A Single Country CGE Model (smod_t): Part 1

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Outline

- Introduction
- Agents in the Model
- Prices
  - Price trees
  - Normalisation rule
- Taxes
  - Tax instruments
  - Tax adjustors
- Production (review)
  - Factor Demands, Intermediate input demands, factor payments
- Income (review)
- Expenditure (review)
- *Macroeconomic Closure and Market Clearing*

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Agents in smod_t

- 4 commodities
- 4 activities
- 4 factors
- 2 households
- Government – taxes and spends
- Savings/investment – no time dimension
- Trade
  - with a single partner, ROW
  - small country assumption
  - CET and CES for each commodity

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Prices

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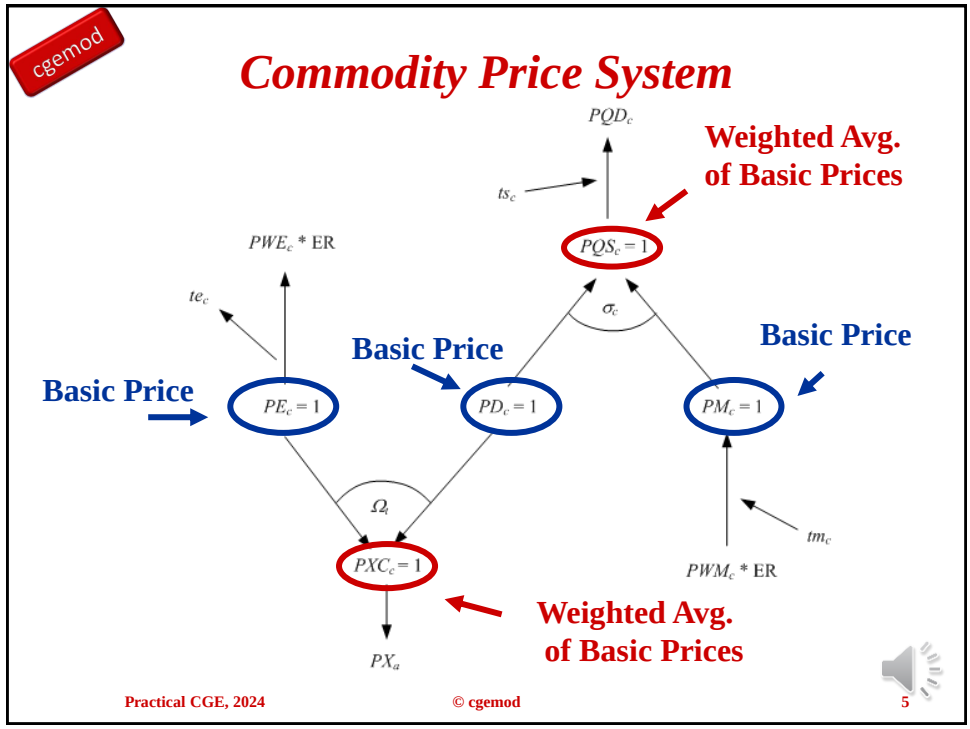
cgemod
Commodity Price System
PQD_c
Weighted Avg.
of Basic Prices
ts_c
PWE_c * ER
$PQS_c = 1$
te_c
σ_c
Basic Price
Basic Price
Basic Price
$PE_c = 1$
$PD_c = 1$
$PM_c = 1$
Ω_t
tm_c
$PXC_c = 1$
PWM_c * ER
Weighted Avg.
of Basic Prices
PX_a
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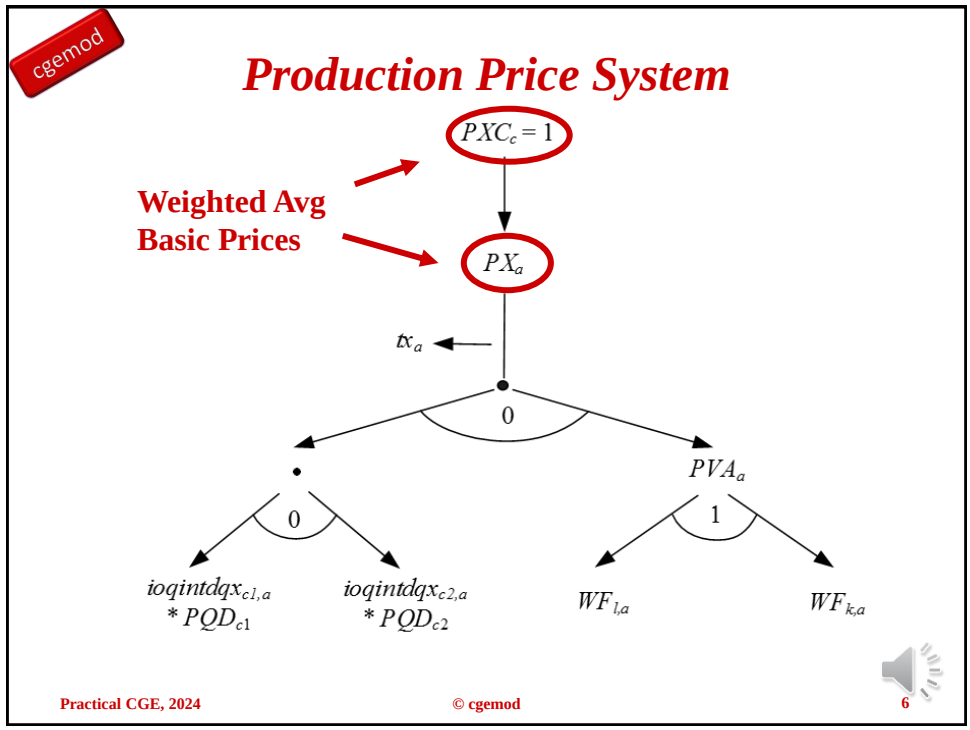
cgemod
Production Price System
$PXC_c = 1$
Weighted Avg
Basic Prices
PX_a
tx_a
0
PVA_a
0
1
$ioqintdqx_{c1,a}$
* PQD_{c1}
$ioqintdqx_{c2,a}$
* PQD_{c2}
$WF_{l,a}$
$WF_{k,a}$
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Price Normalisation Rule

