Poverty and Inequality Analysis within a CGE Framework: A Comparative Analysis of the Representative Agent and Micro-Simulation Approaches

By Luc Savard[1]

Abstract

We have observed a flourishing literature in recent years on the use of CGE models to perform poverty and income distribution analysis. In this context two approaches have emerged and no rigorous comparison of the two approaches has been done yet. The first approach is the traditional representative agent that has been used for a number of year to do inter group distributional analysis and more recently some extensive poverty analysis and the second approach is the micro-simulation CGE approach which consists of using large number of households in CGE models to perform poverty and income distribution analysis. In this paper we used three simple CGE models with representative agent and micro-simulation approaches to verify - if when used in a context of poverty and income distribution impact analysis - the two approaches produces compatible results. We concentrated our effort in using three simple models and adding some heterogeneity from one to the other to verify if changes in hypothesis would modify the differences or similarities we would obtain in the exercise. The results are quit surprising insofar as either for poverty analysis or for income distribution, the two approaches produce systematic opposite results. Pro-poor policies in the representative agent CGE model become a pro-rich policy when being analysed in a micro-simulation CGE context. And these results appear to be quit robust.

Key words: Computable general equilibrium models, Measurement and Analysis of Poverty, Personal Income and Wealth Distribution,

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Introduction

The purpose of this paper is to compare the results of the analysis of the poverty and inequalities generated by different models of representative agent computable general equilibrium (RA-CGE) and top-down/bottom-up (TD-BU) CGE micro-simulation models to see if there is value added to applying such models. The important contribution of micro-simulation is to endogenize intra-group variance. We built three versions of the models corresponding to each of the two approaches. We started this comparative exercise with a fairly simple standard CGE model. This model only captures limited heterogeneity elements in household behavior. There are only two factor remunerations (salary and capital remuneration) while income and expenditure structures are heterogeneous. In the second model, a linear expenditure system (LES) replaces a demand system derived from a Cobb-Douglas utility function. In the third and last model, we assumed that capital was no longer mobile between sectors and therefore, we have several capital remunerations. We also introduce a perfectly segmented labor market (formal and informal). The two labor markets have their specific wage. We compared, in the first place, the contribution of both approaches using the three versions of the model to change poverty and inequality indices. This exercise highlighted the contribution of household disaggregation in the context of CGE of modeling exercise and the marginal contribution of introducing heterogeneity elements. Moreover, we made this comparison[2] exercise easier by using fairly standard models.

There is extensive literature on the impact analysis of reforms and macro-economic policies focusing on the representative agent model. These models have been adapted over the past few years, prompting enriching debate over reform impact on poverty and income distribution. Another objective of this paper is to demonstrate the importance of taking this intra-group variance into consideration since the conclusions reached by the analyses are potentially inter-dependent. And this is only possible in the context of CGE micro-simulation modeling.

Since 1982, Dervis and al. (1982) have raised the problem of capturing intra-group variance through the representative agent approach and many other authors including Decaluwé and al. (1999a), Bourguignon and al. (2002) have done the same. In the past few years, several authors (Decaluwé and al (1999b), Cogneau and Robillard (2000), Cockburn (2001), Cororaton (2003) Bussolo and Ley (2003) and Boccanfuso and al. (2003)) have introduced disaggregated households in CGE modeling exercise to better capture intra-group variance changes. In our work, we use the top-down/bottom-up (TD/BU) micro-simulation approach proposed by Savard (2003). This method appears to be more flexible than the CGE integrated approach proposed by Decaluwé et al (1999b). The common feature

[2] With the introduction of quite many hypotheses, it is indeed difficult to analyze the results of CGE models as it becomes increasingly difficult to isolate the mechanisms through which the effects of simulated economic policy are transmitted.

of these recent approaches is their endogenization of intra-group variance by using all households in modeling exercise.

Models

The micro-simulation method proposed in this paper is based on the bi-directional relationship of both a CGE model and a household model. What distinguishes this method from the work of Janvry and al. (1992), Meagher (1993) and Bourguignon and al. (2002) is its bi-directional relationship. The models link both models only through a top-down relationship although the last one attempts to introduce constraint to respect the coherence between the models as where the two others don't make this difficult effort. A detailed description of the top-down/bottom-up approach is available in Savard (2003); there is therefore no need to dwell on this aspect.

Three major models are described hereinafter and are characterized by the following hypotheses:

- Model 1: Full factor mobility with the expenditure function derived from a Cobb-Douglas utility function;
- Model 2: Full factor mobility with a linear expenditure system;
- Model 3: Fixed capital, full formal and informal labor market segmentation and a linear expenditure system.

Table 1: Synthetic Model Presentation

Hypotheses	Model 1	Model 2	Model 3
Factors	Full Factor Mobility	Full Factor Mobility	Labor Market Segmentation and Fixed capital
Consumption	CD	CD-LES	CD-LES
RA-CGE Approach	RA-CGE	RA-CGE	RA-CGE
CGE-TDBU Approach	Top-CGE Bottom-HM	Top-CGE Bottom-HM	Top-CGE Bottom-HM

For each of these three models, we present a version of representative agent (RA) CGE model and TD-BU version. It is important to mention that with TD-BU approach. The CGE models developed in this paper uses Decaluwé, Martens and Savard's (2001) EXTER model developed in chapter 9 as a starting point. This EXTER model contains the main elements of the standard CGE model of a developing economy.

