MAST 2026 · WORKSHOP ON CGE MODELING AND GTAP



Foundations of Computable General Equilibrium Modeling with the GTAP Framework

Roshen Fernando and Patrick Jaime Simba
Economic Research and Development Impact Department
Asian Development Bank

2026 October 27
Jakarta, Indonesia

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Our Objectives

Think in general equilibrium

Trace how one policy change ripples through markets, sectors, and countries.

Explain how GTAP works

Describe its database, agents, behavior, closures, and how a shock becomes results.

Run and read a simulation

Set up a shock in RunGTAP, solve it, and find the results that answer a question.

Use CGE results critically

Ask the right questions of any CGE-based policy study you read or commission.

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Scope: The Standard, Static GTAP Model

What we cover

- Economy-wide modeling and CGE basics
- The GTAP Data Base and social accounting matrices
- The standard GTAP model (version 7) and its agents
- Shocks, closures, and elasticities in RunGTAP
- Reading results, including welfare (EV)
- Hands-on: three GTAP 101 / Burfisher exercises

What we only mention

- Dynamic GTAP models and baseline projections
- Building or updating a database from raw data
- Programming model code in GEMPACK
- Estimating elasticities econometrically
- Specialized extensions (energy, land use, value chains)

Based on the GTAP 101 course (Purdue) and Burfisher, Introduction to Computable General Equilibrium Models, 3rd ed.

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Today's Plan

09:15–10:15	**Session 1** · Foundations: Economic Modeling, CGE, GTAP, SAMs, Software
10:15–10:30	Break
10:30–12:00	**Session 2** · Inside the GTAP Model: Households, Firms, Government, Trade, Savings, and Investment · Exercise briefing in the last 15 minutes
12:00–13:30	Lunch
13:30–15:00	**Session 3** · Hands-on: 30 min group exercise + 60 min presentations
15:00–15:15	Break
15:15–16:45	**Session 4** · Beyond the Basics: Closures, Parameters, Welfare, and Extensions

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How the Day Works: Learn, Apply, and Explain

S1–S2 MORNING

Learn

Concepts, data, and the model's agents

11:45

Brief

Groups, exercises, and deliverables

13:30

Run

30 minutes in groups with RunGTAP

14:00

Explain

10 minutes per group, with Q&A

15:15

Extend

Debrief and the next level

6 groups (assigned at registration)
3 exercises · each exercise run by 2 groups

You have: **RunGTAP** with NUS333 and NIMMIG, the **exercise workbook** and **presentation templates**

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MAST 2026 · WORKSHOP ON CGE MODELING AND GTAP



Session 1 · 09:15–10:15

Foundations of CGE Modeling and the GTAP Framework

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Part I:
Economic Modeling and Modeling Philosophies

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ECONOMIC MODELING

A Model Is a Deliberate Simplification

It keeps the mechanisms that matter for a question and leaves out the rest, so we can reason about cause and effect.

1

Assumptions

How agents behave and what is held fixed

2

Structure

Equations that link prices, quantities, and incomes

3

Data

Numbers and parameters that connect the model to a real economy

Judge a model by whether it fits the question, not by how "realistic" it looks.

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ECONOMIC MODELING

Partial vs General Equilibrium

Example: a new sales tax on domestically manufactured goods (MFG)

Partial Equilibrium

One market; everything else held constant

- MFG consumer price rises
- MFG quantity demanded falls
- Government collects tax revenue
- …and the analysis stops here

General Equilibrium

All markets linked by prices, incomes, and resource limits

- Workers and capital leave MFG for other sectors
- Other sectors expand; wages and rents adjust
- Lower producer prices make MFG exports cheaper
- Exchange rate and imports respond
- Household income and spending change



Use GE when a shock is large, or spills over across sectors, factors, or economies.

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ECONOMIC MODELING

A Family of Economy-wide Tools

Tool	Strength	Some Limitations
Input–Output (IO)	Simple sector linkages and multipliers	Fixed prices; no resource limits
SAM Multipliers	Adds income flows to households and government	Still fixed prices and demand-driven
CGE Models	Prices, behavior, and resource limits across all markets	Calibrated parameters; stylized timing
Econometric / Time-series / Machine Learning Models	Estimated from time series; short-run forecasts	Little sector detail; weak for new policies or shocks
DSGE Models	Expectations and dynamics; role of money	Few sectors; heavy on assumptions
Microsimulation Models	Household and firm records; distribution	Usually no economy-wide feedback
Partial Equilibrium / Gravity Models	Product-level trade detail; estimated elasticities	One market at a time

These tools are complementary: CGE results can be linked to other models, such as DSGE, microsimulation, or product-level models.

