Endogenous Labour Supply in CGE-Household Micro-Simulation-Top-Down/Bottom Up Model

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Linking Microsimulation and Macro Models - Workshop at the Institute for Employment Research

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Objective and a brief history of CGE modeling

CGE modeling with labour supply

Magnac labour supply model (1991)
  - Main characteristics
  - The econometric model

CGE-TD/BU model applied to the Philippines
  - Macroeconomic results
  - Effects on poverty for the whole population and by education groups
  - Comparative Growth Incidence Curves for population

Conclusion and to follow up the thinking
Use of a new approach to model macro-micro linkages to analyse impacts of policies/external shocks on poverty and income distribution

Introduce a labour supply with unemployment (regime switching) for poverty analysis

Introduce endogenous labour supply
As previously presented: Three types of approaches

- Representative households (RH approach)
- Integrated Multi-household approach (IMH approach)
- Macro-micro-simulation (CGE-MS approach)
CGE-TD/BU approach

Linking the CGE model to a household (HHMS) model (Top-down) and the HHMS model to the CGE model (Bottom-Up) until a converging solution is found

**Pros.**
- Allows rich micro-behaviour
- Allows intra-group distributional analysis
- Removes the group choice constraint
- Takes into account micro-household feedback effects in the CGE model
- Provides macro coherence framework
- No need to have a consistency between micro and macro data
- No limit to the level of disaggregation (production sectors and number of HH)

**Cons.**
- Data and technically intensive
A top-down/bottom-up approach

The algorithm: linking the models

**Top Module: CGE**

Exogenous: \((\text{Consumption}, C, \text{Labor supply}, L)\)
Endogenous and output to HHMS: \((p, w)\)

Loop until
\[
\|\Delta C, \Delta L\| \leq \varepsilon
\]

**Bottom module: household micro-simulation (HHMS)**

Exogenous \((p, w)\)
Endogenous \((Y_h, C_h, L_h)\)
Output to CGE \((\text{Total Consumption}, C, \text{Total Labor supply}, L)\)
Applications of CGE-RH approach:
- Fortin, Marceau and Savard (1997)
- Savard and Adjovi (1998)
- Devarajan, Ghanem and Thierfelder (1999)

According to our knowledge, no application with Integrated Multi-household approach

Applications of CGE-MS approach:
- Bourguignon, Robilliard and Robinson (2002)
- Bussolo and Lay (2003)
- As seen in other presentations

CGE-TD/BU ⇒ An illustration in this presentation of Savard’s version
Endogenous Labour Supply in CGE-TD/BU Model

Magnac labour supply model (1991)

Main characteristics

- Fixed formal wage, excess supply of labour
  - The supply of labour is based on the potential wage estimated from the Magnac model
    - This potential wage takes into account the cost of entry into the formal sector
    - Hiring (most skilled from unemployed and informal sector)
    - Fired (least qualified of the formal sector)

- Informal sector labour supply
  - Based on the reservation wage calculated from the estimation of the Magnac model
    - Work if reservation wage is below prevailing wage
    - Unemployed if reservation wage is above
The potential wage $\omega^j_h$ of individual $h$ in the segment $j$ (1=formal and 2=informal) of the labour market is given by:

$$\omega^j_h = \pi_h \cdot w^j$$ (1)

with

$$\ln \pi_h = H_h \cdot \gamma^j + u^j_h$$ (2)

where

- $w^j$ is the general level of earnings in segment $j$ (solution of the aggregate CGE model)
- $H_h$ are the human capital characteristics of worker $h$
- $\gamma^j$ is a vector of coeff. specific of segment $j$ and
- $u^j_h$ is the residual term for the effect of unobserved characteristics on worker productivity in $j$
Participation decisions are taken by comparing the potential wage on both segments to a reservation wage $\omega_h^0$:

$$\ln \omega_h^0 = H_h \cdot \gamma^0 + Z_h \cdot \delta + u_h^0 \quad (3)$$

where

- $\gamma^0$ are the elasticities of the reservation wage with respect to the observable characteristics of workers
- $\delta$ are the elasticities of the reservation wage with respect to the household characteristics and
- $Z_h$ and $u_h^0$ summarize the effect of unobserved variables

As $\omega_h^0$ is not directly observed and must be inferred from the observed participation behaviour of individuals.
Decision process of an individual who has to choose among three alternatives (Roy’s model):

