# Foresight Online Economic Modelling Training Course

## Overview

The CGIAR Foresight Initiative aims to **enhance the modeling capacity** of the participants who undertake the courses and the institutions from which they come. From an institutional perspective, it is important to build a solid institutional modeling framework. By **training all three types of model users, i.e. senior policy managers, policy analysts, modeling specialists in an institution, you create a solid capacity for understanding model results; analysts that can run and interpret models; and model specialists that can develop and adapt models.** A cohesive training program, like the one we have developed, sets a framework for good institutional modeling practices. It leads to consistency in model use across the institution with the hope to sustain the institution's capacity over time.

The Foresight Initiative invested in the development of an Online Economic Modeling Training Course. This led to the design of **a modular online training course with seven modules**. These seven modules cover introduction to models and economic modeling, and two separate tracks for multi-market modeling with partial equilibrium (PE) models and computable general equilibrium (CGE) models and modeling.

## Target audience

The course is designed for ministry workers and policy analysts, networks and research institutes, and university students at the master's and doctorate levels and acknowledges three types of model users: (1) Senior policy managers, (2) Regular policy analysts, and (3) Modeling specialists.



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## Requirements

For the course to be efficient and with useful peer exchanges the size of the group of trainees is at minimum 15 and maximum 20 participants.

Trainees/ students of the course will need to take all modules. They will only choose one track, i.e. track A or track B, and lectures to pass each module before moving forward in the course.

During Module 3, students will produce a Capstone Project which will be an application using knowledge and skills they've learned. These projects will be presented to their track cohorts and select, or shortened presentations will be presented in the Virtual Conference.

Software Requirements

- Excel (version 2016 or newer) – need basic knowledge
- GAMS – free license for duration of course provided; do not need previous knowledge of this software (not required until Module 2 and 3 onwards.

Hardware Requirements

- Available PC
- Good internet connection

Time commitment requirement

- Module 0: 50 min presentation
- Modules 1, 2a, 2b, 3a, 3b: each module runs over eight weeks with an estimated time investment of 6-8 hours per week for each of the eight weeks courses.

Additionally recommended

- Teaming up with colleagues to have a peer study partner for discussions and interactions on practical application;
- Being involved in a concrete project that has modeling requirements for hands on application;
- Exchanging ideas as a member of any economic modeling communities for professional growth;
- Connecting through annual conferences, like the American Economic Association Meetings (AEA/ASSA, www.awaweb.org) - in January; Global Trade Analysis Project (GTAP), www.gtap.agecon.purdue.edu - in June; EcoMod, Modeling with Impact (www.economd.net) and Agriculture and Applied Economics Association (AAEA, www.aaea.org) - both in July; European Trade Study Group (ETSG, www.etsg.org) - in September.

The described requirements might also be used for selection and admission to the course to ensure that the cohort of trainees can maximize their learning and exchanges.



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## Course description

**MODULE 0: Introduction Lecture and Course Overview**
This overview video consists of an overview lecture on economic modeling and an overview of the online economic modeling course. It includes discussions on why we need models, how they work, different types of models and model users.

**Module 1: Module Basics**
This module explores micro and macro economic relationships in the Partial Equilibrium/Multi Market Models and the General Equilibrium Models through the exploration of a Social Accounting Matrix (SAM), the 123 Model and CGE Models.

**TRACK A - Partial Equilibrium/ Multi-Market Models**

**Module 2A: Multi-Market Model Setup** In-depth study of a partial equilibrium, single-country multi-market model, including the economic theory that underlies supply and demand behavior, data inputs and key parameters; skill development in the critical assessment of multi-market model results. HANDS-ON: Exercises with a simplified multi-market model.

**Module 3A: Multi-Market Applied Modeling** Build applied skills in defining experiments; evaluating data and parameters; and explaining, critiquing and effectively communicating results, focusing on a multi-market PE model coded in GAMS (i.e. IMPACT-SIMM)

**TRACK B: Computable General Equilibrium Models**

**Module 2B: CGE Model Setup** In-depth explanation of a computable general equilibrium model, including the underlying SAM data and economic theory of supply and demand behavior, data inputs and key parameters; skill development in the critical assessment of GGE model results. HANDS-ON: Exercises with an Excel-interfaced CGE model.