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ECONOMIC MODELING

Three Modeling Philosophies

	Econometric Models	DSGE Models	CGE Models
Parameters from	Regressions on many years of data	Calibration plus estimation (often Bayesian) on macro time series	One balanced base year + elasticities from the literature
Driven by	Patterns observed in the data	Forward-looking agents, price and wage frictions, random shocks	Economic theory: optimizing agents, market clearing
Checked by	Statistical tests and fit	Impulse responses and fit to business-cycle data	Replication, plausibility, and sensitivity analysis
Typical answer	"What will happen next?" (forecast)	"How do shocks and policy spread over time?" (dynamics)	"What difference does the policy make?" (what-if)

A CGE model is a decision-support tool: it compares a world with and without a policy.

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ECONOMIC MODELING

Start from the Question, Then Pick the Tool

How many local jobs does a new factory support?	→ **IO / SAM multipliers**
How will a tariff change trade, output, and welfare across countries?	→ **Global CGE (GTAP)**
What will inflation be next quarter?	→ **Macro-econometric / Time-series / Machine Learning**
If the central bank raises interest rates, how do output and inflation respond over the next two to three years, given that people anticipate future policy?	→ **DSGE**
Which households lose from a VAT reform?	→ **Microsimulation, often linked to CGE**
How will a duty on one product line affect its imports?	→ **Partial equilibrium / gravity**

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Part II:
CGE Modeling and Modeling Approaches

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CGE MODELING

A CGE Model Describes a Whole Economy and How Its Agents and Sectors Interact

MICRO: BEHAVIOR

- Firms: what and how to produce
- Households and other buyers: what to demand
- Factor markets: labor, capital, land
- International trade: imports and exports



adds up to

MACRO: OUTCOMES

- GDP and welfare
- Trade balance and exchange rate
- Savings and investment
- Wages and rents

Micro decisions and macro totals are solved together, so they are always consistent with each other.

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CGE MODELING

“Computable”: From Direction to Magnitude

Real data

Built on official data for a base year

Experiments

Change a policy or condition and solve again

Numbers

Quantified changes in prices, output, trade, welfare

THEORY TELLS US

A consumer subsidy on a good raises the quantity demanded.

A CGE MODEL TELLS US

By how much (“+X%”), and what happens everywhere else.

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CGE MODELING

“General”: Every Market Is Connected

Example: a sales tax on domestic manufactured goods (MFG)

Direct Effects

- Domestic demand for MFG falls
- MFG production and employment fall
- MFG producer price falls

Indirect (General Equilibrium) Effects

- Released workers and capital move into other industries, whose output rises
- Cheaper MFG raises foreign demand for US exports
- The real exchange rate and imports adjust

A CGE model captures both columns at once, and the feedback between them.

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CGE MODELING

“Equilibrium”: The Database Is a Balanced Starting Point

At base-year prices, supply equals demand in every market, and no agent wants to change its choices.

Workers

content with wages and employment

Consumers

content with their basket of goods

Producers

content with inputs and output

Savers

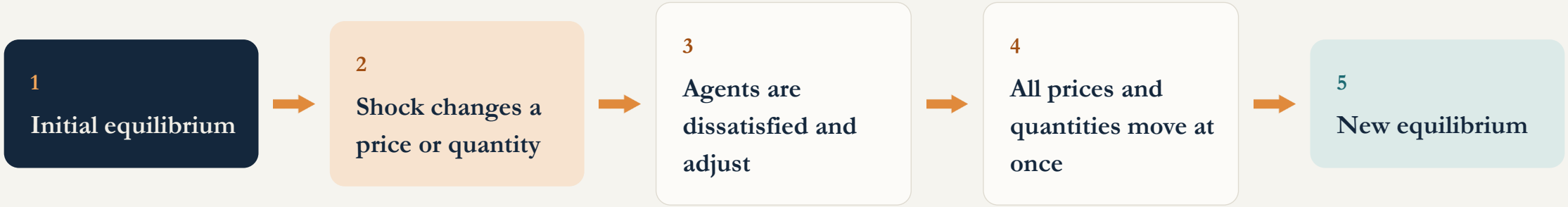
savings fully spent on investment

Every result in the new equilibrium is reported relative to this initial equilibrium (the baseline).

