A Customizable Microsimulation Tool to Analyze Distributional Effects of Country Fiscal Policies

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Microsimulation modelling has become a powerful tool to analyze the effects of fiscal policy changes. The World Bank’s Equity Policy Lab (EPL) has developed a customizable microsimulation tool to assess the distributional effects of tax, benefits, and other fiscal reforms. This Note explains why and how countries use the microsimulation tools, using examples from Ecuador and Armenia—2 of the more than 20 countries that have developed and used the tool over the past 2 years—to demonstrate its effectiveness in engaging government officials and informing policy making.

Policy makers are eager to analyze distributional effects of potential fiscal policy reforms. They want to understand the potential effects on poverty and inequality, populations most affected, the progressivity of taxes, “winners and losers” from reforms, and impacts on government fiscal budgets. Governments are increasingly using tax and benefit microsimulation tools to inform fiscal policy. This is part of a broader movement towards evidence-based public policy formulation and reform. Microsimulation tools enable assessment of the effects of changes in fiscal policies prior to national implementation, where pilots are not cost-effective or feasible. The information requirements for developing these tools are relatively low, and assumptions and modeling approaches are relatively transparent. The tools are designed to be simple enough for policy makers to use directly, alongside other evidence-based approaches, such as post-program evaluations and social/natural experiments. Although microsimulation tools have been widely used in developed countries, few developing countries have developed this type of tool, either because policy makers are not fully aware of such tools or due to lack of experts and funding to develop the tool.

The World Bank Equity Policy Lab (EPL) has developed fiscal policy microsimulation tools to help engage policy makers in designing tax and benefit policies. Built on the current fiscal policy system in the country, these tools combine tax and benefit policies with household survey and model the details of each fiscal intervention, such as eligibility criteria for benefit programs, as well as allowances, exemptions and deductions for tax interventions. These tools show how tax and benefit policies affect household incomes and display the distributional effects of alternative fiscal policies on income and welfare of the population, by simulating individual and household tax liabilities and benefit entitlements. Using outcomes generated with the tool, policy makers can understand what policies mean, in concrete terms, for poverty, inequality, and government’s revenues and expenditures. The tools developed by EPL are more flexible compared to a harmonized multi-country tool, such as the European Union’s EUROMOD, Modelers can include country-specific fiscal policies or characteristics, and even incorporate sub-national tax policies for local policy makers.

1 There are many types of simulation tools in economics study. Tax and benefit microsimulation tools (or fiscal policy microsimulation tools) are the tools used in studying fiscal policies.
Methodology

The microsimulation model is built on comprehensive fiscal incidence analysis to study existing and potential fiscal interventions. The model is based on the Commitment to Equity (CEQ) methodology, a rigorous and widely-used fiscal incidence diagnostic method. However, it goes beyond fiscal incidence analysis, which simply identifies tax and benefit components observed in the survey. Microsimulation requires that each tax and benefit intervention can be modeled with enough detail to enable users to change policy parameters for simulation purposes.

Generally, the tools simulate a set of taxes and benefits. The taxes and benefits typically include direct taxes (such as personal income tax, payroll taxes, agriculture taxes), social security contributions, direct transfers (such as cash and food transfers, unemployment benefits, child benefits, other social assistance and income-related benefits), indirect taxes (such as VAT and excise), indirect subsidies (such as energy and water subsidies), and education and health "in-kind" transfers. Following the CEQ approach, 4 income concepts (market income, disposable income, consumable income, and final income) are constructed by including or excluding certain fiscal interventions in order to assess the overall impact of the fiscal system on poverty and inequality.

Following best practices, baseline model results are validated and tested at both the micro and macro level. At the micro level, simulated taxes and transfers are compared with respondent survey answers. At the macro level, the estimates for total tax collection, transfers, and number of taxpayers/beneficiaries are compared with administrative data, usually collected by the Ministry of Finance.

A microsimulation tool produces several standard figures and tables, including:
- Poverty and inequality estimates.
- Net cash position by income decile, which assesses the net receivers or net payers to the fiscal system.
- Incidence by income decile, which displays taxes borne (or benefits shared) by the population group.
- Progressivity of each intervention and its marginal contribution to poverty and inequality.
- Concentration curves for each intervention, which shows proportion of taxes paid (or benefits received) by the bottom x% of population.
- Effects on government revenues and expenditures.

In addition to these standard outputs, modelers can customize the outcomes based on client needs. The tool can be used for analysis at the national level or at state/provincial levels. It can be customized to show results for population subgroups defined by gender, household type, etc.

Data

Input requirements for the EPL tool are relatively low. The main input is data from a nationally representative household survey, which contains sociodemographic characteristics, labor market outcomes, income from various sources, and detailed consumption information. For countries that collect income and consumption information in different surveys, a survey-to-survey algorithm can match different household data. For surveys with employment questionnaires rather than individual income information, market income can be imputed with a “consumption-to-income” procedure using administrative data, usually collected by the Ministry of Finance.