**Module 3B: CGE Applied Modeling**
Training in developing analysis using a static, single-country CGE model in GAMS Studio. Build applied skills in defining experiments; evaluating data and parameters; and explaining, critiquing and effectively communicating results from a CGE model coded in GAMS.

For more details see the attachment or visit the Foresight Portal website.



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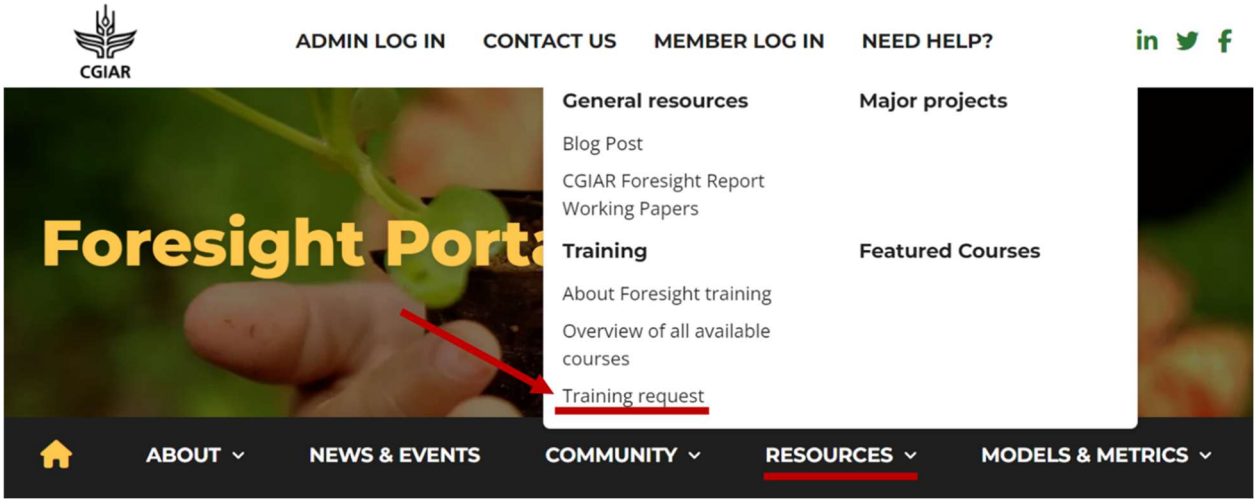
## How to sign up

Please go to our Foresight Portal website and under *Resources* you can make a training request.




We are looking forward to your interest, exchanges, nominations and registrations.

Contact: ????

## Course Modules Details

The illustration figure 1 shows the different modules of the online training course. Each module is described in greater detail afterwards.