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CGE MODELING

A “Shock” Moves the Economy to a New Equilibrium



EXAMPLES OF SHOCKS

A new sales tax raises consumer prices → people buy less

Higher productivity lowers costs and prices → demand grows

Essential inputs raise producer prices → sales fall

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CGE MODELING

Two Forces Drive Every Adjustment: Behavior and Constraints

Behavior: agents optimize

Consumers maximize utility

given prices and their budget

Producers minimize cost

given input prices, output and technology

Constraints: markets clear

- Supply = demand for every good
- Available workers, capital, and land are employed
- Income = expenditure for every agent
- Global savings = global investment

Constraints are written as **market-clearing equations**: the solution must satisfy all of them at once.

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CGE MODELING

Every CGE Model Has Six Building Blocks

1

Database

A consistent benchmark economy (the SAM)

2

Parameters

Elasticities that govern how strongly agents respond

3

Equations

Behavior, accounting identities, and market clearing conditions

4

Closure

Which variables are fixed and which adjust

5

Shock

The policy changes or external shocks

6

Results

The new equilibrium, compared with the base

Blocks 1–4 are the model. Blocks 5–6 are the experiment.

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CGE Modeling Approaches

Single vs Multi-country Models

Single-country

One economy in detail; the rest of the world is a source of imports and a market for exports

Multi-region (global)

Several regions in detail, linked by bilateral trade and investment flows

Dynamics

Comparative Static

Before vs. after the shock: the closure and calibration imply the adjustment period

Recursive Dynamic

A sequence of static solutions linked by capital accumulation and growth

Intertemporal Dynamic

Forward-looking agents optimize over the whole time path

The core is the same in all of them: optimizing agents, a balanced database, and market clearing conditions.

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Widely Used CGE Models and Software

Model	Software
GTAP (Purdue)	GEMPACK
ORANI / VU models (Australia)	GEMPACK
IFPRI standard model	GAMS
PEP models	GAMS
MIRAGE (CEPII)	GAMS
ENVISAGE / LINKAGE (World Bank)	GAMS
MPSGE.jl: open-source MPSGE for writing CGE models (Lazarus, Phillipson, Anthoff and Rutherford)	Julia (JuMP)
GTAP v7 model in levels (Ivanic, 2025)	Julia (JuMP, Ipopt solver)
WiNDC models of the US economy (University of Wisconsin)	Julia (WiNDC.jl, MPSGE.jl)

Many of these models are built on the GTAP Data Base · Julia packages are free and open source

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Part III:
GTAP and the GTAP Framework

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GTAP: The Global Trade Analysis Project

Founded in 1992 and coordinated by the Center for Global Trade Analysis at Purdue University

A network

Researchers and institutions doing quantitative analysis of global issues

A database

Documented global data for economy-wide analysis

Models and tools

The standard GTAP model, extensions, and software, such as RunGTAP

Training and community

Courses (GTAP 101, short course), an annual conference, a journal

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GTAP

The GTAP Data Base Tells Us Where the Economy Starts

65
sectors

140+
individual countries, plus composite regions

7
reference years, 2004–2023

WHAT IS INSIDE (FOR EVERY REGION)

- Output and intermediate input use by sector
- Household, government and investment demand
- Payments to labor, capital, land, natural resources
- Bilateral trade flows and transport margins
- Taxes, subsidies, and tariffs
- Satellite data: energy, emissions, land use

Figures for GTAP Data Base Version 12 (Journal of Global Economic Analysis, 2025)

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GTAP

The Standard GTAP Model (Version 7) in Eight Features

Global
Many regions linked by bilateral trade

Comparative static
Compares two equilibria: before and after

Perfect competition
Constant returns to scale; zero profits

Armington trade
Goods differ by country of origin

Regional household
Collects all income and splits it three ways

Global bank
Pools world savings; allocates investment across regions

Global transport
Supplies international shipping margins

New in v7
Activities can make several commodities; more tax detail

The regional household, global bank, and global transport are distinctive features of the GTAP approach. Session 2 explores these features in depth.

