GRÉDI

Groupe de Recherche en Économie et Développement International

Cahier de recherche / Working Paper
10-04

Using an Almost Ideal Demand System in a Macro-Micro Modelling Context to Analyse Poverty and Inequalities

Luc Savard

UNIVERSITÉ DE
SHERBROOKE

Using an Almost Ideal Demand System in a Macro-Micro Modelling Context to Analyse Poverty and Inequalities

Luc Savard

February 2010

Abstract

In this paper, we explore the contribution of introducing a flexible form for household consumption in a macro-micro modelling context for poverty and income distribution analysis. The almost ideal demand system exhibits interesting features allowing for the introduction of inter-household heterogeneity in a rigorous fashion. In order to illustrate the contribution of the AIDS system in the macro-micro modelling context, we perform a comparative analysis with an equivalent model using a LES demand system and a CGE with representative households including an AIDS. Results show the strong contribution of using an almost ideal demand system in a microsimulation context and its value added versus a linear expenditure system to analyse poverty and income distribution changes following a policy simulation.

Introduction

Analyzing the impact of economic reforms on poverty and income distribution has gained significant interest since the late 1990s. Various approaches have been proposed in the literature to capture macro-micro transmission mechanisms. The analytical methodologies presented below will be examined further on. It should be mentioned from the outset that in a number of applications studied, little effort was made to introduce heterogeneity between households included in modelling exercises. The work of Bourguignon, Robilliard and Robinson (2002), Bussolo and Ley (2003) and Savard (2003) can be cited as making a particular effort to introduce heterogeneity in terms of the behaviour of labour supply. However, the element of consumption has not been examined in depth when it comes to increasing heterogeneity between households. In fact, the near totality of works studied in Savard (2004) use Cobb-Douglas (CD) and Stone-Geary (linear expenditure system - LES) expenditure systems. In both scenarios, price and income elasticities are the same for the whole of households. This implies that the differences between household behaviours is in terms of the marginal share of consumption for demand functions derived from a Cobb-Douglas. In the case of the linear system (LES), marginal shares are also different, in addition to the incompressible expenses specific to each household. As demonstrated in Savard (2004), the change from a CD system to a LES system in a CGE microsimulation model allows for increasing the level of heterogeneity between households and therefore enriching the analysis, but the differences in the results are relatively weak. In this context, we consider that introducing a richer and more flexible demand system would allow for an increase in the degree of heterogeneity between households in a modelling context, and thereby improve resulting analysis of poverty and inequality.

The demand system derived from a Cobb-Douglas utility function generates continuous demand functions that are doubly differentiable, since the preferences are strictly concave. Moreover, the standard writing of this form in the model is linear and allows for a very large number of households without sacrificing the model's resolution speed.[1] However, the system is not very information-rich and imposes a substitution elasticity equal to 1 for the whole of households in the model and for each of the goods consumed by the households. With this approach, it is possible to differentiate household behaviours using calibration in two ways. The first is the standard method and consists in calibrating consumption shares in value $\left(\beta_{i,h} \right)$ in order to reproduce the reference data. This approach implies that each household will have its marginal share of consumption. The other approach consists in specifying the same share in value $\left(\beta_i \right)$ but calibrating a scale parameter.

---

[1] Cororaton (2003) used 15.000 households in a multi-household integrated CGE model without encountering resolution problems using a demand system derived from Cobb-Douglas utility functions, and with ten or so branches/goods. For their part, Boccanfuso et al. (2003), with 10 goods and 3.278 households, encountered numeric resolution problems with a model similar to the one presented in the first chapter with a demand system derived from a Stone-Geary utility function. We can see that a function derived from a Cobb-Douglas has the following form: $Pq_i C_{h,i} = \beta_{h,i} Y dm_h$ and consequently does not present particular numerical resolution problems.

The linear demand system (LES) is fairly close to the Cobb-Douglas, but is richer in content. Moreover, this system is less linear and allows for the introduction of greater heterogeneity in terms of households or groups of households by means of the incompressible expenses and marginal shares that can be specific to each of them. Substituting the expenditure system derived from the CD utility function with the system derived from a Stone-Geary utility function increases the degree of nonlinearity in the model. As a result, there will be an increase in the model's resolution time.

To enrich analysis and open the door for introducing greater inter-household heterogeneity, we have chosen to integrate the AIDS demand system in a context of CGE microsimulation modelling. This may contribute to increasing heterogeneity between households and therefore increasing intra-group variation of household income changes for the poverty study. The principal contribution of this demand system is that it allows for price and income elasticities specific to each of the households, and these elasticities are endogenous to the model.[2] Nevertheless, due to the properties of this demand system, problems can occur during its application. First, the price index is potentially sensitive. Second, we observe null consumption shares in the reference period, and this can generate negative consumption shares in simulations. Finally, the demand system behaves well locally but not necessarily globally, as it is not globally quasi-concave. In light of these potential problems, it will be necessary to adapt the approaches used to integrate microeconomic behaviour and to take into account the feedback effect. These are the two central objectives of this paper, and will be discussed further in the work.