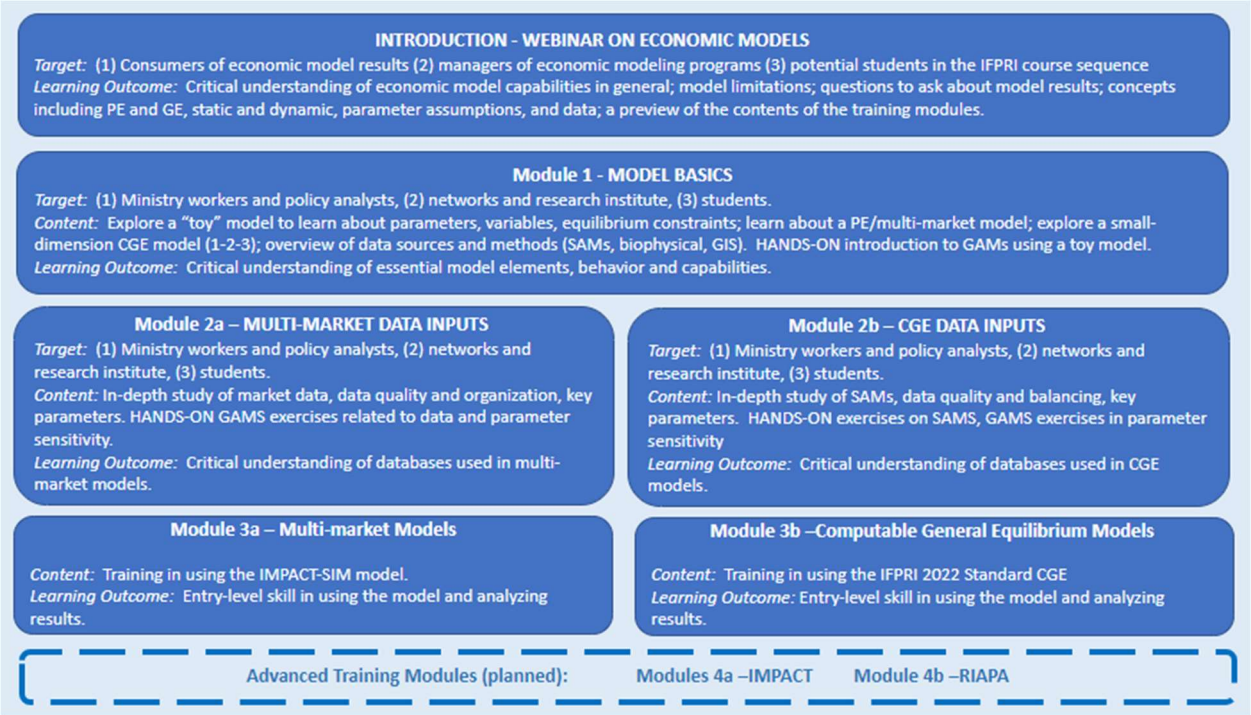



*Figure 1 Overview of training modules*

## MODULE 0 – Introduction Lecture

Module 0 gives an overview on economic modeling and an overview of the online economic modeling course. The lecture is in movie format and hosted outside a password protected course as a free community resource and as an advertisement for the course. Here. Topics include the following:

- Foresight Initiative Goals and Course Developers
- Why do we need models: description of models, types and usage
- Partial equilibrium models: descriptions and examples
- Economy-wide models descriptions and examples
- Identifying 3 types model users
- Overview of the online economic modeling course



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## MODULE 1 – Model Basics

There are eight Units in Module 1. Each Unit consists of approx. 3 lectures of 15-20 minutes in length. Each lecture section has a short quiz as a check of understanding where appropriate. Each Unit also has an exercise which consists of qualitative or quantitative analysis. The lectures are delivered in PowerPoint with an AI voice overs and stored in a MOODLE Learning Management Software.

### Module 1 Outline

| Unit | Content |
|---|---|
| 1_The Economy-wide Context for Economic Policy | • Introducing an economy-wide framework<br>• Introduce a SAM<br>• Discuss circular flow<br>• Think about economy wide policies in the SAM framework |
| 2_Using a SAM to Think about Change | • Introduction to multipliers<br>• Examine IO table within SAM<br>• SAM multipliers<br>• Linear models, CGE models<br>• Fixed prices versus flexible prices<br>• Linear/nonlinear behavior |
| 3_Introducing Partial Equilibrium Models | • Introducing a PE model and its basic assumptions<br>• Multi-market models<br>• Advantages and limitations<br>• Static and dynamic models and analysis<br>• Types of agric-system focused PE models<br>• IMPACT-SIMM: Model history and high-level model structure |
| 4_Important Concepts in Equilibrium Modeling | • Equilibrium/Price-clearing<br>• Own price and income elasticities<br>• Production in domestic markets (incl high-level reference to IMPACT: discussion on certain crops, processing)<br>• Demand (incl high-level reference to IMPACT: household demand, intermediate demand, feed, processing, with link back to SAM)<br>• Trade (incl high-level reference to IMPACT) |
| 5_Exploring Partial Equilibrium Models | • IMPACT projections in IFPRI's GFPR<br>• Interpretation and commentary on GFPR projections<br>• Comparative static analysis: Getting to understand baselines and scenarios<br>• Explore and interpret the types of output products by models such as IMPACT-SIMM |
| 6_1-2-3 Model | • Introduction to the 1-2-3 Model<br>• An intuitive exposition of the 123 model<br>• How to use the 123 Model in Excel Concepts include:<br>a. General equilibrium<br>b. Functional forms<br>c. Elasticity of substitution<br>• Explore a policy experiment using the 1-2-3 Model in Excel |