Corong et al. (2017), "The Standard GTAP Model, Version 7", Journal of Global Economic Analysis 2(1)

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GTAP

One Framework, Many Policy Questions

Policy question	Typical outcomes reported
What happens if tariffs increase?	GDP, trade, sectoral output, welfare
How would a global oil price shock affect the economy?	Prices, output, sectoral impacts
What are the impacts of a carbon tax?	Emissions, energy demand, welfare
What if agricultural productivity rises?	Food prices, output, rural incomes
What if the labor force grows, e.g. through migration?	Employment, wages, GDP
What if farm subsidies are removed?	Output, land rents, exports, trade partners

The model stays the same; only the shock (and sometimes the closure) changes.

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GTAP

Today's Models Are Small on Purpose

NUS333

Exercises 1 and 3

Regions	USA, ROW (rest of world)
Sectors	AGR, MFG, SER
Factors	LAND, LABOR, CAPITAL
Data	GTAP 8.1 database, base year 2007

NIMMIG

Exercise 2

Regions	USA, ROW
Sectors	AGR, MFG, SER
Factors	UNSKILLED and SKILLED labor, CAPITAL
Use	Labor-market questions such as immigration

Two regions and three sectors keep the mechanisms visible. Real studies use larger aggregations of the same database.

Both models run on GTAP Model v7 in RunGTAP

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Part IV:
Social Accounting Matrices

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SOCIAL ACCOUNTING MATRICES

A SAM Records Every Transaction in the Circular Flow

A Social Accounting Matrix is a square table of all income and spending flows among the agents of an economy in one year. Its layout mirrors the structure of the CGE model.

Square

Each account has both a row and a column

Columns spend

A column shows what an account pays out

Rows earn

A row shows what an account receives

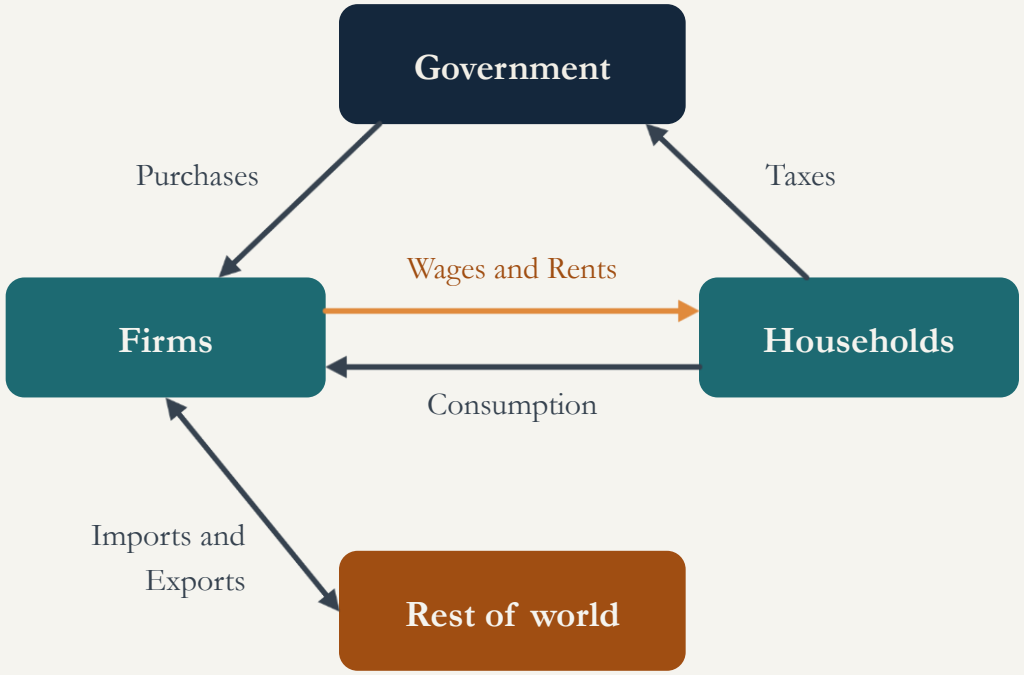
It balances

Row total = column total for every account

Each cell is at once spending by its column account and income to its row account.

