

Macroeconomics, Trade & Investment

MTI Practice Notes

Using Computable General Equilibrium Models to Analyze Economic Benefits of Gender-Inclusive Policies

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Introduction

Computable general equilibrium (CGE) models are economy-wide simulation tools that can be very useful in answering the policy questions related to closing gender gaps. They allow us to estimate the contributions of gender-inclusive policies, quantify costs and benefits of associated reforms for policy prioritization, identify winners and losers of suggested reforms, and understand transmission channels. They also allow us to estimate distributional and sectoral impact of economy-wide shock such as the containment measures to mitigate the spread of COVID-19. Until now, the MTI Macroeconomic modeling team and Africa Gender Innovation Lab (GIL) have collaborated to improve the existing modeling approaches to incorporate gender gaps in these models. The results so far have been encouraging in quantifying the aggregate benefits of closing the gender gaps and allowing a better policy dialogue with stakeholders.

Achieving gender equality is one of the Sustainable Development Goals (SDGs) – SDG5 calls for ending “*all forms of discrimination against all women and girls everywhere.*” The SDGs emphasize inclusion, not just as an end in and of itself, but as critical to development

effectiveness. In 2015, the year when the SDGs were adopted by the United Nations, the World Bank Group adopted an institution-wide [Gender Strategy](#) 2016–2023: Gender Equality, Poverty Reduction and Inclusive Growth (World Bank 2015). At the center of the strategy is the achievement of gender equality and empowerment of all women and girls, contributing to the World Bank Group’s goals of accelerating growth and fighting poverty and reducing unequal access to opportunities.

The Gender Strategy sets forth an action plan to achieve women’s empowerment by addressing constraints to women across four main areas: Improving human endowments (health, education, and social protection); removing constraints for more and better jobs; removing barriers to women’s ownership and control of assets; and enhancing women’s voice and agency and engaging men and boys. Gender-inclusive policies to address these constraints and to close gaps in the four pillars contributes to inclusive economic growth.

The Bank Group is raising the bar on gender equality by going beyond mainstreaming¹ and moving toward an approach that emphasizes outcomes and monitors results in Bank Group-supported interventions in client countries. It has committed to reaching a range of gender-related targets, notably in the

¹ This is a process that systematically integrates gender perspectives into legislation, public policies, programs, and projects (UN 2002).

context of the 2018 capital increase² and IDA19.³ To ensure that operations are designed in a way that produces sustainable results, practical tools for quantification of gender-based interventions need to be made available to project teams.

This note provides a brief overview of **computable general equilibrium model-based analysis in the context of gender-inclusive policies**. The purpose of this note is to familiarize non-CGE modelers with this tool and advance discussion on how results derived from it can be used to aid policy dialogue and enhance the design and implementation of gender activities in operations, leading to more gender-inclusive economies and sustainable results for women on the ground. The note covers what the World Bank has been doing on this front, data requirements for such analysis, and how to chart the way forward.

What is CGE Model-Based Analysis?

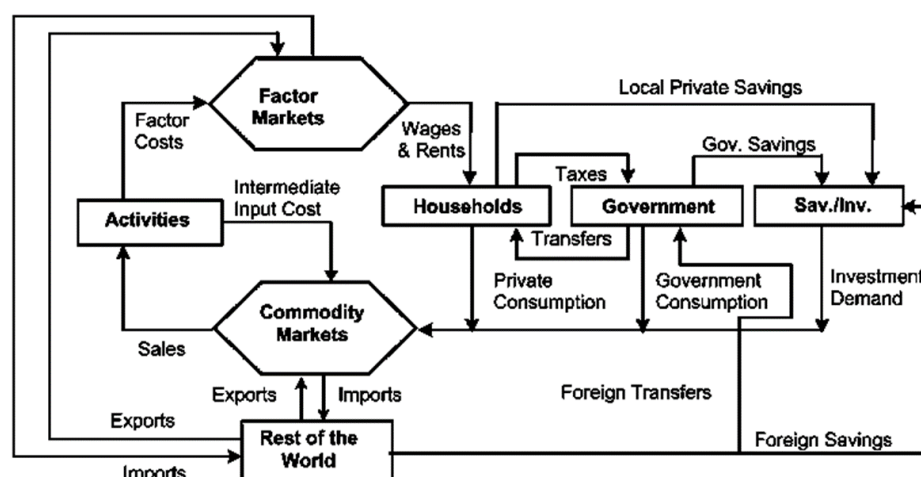
CGE analysis is an approach to economic analysis that uses an **economy-wide simulation⁴ model**. CGE models use economic data (see Annex) to simulate how an economy

might react to changes in policy or other external shocks, such as changes in labor force participation of women.

