Poverty and Income Distribution in a CGE-Household Micro-Simulation Model:
Top-Down/Bottom Up Approach

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Objective and introduction

- ❏ Propose a new approach to model macro-micro linkages to analyse impact of policies/external shocks on poverty and income distribution
    - ❏ or implicitly a different resolution approach
- ❏ Compare this micro simulation approach with the CGE-RA approach

Introduction

- CGE for poverty and Income distribution analysis
  - We classify CGE & income distribution in 3 categories
    - Representative households (RA approach)
    - Integrated Multi-household approach (IMH approach)
    - Macro (CGE)-sequential micro-simulation (CGE-MS approach)

Representative household approach

- Dervis, de Melo and Robinson 82, Gunning 83, OECD work 91, Decaluwé et al 99 among others
  - More than 25 applications surveyed in Savard (2006)
- Use change in income of RA to modify the distribution by assuming that RA = Average agent and use a theoretical relationship between average and variance to modify the income distribution: Lognormal
- Or use change in income of RA to modify income of households in group by same proportion
- Or use deciles to perform the analysis

Representative household approach

- **Pros**
  - Tractable and can be done with standard CGE model
- **Cons**
  - No intra-group distribution tied to economic behaviour
  - Behaviour of group dominated by the richest of the group since household data for a group is an aggregate (even for poor groups)
  - Group selection constraint
  - Constrained by a parametric distribution
  - Deciles approach does not hold since parameter for classification is endogenous to model

CGE-Integrated multi-household

- Decaluwé, Dumont and Savard (1999), Cogneau & Robillard 2000, Gortz et al. (2000), Cockburn (2001), Boccanfuso, et al (2003), Cororaton (2003) among others. (over 30 applications of this approach)
  - Pros
    - Takes into account intra-household distributional changes
    - Not constrained by choice of target groups
  - Cons
    - Data reconciliation (macro-micro and HH)
    - Constrained by level of disaggregation (macro and HH),
      - Non-linearity of functional forms is key in this constraint
    - Constrained by behavioural forms
      - regime switching
        - work and no work
        - On farm off farm

Macro (CGE)-Microsimulation (MS)

- Two sub-categories of top down CGE microsimulation
- First category is micro accounting approach first proposed in Powell (1981) for Australia
- Revisited in Robinson and D'Andrea Tyson (1984) and more recently by Chen and Ravallion (2004)
- The change in welfare at the household level is obtained by applying changes in prices (goods and services as well as wages) to endowments of household surveys
- In this version, households do not react to price changes but incur them
- Bourguignon, Robilliard & Robinson 2002 & 2003, Bussolo & Lay (2003), Chen & Ravallion (2004).

Macro (CGE)-Microsimulation (MS-1)

- MS micro accounting approach by Chen & Ravallion (2004).
  - Pros
    - Captures intra-group distributional changes
    - Not constrained by choice of target groups
    - Relatively easy to apply with a standard CGE and access to a household survey
  - Cons
    - No feedback effect of household micro-behaviour back into CGE model
    - No guarantee of coherence between the two models
    - Error tied to these two elements are linked to the aggregation error between the micro and macro model
      - We will come back

Macro (CGE)-Microsimulation (MS-2)

- Two sub-categories of top down CGE microsimulation
- The second approach consist in adding micro behaviour to individuals or households.
- Among authors who provided impetus to these applications are Bourguignon, Robilliard & Robinson 2002 & 2003, Bussolo & Lay (2003).
- Bourguignon, Bussolo and Pereira da Silva (2008) provide many examples of this approach
- As the previous approach, CGE model generates prices changes which are introduced into a household model with rich household behaviour
- Household behaviour is generally drawn from a microeconometric model

Macro (CGE)-Microsimulation (MS)

- The second approach consist in adding micro behaviour to individuals or households
  - Pros
    - Rich/flexible micro-economic household behaviours (heterogeneity)
    - Captures intra-group distributional changes
    - Not constrained by choice of target groups
  - Cons
    - No feedback effect of household micro-behaviour back into CGE model
    - No guarantee of coherence between the two models
      - Complex procedure to obtain coherence
    - Technically challenging (econometrics + CGE)
      - In terms of coherence and skills
    - Data intensive