Basically, TD-BU approach consists in using a CGE model and a household model and introducing a bi-directional relationship. In this exercise, we resolve both models in a top-down and bottom-up recursive way so that we can capture the feedback effect generated by the non-aggregation of household behaviors in the household model. The CGE model includes all standard equations but with household consumption held constant. This module computes a price vector (including factor payments). This household consumption at the disaggregated level is computed in the bottom component, the results are then feeds into the CGE model allows to calculate the new price vector. We obtain a macro-economic coherence with this model because we iterate recursively until CGE and HM generate a convergent solution from one iteration to another.

Model 1: CGE-TD-BU, Cobb-Douglas with Full Factor Mobility

Computable General Equilibrium Model (CGE)

In the following section, we describe the main hypotheses underlying three versions of the representative agent (RA) models and TD-BU micro-simulation as shown in a Table earlier herein. To compare approaches, we decided to start with a fairly simple model, which, however, integrates all the standard characteristics of the CGE model of a small developing country with an open economy. The 1997 social accounting matrix (SAM) of the Philippines used for modeling covers twenty (20) production sectors and four (4) agents (Government, firms, rest of the world and household)[3] This model reflects an open economy using Armington's hypothesis (1969) for import demand and the small country hypothesis for exports that do not influence world market prices. On this basis, the country is faced with infinite demand for its exports. Although this demand for exports is infinite, export supply is constrained by a constant elasticity of transformation (CET) function. The demand system is derived from a Cobb-Douglas utility function, with two fully mobile production factors (capital and labor), and their respective wages adjust to clear out their markets. Regarding households, we have an income function consisting of labor and capital remuneration, dividends and transfer from other agents. These households pay taxes, make savings, effect transfers to the other agents and consume goods and services according to a demand function derived from a Cobb-Douglas utility function. The Government obtains its direct and indirect tax earnings, customs duties and transfers of the other agents. Its main expenditure consists of publicly produced good consumption and pay subsidies.

Household Model (HM)

[3] For RA-CGE model version, we disaggregated household agent into seven household agents by head of household education level. This matrix therefore includes ten agents and not four as described here.

As we have pointed out in our introduction, the household model (bottom component) is used to calculate specific income and expenditure of household based on the same behavioral equations as CGE model[4]. The household model operates as follows: income equations are specified as in CGE model but at a disaggregated level and we introduce the demand system, which is characterized by specific marginal consumption shares[5]. It is resolved sequentially where income is solved first followed by savings and consumption. This demand function is used to calculate the consumption matrix (39,520 households x 18 goods). We then sum the consumptions over all households to obtain an aggregated household consumption vector (1 x 18). We use the variation of aggregate consumption of this model as the upward input in the CGE model to iterate. The same procedure is used in the HM modules of model 2 and 3 and therefore we won't come back to the description from hereon.

Model 1: RA-CGE Model, Representative Agent CGE Version

The model used in this section is similar to the basic CGE model described earlier herein. The only differences that we endogenize the consumption function and use the same demand system as in the Household model and instead of having a single representative household, it is disaggregated into seven representative households. The disaggregating criterion retained is household head's education level. Each household will have similar functions as the representative household with its own specific income and expenditure structure. The same guidelines are used for the others models (2 and 3) and therefore we won't come back to the CGE-RA versions.

Model 2: LES, with Full Factor Mobility

In model 2, the only modification introduced is a change in the expenditure system. In this group of models, the expenditure function derived from the Cobb-Douglas utility function type is replaced by the non-linear expenditure system introduced in economic literature by Stone in 1954. The non-linear expenditure system is derived from a utility function of the following form:

$$(1)\ U = \prod_i (Cm_i - \gamma_i)^{\beta_i}$$

where Cm_i is the consumption of good i, γ_i the minimal consumption and β_i the marginal share parameter of the function. Following the implementation of a utility maximization program under budgetary constraint:

$$(2)\ Ctm = \sum_i Pq_i Cm_i\ ,$$

[4] At least for the income side as consumption is exogenous in the CGE model.

[5] It is interesting to note that these do not aggregate perfectly to what is computed by the representative household.

where *Ctm* is the total household consumption, Pq_i the market price of good *i*. The then obtain the following demand functions:

$$(3)\ Cm_i = \gamma_i + \frac{\beta_i \left(Ctm - \sum_j Pq_j \gamma_j \right)}{Pq_i}$$

This change being made, it is also important to modify the savings function in which we deduce to cost of incompressible expenditure before applying the marginal propensity to save. The rest of model equations remain unchanged.

Model 3: LES, with Fixed Capital and Labor Factor Break Down

In this third model, a few hypotheses have been modified. First, the labor factor has been disaggregated. It is assumed that there are two fully segmented labor markets; formal (qualified) labor and informal (non-qualified) labor. Labor is always mobile but only within respective markets. The salaries of each market adjust to balance both markets. The second hypothesis is that capital is specific to each of their respective branches.

Regarding labor, we thus know that labor factor *(Ld)* breaks down into two types of labor one of which is informal labor (*Ldi*) and the other, a formal labor (*Ldf*). At the production level, the relationship between these two types of labor is determined by a constant elasticity of substitution (CES). The second modification implies an increase in the number of capital remuneration. From Models 1 and 2 were had had one capital payment, in model 3 we move to 19 capital remunerations. With this modification, it is clear that factor endowment structure will contribute significantly to an increased heterogeneity between households. This will directly contribute to increasing intra-group variance in the impact analysis of economic policies on poverty and inequalities.