In the section that follows, we describe the origins of the AIDS demand system, as well as its properties, then present a brief review of the literature concerning applications of the AIDS demand system in the context of CGE and microsimulation modelling. Next, we present the implications of introducing this demand system in the CGE-microsimulation context, the difficulties encountered and the solution proposed. We will pursue our study with a description of three models used, namely a CGE model with representative agent with the AIDS demand system, a CGE-TD/BU model with a LES demand system and a CGE-IMH model with the AIDS demand system. To show the contribution of introducing the AIDS demand system in a CGE-microsimulation context, we will conduct a simulation in the three models. We will then analyze the macroeconomic and sectorial results before examining poverty and inequalities and presenting concluding remarks.

Historical Background of the AIDS

Studying household consumption behaviour has long been a subject of interest to economists. A significant body of literature developed following Stone's 1954 contribution of estimating a demand system based on consumer theory. A multitude of increasingly rich theories has thus emerged. After Stone (1954), significant contributions were made by Theil (1965) proposing the Rotterdam system, followed by the indirect Translog model of Christensen, Jorgenson and Lau (1975). A new

---

[2] In the section presenting the demand system, we will see the form the elasticities will take, in order to illustrate the fact that they are both specific to households and endogenous.

wave of work was inspired in the early 1980s by Deaton and Muellbauer (1980) with the almost ideal demand system (AIDS). This approach was inspired by work on flexible forms such as the Translog demand system. The idea behind this demand system was to have a more general system than the Rotterdam and Translog ones, a system that would better respect the desired properties of consumer theory.

Since their 1980 paper, many empiricist economists have estimated, applied and adapted this model to various contexts. In their paper, Deaton and Muellbauer estimate their model using annual English consumption data from 1954-74 on seven goods. The results obtained have been encouraging, even if the authors were aware of the limitations of their model. A number of authors such as Blanciforti, Green and King (1986), Pashardes (1993) and Ng (1997) have proposed new estimation methods and variants of the demand system, allowing for improved estimations. Other authors such as Lee and Pashardes (1988), Decoster and Schokkaert (1990), Decoster (1995), Decoster and Vermuelen (1998) as well as Nichèle and Robin (1995) have used it to simulate impacts of external policies or shocks on household consumption.

Studying consumption behaviour is important when analyzing poverty and inequalities for two reasons: first, the particularities of the demand system can play a significant role in the equilibrium of markets in the economy and therefore on the price vector with which consumers will be confronted (goods and factors) and second, the specificity of the indirect utility function from which the demand system is derived is central in the analysis of change in household welfare. In our case, we use the equivalent variation to measure change in household welfare. In view of the endogenous property of the shares of the AIDS demand system, the endogeneity and specificity of price, and income elasticities, this demand system offers greater richness than traditional demand systems. By applying this demand system in a macro-micro modelling context, we seek to find out whether this system's contribution is real in terms of both general equilibrium effects and poverty and inequality indices. As previously stated, the objective is also to ascertain whether it is possible to introduce this demand system in a CGE microsimulation context in light of the potential problems this can represent.

The AIDS Demand Function

The AIDS demand system is obtained using the "Price independent generalized logarithmic" (PIGLOG) cost function, noted $c(p,u)$. Deaton and Muelbauer (1980) use two functions whose particularities are having primary and secondary derivatives related to these two arguments, equal to an arbitrary cost value.

$$(1)\ \log a(p) = \alpha_0 + \sum_k \alpha_k \log p_k + \frac{1}{2} \sum_k \sum_j \gamma_{kj}^* \log p_k \log p_j$$

$$(2)\ \log b(p) = \log a(p) + \beta_0 \prod_k p_k^{\beta_k}$$

Based on these two equations, we can write the cost function for the AIDS system as follows:

$$(3) \ \log c(u, p) = \alpha_0 + \sum_k \alpha_k \log p_k + \frac{1}{2} \sum_k \sum_j \gamma_{kj}^* \log p_k \log p_j + u\beta_0 \prod_k p_k^{\beta_k}$$

where α_k, β_k and γ_{kj} are parameters, u is utility and p is prices. To ensure that the cost function is linear and homogeneous and that it respects the properties of additivity, the following conditions are imposed on the parameters;

$$(4) \ \sum_i \alpha_i = 1, \sum_i \gamma_{ij} = 0, \sum_i \beta_i = 0 \text{ and that } \sum_j \gamma_{ij} = 0,$$

