

Introduction to computable general equilibrium (CGE) Modelling

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Outline of the presentation

- 1) Scope of CGE models
- 2) Implementation of a CGE model
- 3) Different kinds of CGE models
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1 .Scope of CGE models (1)

- CGE modeling is by nature an ex-ante approach used to explore future impacts of a given policy which is different from gravity modeling for example where the modeler uses ex-post analysis.
- CGE models show how different sectors inside one economy are linked and how multiple economies are connected to each other, and how resources such as labor, capital and natural resources are best allocated across all economic activities.
- One of the main motivations underlying their use is to be able to consider **large scale policy changes** using the present economy as a benchmark.
- CGE models are generally preferred to partial equilibrium models when the scope of the economic policy experiment is large and when inter-market linkages, budget constraints and real exchange rate effects are expected to be particularly important.
- Trade policy generally presents the latter characteristics, especially when it comes to examining the effects of trade liberalization, regional integration or the implementation of a customs union.

1. Scope of CGE models (2)

- The main advantage of using a CGE model lies in the possibility of combining detailed and consistent databases with a theoretically sound framework, able to capture feedback effects and market interdependencies that may either mute or accentuate first-order effects
- One popular field of research has been to quantify the macro, employment, allocation and welfare effects of changes in terms of foreign trade and changes in taxation policy. The environmental effects of energy production, effects of regional policy changes and regional effects of large infrastructure investments have also been studied using CGE model simulations
- Most developed countries now have at least a national CGE model.

2. Implementation of a CGE model (1)

Building a CGE model can be decomposed into three main steps that bring together three different skills of the modeler:

- 1) Model specification is mainly a theoretical work based on the economic theory
- 2) Model calibration consists of collecting and harmonizing the data, most often in the form of a SAM, and assigning values to the parameters of behavior.
- 3) Resolution of the model, that is the mathematical transcription of the theoretical model in a programming language and the implementation of the scenarios are essentially of a computer nature

2. Implementation of a CGE model (2)

1) Step of the model Specification:

To accomplish this step, one needs to understand truly the structure of the economy by addressing five main aspects:

- How do goods and factors flow through the economy?
- In each sector, how does production take place?
- In each industry, how does the market structure look like?
- At the consumer level, how does consumption take place?
- Who owns which factors of production and firms?

2. Implementation of a CGE model (3)

2) Step of the model Calibration:

- The modeler has to gather data on the endogenous and exogenous variables of the model in the form of a SAM for a particular geographical entity and year
- The building process of the SAM is not an easy task particularly because the modeler has to harmonize heterogeneous data coming from different available sources.
- The modeler has to reduce the space of unknown parameters by exogenously specifying elasticity values, which are usually based on previous literature estimates because the benchmark data only give price and quantity observations associated with a single equilibrium.

3) Step of the model resolution:

This step consists in solving the model as a system of non linear equations using GAMS Software or any other appropriate softwares

3. Different kinds of CGE models (1)

- Differences across models reflect differences in the theory behind the behavioral equations, the extent to which linkages within the economy are explained, and the data used to conduct the analysis.
- In the empirical literature, we distinguish a variety of CGE models: Static versus dynamic, single country, regional and global CGE

Static versus dynamic CGE models:

- In their static form, the impact of a policy reform such as a tariff reduction is assessed by comparing equilibrium properties before and after that reform. In other words, Static CGE models don't reveal the path of the economy from the benchmark equilibrium to the new equilibrium when a shock enters.

3. Different kinds of CGE models (2)

- The distinguishing feature of a dynamic CGE model, however, is that growth of output is possible and changes due to policy reforms can be tracked over a given period of time.

There are two types of Dynamic CGE models:

- Recursive dynamic CGE models

- They consist of multiple static models linked to each other sequentially.
- The underlined assumption is that current economic conditions are dependent on past outcomes but are unaffected by forward-looking expectations.
- Some of the variables in the model may evolve exogenously following a pre-determined baseline scenario (for example population demography, productivity)

3. Different kinds of CGE models (3)

- Inter-temporal dynamic CGE models

- These models are based on optimal growth theory, where the behavior of economic agents is characterized by perfect foresight.
- The underlined assumption is that current economic conditions are dependent on past outcomes but are unaffected by forward-looking expectations.
- Households choose a consumption plan (a sequence of consumption decisions) during the period under consideration that maximizes the discounted stream of their utilities. This means that in some periods households may consume more than they earn (dissave), while in other periods they may consume less than they earn (save).
- Firms choose a production plan (a sequence of production decisions) that maximizes their discounted stream of profits.