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From the Circular Flow to the SAM



Pays → Receives ↓	Firms	Households	Government	ROW
Firms	Inputs	Consumption	Purchases	Exports
Households	Wages, Rents		Transfers	
Government	Taxes	Taxes		
ROW	Imports			

Every arrow in the diagram becomes one cell in the matrix: the column pays, the row receives.

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Why the SAM Must Balance

1

Every payment has a counterpart

A firm's wage bill is labor income to households; an import payment is export revenue to the rest of the world.

2

Every account has a budget

Producers: value of output = input costs + factor payments + taxes. Agents: income = spending.

3

Every commodity: supply = use

What is produced or imported is used at home or exported.

Domestic Output + Imports = Intermediate Use + Final Demand + Exports

A balanced SAM is a consistent initial equilibrium. Only then can the model be calibrated and shocked.

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A SIMPLE GTAP SAM (US$ BILLION)

Reading a SAM: Columns Spend, Rows Earn

	Production	Commodities	Factors	Taxes	Regional HH	Private HH	Government	Savings	ROW	Total
Production		550								**550**
Commodities	300					**150**	75	25	50	**600**
Factors	200									**200**
Taxes	50		25							**75**
Regional HH			175	75						**250**
Private HH					**150**					**150**
Government					75					**75**
Savings					25					**25**
ROW		50								**50**
Total	**550**	**600**	**200**	**75**	**250**	**150**	**75**	**25**	**50**	

Private households **earn** 150 from the regional household (their row) and **spend** 150 on commodities (their column): income = spending.

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A SIMPLE GTAP SAM (US$ BILLION)

What Each Row and Column Records

Account	Row: what it receives (income)	Column: what it pays (spending)
Production	Sales of domestic output: 550	Inputs 300 + factors 200 + production taxes 50
Commodities	Purchases: firms 300, households 150, government 75, investment 25, exports 50	Domestic output 550 + imports 50
Factors	Wages and rents from production: 200	Income tax 25; the rest (175) to the regional household
Taxes	Production taxes 50 + income tax 25	All revenue (75) to the regional household
Regional household	National income 250: net factor income 175 + taxes 75	Splits it: private 150, government 75, savings 25
Private household	Its share of income: 150	Consumption of commodities: 150
Government	Its share of income: 75	Purchases of commodities: 75
Savings	Regional savings 25 + foreign savings 0	Investment goods: 25
Rest of world	Payments for imports: 50	Payments for exports: 50



The **regional household** is GTAP's own account: it collects all income, then splits it three ways.

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A SIMPLE GTAP SAM (US$ BILLION)

Following Production and Supply through the SAM

	Production	Commodities	Factors	Taxes	Regional HH	Private HH	Government	Savings	ROW	Total
Production		**550**								**550**
Commodities	**300**					150	75	25	50	**600**
Factors	**200**									**200**
Taxes	**50**		25							**75**
Regional HH			175	75						**250**
Private HH					150					**150**
Government					75					**75**
Savings					25					**25**
ROW		**50**								**50**
Total	**550**	**600**	**200**	**75**	**250**	**150**	**75**	**25**	**50**	

Production column: 300 inputs + 200 factors + 50 taxes = 550 of output. **Commodity column:** 550 domestic + 50 imports = 600 of supply, sold along the commodity row.

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A SIMPLE GTAP SAM (US$ BILLION)

Following Income through the SAM

	Production	Commodities	Factors	Taxes	Regional HH	Private HH	Government	Savings	ROW	Total
Production		550								**550**
Commodities	300					150	75	25	50	**600**
Factors	**200**									**200**
Taxes	50		**25**							**75**
Regional HH			**175**	**75**						**250**
Private HH					**150**					**150**
Government					**75**					**75**
Savings					**25**					**25**
ROW		50								**50**
Total	**550**	**600**	**200**	**75**	**250**	**150**	**75**	**25**	**50**	

Factors earn 200, pay 25 in income tax and pass 175 on. The **regional household** adds 75 of taxes, then splits its 250: 150 private, 75 government, 25 savings.