The models are typically based on neoclassical theories of firm and household behavior, assuming that firms are profit maximizers and households are utility maximizers. The model encompasses the following three concepts:

- Computable → solvable numerically
- General → economy-wide (all production, consumption, investment, and trade that is covered by the national accounts)
- Equilibrium →
 - optimizing agents have found their best solutions subject to their budget constraints
 - quantities demanded = quantities supplied in factor and commodity markets
 - macroeconomic balance: receipts = spending for government, balance of payments, and savings-investment balance

Figure 1: Basic Economic Flows Among Agents in an Economy in a Typical CGE Model



Source: Holden et al. 2005.

² Capital Package Proposal Commitments: The proportion of IBRD operations that narrow gender gaps (“gender tagged”) in the four key pillars of the Gender Strategy will increase from 42 to 55 percent by FY23 with ambition maintained or increasing to FY30. In addition, there will be an increase in the share of IBRD operations with financial sector components that include specific actions

to close gender gaps in access to and use of financial services from 55 to 60 percent by FY23.

³ For more on specific policy commitments, see [IDA19 Special Theme: Gender and Development](#) report.

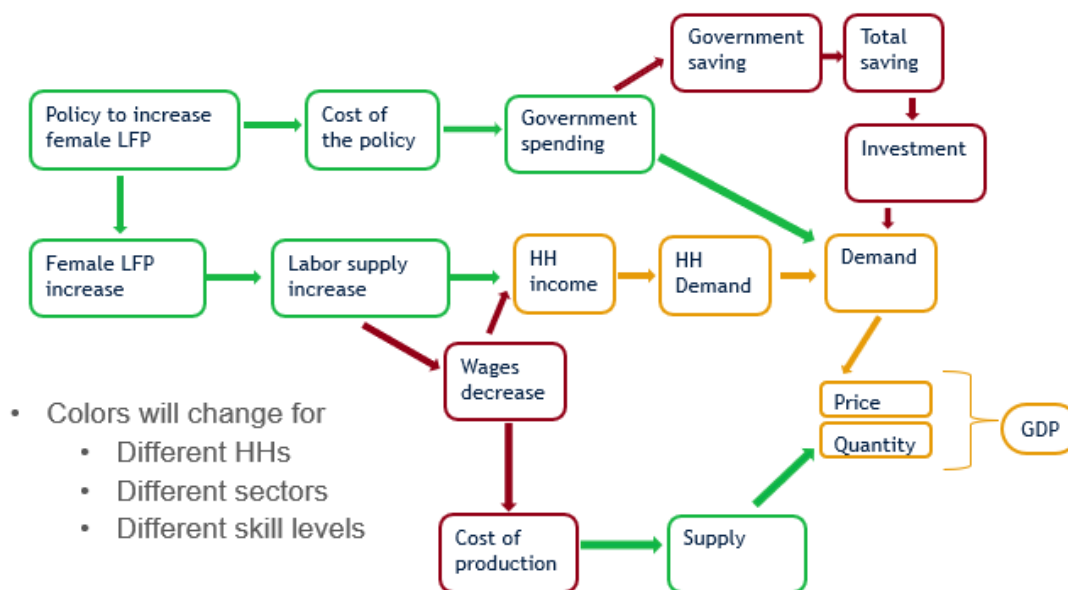
⁴ Simulations are not forecasts. Rather, they focus on how the future may differ depending on the presence/absence of specific exogenous or policy shocks.

Why Use CGE Models for Gender-Inclusive Policy Analysis?

- Gender gaps affect many different aspects of an economy, and policies to reduce them will affect the whole economy via different channels. CGE models are suitable for economy-wide analysis because they include almost all areas⁵ of a given economy.
- CGE models enable researchers to analyze the macro benefits of closing gender gaps and to look at the ex-ante impact of suggested policy reforms on crucial economic indicators, such as (i) GDP per capita, (ii) GDP growth, (iii) labor force, (iv) human capital (education, health, skills) development, (v) financial development, and (vi) informal sector.
- The models allow assessment of (i) effects by sector and (ii) distributional effects.
- CGE analysis can identify the winners and losers of reforms in various categories: sectors, households, skilled or unskilled labor, and so on.