3. Different kinds of CGE models (4)

Single country CGE models

- The single country CGE models are the most used CGE type to tackle various issues of economic policies. This is because decision makers are generally interested on details and would like to have models as detailed as possible.
- This kind of model has been used extensively to analyze external sector issues as the impact of restrictions on foreign trade or the impact of changes in net foreign transfers or world prices on the equilibrium of the real exchange rate.
- The single country CGE model has also been used widely to explore the likely effects of trade liberalization. We can cite the examples of Tunisia-UE or Morocco-UE.
- The main drawback behind their use to treat trade issues is that they tend to overestimate the impacts on welfare of trade liberalization.

3. Different kinds of CGE models (5)

- The reason that underpins this overestimation is related to the modeling of trade. Indeed, it is assumed that the partner of Tunisia or Morocco which is in this case Europe has an infinite demand function of imports. That is the restrictions imposed by Europe on Tunisian or Moroccan exports cannot be modeled explicitly. In this case, the modeler can only impose a weak value of the elasticity of transformation to express a difficulty of exporting to the EU.
- The impacts on welfare of trade associations between Tunisia or Morocco with the EU using Regional or global CGE models are found to be much weaker than those obtained using a single country CGE model because in these kind of models trade restrictions imposed by the EU can be introduced explicitly.

Regional CGE models

- Regional trade CGE models add to the previous single country models the desire to examine the interactions or the impact on welfare between two or few number of countries or regions with the distinction of the Rest of the World as a big partner.

3. Different kinds of CGE models (6)

- The rest of the world is still considered as a big residual partner and world prices are set exogenously
- Import demand and export supply are however endogenous.
- When the model is actually used, the within country and between country relationships are solved simultaneously.
- The model database consists of SAMs for each country, including data on their trade flows.
- The literature covers several regional trade CGE models implemented to tackle various issues. For example, Elbehri and Hertel (2004) have conducted a study focused on Morocco, where the effects of a preferential, bilateral liberalization process with the EU are assessed, then compared with those from a multilateral liberalization scenario for Morocco.

3. Different kinds of CGE models (7)

- Ben Hammouda et al. (2007) estimate the impacts of the Tunisian, Moroccan and Egyptian bilateral agreements with the EU jointly in a regional CGE model using “MIRAGE”.
- The authors examine whether broadening the agreements’ coverage to include agriculture could mitigate the losses for North African economies. The answer is negative and none of the measures envisaged to reduce distortions in agriculture manages to yield positive welfare effects for North African economies
- Global CGE models
- Typically a global CGE links all countries through a set of import and export demand. The interaction between them determines a new equilibrium for prices and quantities of goods in the world.

3.

3. Different kinds of CGE models (8)

- In this kind of CGE model, there are no exogenous commodities prices, since the model is global. Any price or quantity change in any country inside the model must generate changes in the overall world equilibrium, and a new equilibrium must be computed.
- In a single country CGE modeling, the small country assumption holds, that is world prices are supposed exogenous whereas in global CGE models, they are by definition endogenous
- A global approach has the unquestionable advantage of taking into account within the same theoretical structure the trade relationships of all countries or groups of countries in the world, such as the EU, the USA, China, India and Africa.
- Accordingly, it is very important to have a consistent economic global database that covers all parts of the world

3. Different kinds of CGE models (9)

- GTAP has been created to satisfy this need. It is a global network of researchers who conduct quantitative analysis of international economic policy issues, especially trade policy.
- The latest version of the GTAP database, GTAP 9.0 is a large social account matrix (SAM). It contains complete bilateral trade information as well as transport and protection linkages among 170 countries or groups of countries and 57 sectors for the base years 2004, 2007 and 2011.
- The most used large- scale global CGE trade models are GTAP and MIRAGE. They have been constructed in order to assess the impact of globalization on the individual regions in the global economy.
- In 2015, a new global CGE trade model has been built by OECD known as METRO (Modelling TRade at the OECD)

4. Different kinds of CGE models (10)

- The METRO database currently covers 61 economies across 57 economic sectors. It is based on the GTAP database and allows users to analyze global value chains (TiVA) by drawing on the OECD-WTO Trade in Value Added database.
- Using METRO, it is now possible to track trade flows by their use (intermediate, household, government and investment) in addition to the bilateral links between source and destination markets. This will greatly enhance the ability to model movements of goods and services, especially along global value chains.
- It is also possible to use this global CGE model to assess the impact of global free trade on the countries' welfare and the distribution of income across the regions.

3. Different kinds of CGE models (11)

- It's also important to highlight that a combination of a single country CGE and a global one can be done when the raised issues necessitate it.
- The interest in this kind of application is growing in recent years, and encompasses a wide range of theoretical as well as practical questions.
- The linkage between the global and the single CGE models can be useful for example when the first determines the new world prices following a given shock which can be transmitted to the single country CGE and feed backs are also possible.

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THANK YOU