Thanks to Shephard's lemma, we deduce the conditional demand functions based on the cost function above by deriving the cost function by their price, that is, $\dfrac{\partial \log c(u, p)}{\partial \log p_i} = q_i(u, p)$. By multiplying both sides by the expression $p_k \big/ c(u,p)$, we obtain the consumption share w_i. If we calculate the logarithmic differential of equation 3, we obtain the following relation:

$$(5) \ w_i = \alpha_i + \sum_k \alpha_k \log p_k + \sum_j \gamma_{ij} \log p_j + \beta_i u\beta_0 \prod_k p_k^{\beta_k}$$

where

$$(6) \ \gamma_{ij} = \frac{1}{2}\left(\gamma_{ij}^* + \gamma_{ji}^*\right)$$

For a consumer maximizing its utility, total expense will be equal to $c(u,p)$. Using equation 3, we can isolate the u, thus giving us the indirect utility, a function of revenue and prices. By substituting the indirect utility into equation 5, we can directly obtain the budgetary shares:

$$(7) \ w_i = \alpha_i + \sum_j \gamma_{ij} \log Pq_j + \beta_i \log\left(\frac{Ym}{P}\right)$$

where P is the price index and Ym is the household's total expenditure;[3]

$$(8) \ \log P = \alpha_0 + \sum_k \alpha_k \log Pq_k + \frac{1}{2} \sum_k \sum_j \gamma_{kj}^* \log Pq_k \log Pq_j$$

As Deaton and Muelbaeur (1980) point out, this price index does not always behave well; the authors suggest substituting it with the Stone price index, which approximates this price index and is easier to manipulate.[4]

$$(9) \ \log P_{Stone} = \sum_i w_i \log Pq_i$$

Equations 7 and 9 are therefore the two key equations for this modelling. To alleviate the presentation, we have not indexed with h so as to have a specific function. For the household model, as we will see below, the h index should be added to terms w_i and Ym of equation 7 to obtain the function that will determine the endogenous consumption shares specific to each household.

---

[3] Here we use the notation of total income that will be equal to total spending.
[4] Most of the authors consulted, such as Banse (1998) and Burfisher et al. (2000) in the CGE context and Ng (1997) in a microeconometric context, use the Stone index.

Based on this demand system, we can obtain the price and income elasticities. The income elasticities are of the following form:

$$(10) \quad \eta_h = 1 + \left(\beta_i \middle/ w_{i,h} \right)$$

For price elasticity, we have the following relation:

$$(11) \quad \varepsilon_{ii,h} = -1 + \left(\gamma_{ii} \middle/ w_{i,h} \right) - \beta_i$$

and finally the crossed price elasticities are:

$$(12) \quad \varepsilon_{ij,h} = -1 + \left(\gamma_{ij} \middle/ w_{i,h} \right) - \beta_i$$

These relations show that the elasticities derived from the AIDS demand system are specific to each of the households. Moreover, they are endogenous in the model, since shares w_{ih} are determined by equation 7, in which prices of goods, household income and the price index are endogenous.

AIDS in the CGE and Microsimulation Context

Three types of demand systems are generally found in CGE and microsimulation modelling. The first is the fixed share system, which is generally used in the context of traditional microsimulation modelling (Mitton, Sutherland and Weeks, (2000). In the CGE context, the demand system derived from the Cobb-Douglas utility function and the linear expenditure system (LES) are generally used. However, some authors have attempted to enrich their analysis by using richer forms often referred to in the literature as "flexible forms."

Flexible forms have only rarely been used in the context of general calculable equilibrium. Certain authors such as Rimmer and Powell (1996) and Yu et al. (2002) advance the problem of regularity properties that can generate consumption shares that are negative or greater than one.[5] While this argument is valid in a macroeconomic context, in a microeconomic one with a representative agent and with a limited number of goods, it should not necessarily be problematic. In a modelling situation in which the modeller works with relatively aggregated households and goods, consumption shares are generally sufficiently different from zero to avoid this problem. A second reason that may explain the parsimonious use of flexible forms in this context is the significant number of parameters required to apply the model. For traditional forms, the limited number of parameters allows modellers to avoid exposing themselves to criticism regarding the choice of values for the parameters chosen. The third reason is that the use of linear forms is much easier to solve, numerically speaking, especially when size is a significant factor in the models. The fourth reason is that the large majority of empirical estimations of flexible functions are done using food goods, while in the context of general equilibrium we examine household consumption over nearly the whole of goods and services produced in the

---

[5] See Yu et al. (2002) for an in-depth discussion on the advantages and disadvantages of using one expenditure system rather than another.

economy. Consequently, it can be more difficult to find parameter values corresponding to the nomenclature of the model.[6] Modellers must therefore carry out econometric estimation themselves or make hypotheses on many parameters. Finally, the sensitivity of the price index may cause resolution problems. Among authors using the AIDS form in CGE modelling, we wish to cite Banse (1998) for Poland and Slovenia, as well as Burfisher, Robinson and Thierfelder (2000) and Benjamin and Pogany (1998). These last two groups of authors have used AIDS to model the demand system of imports, while the first have used the AIDS demand system to model household consumption.