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2 Fiscal incidence analysis studies the economic impact of taxes and expenditures on households.
4 The caveats of the approach are, first, the microsimulation model does not consider general equilibrium effects; therefore, results should be interpreted as short-term effects. Second, as with most static models, the simulations usually do not consider behavioral responses. Finally, household surveys typically do not have families with extremely high incomes, so the tool cannot evaluate effects on these households unless the survey is merged with tax and administrative records on top earners.
Mincer regressions and household consumption. Main macro inputs are an input-output matrix, which shows the interdependencies between different sectors of the economy and recent macroeconomic statistics, such as GDP growth, inflation, poverty, and unemployment. In addition, modelers need to collect information on tax and benefit policies, usually from the Ministry of Finance, including revenue collection and expenditures and the number of taxpayers and beneficiaries.

**Programming Language and User Interface**

Currently, tool modelers can choose from 2 programming languages and user-interfaces to develop the tool. One uses Stata software combined with an Excel interface, and the uses R software with an R Shinny interface. Developing the Stata-plus-Excel option is easier for a larger share of Bank staff, while the R-plus-R Shinny interface is more user-friendly, allowing a broader set of clients to use the tool.

**Case Studies**

In the past 2 years, EPL has assisted 22 countries to conduct CEQ benchmark analysis and build microsimulation tools (see Table 1). Case studies for Ecuador and Armenia illustrate the use of these tools and team engagement with governments.

**Ecuador**

The Government of Ecuador (GoE) invited the World Bank to assess the distributional impact of various fiscal reform proposals, compare different tax-subsidy systems, and help select the most efficient and effective policies. In July 2019, upon request from the Ministry of Economics and Finance (MoEF), EPL staff traveled to Ecuador to help build a fiscal policy microsimulation tool (ECUTOOL). The GoE planned comprehensive tax-subsidy reforms—including changes in income, corporate, value-added and excise taxes—and on energy subsidies. These reform proposals were scheduled to be submitted for National Assembly approval in November 2019.

The EPL collaborating with World Bank Ecuador country team developed the ECUTOOL over 2 weeks to address the MoEF’s urgent request. The team communicated with policy makers frequently to understand their needs and revise the tool. Following a 2-hour training session to demonstrate the tool and provide instructions to the MoEF economics team, the tool was transferred to Ecuadorian authorities.

ECUTOOL allows users to compare distributional effects of different tax and subsidy policy scenarios and to estimate the magnitude of shocks resulting from fiscal reforms. The tool can also perform sensitivity analysis by changing model assumptions and/or policy parameters. The team later learned that the MoEF used the tool during its decision-making by simulating approximately 1000 alternative policy proposals, with results presented to Ecuador’s Vice President.

**Armenia**

EPL assisted the World Bank Armenia team to develop a web-based interactive tool (ARM Web Tool). This was in response to the Armenian Ministry of Finance’s (MoF) request to help analyze distributional effects of various taxes and transfers. The ARM Web Tool was based on an

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5 The Mincer earning function is a model that explains wage as a function of schooling and experience, named after Jacob Mincer.
updated fiscal incidence analysis. The tool allows estimating the distributional effects of a proposed personal income tax reform and an upcoming increase of the minimum wage, as well as a number of additional changes in taxes or transfers. For instance, the tool helped the Government of Armenia (GoA) evaluate effects of a potential universal health insurance reform financed partly through direct and indirect taxes.

One of the features of the ARM Web Tool is that it has a “dynamic simulation” option. This enables users to simulate tax and transfer policies for a span of 6 years to observe changes in distributional effects over time. This feature relies on assumptions on GDP growth and inflation. In November 2019, the team delivered a 2-day training to MoF staff to introduce the fiscal incidence methodology and demonstrate the use of the tool, and about 11 MoF staff completed the training. The tool strengthened the MoF’s capacity to analyze welfare impact of policy reforms before implementation.

Lessons and Moving Forward

A few key lessons have emerged after constructing several microsimulation tools:

- Once a customized country tool is developed, it can be used for multiple years with regular updates.

- Building a user-friendly interface could allow a wider audience to access the tool, especially users who do not have modelling or technical skills.

- Collaboration across World Bank practices, such as between the social protection and the macro-fiscal or energy team, can improve tool design and ensure consistent messaging to policy makers.

Standardizing the tool design process, such as using the same coding structure and user interface, would simplify and speed tool construction, enabling users to recognize similar tax-benefit components across countries.

Finally, the microsimulation tool can be combined with other macro-micro models and tools—such as ADePT ⁶ and Computable General Equilibrium models⁷—to account for external shocks, such as COVID-19, in the distributional analysis.

The EPL team plans to improve and enhance the tool. The team has begun modelling the effects of behavioral responses and fiscal and distributional issues. This is critical for evaluating dramatic changes, such as removal of energy subsidies or hyperinflation scenarios. The team is also considering developing dynamic models to capture household whole lifecycle income or consumption instead of just focusing on one period, which is important for policies whose benefits are difficult to observe in the short-term, such as cigarette taxes or pension reform. In addition, the team plans to develop short-term complementary models using high frequency data, such as monthly income or labor force participation data, and employing time-series regressions, to help policy makers monitor poverty and distribution more frequently.

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⁶ Automated Development Economics Poverty Tables (ADePT) is a tool to simulate distributional impacts of macro-dynamics, which is developed by World Bank economists. For details, please see Olivieri et al. 2014. Simulating Distributional Impacts of Macro-dynamics: Theory and Practical Applications. Washington, DC: World Bank.

⁷ Computable General Equilibrium (CGE) models are large numerical models which combine economic theory with real economic data in order to derive computationally the impacts of policies or shocks in the economy.