For example, consider the effects of higher female labor force (LFP) participation, illustrated in Figure 2. Labor supply will increase in the market, resulting in more competition, and wages may decrease. Earnings of women currently in the labor force could be affected by the entry of more women into the labor market. If these new female workers also have attained higher education, they may have access to the same employment opportunities as men, resulting in reductions in the occupational segregation by gender that has traditionally led to higher earnings for men. Thus, there are general equilibrium, sectoral, and distributional effects to be assessed for which a CGE model-based analysis can be very useful.

Figure 2: Economic Flows Related to Increasing Female Labor Force Participation



Note: Green, brown, and orange indicate increased, decreased, and ambiguous changes, respectively.

⁵ CGEs use Social Accounting Matrices (SAMs, discussed in later sections) as a base for calibration. In the current format of most SAMs, there are subsequent

limitations in accounting for unpaid domestic work and care labor in the reproductive economy.

Other examples of policy scenarios that can be assessed through CGE-based analysis include:

- Higher female LFP: Moving women from informal labor market to formal labor market
- Closing the gender gap through skill building: Transformation of unskilled female labor to skilled through increased education or training
- Closing financial inclusion gaps: Increasing the access of female-headed households to credit, which would reduce their saving rate and increase consumption.

CGE models are not standalone tools for a comprehensive gender assessment. Economic gaps are only one manifestation of gender inequality, and CGE models have their own caveats, such as reliance on an indicator of economic activity (for example, GDP) that does not capture all impacts of gender equality.

Comparison with Other Models

CGE offers an unambiguous counterfactual to assess the impact of a shock. The main advantage of counterfactuals is that the effects of a specific shock can be isolated from the effects of all other events occurring during the period of interest. Micro-evaluation techniques, by contrast, do not capture effects at the macro level.

For economy-wide analysis, CGE models are a more effective tool than partial-equilibrium⁶ (PE) models. PE model-based analyses are logical approaches if a researcher is interested in how a macroeconomic shock will affect only a limited number of an economy's markets, needs to incorporate a great amount of sectoral detail, or has limited time available. When examining the question of poverty, PE analysis usually requires a

researcher to abstract from the income side of the issue or limit the analysis to consideration of a single factor (typically labor). The circular flow of income from factors to household is broken in PE analysis. CGE analysis, on the other hand, allows tracking of income from factor returns to household, which makes it the preferred method to conduct analysis to realize distributional effects.

A prime example of an economy-wide shock across all income distribution with visible heterogeneous effect across sector, occupation, and gender is the COVID-19 crisis. Subject to data availability a CGE analysis would allow gender-differentiated economic impact by sector accounting for both direct and indirect effects.

CGE-Gender Analysis in the Literature

Laderchi et al. (2010) is one of first studies looking at costs and financing methods of gender gap-reducing policies, such as closing education gaps, increasing productivity in domestic work, and reducing wage discrimination. The new millennium saw the introduction of male/female labor by skill levels and formality status and first attempts to introduce "household production" or "social reproduction services" to endogenize female labor force participation in economic discourse of policy analysis methods (Arndt and Tarp 2000; Fofana et al. 2005; Fontana and Wood 2000; Fontana et al. 2001; Siddiqi 2005; Sinha and Sangita 2003). However, these studies focused more on impact of economic policies (for example, trade policies) on female labor rather than the impact on economic indicators of policies to close gender gaps.

Starting with the pioneering work of Marzia Fontana (see Fontana and Wood 2000; Fontana et al. 2001), there is an increasing recognition of unpaid domestic work in these model-based studies (Cicowiez et al. 2018; Severini et al. 2018; and the draft work of Lofgren et al. 2018⁷). Cicowiez and Lofgren follow an approach to segregate male and female labor

⁶ Partial equilibrium is a condition of economic equilibrium which takes into consideration only a part of the market, *ceteris paribus*, to attain equilibrium.

⁷Work presented at the 21st Annual Conference on Global Economic Analysis, Cartagena, Colombia, 2018. Draft work requested not to be cited. To learn more

about the modeling approach, visit:

<https://research.american.edu/careworkeconomy/research-area/gender-aware-applied-modeling/>

categories, formal and informal labor, unpaid domestic work, unpaid labor in activities not related to the care economy (such as family workers in agricultural activities), and labor-leisure choice or labor supply decision for men and women.

