX0 \* FTAX.FX = FTAX0DTAX.FX = DTAX0

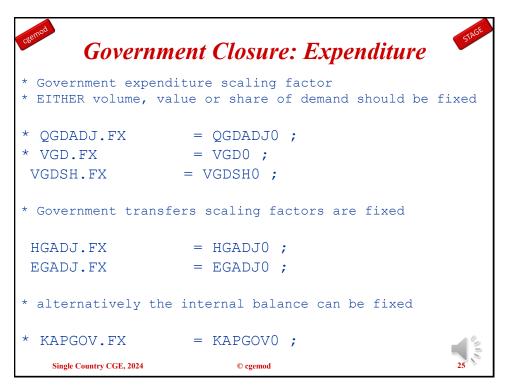
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# Tax Replacement: Theory



Fixed internal balance and government spending Other agents adjust to the policy shock:

Direct taxes adjust → a lump sum change in household income, consumption changes, 'no' price distortions

#### OR

Indirect taxes change → distort price signals and alter consumption patterns

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# Tax Replacement: Practice



Household income taxes adjust (other tax adjustors held constant at one)

```
KAPGOV.FX = KAPGOV0 ;
TYHADJ.LO = -INF ;
TYHADJ.UP = +INF ;
```

Sales taxes adjust (other tax adjustors held constant at one)

```
KAPGOV.FX = KAPGOV0 ;
TSADJ.LO = -INF ;
TSADJ.UP = +INF ;
```

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# Macroeconomic Closures

The End

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