- Being unemployed
- Working in formal sector or
- Working in informal sector

Imperfection of the labor market and entry restrictions in formal sector are got by a cost of entry in that sector. Then the net gain in the formal segment is defined as:

\[ \ln \omega^1_h + u^c_h \]  

(4)

where \( u^c_h \) stands for the proportion of earnings in formal sector received by the worker after taking into account the cost of entry.
The employment decision process can be described by the following set of conditions:

- **Formal employment:** \( \ln \omega_h^1 + u_h^c > \ln \omega_h^2 \) and \( \ln \omega_h^1 + u_h^c > \ln \omega_h^0 \)
- **Informal employment:** \( \ln \omega_h^2 > \ln \omega_h^1 + u_h^c \) and \( \ln \omega_h^2 > \ln \omega_h^0 \)
- **Unemployed:** \( \ln \omega_h^0 > \ln \omega_h^1 + u_h^c \) and \( \ln \omega_h^0 > \ln \omega_h^2 \)

Under the assumption of a normal distribution of the unobserved terms, the model could be estimated by different ML methods:

- Generalized bivariate Tobit (Amemiya, 1985)
- In two steps (Heckman, 1979): 1- Bivariate probit (participation and choice sector) or univariate probit (participation) and 2- OLS on wage equations with Mill’s ratio
Endogenous Labour Supply in CGE-TD/BU Model

Magnac labour supply model (1991)

The rationing scheme

Non workers ranked by their productivity ➔ unobserved

Unemployed (rationed and waiting) with
\[ \ln \omega_0^0 > \ln \omega_1^1 + u_0^c \text{ and } \ln \omega_0^0 > \ln \omega_2^2 \]

Informal workers (not rationed) with
\[ \ln \omega_2^2 > \ln \omega_1^1 + u_0^c \text{ and } \ln \omega_2^2 > \ln \omega_0^0 \]

Workers with: \( w_1^1 \), \( \omega_1^1 \), and \( u_1^c \) assessed from the econometric model ➔ rationed and observed such that
\[ \ln \omega_1^1 + u_1^c > \ln \omega_2^2 \text{ and } \ln \omega_1^1 + u_1^c > \ln \omega_0^0 \]
Standard CGE model: EXTER model from Decaluwé, Martens and Savard (2001)

- 20 production branches
- HH consumption modeled with a LES based on consumption expenditures
- Fixed capital in production branches
- Small country: Armington assumption

Contribution

- Segmented labour market such as Magnac (1991) with functions mimicking the labour supply behaviour of the HHMS model
Data used for the Household model/Labour supply estimation (Bottom part)

- 39,520 households of the FIES 1997 survey
- Income and expenditure structures taken exactly from FIES
- Labour supply (Magnac, 1991) assessed as Heckman and Sedlecek (1985)
  - Modern/formal labour market: rationed by fixed wage
  - Informal sector with flexible wage
  - Unemployment (rationed and waiting)
- Used data from LFS (three passages combined with FIES (at 98%) for 1997)
Simulation: An across-the board reduction in import duties of 30%

- The Philippines are a rather open economy;
- Such a reform entails some restructuring of the economy implying
  - effects on price system and
  - on distribution of welfare

- Popular reform in 90's

The simulation is performed under two specifications:

- Real wage fixed and TD/BU specification
- Real wage fixed but ignoring the feedback effects from the microsimulation to the macro (TD specification)
Endogenous Labour Supply in CGE-TD/BU Model

- CGE-TD/BU model applied to the Philippines
- Macroeconomic results: Comparison of both approaches

<table>
<thead>
<tr>
<th>Variables</th>
<th>Base</th>
<th>TD/BU_FX_w¹</th>
<th>TD_FX_w¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross domestic product</td>
<td>104,510</td>
<td>-0.69%</td>
<td>-1.27%</td>
</tr>
<tr>
<td>Real Household income</td>
<td>86,476</td>
<td>1.13%</td>
<td>0.64%</td>
</tr>
<tr>
<td>Household real consumption</td>
<td>72,607</td>
<td>1.40%</td>
<td>1.03%</td>
</tr>
<tr>
<td>Formal Wage (index)</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Informal Wage (vs formal)</td>
<td>0.5</td>
<td>-1.25%</td>
<td>-0.46%</td>
</tr>
<tr>
<td>Government income</td>
<td>20,367</td>
<td>-8.43%</td>
<td>-8.84%</td>
</tr>
<tr>
<td>Real public spending</td>
<td>16,818</td>
<td>-11.34%</td>
<td>-13.02%</td>
</tr>
<tr>
<td>Real investment</td>
<td>23,684</td>
<td>2.26%</td>
<td>2.17%</td>
</tr>
<tr>
<td>Firms' income</td>
<td>26,172</td>
<td>0.55%</td>
<td>0.14%</td>
</tr>
<tr>
<td>Firms' savings</td>
<td>7,810</td>
<td>0.95%</td>
<td>0.24%</td>
</tr>
<tr>
<td>Employment rate</td>
<td>0.8316</td>
<td>-0.66%</td>
<td>-2.03%</td>
</tr>
<tr>
<td>Exchange rate (index)</td>
<td>1</td>
<td>0.30%</td>
<td>0.27%</td>
</tr>
</tbody>
</table>