Aggregation error

- Aggregation error is the key element in determining the importance of information lost from lack of feedback effect:
  - Incoherence between CGE and micro household model
  - Lack of feedback effect
- If one uses functional forms that aggregate perfectly at the micro level, a sequential (top down) MS model will generate the same solution as the CGE IMH approach
- Historically, a literature on aggregation developed to justify the use of RA in macro models since it was not possible to use large number of households
- It is no longer impossible to increase the number of agents in models

Aggregation error

□ One can chose functional forms that aggregate well to justify using a sequential approach

□ Or one can attempt to introduce richer behaviours to be closer to effective behaviour and attempt to take into account the feedback effect

□ The more aggregation error one has, the larger the loss of information will be between a micro CGE module and HH model

□ For example, our experiments have shown that using a Cobb-Douglas utility function to derive demand system and fixed production factors will not lead to large aggregation error and distributional analysis results are generally robust

A top-down/bottom-up approach: CGE-MS

☐ The approach consists of linking the CGE model to a household (HHMS) model and the HHMS model to the CGE model until a converging solution is found

- ☐ Allows rich micro-behaviour
- ☐ Allows intra-group distributional analysis
- ☐ Removes the group choice constraint
- ☐ Takes into account micro-household feedback effects into the CGE model
- ☐ Provides macro coherence framework
- ☐ Data & technically intensive

A top-down/bottom-up approach: CGE-MS

- Present applications for comparative analysis
- Work with relatively standard functional forms used in CGE
- We start with simpler models and introduce more heterogeneity
- An application to the Philippines economy

The models: CGE model

- ❑ Relatively standard CGE models to do the comparative analysis
  - ❑ Used EXTER model from Decaluwé, Martens and Savard 2001 as a starting point.
  - ❑ 20 production branches
  - ❑ Small country, Armington assumption
  - ❑ Various models used

The models

Hypotheses	Version 1	Version 2	Version 3
Factors	Full Factor Mobility	Full Factor Mobility	Labour Market Segmentation and Fixed capital
Consumption	CD	CD-LES	CD-LES
RA-CGE Approach	RA-CGE model	RA-CGE model	RA-CGE model
TD/BU-CGE Approach	Top-CGE component / Bottom-HH component	Top-CGE component / Bottom-HH component	Top-CGE component / Bottom-HH component

The models: Household microsimulation model

- ❑ Household model
  - ❑ 39520 households of the FIES 1997 survey
  - ❑ Income and expenditure structures taken exactly from FIES
  - ❑ C-D and LES for consumption
  - ❑ Factor endowments are held constant
  - ❑ Solve sequentially by starting with Income, disposable income, consumption, and EV

Linking the models (Algorithm)

CGE Model
Endogenous (C,P,Y,X,LS)
Exogenous (γ,Z,φ)
Output to HH model (P)

HH Model
Endogenous (Y,C)
Exogenous (γ,P)
Output to CGE*(C)