Using a demand system in the CGE microsimulation modelling context implies working with a nonlinear functional form that does not have all of the properties generally sought in CGE models. Three approaches are generally used in macro-micro modelling. The objective of these approaches is to take into account variation in intra-group income following a shock from an economic policy. The first integrated multi-household (IMH) approach proposed by Decaluwé et al. (1999b) and Cockburn (2001) consists in including a large number of households in a traditional CGE model. The second is the multi-household sequential (MHS) approach proposed by Bourguignon, Robilliard and Robinson (2002), which consists in sequentially relating a CGE model with a microsimulated household model, and the final approach is that proposed by Savard (2003), which consists in recursively associating a CGE model with a household model in order to take into account the feedback effects of the household model in the CGE model. For more information on the advantages and disadvantages of each approach, see Savard (2004).

In this work, the objective is to integrate the AIDS demand system in a CGE microsimulation modelling context. Without entering into details, with regard to the approach chosen, we would like to underscore that the TD/BU approach did not allow for finding a convergent solution, given the gap between results obtained in the aggregated and multi-household versions,[7] and the traditional IMH model did not allow for finding an optimal solution given, among other things, the presence of a negative consumption share. We have not definitively isolated the sources of problems in this frame, but we think that the sensitivity of the price index and the global non quasi-concave nature as well as the nonlinearity of the demand functions are certainly at the root of resolution problems. This is especially so because the same functions with the same parameters posed no particular resolution problems for the representative agent version of the CGE model, in which we included seven representative households.[8] We have chosen not to use the MHS because we ran into

---

[6] In such a situation, modellers can be forced to estimate the parameters of their model themselves, and the required data for this work will not necessarily be available.

[7] For more information on the convergence problems of this exercise, see Savard (2004).

[8] In this case, the model contained 900,000 equations and the nonlinear form of the AIDS demand system, the sensitivity of the Stone price index and the parameters that are negative or superior to one have certainly contributed to the problem of non-convergence of this approach. For the MHS, given the gap between the results obtained in the first iteration loop of the TD/BU approach, which is equivalent to the MHS in the first loop, we have concluded that the information loss resulting from the gap between consumption in the two models suggests the inappropriateness of this model.

aggregation problems with the TD/BU approach.[9] This informs us on the information loss related to the non-consideration of the feedback effect of microeconomic behaviour generated by the AIDS demand system in the CGE model. And because the objective of this work is to take into account this feedback effect, this would not have allowed us to reach our objective.

In light of the problems of non-convergence in these two approaches, we have opted for an intermediary solution. This solution consists in using a minimum of equations related to the disaggregated households by using an equation representing the aggregate of household consumption in the IMH model, but taking into account the specificity of income variation of each household. We present in the appendix the equation that measures average logarithmic deviation, or the aggregation error resulting from the use of a representative agent for the AIDS demand system. Introducing only a demand function of the AIDS system in the IMH model greatly reduces the number of nonlinear equations in the model and facilitates resolution. This choice has implications in terms of the degree of heterogeneity that we introduce into the model, but represents the borderline inferior case of heterogeneity that the AIDS demand system can bring to the modelling exercise. In fact, this constrains us to use the same parameters α_i, γ_{ij}, et β_i for all households. The demand function for the good by household in the case of the standard CGE-IMH approach is obtained by substituting equation 7 into equation 13 below representing the share in value of a household's consumption:

$$(13)\; w_{ih} = \frac{Pq_i C_{ih}^*}{Ym_h}$$

where we isolate the consumption matrix to obtain this equation:

$$(14)\; C_{ih}^* = \frac{\alpha_{i\;i}^c Ym_h}{Pq_i} + \frac{Ym_h \sum_j \gamma_{ij} \log Pq_j}{Pq_i} + \frac{Ym_h \beta_i^c \log\left(\dfrac{Ym_h}{P_{Stone}}\right)}{Pq_i}$$

For the equivalent demand function of a representative agent, we have the following relation:

$$(15)\; C_i = \frac{\alpha_i^c YM}{Pq_i} + \frac{YM \sum_j \gamma_{ij} \log Pq_j}{Pq_i} + \frac{YM \beta_i^c \log\left(\dfrac{YM}{P_{Stone}}\right)}{Pq_i}$$

where $YM = \sum_h Ym_h$. To arrive at the aggregated consumption of 14, one need only add C_{ih} over the whole of households, yielding the following relation:

$$(16)\; C_i = \frac{\alpha_i^c YM}{Pq_i} + \frac{YM \sum_j \gamma_{ij} \log Pq_j}{Pq_i} + \frac{YM \beta_i^c \sum_h \log\left(\dfrac{Ym_h}{P_{Stone}}\right)}{Pq_i}$$

---

[9] The problem we encountered is that the gap between the result obtained with a representative agent in the CGE module and the household module is fairly significant. This problem is at the source of the non-convergence of the TD/BU approach with the AIDS demand system. We will come back to the measure of the gap between the two models in the text, and the measure (average logarithmic deviation) is presented in the appendix.

