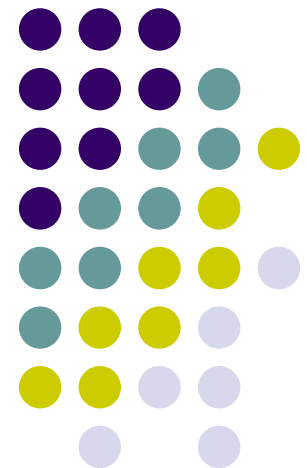# WTO/ESCAP 3ʳᵈ ARTNeT Capacity Building Workshop on Trade Research

Introduction to CGE Modeling and GTAP

Allan N Rae

Massey University

New Zealand

GTAP: What Is It?

- GTAP (Global Trade Analysis Project) is a global network of researchers and policy makers conducting quantitative analysis of international policy issues.

- GTAP's goal is to improve the quality of quantitative analysis of global economic issues within an economy-wide framework.

- Developed and Coordinated by the Center for Global Trade Analysis, Purdue University, USA.

What Does GTAP Offer?

- Database
- Models – multi-region applied general equilibrium (static & dynamic)
- Software
- Global network of researchers
- Guidance from national & international supporting agencies (e.g. World Bank, WTO, OECD, ADB, FAO, UNCTAD)
- Database & standard model is fully documented & publicly available

…also..

- Annual short courses for new users
- Annual conferences
- Website http://www.gtap.agecon.purdue.edu/
- Can download
  - Software
  - Data
  - Publications
  - Applications
  - Information on courses & conferences

Why Use Computable General Equilibrium Models?

- CGE modelling helps to make explicit the implications of alternative courses of action
  - ideal for examining the effects of policy changes on resource allocation
  - enables us to assess gainers and losers
- To facilitate policy analysis within a framework broadly consistent with microeconomic theory
- When quantification is needed to determine the signs & relative magnitudes of effects
- Some problems too complex to work out 'on back of an envelope'
- May generate fresh insights

Why is general equilibrium analysis important?

- interactions between sectors and between economies are often important

- sometimes GE results confirm the suggestions of partial equilibrium calculations

- but sometimes partial equilibrium analysis misses vital things

Limitations of PE Analysis

- **Does not acknowledge finite resource endowments (e.g. a subsidy pulls resources away from other sectors)**

- **Who pays for the subsidies? (subsidy may increase welfare of some, but at the expense of others)**

- **Does not capture income effects endogenously (no link between factor income and expenditure)**

- **No consistency check: Walras' Law does not apply.**

What is Walras' Law?

- We can't have a situation where only one market is in disequilibrium
- Walras Law states that if there is excess supply in one market (eg involuntarily unemployed labour) then there must be a 'matching' excess demand elsewhere (eg. an excess demand for commodities).

What is applied general equilibrium (AGE) modelling?

- general equilibrium
  - attention is given to the structural detail of the economy
  - inter-relationships between sectors
  - prices and quantities are determined simultaneously
  - markets usually are assumed to clear

- computable general equilibrium (CGE) models are usually large and well-specified economic models
  - based on input-output/social accounting matrix data
  - model behavioural functions e.g. for producers and consumers
  - market equilibrium
  - also encompass some macroeconomic components e.g. BoP, government budget, savings and investment, aggregate supply of primary factors

- important features of the modelling
  - optimising behaviour by producers and consumers
  - constraints exist e.g. availability of factors of production
- prices induce adjustment
  - contrasts with traditional input-output analysis where output responses do not reflect optimising behaviour or the operation of constraints
  - "policy laboratories"
  - emphasis on practical application

A rapidly growing area of applied economics

- there is increasing demand for improved quantitative policy analysis
  - national level
  - international level
- extensively-used for policy analysis
  - E.g. to analyse RTA and FTA
- used by many international organisations e.g. current Doha negotiations

The bad news...

to do applied general equilibrium modelling

"...one has to be familiar with general equilibrium theory, to be able to program, to be familiar with data and be able to manipulate and convert it into a model admissible form, to be conversant with literature estimates of key parameters, to have a clear sense of policy issues and institutional structure, and to be able to interpret results"

[John Whalley 1986]

The good news...

- advent of special purpose software has lessened the need for programming skills – e.g. GEMPACK

- teams of researchers have developed excellent and well-documented models – e.g. GTAP models

- AGE is becoming more powerful and more easily accessible

- this course will give you hands-on experience with 'real' data and models.

Computing software

- General Equilibrium Modelling Package (GEMPACK) is a set of general purpose software specifically designed to assist the implementation of large economic models

  - the user can write out the model in a transparent fashion, even with no previous programming experience

  - You will start to become familiar with it in this course

  - You need to know the language if you wish to make changes to the GTAP model

The GTAP database

- the Global Trade Analysis Project (GTAP) model and database

  - internationally recognised and supported

  - amenable to a wide range of applications

  - regularly updated and well documented

  - Contains only value flows as levels

- Latest (2001) version 6 contains 87 regions and 57 sectors – can be purchased

- we generally aggregate this to a smaller number of regions and sectors for simulations

  - to aid computation

  - to highlight the implications for the regions and sectors of particular interest

Introduction to the Structure of the Standard GTAP Model
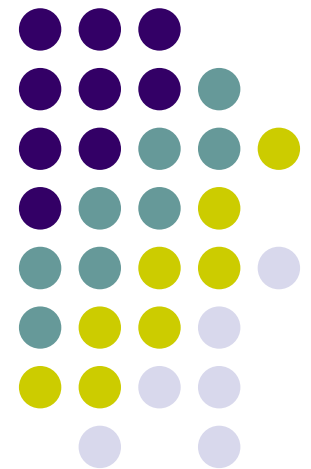
Structure of GTAP