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A SIMPLE GTAP SAM (US$ BILLION)

Savings, Trade, and the Initial Equilibrium

	Production	Commodities	Factors	Taxes	Regional HH	Private HH	Government	Savings	ROW	Total
Production		550								**550**
Commodities	300					150	75	**25**	**50**	**600**
Factors	200									**200**
Taxes	50		25							**75**
Regional HH			175	75						**250**
Private HH					150					**150**
Government					75					**75**
Savings					**25**				**0**	**25**
ROW		**50**								**50**
Total	**550**	**600**	**200**	**75**	**250**	**150**	**75**	**25**	**50**	

Savings (25) buy investment goods (25). **Imports = exports** (50), so foreign savings are 0. All row totals equal column totals: the **initial equilibrium**.

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SOCIAL ACCOUNTING MATRICES

The SAM's Role: Benchmark and Calibration

Source data → Harmonize → Reconcile → Balance → **Benchmark SAM**

Calibration: parameters from data

Households spend 150; suppose 15 of it goes on food.

`15 / 150 = 0.10` → budget share for food

With fixed-share preferences, 0.10 *is* the share parameter. Elasticities the data cannot reveal come from the literature.

Replication check

Solve the calibrated model with no shock: it must reproduce the SAM exactly.

RunGTAP's test simulation runs a consistency check and a numeraire test whenever you set up a new version.

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Part V:
GTAP Software and Terminology

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GTAP SOFTWARE

The GTAP Software Toolkit

RunGTAP

Windows interface: choose a version, set closure and shocks, solve, view results

GEMPACK

The solver engine behind RunGTAP; model code lives in TAB files

GTAPAgg / FlexAgg

Aggregate the full database into the regions and sectors you need

ViewHAR / ViewSOL

Open data files (.har) and solution files

TABmate

Read and edit the model's equations (TAB files)

Already done

You installed RunGTAP and ran a test simulation in the set-up session

Today we work only in **RunGTAP**; the other tools run behind it or are for advanced work.

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GTAP SOFTWARE

The CGE Modeling Workflow

1

Policy question

What do we want to know?

2

Mechanism

How would the policy work in the economy?

3

Model Shock

Which variable represents it, and by how much?

4

Data and Closure

Which aggregation, parameters and assumptions?

5

Solve

RunGTAP computes the new equilibrium

6

Results

Read the variables that answer the question

7

Interpretation

Explain why, and what it means for policy

The software does step 5.

Every other step is economic reasoning.

The group exercises follow exactly these steps.

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GTAP TERMINOLOGY

Ten Words You Will Hear All Day

Term	Meaning	Example
Set	A list of elements	REG = USA, ROW
Base Values	Base-year data, in levels (US$ million)	VMSB
Parameter	A fixed behavioral value, usually an elasticity	ESUBVA
Variable	What the model solves for, mostly as a % change	qo, pm, EV
Exogenous	Fixed by the modeler; only these can be shocked	tms, qe
Endogenous	Determined by the model's solution	prices, outputs
Closure	The choice of which variables are exogenous	"Rest Endogenous"
Shock	A change imposed on an exogenous variable	tms +5 points
Version	A database aggregation set up in RunGTAP	NUS333, NIMMIG
Experiment	Saved shocks, closure, parameter file, and solution method	TRDWAR1

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GTAP TERMINOLOGY

How to Read a GTAP Name

Four rules

lower case = % change from base
UPPER CASE = levels (data, EV)

First letter: **q** quantity · **p** price · **t** tax · **a** technology

Indices: (commodity or factor, activity or source, region or destination)

Bilateral flows: first region = **exporter**, second = **importer**

`qxs(MFG,ROW,USA)`
% change in MFG shipped from ROW to the USA

`tms(MFG,ROW,USA)`
US import tariff on MFG from ROW (power of the tax)

`pfe(LAND,AGR,USA)`
% change in the price US farms pay for land

`qe(UNSKILLED,USA)`
% change in the US endowment of unskilled labor

`EV(USA) · VMSB(MFG,ROW,USA)`
Levels: welfare change in US$ million · base value of US MFG imports from ROW

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SESSION 1 RECAP

Three Things to Take into Session 2

1

A CGE model is a **calibrated what-if tool**: it compares a world with and without a policy.

2

The **balanced SAM** is the starting equilibrium; every result is a change from it.

3

GTAP names follow rules: **lower case = % change**, first letter = q, p, t, or a.

Next, 10:30: Inside the Model: Households, Firms, Government, Trade, and Savings and Investment

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