Loop to :
$C_t - C_{t-1} < 1\times10^{-6}$

CGE* Model
Endogenous (P,Y,X,φ)
Exogenous (γ,Z,C)
Output to HH model (P)
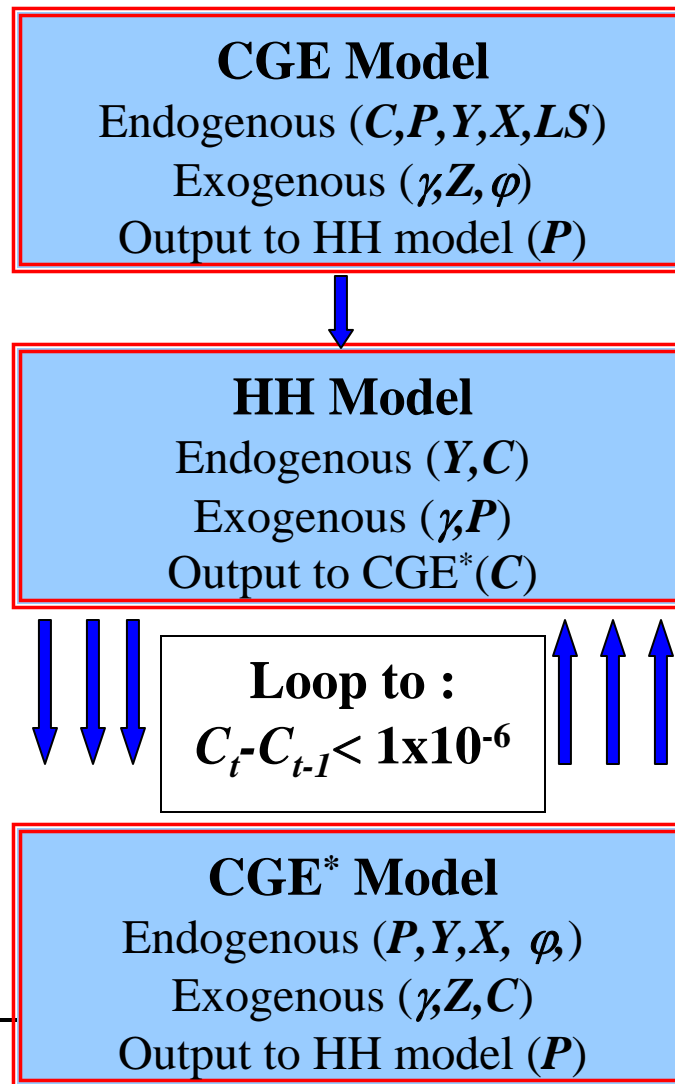
Macro convergent results

Variables		Reference	Version 1		Version 2		Version 3	
			RA-CGE	TD/BU	RA-CGE	TD/BU	RA-CGE	TD/BU
w^1	Formal wage	1	-1.76	-1.74	-1.86	-1.81	-6.89	-6.73
w^2	Informal wage	0.5	*N-A*	*N-A*	*N-A*	*N-A*	0.96	1.11
mps	Marginal propensity to save	0.11	-0.47	-0.47	-4.18	-4.18	-4.80	-4.80
Yg	Government income	20367	-13.96	-13.96	-14.14	-14.13	-14.30	-14.24
Sg	Government savings	-1163.1	13.33	16.06	21.29	24.00	-0.21	12.43
G	Government spending	16818.8	-15.98	-15.79	-15.65	-15.45	-17.33	-16.39
Ye	Firms income	26172.9	1.3	1.29	1.33	1.30	1.42	1.32
Se	Firms savings	7810.5	2.26	2.22	2.30	2.24	2.46	2.28
e	Nominal exchange rate	1	0.71	0.71	0.63	0.60	0.33	0.37
GDP	Gross domestic product	101255.1	0.01	0.01	0.01	0.01	-0.07	-0.07

Macro convergent results

Variables	Definition	Reference	Version 1		Version 2		Version 3	
			RA	TD/BU	RA	TD/BU	RA	TD/BU
Yh	Income	86476.9	-0.26	-0.29	-0.26	-0.29	-0.43	-0.46
Sh	Savings	9651.8	-0.83	-0.47	0.16	0.57	-2.29	-0.66
Ev	Welfare	0		-0.24		1.53		1.48
mps		0.11	-0.47	-0.47	-4.18	-4.18	-4.80	-4.80
Ev	0	0	0.66		2.28		3.46	
	1	0	0.13		1.74		2.69	
	2	0	-0.07		1.55		2.30	
	3	0	-0.19		1.41		1.83	
	4	0	-0.25		1.31		1.41	
	5	0	-0.24		1.22		0.94	
	6	0	-0.35		1.02		0.16	

Results of Poverty Analysis

	Code	Reference	Version 1		Version 2		Version 3	
			RA	TD/BU	RA	TD/BU	RA	TD/BU
National		**31.1**	**0.091**	**0.172**	**-1.621**	**-2.487**	**-2.423**	**-3.229**
	0	53.5	-0.544	0.582	-1.227	-1.080	-2.203	-1.723
	1	48.9	-0.168	-0.001	-1.429	-2.022	-2.621	-2.717
education level	2	39.2	0.242	0.291	-1.683	-2.783	-2.555	-3.232
	3	34.0	0.350	-0.046	-2.366	-2.818	-2.717	-4.362
	4	21.4	0.474	0.185	-1.734	-3.172	-1.844	-4.225
	5	12.1	0.894	1.265	-1.419	-3.878	-0.866	-4.315
	6	2.7	0.000	-2.024	0.000	-7.030	0.000	-6.691

