Introduction to Nested Functions (smod_t2/t3)

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Outline

- Introduction
- Why use Nested Functions?
  - Reasons
  - Uses
  - Disadvantages
- Behaviour in *smod_t/2/3*
- Production systems
  - Price & Quantity Systems
- Method
- Exercises and Experiments

Model Tech Document:

- smod_t_model.pdf covers smod_t.gms, smod_t2.gms and smod_t3.gms.
- Production systems for smod_t2.gms and smod_t3.gms detailed in Appendices 2 &3

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Introduction

- Model *smod_t* - 'state-of-the-art' c1980s
- *smod_t2*
  - 'state-of-the-art' c1990s
  - 2 level production nest
- *smod_t3*
  - 'state-of-the-art' c2010s
  - 3 level production nest
- Databases (SAMs)
  - Aggregates of regions (*smod_t*)
  - Less aggregated SAMs

Many 'modern' models are not 'state-of-the-art' c2024

***smod_t3*: a model that provides a framework that can be augmented to produce a model that is 'state-of-the-art' c 2015**

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Why Use Nested Functions?

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Reasons for Nested Functions

- Enhanced representation of economic systems
- Allow different substitution possibilities between 'groups' of inputs
  - Capital and aggregate labour
  - 'Skilled' and 'unskilled' labour
  - Land and 'fertiliser'
  - Capital and aggregate energy
  - etc....

"when used in equilibrium modelling applications, traditional flexible functional forms suffer from an excess of flexibility" (Perroni and Rutherford, 1995, p 336)

Nested CES functions "provide a second-order local approximation to any cost function if and only if the function to be approximated is globally regular". (Perroni and Rutherford, 1995, p 336)

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Uses of Nested Functions

- Production
  - 'Standard' models, e.g., aggregates of different 'groups' of factors (usually labour types)
  - 'Energy' models, e.g., aggregates of different energy inputs
  - Agriculture focused models, e.g., aggregates of land/fertiliser/phytosanitary inputs
  - Climate change/IAM models, e.g., 'energy' models plus emissions plus ….
  - Water models, e.g., potable water/irrigation water, etc...
- Trade
  - Multiple trade partners, e.g., global CGE models
- Consumption
  - Aggregates of different 'groups' of commodities, e.g., substitution between types of food
  - Labour-Leisure trade-offs
  - Substitution between commodities produced within and without the SNA production boundary

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Disadvantages of Nested Functions

- How much nesting is the appropriate amount of nesting?
  - Economic logic
  - KISS
- Where do we get estimates of the substitution elasticities?
  - Little empirical evidence
  - Sensitivity analyses

"Essentially, all models are wrong, but some are useful" (G Box)

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Behaviour

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Social Accounting Matrix

	cagr	cnres	cmanu	cserv	aagr	anres	amanu	aserv	flnd	fuskl	fskllb	fcap	h_urban	h_rural	imptax	exptax	saltax	prodtax	dirtax	Govt	i_s	row	total
cagr	0	0	0	0	31	0	52	9	0	0	0	0	136	44	0	0	0	0	0	0	3	22	297
cnres	0	0	0	0	0	7	86	1	0	0	0	0	1	0	0	0	0	0	0	0	0	219	315
cmanu	0	0	0	0	36	36	356	171	0	0	0	0	271	109	0	0	0	0	0	7	190	143	1,318
cserv	0	0	0	0	25	33	174	201	0	0	0	0	219	105	0	0	0	0	0	178	19	62	1,016
aagr	276	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	276
anres	0	291	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	291
amanu	0	0	930	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	930
aserv	0	0	0	935	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	935
flnd	0	0	0	0	24	66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	90
fuskl	0	0	0	0	110	17	93	156	0	0	0	0	0	0	0	0	0	0	0	0	0	0	375
fskllb	0	0	0	0	1	3	19	116	0	0	0	0	0	0	0	0	0	0	0	0	0	0	139
fcap	0	0	0	0	45	123	134	258	0	0	0	0	0	0	0	0	0	0	0	0	0	0	559
h_urban	0	0	0	0	0	0	0	0	57	307	112	222	0	0	0	0	0	0	0	0	0	0	698
h_rural	0	0	0	0	0	0	0	0	33	68	27	176	0	0	0	0	0	0	0	0	0	0	304
imptax	6	1	54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	61
exptax	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
saltax	1	0	33	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	42
prodtax	0	0	0	0	5	7	17	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	51
dirtax	0	0	0	0	0	0	0	0	0	0	0	0	20	16	0	0	0	0	0	0	0	0	36
Govt	0	0	0	0	0	0	0	0	0	0	0	0	0	0	61	3	42	51	36	0	0	0	193
i_s	0	0	0	0	0	0	0	0	0	0	0	162	51	29	0	0	0	0	0	8	0	-38	212
row	14	22	299	73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	408
total	297	315	1,318	1,016	276	291	930	935	90	375	139	559	698	304	61	3	42	51	36	193	212	408	

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Behaviour: from smod_t

- Trade with ROW (rest of world)
  - Imports
    - Armington insight (CES)
  - Exports
    - Symmetrical treatment to imports (CET)
  - Current Account balance
  - Exchange rate
- Household
  - Stone-Geary (LES) utility functions
- Government
  - Fixed real shares of government income
- Taxes
  - Import duties; export; GST; Production; Income
- Investment
  - Fixed real shares of savings

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Behaviour: Production

- *smod_t2*
  - Two-level production nest
    - Aggregate intermediate & 'primary' inputs
      - Leontief or CES
    - Aggregate 'primary' inputs
      - CES
- *smod_t3*
  - Three-level production nest
    - Aggregate intermediate & 'primary' inputs
      - Leontief or CES
    - Aggregate 'natural' and aggregate 'primary' inputs
      - CES
    - Aggregate 'natural' 'primary' inputs
      - CES