It is clear that the last terms in equations 15 and 16 are not equal and the gap represents the average logarithmic deviation (ALD).[10] The solution lies in using equation 16 instead of equation 14 in an IMH model, thus enabling the elimination of the ALD at the origin of non-convergence in the TD/BU approach while maintaining a reasonable number of equations in the model. The only microeconomic behaviour equation that must be introduced into the model is the equation of determination of household income. This makes a CGE model with representative agent go from 860 equations and endogenous variables to 40,380 with the addition of 38,520 equations for household income.[11] The resolution of the module is much longer (60 times longer) than that of the equivalent model with representative agent, but there is no problem finding an optimal solution. The IMH version of the model with which we experimented involved 632,860 equations, including 435,500 strongly nonlinear consumption equations. The solution generated with this approach is the same as that obtained with an equivalent IMH model, although it is more restrictive.[12]

Description of Models Used

To be able to conduct a comparative analysis of the contribution of introducing an AIDS demand system in a multi-household integrated model, we have constructed an equivalent model with representative agents. We have also compared the results with an equivalent TD/BU model but with a LES demand system instead of the AIDS system. We do not present this last model but a complete description is presented in Savard (2004). Applying this simulation in these various versions of the models allows us to compare in a first phase the contribution of adding a richer and more flexible demand system and, in a second phase, that of working with a large number of households (IMH) compared to the CGE-RA approach. We first present the general structure shared by the three approaches, then present the TD/BU approach, followed by the IMH model and finally the CGE-RA model.

The models we have constructed are inspired by the EXTER model of Decaluwé, Martens and Savard (2001). It is a model of a small open economy with global prices for exogenous imports and exports and an infinitely elastic export supply. Production is determined by a three-level system: total production (*XS*), composed of value added (*VA*) and intermediary consumptions (*IC*). The relation determining the level of *VA* is a Cobb-Douglas function between composite labour (*LD*) and capital (*KD*). Composite labour is subdivided into formal and informal labour and the combination of these two factors is determined by a CES function. Intermediary consumptions are modelled as fixed shares corresponding to input-output coefficients calculated based on the SAM.

Household income is composed of labour renumeration (formal and informal) and of capital renumeration specific to each of the branches (implicit hypothesis of fixed

---

[10] The expression of the average logarithmic deviation is presented in the appendix.

[11] We will come back to this question, but we work with a sample of 39,520 households based on the 1997 Philippine Family Income and Expenditure Survey.

[12] As previously mentioned, our solution constrains us to use the same parameters for all households. In the CGE-IMH approach, it would be possible to introduce differentiated parameters for the households given certain characteristics specific to them.

capital). Business income is the balance of capital renumeration not payed to households, to which are added state subsidies and transfers from the rest of the world. State revenue comes from production taxes, customs duties, business taxes and transfers from the rest of the world (budgetary aid). The state spends its budget in different ways: the purchase of goods and services, transfers to households and transfers to the rest of the world. Import and export prices are exogenous and therefore the country exerts no influence on world prices.

The model's equilibrium conditions are also fairly standard. We thus have the goods market, the factor (labour) market, the equilibrium of the current balance and the savings/investment equilibrium. Moreover, the labour market is perfectly segmented between a formal and informal labour market. It is therefore possible for workers to go from one activity branch to another without going from one market to another. The balance of current operations is fixed and as a result, the nominal exchange rate is adjusted to balance this market. As for the savings/investment equilibrium, the total investment is exogenous and state savings are adjusted to ensure such an equilibrium. When it comes to the two labour markets, the total supply on each of the markets is exogenous and the nominal salary is adjusted to equalize the supply and demand of labour.[13]

The various versions of the models have been applied on data from the Philippines. The models were constructed using the 1997 FIES household survey and the 1990 SAM. The FIES has been used to construct the household database used in the various versions of the model and the SAM has been used in the construction of CGE models. Data manipulation was required to convert the FIES nomenclature so that it would be compatible with the national accounts of the SAM. We therefore had 20 production branches, 11 goods consumed by households, 39,520 households.

The CGE-TD/BU Approach

The fundamental idea of the approach is to use a CGE model to generate a price vector (renumeration of factors included) and a household microsimulation model to calculate the income and consumption of individual households. Next, individual consumption of households is aggregated to obtain a consumption vector that will become the output of this sub-model. This consumption vector is then used as an input to the CGE sub-model and this iteration process is continued until the solutions of the two models converge from one period to another. In this context, it is important to have the two models and consistent databases in order to facilitate convergence. In what follows, we will refer to this model as the TD/BU model.