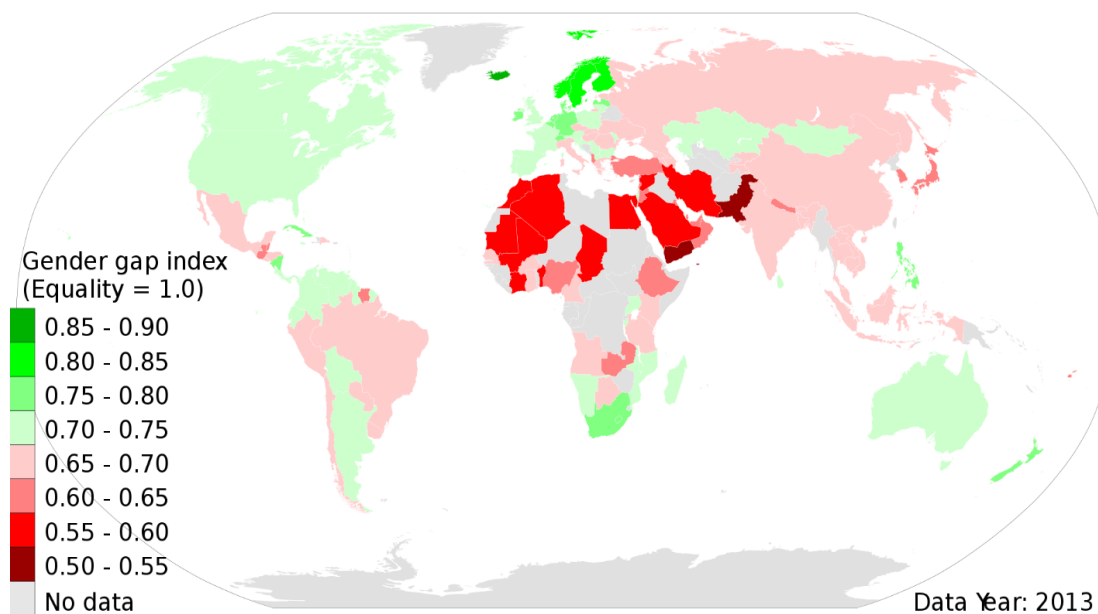
Going forward, the approach of Cicowiez et al. (2018) and Lofgren et al. (2008) seems to hold the most plausible set of assumptions with scope to contribute to the existing literature. Extending CGE frameworks can better capture the dynamics of skill building and labor force participation by endogenizing labor force participation of households and explicitly modelling the transformation of unskilled labor to skilled labor through education and training.

What is the World Bank Doing in this Area?

Using CGE analysis to assess economic benefits of gender-inclusive policies as part

of Advisory Services and Analytics (ASAs), to inform Country Partnership Frameworks (CPFs) and Systematic Country Diagnostics (SCDs), and to design DPOs is relatively new in the World Bank. This approach has much potential and is eliciting increasing interest. The first two initiatives in this area were products of a workstream by the Macro, Trade and Investment (MTI) Global Practice and the Africa GIL in 2019: [Economic Impacts of Gender Inequality in Niger \(World Bank 2018\)](#) and [Guinea – The Economic Benefits of a Gender-Inclusive Society \(World Bank 2019\)](#). The Sahel region has one of the lowest gender gap indices (see Figure 4), and thus, the potential for improvement via targeted policies is high. Current work on CGE-based analysis of the economic benefits of closing gender gaps is continuing in Burkina Faso and Chad, and efforts are underway to initiate similar work in the Middle East and North Africa region.

Figure 3: Map of Gender Gap Index

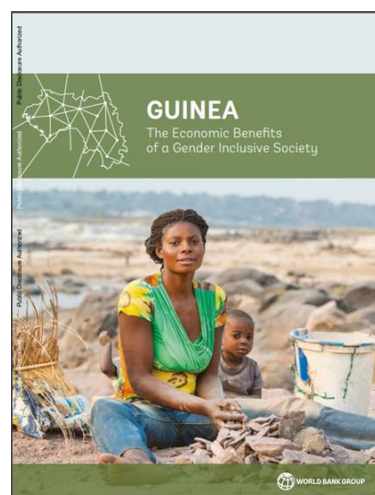
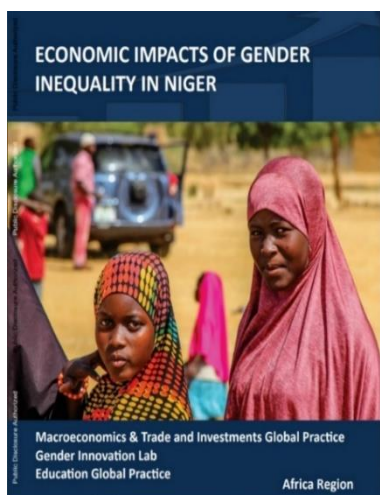


Source: Map created by M. Tracey Hunter based on gender gap index in Global Gender Gap Report 2013. Note: The Index benchmarks national gender gaps on economic, political, education and health criteria, capturing gaps in outcomes.