Simulation and Model Results Analysis

We only performed one simulation to illustrate the approach's contribution. Different simulations have been tested to verify whether the conclusions reached in terms of poverty and inequality analysis were robust which was the case. We tested the robustness of the results by modifying[6];

[6] The robustness that we have been trying to test is found at two levels. First, we wanted to test the efficiency of the algorithm used to obtain convergent solutions with different versions of the model and different closing rules.

i) different simulations;
ii) different versions of retained model;
iii) different closing rules; and
iv) different free parameter values (CES, CD-LD and CET function).

The results obtained in the six versions of the models will be simultaneously analyzed starting with macroeconomic results, followed by sectoral results before we proceed to analyze the simulation impact on poverty and income distribution.

Accordingly, a partial trade liberalization simulation was retained and customs duties were uniformly lowered by 50%. We expected the prices of imported goods to drop, sectors using more intensively imported goods as inputs into production to grow, protected sectors such as « *Paley & Corn*, *Fruits and Vegetables* and *other manufacturers* (about 35%) to significantly contract and non-protected sectors to expand. Labor being rather intensive in protected sectors, this policy is expected to exert a downward pressure on salaries and an upward pressure on capital remuneration.

Analysis of Macroeconomic and Sectoral Results

The first important observation is that the different models generate very similar results at the macroeconomic and sectoral levels.

Table 2: Model Macroeconomic and Sectoral Results

Variables		Base value	Model 1 EGC-AR	Model 1 TD-BU	Model 2 EGC-AR	Model 2 TD-BU	Model 3 EGC-AR	Model 3 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	Frims savings	7810,5	2,26	2,22	2,30	2,24	2,46	2,28
e	Nominal exchange rage	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
r	Paley & corn	1	1,47	1,45	1,55	1,51	6,71	7,23
r	Fruit & vegetable	1	1,47	1,45	1,55	1,51	4,49	4,15
r	Coconut	1	1,47	1,45	1,55	1,51	3,57	3,34
r	Livestock	1	1,47	1,45	1,55	1,51	4,95	4,21
r	Fishing	1	1,47	1,45	1,55	1,51	4,90	4,85
r	Other agric.	1	1,47	1,45	1,55	1,51	0,48	0,36
r	Logging and timber	1	1,47	1,45	1,55	1,51	6,18	5,75
r	Mining	1	1,47	1,45	1,55	1,51	5,56	5,50
r	Manufacturing	1	1,47	1,45	1,55	1,51	0,91	0,90

Secondly, we wanted to ensure that the conclusions reached in the exercise were robust to changing hypotheses and parameters.

r	Rice manufacturing	1	1,47	1,45	1,55	1,51	3,99	4,43
r	Meat industry	1	1,47	1,45	1,55	1,51	4,24	3,55
r	Food manufacturing	1	1,47	1,45	1,55	1,51	0,83	0,17
r	Elec. Gas Water	1	1,47	1,45	1,55	1,51	-4,47	-4,52
r	Construction	1	1,47	1,45	1,55	1,51	3,54	3,52
r	Commerce	1	1,47	1,45	1,55	1,51	0,38	0,33
r	Trans. & comm.	1	1,47	1,45	1,55	1,51	1,95	1,80
r	Finance	1	1,47	1,45	1,55	1,51	-4,76	-4,42
r	Real estate	1	1,47	1,45	1,55	1,51	-1,24	-2,50
r	Services	1	1,47	1,45	1,55	1,51	-0,76	0,35

For example, *GDP* increases very marginally in the first four models (0.01%) and decreases marginally by 0.07% in the two models 3 (RA-CGE and TD-BU). The difference appearing between the results of the first four models and the last two models is due to the fact that the low efficiency gains generated by factor (capital) re-allocation have been almost completely eliminated in the two models 3 because capital is fixed and the two types of labor cannot fully substitute each other. As a result, there is a slight fall in GDP for the two models 3. Government income *(Yg)* declines by a maximum 14.30% in RA model 3 and a minimum 13.96% in both version of model 1. Nominal exchange rate *(e)* appreciates by a maximum 0.71% in the two models 1 and a minimum 0.33% in RA-CGE model 3. In the four models with a single capital remuneration, the extremes are +1.45% for TD-BU model 1 and 1.51% for RA model 2. In these four models, salary (w^1) decreases by 1.74% to 1.86%. For informal salary in models 3, the impact is more significant in TD-BU model with a 1.11% increase compared to an only 0.96% increase in RA model.