CGE-RA and CGE-IMH Models

For the model with representative agents, we have used the same functions as in the multi-household model and the same behaviour parameters of the demand function for the 7 representative households. The decomposition of household groups was done according to the education level of household heads. In this model, we thus have a consumption matrix of 7 households by 11 goods, while in the IMH model we have a

---

[13] Complete list of equations provided on demand.

vector of aggregated consumption over 11 goods. The other distinction between the two models is the fact that we have 7 equations to represent the function of household income, while we have 39,520 equivalent equations in the IMH model.

As for the choice of parameter values, we decided to adopt the values of parameters β_i and γ_{ij} based on those presented in the work of Lee and Parshardes (1988) for equation 16.[14] Parameter α_i is free and allows for the calibration of the function on data from the reference year according to the parameters from the literature. From equation 16, the α_i represent the scale parameters or the portion of the household share that is incompressible h for good i, the γ_{ij} are the parameters related to the proper or crossed price elasticities, the β_i represent the parameters related to income elasticity and P_{Stone} is the Stone price index as defined in equation 9. It is important to remember that this price index is a function of consumer prices and of consumption shares w_i. Since the model contains more than one household, it is essential to substitute the shares of the middle agent with weighted average shares, which we denote as $\bar{\phi}_i$. Hence, the Stone price index becomes:

$$(3.\ (17)\ \log P_{Stone} = \sum_i \bar{\phi}_i \log p_i$$

In the rest of this work, we will refer to the CGE-IMH model using the acronym IMH to simplify the presentation, and will retain the acronym CGE-RA for the model with representative agents. These two models integrate the AIDS demand system.

Simulation and Analysis of Results

To illustrate the functioning of the model and show the contribution of introducing this demand system to enrich the analysis of poverty and inequalities, we have carried out an identical simulation on the three models. The simulation chosen for the exercise is a 30% reduction of customs duties.

The first remark we can make is that, as in the first chapter, the macroeconomic results are fairly similar if we compare between the various approaches. The two variables most sensitive from one approach to another are state savings and the nominal rate of change. In the case of state savings (Sg), the sensitivity comes from the fact that the deficit is relatively close to zero in the reference period, and consequently all nominal change produces percentage variations relatively stronger than for the other variables. We observe that the most significant increase for savings is in the IMH-AIDS model, with 11.89%. The weakest (7.15%) can be observed for the TD/BU approach. For exchange rate (e), it is in the TD/BU that the effect is weakest, with an appreciation of 0.21% and the strongest increase in the IMH-AIDS model with 0.73%. This appreciation stems from an increase in imports due to the fact that import prices decrease. Because the current account balance is exogenous, the exchange rate must appreciate to balance this account.

---

[14] We could have estimated the parameters of the demand system; however, we have chosen to focus on the application of the system in the context of the objectives of this work.

For the other variables, the effect is, for all practical purposes, the same for the three models. For instance, the aggregated household income Ym varies most in the CGE-RA model from –0.28% and least in the IMH-AIDS model from –0.24%. The decline in income of the aggregated household essentially comes from the relatively strong decline in formal salary that is not compensated by the increase of informal income. As shown below, capital income increases for most branches, but does not allow for compensation of income losses generated by the decline in formal salary. The decline results from the fact that the protected sectors are the ones most intensive in qualified work, and this policy puts them at a disadvantage. This decline in formal salary is also explained by the decrease in the production of public goods (from –7.09% to –7.33% depending on the version of the model) because state revenue has strongly decreased. This decline in employment in the public sector produces an excess of supply on this formal labour market and a decline in salary is required to absorb these surplus workers. It is interesting to note that the effect on the GDP is stronger in the two models using the AIDS (-0.23% and –0.24%) compared to the TD/BU-LES (-0.05%), but that the effect is almost identical between these two last models. The most sensitive reaction of households in terms of their consumption compared to income variation and price variations is at the source of this difference. According to table 1, it does not seem that introducing the almost ideal demand system (AIDS) significantly modifies the macroeconomic results, and the principal tendencies are respected.