$PE_c = PD_c = PM_c = 1 \qquad \forall c$ **Basic Prices**

ALL prices are derived relative to BASIC PRICES

$PQS_c = PXC_c = PX_a = 1 \qquad \forall c = a$

If price data exist they could be used to identify the 'observed' basic prices of the system

The results would be different in absolute units, BUT would be the same in proportionate units

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Tax Instruments

Instrument	Name	Base Price	Behaviour
Import duties	tm_c	PWM_c	*ad valorem*
Export taxes	te_c	PWE_c	*ad valorem*
Sales taxes (GST)	ts_c	PQS_c	*ad valorem*
Production taxes	tx_a	PX_a	*ad valorem*
Income taxes	tyh_h	YH_h	*ad valorem*

Two new tax instruments
- Import duties
- Export taxes

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Tax Rate Adjusters

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Why Tax Rate Adjusters?

- Tax rates are parameters in this model
  - therefore tax rates cannot be target variables
  - but 'optimal' tax rates are policy objectives
- Models are square - variable & equation counts equate
  - multiple tax rates
  - single target variables
  - must maintain equation and variable counts
- Simplify simulations
  - tax rate adjusters exist **SOLELY** to aid simulations

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Tax Rate Equations

$$PE_c = pwe_c * ER * (1 - TEADJ * te_c)$$

$$PM_c = pwm_c * ER * (1 + TMADJ * tm_c)$$

t*(.) > 0 tax
t*(.) < 0 subsidy

$$PQD_c = PQS_c * (1 + TSADJ * ts_c)$$

$$PVA_a = \left[PX_a * (1 - TXADJ * tx_a) \right] - \left[\sum_c PQD_c * ioqintdqx_{a,c} \right]$$

$$HEXP_h = \left[YH_h * (1 - TYHADJ * tyh_h) \right] * (1 - SADJ * shh_h)$$

NB1: Savings rate defined as AFTER payment of direct taxes. Important for the calibration – check this out for yourself.

NB2: Adjuster also used on the savings rate (SADJ)

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Model Equations

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Trade: Exports

$$PE_c = PWE_c * ER * \left(1 - \left(TEADJ * te_c\right)\right) \qquad \forall c \in ce$$

Basic price of exports (*PE*)

$$QXC_c = at_c \left(\gamma_c * QE_c^{\,rhot_c} + \left(1-\gamma_c\right) * QD_c^{\,rhot_c}\right)^{\frac{1}{rhot_c}} \qquad \forall c \in \left(cd \cap ce\right)$$

Commodity Demand

$$\frac{QE_c}{QD_c} = \left[\frac{PE_c}{PD_c} * \frac{\left(1-\gamma_c\right)}{\gamma_c}\right]^{\frac{1}{\left(rhot_c - 1\right)}} \qquad \forall c \in \left(cd \cap ce\right)$$

FOC

$$QXC_c = QD_c + QE_c \qquad \forall c \in \left(cd \cap cen\right) \text{ or } \left(cdn \cap ce\right)$$

NO exports or NO production

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Trade: Imports

$$PM_c = PWM_c * ER * \left(1 + \left(TMADJ * tm_c\right)\right) \qquad \forall c \in cm$$

Basic price of imports (*PM*)

$$QQ_c = ac_c \left(\delta_c * QM_c^{\,-rhoc_c} + \left(1-\delta_c\right) * QD_c^{\,-rhoc_c}\right)^{-\frac{1}{rhoc_c}} \qquad \forall c \in \left(cx \cap cm\right)$$

Commodity Supply

$$\frac{QM_c}{QD_c} = \left[\frac{PD_c}{PM_c} * \frac{\delta_c}{\left(1-\delta_c\right)}\right]^{\frac{1}{\left(1+rhoc_c\right)}} \qquad \forall c \in \left(cx \cap cm\right)$$

