

$$1 - \left(\sum_i \text{abs}([M_{ij} / M_i] - [X_{ij} / X_i]) \right) / 2$$

$$\sum_p t_{mp} u_{mp}^0 (m_p^1 - m_p^0)$$

$$t_{mp} = \sum_{m \in M_p} \left(\frac{M_{m,p} I_m}{\sum_{m \in M_p} M_{m,p}} \right)$$

$$\sum_p x_p^E (u_{xp}^1 - u_{xp}^E) - \sum_p m_p^E (u_{mp}^1 - u_{mp}^E)$$

Methodology for Impact Assessment of Free Trade Agreements

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Foundations for Computable General Equilibrium Analysis

Foundations for Computable General Equilibrium Analysis (cont'd)

- For analytical tractability, theoretical models of FTAs have usually restricted the number of countries and goods in the analysis.
- They have also ignored characteristics like **economies of scale** or **imperfectly competitive markets** for the most part.
- To overcome **these limitations** and to provide more relevant policy advice, researchers have turned to **computer-based modeling**.
- This type of modeling can include **any number of commodities** and **partner countries** or economic features provided there are no data or memory restrictions.
- These computer-based models frequently perform **general equilibrium analysis** with many dimensions.
- General equilibrium analysis takes account of all **the important interactions between markets** and can give **more complete and precise answers** to policy questions.

Foundations for Computable General Equilibrium Analysis (cont'd)

- There are several reasons to use CGE models for the analysis of FTAs.
- First, CGE modeling is based on explicit assumptions in a framework **consistent with microeconomic theory**.
- Second, as CGE models produce **quantitative results** that are **clear and exact**, **policy makers** can more **easily assess who gains and who loses** from an FTA.
- Third, as an FTA involves changes in trade policy in **multiple markets**, the analysis may be **too complex using algebraic or geometric methods**.
- Lastly, CGE analysis may generate fresh insights about the **role of certain economic assumptions** in determining the results of an FTA.

Foundations for Computable General Equilibrium Analysis (cont'd)

- There are **several other ways by which one market is linked to other markets**. A change in the price of a good in a particular market will **affect the quantity demanded for related consumption goods** (substitutes or complements) and the **demand for production inputs, such as raw materials, labor, machinery, and factory premises**.
- In turn, this may **change the incomes of different households** and their **demand for other goods and services, some of which may be imported**.
- This may also change the **government's budget**, particularly in terms of **tax revenue** and **government subsidies**. For an open economy, equilibrium must also hold in terms of the balance of payments.

Foundations for Computable General Equilibrium Analysis (cont'd)

- The crux of general equilibrium analysis is that no market remains with excess demand or supply, i.e., **circular flows of income and expenditure must all be balanced**.
- To achieve market equilibrium, **prices are assumed to adjust until demand for factors of production equals available endowments**, consumers have chosen the desired basket of goods given their incomes, and firms have chosen production levels that maximize their profits.
- Because an FTA introduces a set of policy changes in an economy, CGE models simulate an economy where **markets have adjusted** and **a new general equilibrium has been reached**.
- The effect of an FTA can be estimated by **comparing welfare** under the old equilibrium with that under the new equilibrium.

Foundations for Computable General Equilibrium Analysis (cont'd)

- A CGE analysis is a study of **these market linkages** using **mathematical modeling** and **real world data** from **a benchmark year**.
- The mathematical modeling is based on a set of **neoclassical economic assumptions** about the motivation of agents in the economy, market structure, consumer preferences, production technology, and market equilibrium conditions.
- These assumptions are coded in mathematical functions and equations, which contain **parameters** that capture **important behavioral relationships**.
- In a CGE model, most of these parameters are **elasticities** (i.e., they measure the **responsiveness of one variable to changes in another**) or share parameters, such as the share of consumption demand in aggregate demand.
- Some of these parameters will have known values while others will have to be calibrated in the mathematical model with real-world data.
- **Calibration** is a step in CGE analysis when values are selected to make the CGE model's output agree with real-world data from the benchmark year.

Foundations for Computable General Equilibrium Analysis (cont'd)

- A CGE model essentially captures demand and supply in each sector and **the linkages among sectors**. The model has **exogenous variables** (i.e., variables that have given values determined outside the model) and **endogenous variables** (i.e., variables that are solved within the model).
- In the analysis of **an FTA**, the exogenous variables typically correspond to the **trade policy variables**, elasticities, and share parameters.
- The rest of the variables in a CGE model of an FTA are endogenous variables, such as prices, import and export volumes, household income, tariff revenue, consumer surplus, and producer surplus.

Characteristics of Agents in a Typical Computable General Equilibrium Model

Characteristics of Agents in a Typical Computable General Equilibrium Model

- A CGE model will typically have **three agents: firms, consumers, and government**. Firms produce output, which is purchased by consumers and the government.
- Firms are profit maximizers and use market prices in deciding how much output to produce and with which inputs. In the typical CGE model, each sector has only **one firm** that **produces a single good**.
- The sector's production is represented by a production function, which shows the relationship between inputs and output. Various functional forms, such as the Cobb–Douglas, Leontief, or constant elasticity of substitution functions, may be used to model production in a CGE model.
- These production functions are usually assumed to exhibit **constant returns to scale** and to be weakly separable between primary factors and intermediate inputs.