Table 1: Macroeconomic results of the CGE module

Variables	Definition	Base	Sim 1 TD/BU (LES)	Sim 1 Mod RA (AIDS)	Sim 1: IMH (AIDS)
Ym	Income of agregate household	86.48	-0.27	-0.28	-0.24
Yg	Government revenue	20.37	-8.29	-9.08	-8.89
Ye	Business income	26.17	0.76	0.58	0.51
Sg	State savings	-1.16	7.15	8.97	11.89
w^1	Formal salary	1	-3.95	-3.63	-2.9
w^2	Informal salary	0.5	0.66	0.99	0.65
e	Nominal exchange rate	1	0.21	0.33	0.73
GDP	Gross domestic product	104.51	-0.05	-0.24	-0.23

We observed a general decline in the production of importable goods,[15] as is generally observed when customs duties are lowered. This decline comes from a substitution, at the level of interior demand for consumption, of locally produced goods with corresponding imported goods that are now less expensive. When it comes to capital renumeration, the differences between the models are greater than in the case of the macroeconomic variables. First, there are qualitative differences in five activity branches (*paley and corn, fruits and vegetables, livestock, wood and forestry, and food industries*) and quantitative differences in seven other branches. These differences primarily stem from the differentiated effects related to the demand system, since this is the only element differentiating the models. The strongest effect on capital renumeration concerns the mining branch in the three models, and the greatest negative effect can be observed in the electricity-gas-water branch in the TD/BU and CGE-RA models. However, in the IMH model, the strongest negative effect can be seen in the livestock sector, with a 2.76% decline. Variations in market prices follow the same tendency, with both qualitative and quantitative differences.

---

[15] These goods include a significant component of imported goods in the composition of composite good Q sold on the domestic market. See table 11 in the appendix for more information on these goods.

The qualitative differences are especially observed in the agricultural branches (somewhat like the rate of return on capital). For the other branches, the effects are fairly similar between the different versions of the models.

Table 2: Sectorial results of the CGE module

Variables	Branches	Base	Sim 1: TD/BU (LES)	Sim 1: RA (AIDS)	Sim 1: IMH (AIDS)
Pq (market price)	Paley & corn	1.01	1.85	-0.97	0.47
	Fruits and vegetables	1.02	0.48	0.32	-0.85
	Coconut	1.02	0.74	0.90	0.77
	Livestock	1.01	0.36	-1.00	-1.61
	Fishing	1.01	0.68	0.47	-0.61
	Other agriculture	1.02	-1.06	-1.36	-0.95
	Wood and forestry	1.01	0.42	-1.54	-1.34
	Mining	1.01	-0.24	-0.10	0.33
	Manufacturing	1.08	-3.73	-3.55	-3.12
	Rice industries	1.00	1.17	-0.79	0.35
	Meat industries	1.01	0.10	-0.24	-0.96
	Food industries	1.03	-0.99	-1.00	-1.32
	Electricity-Gas-Water	1.01	-3.09	-2.67	-1.84
	Construction	1.01	-1.33	-1.11	-1.15
	Business	1.05	-1.09	-0.85	-0.37
	Transport. & comm.	1.01	-1.13	-0.61	-0.85
	Finance	1.05	-2.01	-2.07	-1.67
	Real estate	1.00	-2.39	-2.27	-1.93
	Services	1.04	-1.69	-1.12	-1.43
	Public services	1.00	-2.35	-2.05	-1.74
r (rate of return on capital)	Paley & corn	1	4.22	-0.33	1.83
	Fruits and vegetables	1	2.47	1.94	-0.33
	Coconut	1	1.9	1.94	1.77
	Livestock	1	2.47	-0.91	-2.67
	Fishing	1	2.85	2.26	0.34
	Other Agriculture	1	0.19	0.64	1.98
	Wood and Forestry	1	3.29	-1.28	-1.10
	Mining	1	3.16	3.12	4.13
	Manufacturing	1	0.45	1.06	2.54
	Rice industries	1	2.60	0.23	1.70
	Meat industries	1	2.08	4.56	1.56
	Food industries	1	0.15	1.87	-0.23
	Electricity-Gas-Water	1	-2.63	-1.81	-0.08
	Construction	1	2.07	2.6	1.54
	Business	1	0.14	0.33	1.20
	Transport. & comm.	1	1.06	2.52	0.95
	Finance	1	-2.56	-3.10	-2.58
	Real estate	1	-1.45	-1.50	-1.35
	Services	1	0.23	2.55	1.48

The variations related to the value added (implicitly production, as they are linked by a Leontief relation of fixed shares) are presented in table 3. We observe that we have differences at both the qualitative and quantitative levels. In this case, the gaps are not as great between the various versions of the model as for prices, but qualitative differences are observed for eight production branches. This policy is more favourable to the mining sector in two models and is second in rank in the other (CGE-RA). However, for reasons we have already mentioned, the public services sector is very negatively affected, with declines of approximately 7% in the three models. The other sector that undergoes decreases in the three models is the finance sector, although its decline is fairly weak.

Because the three compared versions of the model assume that capital is fixed, the effects on the demand for work are similar to the effects on value added, but with an amplification of variations. To conclude this section, it is interesting to note that the gaps between the CGE-RA version and the IMH version are fairly weak in terms of macroeconomic variables, but that the sectorial results are differentiated.