Table 3: Household Model Results

Variables	Base value	Model 1 EGC-AR	Model 1 TD-BU	Model 2 EGC-AR	Model 2 TD-BU	Model 3 EGC-AR	Model 3 TD-BU
YM	86476,9	-0,26	-0,29	-0,26	-0,29	-0,43	-0,46
SM	9651,8	-0,83	-0,47	0,16	0,57	-2,29	-0,66
EV	0		-0,24		1,53		1,48
pms	0,11	-0,47	-0,47	-4,18	-4,18	-4,80	-4,80
Ym_0	2258,1	0,664		0,914		2,395	
Ym_1	11781,7	0,106		0,223		1,506	
Ym_2	15807,4	-0,112		-0,065		0,993	
Ym_3	8836,5	-0,258		-0,270		0,346	
Ym_4	20226	-0,336		-0,367		-0,255	
Ym_5	13156,6	-0,339		-0,384		-0,976	
Ym_6	26117,1	-0,488		-0,553		-2,516	
Sm_0	135,5	0,240		1,215		3,595	
Sm_1	824,7	-0,360		0,526		2,856	
Sm_2	1264,6	-0,590		0,451		2,497	
Sm_3	795,3	-0,750		0,374		1,290	
Sm_4	2022,6	-0,840		0,372		-0,095	
Sm_5	1447,2	-0,870		0,452		-2,358	
Sm_6	3161,9	-1,080		-0,407		-8,089	
Ev_0	0	0,664		2,283		3,463	

Ev_1	0	0,134		1,735		2,692	
Ev_2	0	-0,065		1,548		2,304	
Ev_3	0	-0,194		1,413		1,827	
Ev_4	0	-0,254		1,310		1,412	
Ev_5	0	-0,244		1,218		0,942	
Ev_6	0	-0,348		1,018		0,160	

When the effects of reduction of import duties at a household or households level are analyzed (according to the model), the representative[7] household income is noted to fall in the six models with the weakest effect on RA model 1 and 2 (-0.26) and the strongest one on TD-BU model 3 (-0,46%). As the impact on income is the direct consequence of the change in factor payments and the variations in this first model go in opposite direction (+1,47% for r and –1.76% for w) the total change in income will be relatively small. In the case of the third model, we have more factor payments with stronger variations and therefore the final effect on the household income is greater. In terms of savings, the results obtained with the models using LES expenditure system are quite different since savings depend on the prices of incompressible expenditure.

Performing impact analysis by household groups provides partial information on the poverty analysis that will be conducted in the following section. It is worth mentioning that this policy appears to be more favorable to households with less educated head, and the higher the education level, the more unfavorable reform is. This observation applies to the three models and this being the case, RA approach would lead us to conclude that this policy is more favorable to the less educated, and as it appears later within the framework of poverty analysis, it is those households with less educated heads that exhibit the highest poverty rates. It is interesting to observe that, in terms of welfare, the increase in purchasing power compensates for household income loss except for 5 households in the case of educated groups in model 1. The household 6 in model 3, the improvement is very small (+0.16%). In all other cases, welfare is noted to have improved in representative households. A comparison of the results of the three RA models shows that the magnitude of the effects augments as you shift from model 1 through model 3 (with a couple of exceptions).

We shall not go into details in analyzing variations in all endogenous variables in all models. We have opted to present key-variables that affect income and welfare. First, the effect of the policy on market price is transmitted through various mechanisms. Some of the transmission mechanisms are direct and others are indirect. The most direct transmission mechanism is lower market price *(Pq_i)*. This lower price is directly linked to the reduction of customs duties, which entails lower domestic prices for imported goods, and since the market price is a composite one in the sense that it takes into account

[7] We have aggregated the results of household income and savings for RA models from the disaggregated results shown in Table 2.3.

the local price of domestically produced good of the same category and the domestic price of imported goods (which includes import duties). The main sector concerned by this direct effect is the manufacturing sector, which exhibits a 24% protection rate and exhibits an important portion of imported goods (+30%) in the domestic supply. The strongest decrease in market price is observed in this sector with decreases ranging from -5.86% to -6.32%. For the other protected sectors (sector with a 25% protection rate), imports represent less than 10% of the value of sales on the domestic market. The direct effect is much smaller on these sectors.

Table 4: Model Sectoral Results

Variables	Definition	Sectors	Base value	Model 1 EGC-AR	Model 1 TD-BU	Model 2 EGC-AR	Model 2 TD-BU	Model 3 EGC-AR	Model 3 TD-BU
Pq	Market price	Paley & corn	1,01	-0,62	-0,63	-0,59	-0,61	2,82	3,18
Pq	Market price	Fruit & vegetable	1,02	-0,59	-0,60	-0,55	-0,57	0,93	0,79
Pq	Market price	Coconut	1,02	-0,37	-0,37	-0,36	-0,36	1,36	1,30
Pq	Market price	Livestock	1,01	-0,69	-0,69	-0,66	-0,68	0,86	0,61
Pq	Market price	Fishing	1,01	-0,91	-0,92	-0,87	-0,89	1,16	1,17
Pq	Market price	Other agric.	1,03	-1,69	-1,70	-1,70	-1,71	-1,79	-1,76
Pq	Market price	Logging and timber	1,01	-1,17	-1,18	-1,16	-1,17	0,95	0,80
Pq	Market price	Mining	1,01	-0,62	-0,62	-0,67	-0,69	-0,43	-0,38
Pq	Market price	Manufacturing	1,08	-5,86	-5,86	-5,87	-5,88	-6,32	-6,27
Pq	Market price	Rice manufacturing	1,00	-0,60	-0,61	-0,58	-0,60	1,71	2,01
Pq	Market price	Meat industry	1,01	-0,76	-0,76	-0,74	-0,75	0,38	0,17
Pq	Market price	Food manufacturing	1,03	-2,27	-2,28	-2,26	-2,27	-1,63	-1,69
Pq	Market price	Elec. Gas Water	1,01	-2,53	-2,53	-2,52	-2,53	-5,29	-5,24
Pq	Market price	Construction	1,01	-2,92	-2,92	-2,94	-2,94	-2,29	-2,23
Pq	Market price	Commerce	1,05	-0,66	-0,66	-0,66	-0,66	-1,87	-1,83
Pq	Market price	Trans. & comm.	1,01	-2,08	-2,08	-2,09	-2,10	-1,94	-1,91
Pq	Market price	Finance	1,05	-0,26	-0,26	-0,26	-0,28	-3,64	-3,46
Pq	Market price	Real estate	1,00	-0,37	-0,37	-0,37	-0,37	-3,54	-4,09
Pq	Market price	Services	1,04	-2,74	-2,74	-2,72	-2,71	-3,25	-2,90
Pq	Market price	Public Services	1,00	-2,20	-2,18	-2,27	-2,24	-4,15	-4,01