Characteristics of Agents in a Typical Computable General Equilibrium Model

- Further, these production functions will include parameters called **elasticities of substitution**, which define the substitutability of one input for another.
- The elasticities of substitution are therefore an **important determinant** of demand for various inputs.
- In addition, production in a CGE model typically involves a **multilevel or nested production** process.
- The use of a nested structure allows for differing elasticities for each pair of factors and makes it easier to incorporate intermediate inputs into the analysis.

Characteristics of Agents in a Typical Computable General Equilibrium Model

- **Consumers** are often modeled with reference to a **representative household**.
- Market prices factor into the decisions of the representative household (i.e., consumers' decisions) on how much of each good to purchase.
- Consumers are **utility maximizers** and their preferences are captured by utility functions, which include parameters that capture **the elasticities of substitution** between final goods.
- Consumers also act as factor owners in a CGE model. They are endowed with **capital, land, labor, and other factors** of production. Based on market prices, **they supply their factors and receive income in return**.
- This income is used to **purchase goods, pay direct taxes** (e.g., income tax) and **indirect taxes** (e.g., import tariffs and sales tax) and, in dynamic CGE models, some of this income may be saved.

Characteristics of Agents in a Typical Computable General Equilibrium Model

- In a CGE model, the government administers only market-related policies, such as **taxes**, **subsidies**, trade **tariffs**, and **quotas**. The government is often assumed not to have an objective function.
- For this reason, and because the effects of government policies are of primary interest, policy variables often enter exogenously into CGE models.

Computable General Equilibrium Models of International Trade and Free Trade Agreements

Computable General Equilibrium Models of International Trade and Free Trade Agreements

- Commonly, CGE models are used to evaluate the effects of trade policy because policy makers require quantitative assessments of the impacts of any policy in order to make decisions.
- As we have seen, economic theory only provides **qualitative conclusions**, which are sometimes **ambiguous**.
- For example, in the case of FTAs, trade creation and **trade diversion** have **opposing effects on welfare**, so the net effect may be positive or negative.
- CGE models provide an empirical foundation for policy analysis that **can quantify the magnitudes** of the effects identified by theory, and suggest the likely **net welfare effect**.

Computable General Equilibrium Models of International Trade and Free Trade Agreements (cont'd)

- In CGE models of international trade, the set of goods available to firms, consumers, and government includes imported goods. For a particular good, the **imported and domestically produced varieties** are typically modeled as **substitutable** but **not perfect substitutes**.
- Besides relative prices, the choice between the **domestic** and the **foreign variety** of a good depends on a parameter known as the **Armington elasticity**.
- This parameter distinguishes goods by their national origin and captures the **substitutability** between **goods from different countries**.
- Armington elasticities are of **key importance** in **determining the impact of trade policy in CGE models**.
- They also produce **more realistic trade responses** than models without national differentiation.
- Further, the use of these **elasticities results in intra-industry trade** (i.e., a country imports and exports different varieties of the same good).
- Another advantage of the **Armington assumption** is that **complete specialization does not occur**.

Computable General Equilibrium Models of International Trade and Free Trade Agreements (cont'd)

- To simulate an FTA, the CGE modeler must first make sure that the model is producing outcomes that match the actual observed values of endogenous variables, such as prices or trade volumes, to recreate the baseline situation.
- Once this is achieved, simulating an FTA is simply a matter of **setting trade barriers to zero** between FTA partners in the model and running the model to produce new estimates. The **simulation represents what the economy would look like if the FTA had occurred**. By comparing post-FTA outcomes with the baseline situation, the modeler can study
 - (i) changes in **welfare** (changes in consumer and producer surplus or other welfare indicators, such as **equivalent variation**);
 - (ii) changes in the **terms of trade** of each partner and the FTA as a whole;
 - (iii) changes in **production by sector**;
 - (iv) changes in the **returns to the factors of production** (i.e., labor by skill, capital, landowners);
 - (v) changes in **imports** and **exports** by sector and by partner.

Computable General Equilibrium Models of International Trade and Free Trade Agreements (cont'd)

- Table 1.1 summarizes the effects of key economic variables of any FTA that can be simulated by a CGE model. The modeler may also wish to **compare the potential effects of different possible FTAs with different partners, different scenarios** that may include or exclude different sectors, or **combinations of trade agreements**.
- By comparing the welfare outcomes of all scenarios, a policy maker would be able to determine the scenario that benefits a country the most.