These CGE-based gender assessment reports typically document patterns of country-specific gender inequality following a lifecycle approach, assess the economic impacts of those patterns, and evaluate policy options.

In the Niger report, gender inequalities were assessed from the angles of: (i) human capital, and (ii) productivity and labor force participation. The scenarios contemplate a reduction in gender inequality associated with policy options initiated in 2018 as a path toward gender parity. With respect to human capital, the scenarios include making a major push toward universal education and reduced fertility. With respect to productivity and labor participation, the simulations include increases in: (i) women's labor force participation; (ii) productivity on agricultural land owned by women; and (iii) productivity of women working in the manufacturing and services sectors. Each scenario is compared to a baseline projection under business-as-usual conditions. The results suggested that reducing gender inequality could increase GDP per capita by 32 percent by 2030. The Niger report contributed to a new Development Policy Financing project (Niger First Laying the Foundation for Inclusive DPF, P169830) with reducing gender gaps as one of three pillars of the operation.

The Guinea report uses CGE analysis to assess the impact of policies related to: (i) closing the gender education gap; (ii) reducing fertility rates; and (iii) closing the gender productivity gap in agriculture. One of the advantages of this approach was that it allowed researchers to assess distributional impacts (poorest and richest households) and regional impacts (by rural and urban areas). The CGE analysis revealed that closing gender gaps in education will have a positive influence in delaying early childbearing with the potential positive impact of lowering fertility. Lower fertility in the model as a reduction in the child dependency ratio and its associated higher savings rate would accelerate capital accumulation and thereby promotes higher growth rates. Lastly, increasing agricultural productivity of female farmers translates into higher contribution of agriculture on growth. The results suggest that reducing gender inequality could increase GDP up to 10 percent in 2035 and policies to attain this would cost around 1.2 percent of GDP. The Guinea findings inspired the production of a music video produced by Banlieuz'art which went viral on YouTube! ([Enjoy](#)), and both reports have been well received by country authorities.





To date, the World Bank has used single-country models for CGE-based analysis of the economic benefits of gender-inclusive policies. Using single-country models keeps the focus on the country in question and allows for more detailed analysis and easier tracking of results. However, CGE analysis can also be conducted for regions using global CGE models (such as GTAP and ENVISAGE), provided data exists for the countries in the region.

MTI and the Africa GIL are continuing their collaboration in assessing the economic benefits of gender-inclusive policies. For these assessments, the MTI macroeconomic modelling team is modifying a dynamic CGE model (MANAGE⁸ – Mitigation, Adaptation, and New Technologies Applied General Equilibrium model) that will incorporate the necessary mechanisms required for such analysis. The team is working on ways to engender the SAMs (including different mechanisms to better understand the impact of various policies to close gender gaps) and on incorporating the care sector in the economy, among other developments.

So far, the focus of analysis in the reports has been on accounts of labor market and demographics. Closing economic gaps is recognized as the most challenging gender gap. Going forward, the agenda calls for analysis to account for: (i) wage gap among male and female labor categories; (ii) informality in the labor market; (iii) unpaid domestic work and unpaid family labor (not related to the care economy); (iv) labor supply decision by men and women and the care economy; (v) skills transformation, and so on. These improvements will allow comparison of the costs and benefits of different policies, which would yield practical policy implications by identifying the main bottlenecks in the economic structure and policy environment.

Way Forward

As emphasized in this note, more and more development organizations and governments are keen on designing gender-based interventions that yield economy-wide outcomes and sustainable system-wide results. Yet the impact of gender-inclusive policies on macroeconomics is a field that is relatively under researched. CGE model-based

⁸ The model documentation is available upon request.

analysis can close these gaps in understanding, provide means for comparing costs and benefits of different policies, and aid World Bank operational units in policy dialogue and operations design with ex ante quantified outcomes.

From an internal perspective, this note, along with subsequent presentations and interactions, is meant to create a space for discussion and mutual learning between gender experts and economists, charting the way toward designing increasingly results-oriented and impactful policy interventions by using a wide range of tools and approaches, including CGE-based modeling.