One major indirect effect of this reform is felt in sectors using large amounts of manufactured goods as intermediate inputs. As the prices of such goods drop dramatically, the production costs of these sectors also decline. The main sectors concerned by this effect are the *construction* sector (78% of manufactured goods as intermediate inputs), the *electricity-gas-water* sector (73%) and the *transport* sector (66%). We should also mention that this policy has a differential impact on factor prices and the labor/capital ratio of each of the branches; it so influences production cost through which it affects the market price. For the first four models, relative factor price (*w/r)* decreases by just over 3%; accordingly, the sectors exhibiting the highest factor ratios *(Ld/Kd)* will benefit in terms of production cost from the implementation of this policy.

A comparison of the results of RA models and TD-BU models reveals that in the case of model 1 and 2, results are almost identical. In the case of model 3 results are very similar but not as similar as what we observe in the first two models. We can note for instance that all prices are qualitatively similar except for capital remuneration in the service branch, which increases from –0.76 in the case of RA model to +0.35 in the TD-BU model. By and large, effects are very close with some prices of factor payments differing slightly. The difference in the models AR and TD-BU come mainly from the fact that we don't have perfect aggregation for savings and consumption items in the household model compared to the RA-CGE model.

To conclude this section, we can state that the differences observed between RA and TD-BU approach are relatively marginal and that effects range expands when more heterogeneity is introduced in household behavior and factor remuneration. Being exclusively interested in these macroeconomic results means that obviously the contribution consisting in introducing large number of households in the modeling exercise does not contribute much in terms of additional information in relation to RA approach. In the next section we will verify is this conclusion is also valid when applying poverty and inequality analysis.

Results of Poverty Analysis

In this exercise, we limit ourselves to applying the poverty index proposed by Foster, Greer and Thorbecke (1984), P_α, with α=0, which pertains to an additively decomposable[8] class of poverty indices. Two types of decompositions have been retained though many others could have been applied depending on the information contained in the household survey. The two types are decompositions by household head's education level and by regions.

Many approaches exist to calculate poverty variations in CGE modeling context. The use of income variations in combination with exogenous and endogenous poverty lines (see Decaluwé *et al* 1999a) is the most frequently used. In this paper we use an alternative approach to measure change in welfare. In fact, the approach is closer to the wellfarist view to poverty analysis as where the previous one being used is more of the non-wellfarist view. To do this we use the change in equivalent variation to approximate the change in household social-welfare. It takes into account the change in income and cost of the household's consumption. This approach is certainly the most rigorous one theoretically speaking. However, it presupposes that there is no link between the cost of the basket of basic needs and poverty line because we assume that the poverty line is exogenous

[8] We applied poverty analysis with α=1 and α=2; but since the results are similar to FGT_0 we do not present the results in this paper. Poverty index calculations were done using a non-parametric approach using the kernel approach with DAD software.

Poverty indices are applied to income vectors by adult equivalent before and after simulation[9]. It is important to note that with RA-CGE approach, the complete income vector (39,520 household) is not directly obtained from the model after simulation. We apply the variation of the representative household welfare to all households pertaining to this group. RA model generates seven different welfare variations, which are applied to the survey households according to household head's education level. Therefore, only seven variation rates will be found for all 39,520 households. This method is generally used in RA-CGE models analyzing poverty such as in Decaluwé and al. (1999a), Agénor and al. (2001) and Montaud (2002). As we shall demonstrate in the section dealing with poverty analysis, this approach does not modify variance in income distribution by household sub-groups for poverty analysis[10]. For TDBU-CGE models, the procedure consists in using the equivalent variation of each of the households to modify their welfare level before applying poverty index. This approach offers the clear advantage of modifying intra-group variance irrespective of the classification retained. In Table 5, the results of poverty impact of simulation are described as a function of the two modeling approaches (RA and TDBU)[11].

Table 5: Poverty index P_0

	Code	Base	RA-CGE Model 1	TD-BU Model 1	RA-CGE Model 2	TD-BU Model 2	RA-CGE Model 3	TD-BU Model 3
National		31.1	0.091	0.172	-1.621	-2.487	-2.423	-3.229
Household head's education level	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
	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
Regions	1	34.1	0.477	1.225	-1.404	-2.741	-2.291	-2.671
	2	30.2	-0.287	-0.287	-2.310	-3.811	-3.396	-5.882
	3	14.9	0.666	0.263	-2.856	-5.058	-4.560	-8.310
	4	24.5	0.392	0.160	-2.768	-4.214	-3.654	-4.956
	5	46.4	0.097	0.391	-1.224	-2.388	-1.861	-3.078
	6	35.0	-0.054	0.193	-1.427	-2.549	-2.172	-3.089
	7	30.1	0.090	0.138	-1.115	-1.703	-1.615	-2.480
	8	38.3	-0.123	0.525	-0.944	-0.902	-1.632	-1.322
	9	32.6	0.025	-0.021	-1.180	-1.805	-1.949	-3.096

[9] Note that the after simulation vector is the modified income base on the change in welfare and not on the change in income.