TD/BU_FX_w¹: TD/BU model with fixed formal wage
TD_FX_w¹: TD model with fixed formal wage
### Endogenous Labour Supply in CGE-TD/BU Model

CGE-TD/BU model applied to the Philippines

Effects on poverty: Comparison of both approaches

<table>
<thead>
<tr>
<th>Poverty Index</th>
<th>Groups</th>
<th>Base</th>
<th>TD/BU_FX_w¹</th>
<th>TD_FX_w¹</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FGT₀</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Philippines</td>
<td>0.311</td>
<td>-1.46%</td>
<td>-1.79%</td>
</tr>
<tr>
<td></td>
<td>Not reported or no grade</td>
<td>0.564</td>
<td>-1.48%</td>
<td>-1.55%</td>
</tr>
<tr>
<td></td>
<td>Elementary undergraduate</td>
<td>0.501</td>
<td>-1.38%</td>
<td>-1.58%</td>
</tr>
<tr>
<td></td>
<td>Elementary graduate</td>
<td>0.384</td>
<td>-0.81%</td>
<td>-1.25%</td>
</tr>
<tr>
<td></td>
<td>One to three years of HS</td>
<td>0.317</td>
<td>-2.11%</td>
<td>-2.45%</td>
</tr>
<tr>
<td></td>
<td>HS graduate</td>
<td>0.184</td>
<td>-3.08%</td>
<td>-3.28%</td>
</tr>
<tr>
<td></td>
<td>College undergraduate</td>
<td>0.092</td>
<td>-0.34%</td>
<td>-2.06%</td>
</tr>
<tr>
<td></td>
<td>At least college graduate</td>
<td>0.021</td>
<td>-1.96%</td>
<td>-3.42%</td>
</tr>
</tbody>
</table>

TD/BU_FX_w¹: TD/BU model with fixed formal wage

TD_FX_w¹: TD model with fixed formal wage
Endogenous Labour Supply in CGE-TD/BU Model

CGE-TD/BU model applied to the Philippines

Growth Incidence Curves: Is this policy pro-poor for the whole population?

**Growth Incidence Curve for total population**

Model: TD/BU_FX_w1

- **Difference**
- **Upper bound of 95% confidence interval**
- **Null horizontal line**

D. Boccanfuso and L. Savard

Endogenous Labour Supply in CGE-TD/BU Model
Endogenous Labour Supply in CGE-TD/BU Model

- CGE-TD/BU model applied to the Philippines
- Comparative Growth Incidence Curves

Comparative Growth Incidence Curve for total population
TD/BU_FX_w\textsuperscript{1} versus TD_FX_w\textsuperscript{1}

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure.png}
\caption{Comparative Growth Incidence Curve for total population, TD/BU_FX_w\textsuperscript{1} versus TD_FX_w\textsuperscript{1}}
\end{figure}
• Taking into account the micro consequences of a macro policy through the integration of a micro data base of HH within a CGE model. Two ways:
  
  • through a conventional CGE-MS approach without any feedback at the macro level (TD-CGE)
  
  • through iterations between those two modules with a TD/BU-CGE model

• Differences between the two approaches in the presence of rigidities in the labor market (rationing situation):
  
  • TD-CGE model tends to overestimate the negative impact on GDP and employment ⇒ to underestimate effects on reducing poverty
  
  • Differences between the two models are higher with a fixed formal wage
Further work:

- Testing the limits or possible sources of non-convergence
- Applying with other micro-modeling such as
  - Almost Ideal demand system (to follow)
  - Agriculture household modeling
  - Gender issues