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| Unit | Content |
|---|---|
| 7_CGE Models: Theory, Features and Small Scale Exercise Model | • Introduction to simple CGE framework<br>• Provide distinction between activities and commodities<br>• Explore factor markets<br>• Explore the addition of government and the rest of the world |
| 8_Full CGE Model Exploration: | • Closure rules and impacts<br>• Macroeconomic and labour market adjustment<br>• Prices. PQ PA PVA PINTA<br>• Savings-investment<br>• Government<br>• Foreign<br>• Labour markets<br>• Equations in simple function form<br>• Elasticities |



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## MODULE 2a – Multi-Market Model Set-Up

In-depth study of a partial equilibrium, single-country multi-market model, including the economic theory that underlies supply and demand behavior, data inputs and key parameters; skill development in the critical assessment of multi-market model results. HANDS-ON: Exercises with a simplified multi-market model. An outline of the proposed content is provided in table below.

### Module 2a Draft Outline

* is material already prepared or needs to be started from scratch

| Unit Title | Readiness Level* | Material covered in each Unit |
|---|---|---|
| 1_Partial Equilibrium Modeling | Covered in module 1, but recap necessary, and tailored to focus on PE modelling | • Rationale for PE modelling<br>  ○ Advantages and disadvantages<br>  ○ Basic assumptions of a PE model<br>• Forecasting vs scenario analysis<br>• Go through some IMPACT analyses (e.g. in GFPR, publications) |
| 2_Multi-commodity Partial Equilibrium Models | Material partially covered in Module 1.<br>Will draw from existing material from previous IMPACT courses, as well as for other PE models | • Explaining commodity detail; FPUs; focus on single-country but mention multi-country model<br>  ○ Maybe some examples of similar partial models?<br>  ▪ IMPACT<br>  ▪ MAGPIE<br>  ▪ Capri<br>  ▪ Aglink-Cosimo<br>  ▪ ESIM (European Simulation Model) |
| 3_Description of the IMPACT/-SIMM Model | Slides to be developed, but will draw from technical documentation of IMPACT-SIMM, and IMPACT<br>Reinforcement of concepts learned in Module 1 | • Coverage: commodities, single-country, and aggregations<br>• Main types of variables analysed<br>• Flow chart of IMPACT-SIMM<br>• Mathematical description<br>  ○ Prices<br>  ○ Crop production<br>  ○ Livestock production; feed demand (use IMPACT) |



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| | | ○ Processed goods (use IMPACT)<br>○ Household consumption<br>○ Demand identities<br>○ Partial equilibrium: what changes<br>• Behavioural parameters: IPRs, elasticites |
| 4_Exercises | Needs to be developed (setting up interface) | • Interpretive: Provide a GDX of IMPACT-SIMM (copied to Excel), and ask users to retrieve and interpret projections |
| 5_Data Requirements | Needs to be developed | • Starting point data: ensuring models capture key features of the commodity market<br>○ FAOSTAT<br>○ DSSAT<br>• What kinds of results are produced? Which are most often used? |
| 6_Data and Parameter Sensitivity | Develop Excel interface for IMPACT-SIMM using latest IMPACT baseline for a specific country (Zambia?) | • Simulation exercises run in an Excel interface linked to IMPACT-SIMM: Alternative scenarios of macroeconomic development, yields<br>• Analytical exercises:<br>○ Do results make sense? (Exercises include critical evaluation of projected growth rates)<br>○ Cereals vs animal-sourced foods<br>○ Oilseeds vs cereals<br>○ For what crops is land being allocated?<br>○ Trends in net trade. What does this mean about production in relation to consumption?<br>• Deeper interpretive exercises: How to communicate simulation results?<br>○ Key assumptions underlying the baseline<br>○ Description of scenario<br>○ Consumption growth by key commodities |