This note was prepared by Kayenat Kabir (MTI) and Hasan Dudu (MTI) with contributions from Anja Robakowski (EFIOS) and publishing support by Mark Volk and Patricia Ellen Steele.

The macroeconomic modelling work on gender gaps has benefited greatly from the valuable contributions and perspectives of our colleagues: Andrew Burns, Calvin Zebaze Djiofack, Caren Grown, Doerte Doemeland, Fulbert Tchana, Isis Gaddis, Israel Osorio-Rodarte, Kristyna Bishop, Lars Christian Moller, Luc Razafimandimby, Michael O'Sullivan, Muthoni Ngatia, Nga Thi Viet Nguyen, Ruth Mill, and Susana M. Sanchez.

The findings, interpretations, and conclusions expressed in this note are entirely those of the authors and should not be attributed in any manner to the World Bank, to its affiliated organizations, or to members of its Board of Executive Directors or the countries they represent.

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Annex: Social Accounting Matrix, Data (and Computational) Requirements

CGE models rely on social accounting matrices, abbreviated as SAMs (Pyatt and Round 1985) for their empirical structure. SAMs combine information from the input-output table, government finances, balance of payments, trade, and micro data (household, labor, agriculture, industrial, and other surveys) to give a snapshot of the flows between economic agents in a given (base) year.

Parameters and base year variables are calibrated with information obtained from SAMs. In other words, the model solution for the base year replicates SAM data. Apart from SAM, the minimum data requirements are elasticities (trade, consumption, production, and so on), labor employment by sector, and stocks (factors, foreign and domestic debts).

SAMs detail all the basic accounting identities which must hold for the economy to be in equilibrium. The fact that households cannot spend more than they earn, or that the same unit of labor, land, or capital cannot be simultaneously employed in two different places, serves to tightly circumscribe the range of possible general equilibrium outcomes. Figure 4 depicts a typical SAM structure — an organized matrix representation of all transactions and transfers between different production activities, factors of production, and agents within the economy and with respect to the rest of the world.

Figure 4: A Typical SAM Structure

	Activities	Commodities	Factors	Households	Firms	Government	Taxes	Savings & Investment	Rest of the World	Total
Activities		Domestic supply								Gross output
Commodities	Intermediate inputs			Household consumption		Government consumption		Investment demand	Exports	Demand
Factors	Compensation of factor									Factor income
Households			Wages, factor rents		Profits	Transfers to households			Foreign remittance	Household income
Firms			Profits							Firm income
Government							Direct and indirect taxes		Foreign aid	Government income
Taxes	Production taxes	Commodity and import taxes	Factor tax	Personal income tax		Company income tax				Tax income
Savings & Investment				Household savings					Current account	Savings
Rest of the World		Imports								Foreign exchange outflow
Total	Gross output	Supply	Factor spending	Household expenditure	Firm expenditure	Government expenditure	Tax revenue	Investment	Foreign exchange inflow	

Usually, there are two main steps in the construction of a SAM:

- First, a macro SAM is built using a country's national accounts and various other sources.
- Second, this macro SAM is broken down with the desired degree of detail: economic activities, produced goods, factors of production (such as labor, capital, land), groups of households, taxes and grants, other institutional sector accounts for the rest of the world (by regions or groups of countries, for instance), and so on.

A detailed micro SAM is usually not balanced, and it is necessary to reconcile receipts and payments from additional statistical data or with the help of econometric methods and optimization.

Often, existing SAMs are not of the most recent years. In such cases, SAMs are updated to match the latest macroeconomic data, and labor and household accounts are subsequently disaggregated by using the most recent household survey. The level of disaggregation depends on the policy questions to be answered as well as data availability.

A CGE model requires computational techniques such as GAMS (General Algebraic Modeling System) and GEMPACK (General Equilibrium Modelling Package) to be solved. These software packages may not be

familiar to many analysts. Typically, CGE modelling teams build or modify the models and conduct simulations, and non-CGE modelers use a front interface of the models to conduct analysis while the CGE models run in the background.

Gender gaps exist in most accounts (household, government, activities, and so on) of a SAM, but the easiest to model in a CGE model is probably the gap in factor markets: the formality and skill level of the activities performed by male versus female labor. Whether or not to “engender” all accounts depends on the policy questions and data availability. CGE model-based analysis is used to inform a macro perspective, and it requires substantial amounts of additional data to engender accounts.