[10] When decomposition for poverty analysis is different from the one used in the model, intra-group variance is not equal to zero.

[11] It is important to point out at this stage that the results of poverty analysis do not correspond to the results obtained by the National Statistics Office (NSO). Many reasons can explain these differences. For instance, during this exercise, we used a single poverty line for the whole country. NSO used 32 poverty lines with a regional and rural/urban decomposition The other source of difference is that we used income by adult equivalent while NSO used per capita income.

	10	41.8	0.119	-0.542	-1.236	-2.330	-2.144	-3.999
	11	34.3	0.176	0.096	-1.911	-2.254	-2.991	-2.808
	12	45.4	-0.035	-0.492	-1.458	-2.198	-1.572	-2.223
	13	6.2	0.957	-5.620	-7.041	-11.017	-11.012	-15.279
	14	38.0	-0.177	-0.124	-2.152	-3.350	-3.003	-3.600
	15	58.2	-0.194	0.756	-1.864	-1.486	-2.711	-0.918
	16	49.0	0.000	0.571	-1.319	-1.344	-1.883	-0.895

The first strong and surprising observation made from this analysis of changes in poverty headcount ratio is that trends are dissimilar when we compare the results generated by RA-CGE models and TD-BU models. With the first approach, poverty is declining in the less educated groups (group 0 and 1) and increasing in the other five groups and the effect increasing with the household head's education level. On average with the RA approach we can say that the policy is pro-poor. TD-BU models produce inverted results, though this trend as clear in model 1. With TDBU-CGE approach, the highly educated households appear to be the great winners under this policy reform while the less educated (poorer) ones are losers. Let's try to analyze why we are generating the opposite results starting with model 1 and ending with model 3, followed by a comparison of the two approaches.

In the case of RA model 1, the policy clearly appears to be more favorable to the less educated who are also the poorest. For models 2 and 3, groups that have started secondary education level (group 3) appeared to be most favored by this policy. In RA model 2, starting with group 3 we have the negative effect attenuates as we move towards the least and most educated. In RA model, the difference is small for the less educated groups (0 to 3), with a 2.2% drop for groups 0 (non-educated) and 2.7% for group 3. In the case of model 3, the least favored group is group 5 (-0.9%) followed by group 4 with a 1.8% drop. It is important to point out that for group 6, we did not observe any change in poverty in the three RA models. This can be explained by the very low initial poverty rate of this group, 2.7% and because the method of calculating poverty rate in DAD is discrete. Consequently, the number of households in the vicinity of the poverty line being limited, no household of the group crosses the poverty line in all three models[12]. Finally, we observe, scale of the quantitative effects tend to increase from model 1 to model 3. This is a consequence in increasing heterogeneity between households moving from model 1 to model 3.

With TD-BU approach model 1 no specific trend emerges. W note that three groups benefit from this policy (groups 6, 3 and 1 with a 2.0%, -0.05% and a very low 0.001% drop respectively) while four groups see their poverty levels increase. The two groups most concerned are groups 5 and 0 with a 1.3% and 0,6% increase respectively. In the other two models, we observe a clear tendency of the educated benefiting most from this policy though all groups see their respective poverty levels decline.

[12] Using an approach to poverty indices calculation with a continuous functional form would have produced results that are different from zero in this case. For more detailed information on this issue, see Boccanfuso, Decaluwé and Savard (2003).

The same tendency is observed as in RA model with the magnitude of effects increasing with model heterogeneity though qualitative effects vary from model 1 to model 2. The only exception to this increase in amplitude of effects between models 2 and 3 is found with group 6 with a reduction in poverty headcount ratio smaller in model 3 (-6.7%) then in model 2 (-7.0%).

As we have said earlier herein, RA and TD-BU models generate very different results in terms of poverty variation as opposed to macroeconomic and sectoral results. Although differences are not major in model 1, results have been totally inverted in models 2 and 3.

It is important to look at the cause of this result inversion between the two approaches. One argument to explain this divergence is the fact that representative agents in traditional CGE models are not true representative agents. In fact, in these models, behaviors (in terms of allocations and consumption structure) have been modeled based on aggregates depending on the information contained in social accounting matrix (SAM) accounts. These structures therefore do not reflect those of an average or median household. In social accounting matrices, the information contained in a representative household is an aggregate of that account. This constraint guarantees that the sum of the accounts is coherent with national accounting totals. Model representative agents therefore have factor allocation and consumption structures that reflect more those of the wealthy than those of the poor. For instance, when we look at the less educated three household groups (0,1 and 2) who also happen to be the poorest, we observe poverty rates of 53.5% 48.9% and 39.2% respectively. However, in each of these groups, there are certainly very wealthy households, and as we have to aggregate all information on households pertaining to the group in order to feed into the SAM's account, the wealthiest households of these groups will be best represented. This problem also applies to the other household groups.