Table 1.1 Summary of Free Trade Agreement Effects Generated by Computable General Equilibrium Models

Impact on welfare: Yes (estimated via equivalent or compensating variation)

Impact on production: Yes (disaggregated and aggregated)

Impact on factor returns: Yes (e.g., effects on skilled and unskilled labor, capital, land)

Impact on price: Yes (by sector, terms of trade)

Impact on trade volume: Yes (aggregated and disaggregated, imports and exports, changes in trade balances)

Impact on custom income: Yes

Impact on "dynamic" variables: Depends (some models don't; some include economies of scale/imperfect competition, changes in capital flows, foreign direct investment, productivity spillovers)

Limitations of Computable General Equilibrium Analysis of Free Trade Agreements

- The use of CGE analysis entails a number of problems.
- First, the **data requirements** for CGE analysis of FTAs are **extensive**, and frequently certain data items are arbitrarily picked by the modeler.
- Second, the model's results may be **very sensitive** to **the assumptions** and **data used**. To address these first two concerns, almost all CGE exercises include a **sensitivity analysis** to obtain **a range of results based on different assumptions** or data. In this way, the modeler can check **the robustness of the results**.
- A third problem with CGE analysis is **the lack of a time dimension**. A CGE analysis of an FTA **will not provide results on how long it will take** for economies to adjust and reach the new equilibrium. Recent work in CGE modeling has attempted to include **some dynamic effects via financial markets**, but it is a long way from capturing the dynamic features that are most relevant to FTAs.
- Fourth, it is **difficult to model** certain **non-tariff barriers** to trade, such as sanitary, phytosanitary, and technical barriers, or customs issues if these are included in an FTA. Moreover, incorporating the level of production on **trade in services** is **challenging due to the lack of data**.
- Last, while some modelers have tried to **endogenize productivity spillovers** in CGE models—which we believe to be **extremely important**—this is an extremely complicated operation.

Various Study Results by Computable General Equilibrium Models

Various Study Results (cont'd)

- To give an idea of the magnitude of the effects generated by the computable general equilibrium (CGE) model, we briefly review a few studies of various free trade agreements (FTAs) and economic cooperation initiatives in the Association of Southeast Asian Nations (ASEAN) and the Asian region.
- Lee, Roland-Holst, and van der Mensbrugghe (2001) estimate the likely impact of Asia-Pacific Economic Cooperation (APEC) trade liberalization on real gross domestic product, sectoral output, exports, and imports.
- Their model predicts that real gross domestic product would increase by about \$42 billion for developed APEC member economies and \$83 billion for developing APEC member economies. Overall, APEC trade liberalization would produce trade expansion in most product categories.
- Park (2008) considers the impact of various potential East Asian FTA strategies. He models several different FTA scenarios, including the ASEAN Free Trade Area (AFTA) and ASEAN agreements with Northeast Asian partners.
- He finds that AFTA will generate a positive effect for ASEAN economies, but that their gains from trade would rise if it were to couple ASEAN integration with other Asian regional trade agreements.

Various Study Results (cont'd)

- Larger results are obtained when CGE models include “dynamic” features and modern elements of FTAs that go beyond the mere focus on tariff and non-tariff-barrier liberalization to include trade facilitation, “best practices,” and other behind-the-border measures.
- Brooks, Roland-Holst, and Zhai (2005) run simulations to show the important differences between “traditional estimates” (induced by liberalization of tariff and tariff-equivalent non-tariff barriers) of gains due to trade liberalization in Asia (Scenario 1) and more general trade cost-reduction effects such as improving customs clearance, lowering transaction costs, and facilitating international market access (Scenario 2).
- They find that under Scenario 1, real income rises in the range of 0.9%–2.9% for East Asia, 1.9%–6.6% for Southeast Asia, and 0.3%–0.6% for South Asia. Such magnitudes are fairly standard in the literature.
- Under Scenario 2, the gains are much larger: 8.1%–53.8% for East Asia, 35.5%–116.6% for Southeast Asia, and 10.4%–22.4% for South Asia.
- The lesson here is that the removal of traditional trade measures—tariffs and non-tariff barriers—is likely to be less significant in improving efficiency and welfare for FTA partners than trade facilitation initiatives.

Various Study Results (cont'd)

- Finally, in estimating the potential effects of the ASEAN Economic Community (AEC), Plummer and Chia (2009) use a CGE model and other techniques to show that there are large attendant benefits to creating a unified market in Southeast Asia, including for the “CLV” countries—Cambodia, the Lao People’s Democratic Republic, and Viet Nam.
- They find that
 - (i) ASEAN economic welfare should rise by 5.3%, or \$69 billion, which is more than six times what the estimated effect of completing AFTA would be;
 - (ii) all ASEAN countries gain from the AEC project, though obviously some gain more than others—Cambodian welfare rises by 6.3%, whereas the Lao People’s Democratic Republic gains by 3.6% and Viet Nam by 2.8%;
 - (iii) the AEC will lead to a robust expansion in ASEAN trade in goods, with exports outpacing imports in all but three manufacturing sectors;
 - (iv) extending the AEC to include “+1” agreements with its East Asian neighbours increases the aggregate welfare benefits to ASEAN by two-thirds, and by an additional one-third if the United States and the European Union are added.
- This is particularly important for Viet Nam as it gains the least under the AEC scenario.
- The extension of the AEC to other East Asian partners, the European Union, and the United States makes Viet Nam the biggest beneficiary from economic cooperation.