Results of Poverty Analysis

	Code	Base	Version 1 AR	Version 1 TD/BU	Version 2 AR	Version 2 TD/BU	Version 3 AR	Version 3 TD/BU
Régions	1	34,1	0,15	1,23	-2,39	-2,74	-2,69	-2,67
	2	30,2	-0,29	-0,29	-2,31	-3,81	-3,74	-5,88
	3	14,9	0,67	0,26	-4,20	-5,06	-5,36	-8,31
	4	24,5	0,27	0,16	-3,39	-4,21	-4,88	-4,96
	5	46,4	-0,02	0,39	-1,39	-2,39	-2,58	-3,08
	6	35	-0,05	0,19	-1,98	-2,55	-3,09	-3,09
	7	30,1	-0,24	0,14	-1,27	-1,70	-1,81	-2,48
	8	38,3	-0,12	0,53	-1,42	-0,90	-2,02	-1,32
	9	32,6	0,03	-0,02	-1,98	-1,81	-2,39	-3,10
	10	41,8	0,12	-0,54	-1,97	-2,33	-2,49	-4,00
	11	34,3	0,18	0,10	-2,91	-2,25	-4,02	-2,81
	12	45,4	-0,04	-0,49	-1,52	-2,20	-1,63	-2,22
	13	6,2	0,00	-5,62	-7,04	-11,02	-11,01	-15,28
	14	38	-0,39	-0,12	-2,37	-3,35	-4,47	-3,60
	15	58,2	-0,26	0,76	-2,34	-1,49	-3,63	-0,92
	16	49	0,00	0,57	-1,77	-1,34	-2,34	-0,90

Results of Inequality (Gini index)

	Code	Base	Ver. 1 AR	Ver. 1 TD/BU	Ver. 2 AR	Ver.2 TD/BU	Ver. 3 AR	Ver. 3 TD/BU
National		0,52	**-0,09**	**0,042**	**-0,14**	**0,066**	**-0,499**	**0,132**
Décomposition de Gini par niveau d'éducation								
Inter-Groupe		**0,45**	**-0,107**	**0,044**	**-0,168**	**0,067**	**-0,601**	**0,134**
Intra-Groupe		**0,06**	**0,028**	**0,03**	**0,053**	**0,059**	**0,223**	**0,118**
Niveau d'éducation du chef de ménage	**0**	**0,4**	**0**	**0,06**	**0**	**0,09**	**0**	**0,233**
	1	**0,41**	**0**	**0,017**	**0**	**0,06**	**0**	**0,116**
	2	**0,41**	**0**	**0,017**	**0**	**0,057**	**0**	**0,138**
	3	**0,42**	**0**	**0,028**	**0**	**0,085**	**0**	**0,081**
	4	**0,41**	**0**	**0,032**	**0**	**0,059**	**0**	**0,025**
	5	**0,46**	**0**	**0,076**	**0**	**0,093**	**0**	**0,264**
	6	**0,49**	**0**	**0,073**	**0**	**0,078**	**0**	**0,252**

Conclusions

- ❏ Propose a new Macro-micro modelling approach or resolution approach
  - ❏ Macro-coherence with highly disaggregated CGE model (sectors and households)
  - ❏ Allows for richer micro-behaviours (see further presentations)
  - ❏ Rich poverty, inequality and distributional impact of policy analysis (or external shocks)
  - ❏ No constraint on choice of groups
  - ❏ Endogenous intra-group distribution
  - ❏ **RA approach results are not robust**

Conclusions

❑ **Further work**

   ❑ Testing with other micro-modelling

      ❑ Agriculture household modelling

      ❑ Gender issues

      ❑ Migration

      ❑ Labour supply extensions

      ❑ Consumption behaviour

      ❑ Dynamic context (sequential)

Objective of the application

□ Introduce more heterogeneity in household behaviour

□ Explore the contribution of the AIDS demand system in a CGE-TD/BU microsimulation context for distributional analysis