The second explanation is indirectly linked to the first one in that what is important in poverty analysis is to clearly reflect the behavior and the income and expenditure structure of the households concerned, and in this case, it is the poor. As we have seen in the first explanation, in the traditional RA-CGE approach, we represent much more the structure of wealthy households than that of poor ones. But as we focus our impact analysis on poverty analysis, it is important that the poor should be clearly targeted. Whereas such is not the case when we use a representative agent since the latter does not necessarily represent the poor of the group[13]. In this type of model, there are two important elements: the structure of factor allocations and consumption as well as the behaviors of associated households. It would be possible in the case of models 2 and 3 to adapt behaviors in LES parameters so as to reflect the behavior of a poor or average household; this is what we have tried to do. Yet, the

[13] If we are only interested in poverty analysis with the P_0 index, we might as well not be too much mistaken if the representative agent corresponds in terms of behavior and structures to households close the poverty line. On the other hand, in terms of poverty depth and severity as well as inequality analysis, no matter the representative agent retained, we will not be able to properly measure changes in these indices.

results obtained have clearly revealed that the structures of factor allocations and consumption play a more important role than the behavior parameters of the linear demand system (LES). In view of this important constraint, it is only by considering a great number of households in a given group that the modeler can rigorously capture changes in poverty and inequality levels following a policy simulation or external shock.

Coming back to the results generated by TD-BU models, they are a direct consequence of the structure of factor endowment and consumption of households around the poverty line in each of the groups. When we look at the effects on poverty, differences between RA and TD-BU at the regional level, the effects are weaker than for educational decomposition. It is interesting to note that model 1 appears to be the one to generate the biggest differences between the two approaches. Qualitative changes have been observed in 6 of the 16 regional groups, and quantitative differences of over 0.5%, in 6 of the 16 regions. In model 2, relative effects are virtually the same, qualitative effects are similar but for most of the regions, the magnitude of the effects is more significant in TD-BU approach for all but two regions (8 and 15). In the case of model 3, qualitative effects are similar and the magnitude is greater in TD-BU approach for 12 of the 16 regions.

Income Distribution Analysis

For income distribution analysis, we have retained the S-Gini index as it allows us to do decomposition analysis to measure changes in income. The results obtained at the national level reveal an interesting specific feature such that RA models and TD-BU models systematically produce inverse results. This is not surprising given the results found in the poverty analysis side

Table 6: Results of the Analysis of Changes in S-GINI Index

	Code	Base	RA-CGE Model 1	TD-BU Model 1	RA-CGE Model 2	TD-BU Model 2	RA-CGE Model 3	TD-BU Model 3
National		0.518	-0.110	0.042	-0.116	0.044	-0.651	0.134
		Gini decomposition by education groups						
Inter-Group		0.454	-0.131	0.044	-0.138	0.046	-0.787	0.138
Intra-Group		0.065	0.037	0.030	0.040	0.031	0.300	0.110
Household head's education level	**0**	0.399	0.000	0.057	0.000	0.059	0.000	0.241
	1	0.407	0.000	0.017	0.000	0.018	0.000	0.098
	2	0.411	0.000	0.018	0.000	0.019	0.000	0.115
	3	0.416	0.000	0.024	0.000	0.026	0.000	0.048
	4	0.413	0.000	0.030	0.000	0.032	0.000	0.019
	5	0.455	0.000	0.075	0.000	0.078	0.000	0.296
	6	0.492	0.000	0.075	0.000	0.078	0.000	0.275
		Gini decomposition by regions						
Inter-Group		0.471	-0.109	0.043	-0.115	0.045	-0.640	0.132
Intra-Group		0.047	-0.116	0.037	-0.122	0.039	-0.767	0.159
Regions	**1**	0.459	-0.090	-0.018	-0.096	-0.019	-0.611	-0.072

	2	0.427	-0.124	0.051	-0.132	0.053	-0.704	0.152
	3	0.385	-0.088	-0.063	-0.093	-0.065	-0.558	-0.084
	4	0.446	-0.097	0.010	-0.103	0.011	-0.602	-0.004
	5	0.468	-0.126	-0.031	-0.133	-0.032	-0.793	-0.141
	6	0.453	-0.133	-0.066	-0.141	-0.069	-0.770	-0.179
	7	0.504	-0.138	0.186	-0.146	0.194	-0.762	0.450
	8	0.465	-0.145	0.024	-0.154	0.025	-0.735	0.078
	9	0.483	-0.144	0.010	-0.152	0.011	-0.684	-0.070
	10	0.524	-0.125	0.006	-0.131	0.006	-0.751	0.129
	11	0.470	-0.128	-0.038	-0.135	-0.039	-0.709	-0.026
	12	0.462	-0.118	0.025	-0.124	0.026	-0.715	-0.040
	13	0.509	-0.069	-0.003	-0.071	-0.003	-0.607	0.100
	14	0.504	-0.131	0.078	-0.138	0.082	-0.706	0.042
	15	0.377	-0.205	0.113	-0.215	0.118	-0.777	-0.007
	16	0.464	-0.110	0.001	-0.117	0.001	-0.635	0.029

The three RA models generate reduction in inequalities at the national level while TD-BU models generate greater inequalities. This is not surprising since the less educated and poorest groups have been the beneficiaries of this reform in the AR models while TD-BU models tend to invert these effects. Still at the national level, when we compare models 1, 2 and 3, the first two models do not generate much re-distributive effect. On the other hand, model 3 produces re-distributive effects up to five times higher than in the first two models though these changes remain relatively marginal.