| | | |
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| | | ○ Production growth by region (make sure to provide a SIMM model with enough FPUs)<br>○ Index values vs ratios (exercises include comparing absolute growth with per capita growth)<br>○ Using visualization effectively (exercises include presenting a transition in the composition of HHD demand for food commodities?) |
| 7. Modelling to Analyze Policy and Investment Alternatives | | • What is a reference scenario?<br>○ Defining and designing scenarios: what data needed to make an informed, plausible scenario<br>○ Simulation exercise in a bigger IMPACT-SIMM model: alternative investment/climatic scenarios?<br>○ Post solution indicators |

## MODULE 2b – CGE Model Set-up

In-depth explanation of a computable general equilibrium model, including the underlying SAM data and economic theory of supply and demand behavior, data inputs and key parameters; skill development in the critical assessment of GGE model results. HANDS-ON: Exercises with an Excel-interfaced CGE model. An outline of the proposed content is provided in table below.

### Module 2b Draft Outline

*is material already prepared or needs to be started from scratch

| Unit Title | Readiness Level* | Material covered in each Unit |
|---|---|---|
| 1_Simple macroeconomic CGE Model | Preliminary presentations and exercises are available. | • The 123 Model |
| 2_Simple microeconomic CGE Model | Most of the work will be adapting them to the current formats and content. | • Production and exchange<br>• Equations/ variable/ parameters<br>• Over-identification of model<br>• Walras law<br>• Numeraire/ relative prices |
| 3_Adding intermediates and Savings and Investment | The narration has been drafted (first round). | • Intermediates<br>• Savings and investment<br>• SI Closures |
| 4_Adding Factor Markets | | • Fixed and flexible aggregate employment<br>• Factor mobility and immobility<br>• Sector specific wage rates |
| 5_Adding Government and Trade | | • Government expenditure, revenue and savings<br>• Exports, imports, the exchange rate and foreign savings |

| | | |
|---|---|---|
| 6_Real World Modelling | Material is mostly ready. Adaptation and narration required. | • Reviewing the standard model |
| 7_and 8_Policy Simulations | Suitable applications have to be developed and adapted for teaching | For example<br>• Tariff removal<br>• Productivity shock<br>• Foreign aid shock<br>• Climate Change |

## MODULE 3a – Multi-Market Applied Modeling

Build applied skills in defining experiments; evaluating data and parameters; and explaining, critiquing and effectively communicating results, focusing on the following objectives:

- Participants can navigate, load, and understand a multi-market PE model coded in GAMS (i.e. IMPACT-SIMM)
- Participants demonstrate an understanding of the GAMS project flow, including data and model calibration, initial solves, baseline assumptions and validation, scenario design, and scenario analysis
- Participants can replace pre-loaded data in IMPACT-SIMM using different methods (direct entry, gdxxrw, etc.)
- Participants can define, code, and critically evaluate scenarios in IMPACT-SIMM
- Completion of a capstone project that will be presented to the class

### Module 3a Draft Outline

* is material already prepared or needs to be started from scratch

| Unit Title | Readiness Level* | Material covered in each Unit |
|---|---|---|
| 1_Brief description of the GAMS environment | Should be merged with Unit 1 of Course 3b? | • Overview of GAMS and GAMS Studio/IDE<br>• Sets, variables, parameters, functions<br>• GMS, INC and GDX files<br>• GAMS features relevant for IMPACT: multiple dimensions, $include, sets, $ operators, conditional expressions, GDX utilities |
| 2_Under the hood: IMPACT-SIMM in GAMS | | • File structure: From a black box to modules<br>• Main model description: Side-by-side comparison of mathematical and GAMS equation in PS-IMPACT.inc<br>• Data and model calibration, initial values<br>• Assumptions for projections<br>• Model solution: Objective functions, constraints, loop statements, result parameters, save and restart, output reports, solvers<br>• Baseline validation |