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Production Systems

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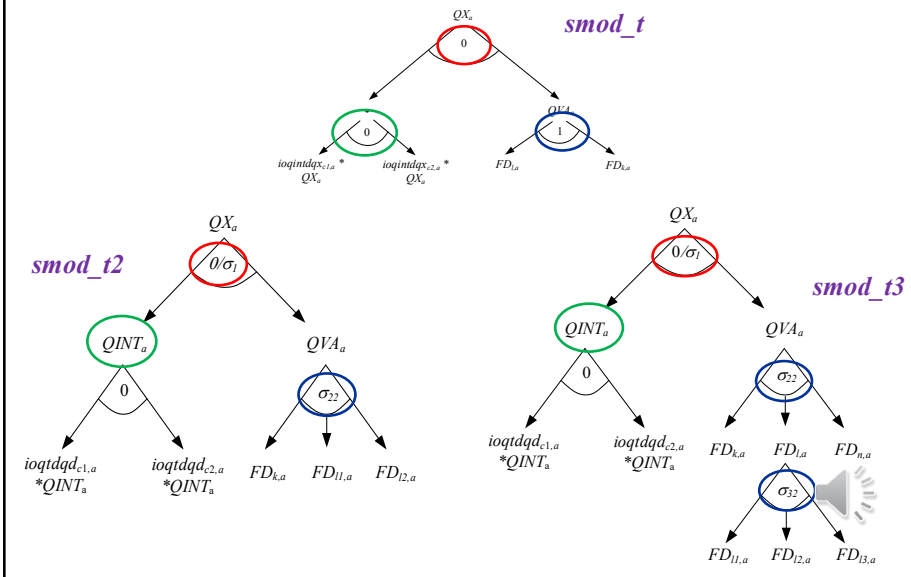
Production Quantity System



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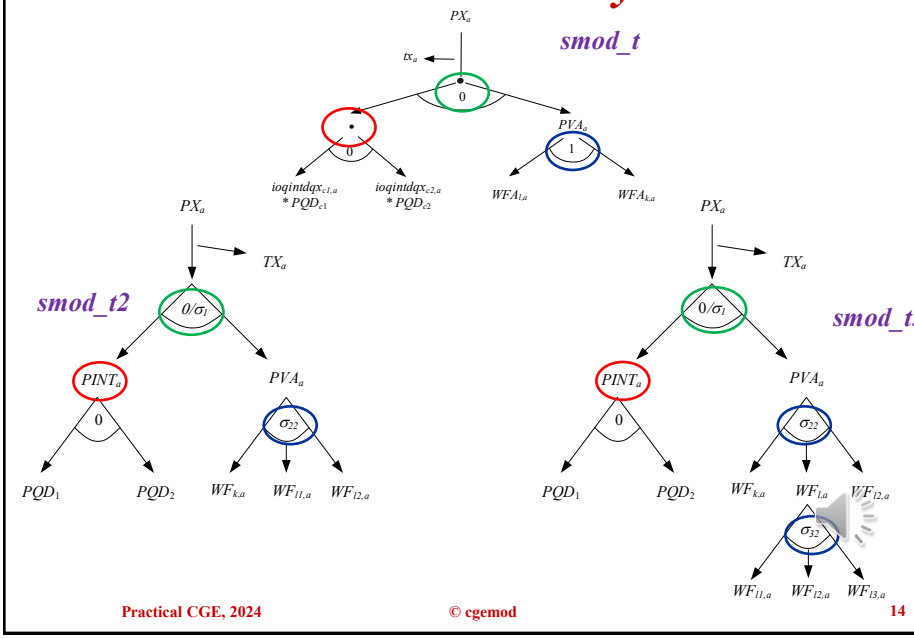
Production Price System



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Method

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smod_t2 v smod_t

- Data
  - Transactions (SAM) data – unchanged
  - Elasticities – add two (*rhox*, *rhova*)
- Sets - unchanged
- Equations
  - Nonproduction equations – no change
  - Production equations – change
- Parameters
  - Nonproduction parameters – no change
  - Production parameters – change
- Closures
  - Modify

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smod_t3 v smod_t2

- Data
  - Transactions (SAM) data – changed
  - Elasticities – add three (*rhox*, *rhova*, *rhofd*)
- Sets - extend
- Equations
  - Nonproduction equations – no change
  - Production equations – add another primal and FOC
- Parameters
  - Nonproduction parameters – no change
  - Production parameters – change
- Closures
  - Modify

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Exercises and Experiments

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Exercises and Experiments: smod_t2

- Exercises
  - Coding: revise production system in *smod_t* to make *smod_t2*
  - Test *smod_t2*
- Experiments
  - Trade tax changes with tax replacement
    - As used in ModO5
  - Compare results using *smod_t* and *smod_t2*

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Exercises and Experiments: smod_t3

- Exercises
  - Data: change data used in *smod_t2*
  - Sets: extend sets and add mapping set
  - Coding: revise production system in *smod_t2* to make *smod_t3*
  - Test *smod_t3*
- Experiments
  - Trade tax changes with tax replacement
    - As used in ModO5
  - Compare results using *smod_t2* and *smod_t3*

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Exercises and Experiments: smod_t3_2

- Exercises
  - Data: same data used in *smod_t3*
  - Sets: extend sets and add mapping set
  - Coding: the exogenous data to run a variant of *smod_t3*
  - Test *smod_t3*
- Experiments
  - Trade tax changes with tax replacement
    - As used in ModO5
  - Compare results using variants of *smod_t3*

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Introduction to Nested Functions (smod_t2/t3)

The End

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