If we look at changes in intra-group inequalities using the education decomposition, RA models, which do not allow any change in intra-group variance, do not modify the S-Gini index for given sub-groups. Inversely, in the case of the three TD-BU models, the effects on intra-group variance increase as a function of the degree of homogeneity introduced in the models. Model 1 generates quite marginal changes in the S-Gini index. These variations range from +0.017% for group 1 (some primary education) to 0.075% for groups 5 and 6 who are the most educated. In model 3, changes in inequalities range from 0.019% for group 4 (the smallest variation) to 0.296% for group 5 (the greatest variation). In relation to the other two models, model 2 generates results, which are just slightly higher than the results for model 1. In TD-BU model 1, less educated households have been less affected by an increase in inequalities and this impact increases with education level. On the contrary, this trend is no longer present in model 3. It is also important to point out that in all scenarios involving TD-BU models, inequalities have increased. Lastly, despite the common characteristics of household heads in terms of education level, intra-group inequalities have been noted to be almost as significant as changes in inter-group inequalities in TD-BU model 3. This result is important in the sense that the models used mainly capture heterogeneity in household structure and little in terms of agents' behavior[14]. Therefore, models that will explicitly capture agents' behavior will potentially allow for

[14] The behavioral parameters playing an important role in these models are similar for all households. This choice can be explained by the fact that the purpose of the paper was to focus on household structures and not on household behaviors.

more significant intra-group distributive and likely become much more important than inter-group distributive effects.

Inequalities in the decomposition by regions produce more significant effects than the education decomposition as expected[15]. Under this scenario, since the classification does not correspond to household classification in RA model, variations of S-Gini indexes are obtained for sub-groups in the application of RA models. No particular trend emerges apart from the fact that RA models have appeared to generate more significant distributive effects than TD-BU models. We also systematically observe that in RA and TD-BU models, effects are larger as heterogeneity increases (moving from 1 to 3). Moreover, RA model 3 generates reduced inequalities in all regions while TD-BU model 3 generates reduced inequalities in nine regions and increased inequalities in the other seven regions. In this latter model, the most significant reduction in inequalities observed was 0.17% for region 6 while the highest increase observed was 0.45% for region 7. Regarding decomposition by regions, in TD-BU model 3, intra-group variance is more important (0.16) than inter-group one (0.13).

2.7 Conclusion

In this exercise, we have demonstrated that micro-simulation in the context of a relatively standard model does not appear to contribute a significant value-added in impact analysis at the macroeconomic and sectoral levels. The RA and TD-BU approaches produce very similar qualitative and quantitative results. However, the inverted results of poverty and inequality analysis, particularly in the case of model 3 reveals that the choice of the approach is crucial when the objective of the analysis is precisely these two items. It is quite likely, that the use of a RA model, which is not able to generate intra-group variance, would lead to biased conclusions. This is all the more disturbing as our exercise focused on household income and expenditure structure and not on behavioral heterogeneity. There is a strong possibility that introducing a stronger heterogeneity at this level would magnify the differences observed[16]. In a context where representative agent CGE models have been increasingly used to do impact analysis on poverty and inequalities, there is reason to wonder about validity the conclusions reached in this type of applied work.

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[15] In fact, decomposition by household head's education level is an important element in determining the level of household income and therefore, these groups should show greater uniformity/equity than decomposition by regions. This stylized fact permeates on reading S-GINI indices calculated on the basis FIES' survey data and which are almost all higher than the reference indexes calculated for decomposition by education (with the exception of two highly educated groups).

[16] In fact, extensions of the work have shown this intuition to be valid. We experimented with an almost ideal demand system and with endogenous labor supply and we found that the increase behavioral heterogeneity reinforces the conclusions found in this papers

Lastly, we have also illustrated through this exercise the contribution of household structure heterogeneity (income and expenditure) in terms of distributive effects if not marginal. Thus, even with limited behavioral heterogeneity it is still extremely important to take into account this structural heterogeneity into the CGE modeling exercise when the objective it to analyze the impact of policy reforms or external shock on poverty and income distribution. Similar macro-economic and sectoral results do not justify not using micro-simulation CGE models.

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Appendix 1: Regional code definition

Region Code	Region Identification	Region Name
1	Region I	Ilocos Region
2	Region II	Cagayan Valley
3	Region III	Central Luzon Region
4	Region IV	Souther Luzon Region
5	Region V	Bicol Region
6	Region VI	Western Visayas Region
7	Region VII	Central Visayas Region
8	Region VIII	Eastern Visayas Region
9	Region IX	Western Mindanao Region
10	Region X	Northern Mindanao Region
11	Region XI	Southern Mindanao Region
12	Region XII	Central Mindanao Region
13	NCR	National Capital Region
14	CAR	Cordillera Administrative Region
15	ARMM	Autonomous Region of Muslim Mindanao
16	Caranga Region	Caranga Region

Appendix 2: Educational code definition

Education Code	Level of education
1	Elementary undergraduate
2	Elementary graduate
3	1st to 3rd Year High school
4	High School Graduate
5	College Undergraduate
6	At least College graduate
0	Not reported or no grade