| Unit Title | Readiness Level* | Material covered in each Unit |
|---|---|---|
| 3_How to prepare data for IMPACT-SIMM | | • Participants provided an IMPACT-SIMM model for a country to do exercises<br>• Data exercise: Replace the population growth estimates in IMPACT-SIMM |
| 4_Scenario analysis: Coding shocks to IMPACT-SIMM parameters in GAMS | | • What makes an informed, realistic shock?<br>• Design a coded shock in IMPACT-SIMM.<br>• Error handling: Common errors, strategies |
| 5_Checking uncertainty | | • Sensitivity analysis<br>• Applications: Probabilistic scenarios of climate change |
| 6_Participants create their own IMPACT-SIMM model for an IMPACT baseline (Need to check with IMPACT team for permission to use an old IMPACT baseline)<br><br>7_CAPSTONE project to present to class | | |

## MODULE 3b –Computable General Equilibrium Applied Modeling

Participants will build applied skills in defining experiments; evaluating data and parameters; and explaining, critiquing and effectively communicating results. Objectives include developing an understanding of:

- Behavioral relationships in a CGE model
- Properties of functional forms commonly used in CGE models
    - Cobb-Douglas functions
    - Constant Elasticity of Substitution (CES) functions
    - The Linear Expenditure System
- Model calibration given the transaction data in a SAM and assumptions about behavior
- How to formulate appropriate simulations for the policy question of interest
- How to write experiments in GAMS
- How to interpret results
- How to present results with an intuitive explanation of the links between the policy shock and the observed changes in model variables
- Completion of a capstone project that will be presented to the class

### Module 3b Draft Outline

*is material already prepared or needs to be started from scratch

| Unit Title | Readiness Level* | Material covered in each Unit |
|---|---|---|
| 1_Introduction to GAMS Studio and basic GAMS | Material is mostly ready. Adaptation and narration required. | • An introduction to GAMS Studio (beginners notes for self-study)<br>• Introducing GAMS<br>• Coding a simple supply and demand model |
| 2_Further basic GAMS | Material is mostly ready. Adaptation and narration required. | • Loops<br>• Fixing errors<br>• Moving from mathematical statements to GAMS code<br>• Displaying and Transforming Results<br>• GAMS output files<br>• Useful GAMS commands<br>• GDX/GDXXRW<br>• Good modeling practice |



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| Unit Title | Readiness Level* | Material covered in each Unit |
|---|---|---|
| 3_Revisit the IFPRI Standard Model and simulations run in Module 2b using GAMS rather than the Excel interface | Material is mostly ready. Adaptation and narration required. | • Participants to complete gaps in the code of model<br>• Set up experiments in GAMS to replicate scenarios developed in Excel in Module 2b. |
| 4_Review the more detailed IFPRI SAMs to be used in this module | Suitable applications have to be developed and adapted for teaching | • Introduction to NEXUS and other SAMs |
| 5_Review a sample of previous studies done using the IFPRI SAMs | Suitable applications have to be developed and adapted for teaching | |
| 6_Replicate results in one of the studies presented | Suitable applications have to be developed and adapted for teaching | • Read the IFPRI SAM into the CGE model<br>• Check model solution reproduces the base |
| 7_Replicating and interpreting a previous study | Suitable applications have to be developed and adapted for teaching | • Design, code and run the simulation<br>• Verify the results from the study<br>• Interpret the results |
| 8_CAPSTONE: Develop a modest extension of the study | Suitable applications have to be developed and adapted for teaching | ○ Design the simulations<br>○ Run the simulations<br>○ Interpret results |
| 9_CAPSTONE Analysis: Write a report based on the extensions done in Unit7 | Suitable applications have to be developed and adapted for teaching | Report components:<br>• What is the policy question?<br>• How the question was represented as a shock to the model?<br>• What are the key findings?<br>• Explain the results intuitively |