FOC

$$QQ_c = QD_c + QM_c \qquad \forall c \in \left(cx \cap cmn\right) \text{ or } \left(cxn \cap cm\right)$$

NO imports or NO production

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Commodity Prices

$$PQD_c = PQS_c * \left(1 + \left(TSADJ * ts_c\right)\right) \quad \forall c \in \left(cd \cup cm\right)$$

Purchaser price (*PQD*)

Applications of Euler theorem

$$PQS_c = \frac{PD_c * QD_c + PM_c * QM_c}{QQ_c} \quad \forall c \in \left(cd \cup cm\right)$$

Basic price of supply (*PQS*)

$$PXC_c = \frac{PD_c * QD_c + PE_{c \in ce} * QE_{c \in ce}}{QXC_c} \quad \forall c \in cx$$

Basic price of demand (*PXC*)

$$CPI = \sum_c comtotsh_c * PQD_c \quad \forall c$$

$$PPI = \sum_c vddtotsh_c * PD_c \quad \forall c$$

Alternate numeraire

Production Block Equations

UNCHANGED

$$QX_a = ad_a \prod_f \left(FD_{f,a}\right)^{\alpha_{f,a}}$$

Production function

$$FD_{f,a} = \frac{QX_a * PVA_a * \alpha_{f,a}}{WF_f}$$

1st Order Condition

$$QINTD_c = \sum_a ioqintdqx_{c,a} * QX_a$$

$ioqintdqx_{c,a}$ = quantity of c per unit of a

Intermediate Input Demand

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Production Block Equations

$$PVA_a = \left(PX_a\left(1 - TXADJ * tx_a\right)\right) - \left(\sum_c PQD_c * ioqintdqx_{c,a}\right)$$

$$QXC_c = \sum_a ioqxcqx_{c,a} * QX_a$$

$$PX_a = \sum_c ioqxcqx_{a,c} * PXC_c$$

One to One Mappings

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Factor Incomes

UNCHANGED

$$YF_f = \sum_a WF_f * FD_{f,a}$$

Acc^g Identity

$$YFDIST_f = \left(YF_f - \left(deprec_f * YF_f\right)\right)$$

After depreciation

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Household Incomes & Expenditure

CHANGED

$$YH_h = \sum_f \left(hvash_{h,f} * YFDIST_f \right) + \left(howor_h * ER \right)$$

Income

Adjuster variables

$$HEXP_h = \left\{ YH_h * \left[1 - \left(TYHADJ * tyh_h \right) \right] \right\} * \left[1 - \left(SADJ * shh_h \right) \right]$$

Consumption Expenditure

CHANGED

$$PQD_c * QCD_{c,h} = \left[PQD_c * qcdconst_{c,h} \right] + beta_{c,h} * \left\{ HEXP_h - \sum_c PQD_c * qcdconst_{c,h} \right\} ;$$

Commodity Demand

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Tax Revenues

$$STAX = \sum_c \left(TSADJ * ts_c * PQS_c * QQ_c \right)$$ **Sales tax Revenue**

$$ITAX = \sum_a \left(TXADJ * tx_a * PX_a * QX_a \right)$$ **Production tax Revenue**

$$DTAX = \sum_h \left(TYHADJ * tyh_h * YH_h \right)$$ **Income tax Revenue**

$$MTAX = \sum_c \left(TMADJ * tm_c * pwm_c * ER * QM_c \right)$$ **Import tax Revenue**

$$ETAX = \sum_c \left(TEADJ * te_c * pwe_c * ER * QE_c \right)$$ **Export tax Revenue**

Note Tax Adjustors in each equation

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Government Income & Expenditure

$$YG = MTAX + ETAX + STAX + ITAX + DTAX + (govwor * ER)$$

Income

Adjuster variable

$$QGD_c = qgdconst_c * QGDADJ$$

Demand

$$EG = \left(\sum_c QGD_c * PQD_c \right)$$

Expenditure

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Savings-Investment

Adjuster variables **Savings Income**

$$TOTSAV = \sum_h \left(\left(YH_h * \left(1 - \left(TYHADJ * tyh_h \right) \right) \right) * \left(SADJ * shh_h \right) \right) + \sum_f deprec_f * YF_f + KAPGOV + \left(KAPWOR * ER \right)$$

Depreciation

$$INVEST = \sum_c \left(PQD_c * QINVD_c \right)$$

Investment Expenditure

Adjuster variable

$$QINVD_c = IADJ * qinvdconst_c$$

Investment Demand

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International Transfers

- Defined as NET transfers
  - Decision is exogenous
  - Currency units – foreign/RoW
  - Unrequited
- External balance
  - Wedge between trade balance and current account balance
- Shocks
  - Change in NET flows
  - Negative or positive

$$YH_h = \sum_f \left(hvash_{h,f} * YFDIST_f \right) + \left(howor_h * ER \right)$$

NET Remittances

$$YG = MTAX + ETAX + STAX + ITAX + DTAX + (govwor * ER)$$

NET Grants/Aid

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The End

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