- See Chapter 2 of the GTAP book
- agents (producers, consumers) optimise, subject to the various constraints of the economy
- prices and quantities of produced commodities are endogenously determined by households and firms optimising, subject to the resource limitations of the economy
- households satisfy their budget constraints and firms make zero pure profits

- Standard model is a comparative-static one. A dynamic version is also available.
- Next:
  - Flow diagram: Overview
  - Notation

Multi Region Open Economy -
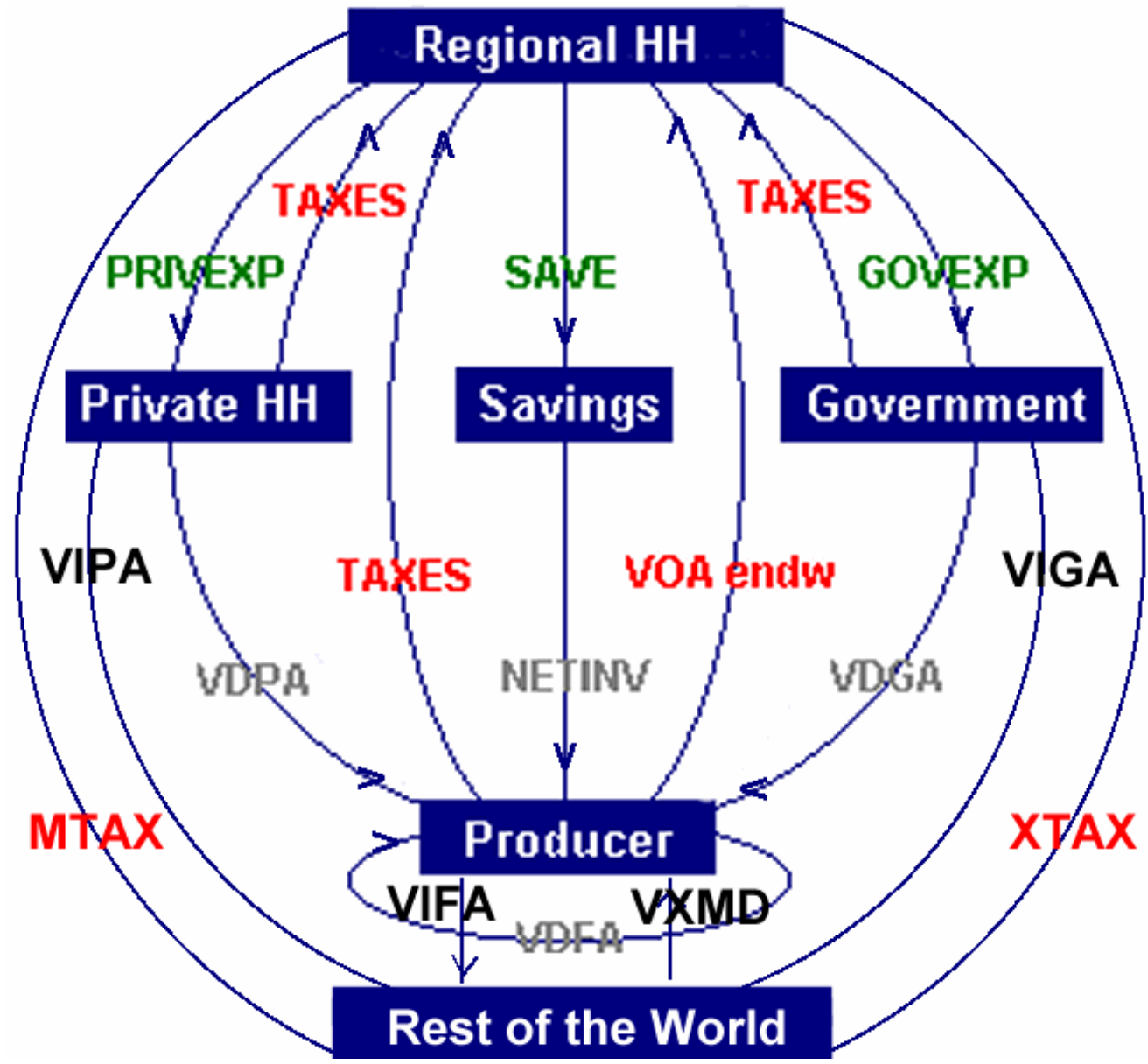
Overview of the Model

- **Regional household** collects all income including taxes: aggregate utility function allocates spending across private, govt. and savings

- Household sources of income: from sale of endowment commodities (land, labour & capital) to firms (VOA)

- Firms combine endowments with intermediate goods (domestic (VDFA) or imported (VIFA)) to produce goods for final demand

- This involves sales to private households (VDPA), govt. (VDGA) or for export (VXMD), or sales of investment goods (NETINV)

- Private households and govt. may also import goods (VIPA and VIGA).

Notation

- UPPER CASE are levels forms of variables
- lower case are percentage changes in variables

- Value of Output at Agents prices
  - or Market prices
- Value if purchases of Domestic tradable commodity by Firms at Agents prices
  - or Imported tradable commodity
- Value of expenditure on Domestic tradable commodity by Private households at Agents prices
- Or by Government

- **V**alue of e**X**ports at **M**arket prices by **D**estination
  - or at **W**orld (fob) prices
- **V**alue of **I**mports at importer's **M**arket prices by **S**ource
  - or at **W**orld (cif) prices
- **V**alue of expenditure on **I**mported tradable commodity by **P**rivate households at **A**gents' prices
- i**M**port **TAX** revenue
- **Q**uantity of commodity **O**utput