Table 3: Sectorial results of the CGE module

Variables	Branches	Base	Sim 1: TD/BU (LES)	Sim 1: RA (AIDS)	Sim 1: IMH (AIDS)
Va (Value added)	Paley & corn	14800	0.52	-0.17	0.18
	Fruits and vegetables	13000	0.32	0.18	-0.13
	Coconut	14100	0.55	0.43	0.49
	Livestock	18700	0.50	-0.32	-0.66
	Fishing	14600	0.43	0.26	-0.04
	Other agriculture	14800	-0.14	-0.09	0.58
	Wood and forestry	3800	0.6	-0.49	-0.38
	Mining	12000	1.72	1.55	1.99
	Manufacturing	96500	1.08	1.08	1.71
	Rice industries	10400	0.73	-0.02	0.44
	Meat industries	12200	0.67	1.33	0.46
	Food industries	20700	0.06	0.47	-0.1
	Electricity-Gas-Water	8200	0.04	0.18	0.54
	Construction	79400	1.21	1.32	0.81
	Business	103500	0.85	0.78	1.08
	Transport. & comm.	44900	0.43	0.93	0.32
	Finance	17400	-0.04	-0.37	-0.32
	Real estate	30400	1.03	0.87	0.63
	Services	65300	0.71	1.84	1.20
	Public services	122228	-7.33	-7.32	-7.09
Ld (Work demand)	Paley & corn	14818	3.67	-1.19	1.28
	Fruits and vegetables	12962	2.03	1.17	-0.8
	Coconut	14088	1.37	1.07	1.22
	Livestock	18666	2.28	-1.43	-2.95
	Fishing	14645	2.32	1.39	-0.21
	Other agriculture	14796	-0.33	-0.23	1.43
	Wood and forestry	3804	2.71	-2.17	-1.67
	Mining	12047	3.93	3.54	4.57
	Manufacturing	97451	2.2	2.25	3.58
	Rice industries	10409	2.64	-0.06	1.59
	Meat industries	12248	2.13	4.25	1.45
	Food industries	20655	0.19	1.57	-0.34
	Electricity-Gas-Water	8188	0.15	0.66	1.96
	Construction	79377	1.97	2.15	1.32
	Business	103460	1.86	1.71	2.38
	Transport. & comm.	44923	0.93	2.05	0.71
	Finance	17422	-0.12	-1.01	-0.87
	Real estate	30432	2.54	2.14	1.54
	Services	65274	1.25	3.25	2.12
	Public services	122228	-7.33	-7.32	-7.09

Poverty Analysis and Income Distribution

In this paper, we use the FGT decomposable index to measure changes in the level of poverty, and the Lorenz curve and the S-Gini index to measure changes in inequalities. Because we introduce greater heterogeneity with the AIDS demand system, we anticipate that the effects on the indices will be stronger in this scenario compared to the TD/BU. We also use two approaches to calculate the poverty indices to be able to isolate the income effect in the total welfare effect. We first use the equivalent variation *(EV)* to measure changes in welfare at the household level and the income to isolate the income effect. The *EV* corresponding to the AIDS demand system is calculated based on the following equation:

$$(18)\ VE = c(Pq^0, u^1) - c(Pq^0, u^0)$$

and using equation 3, we can write the indirect utility function as:

$$(19)\ v(Pq, Ym) = \frac{1}{b(Pq)} \ln\left(\frac{Ym}{a(Pq)}\right)$$

by substituting 18 and 17, we can rewrite the equivalent variation as follows:

$$(20)\ VE = C(Pq^0, v(Pq^1, Ym^1)) - Ymo.$$

By substituting 18 and 3 and carrying out a few algebraic manipulations, we obtain:

$$(21)\ VE_h = P_{Stone} * \exp\left[\left(\frac{\prod_i Pqo_i^{\beta_i^c}}{\prod_i Pq_i^{\beta_i^c}}\right) \log\left(\frac{Ym_h}{P_{Stone}}\right)\right] - Ymo_h$$

where *Pqo* is the market price for the reference simulation and *Ymo*, the income available at the reference. Based on this equation, we can see the important role that to be played by the price index and price variations in determining the equivalent variation. It is necessary to underscore that the poverty analysis for the model with representative agent was conducted using the approach proposed by Decaluwé et al. (199a), in which the variation of the income of the representative household is applied to the whole of households in this group in the study. This implies that intra-group variation is null for this group following a simulation.

The first remark on the results of the poverty analysis is that the price effect seems to strongly dominate the income effect. It should be recalled that the income effect is calculated simply by using the variation in available income to calculate the poverty indices, while the use of the equivalent variation allows for an integration of both the price effect and the income effect. The source of these results is the sensitivity of the measure of *EV* to the Stone price index and to general price variations that are fairly strong (equation 9).[16]

As for the poverty analysis, the first strong observation is that we see an inversion of results when comparing the results of the CGE-RA and IMH approaches.[17]

---

[16] Ng (1997) presents the questions related to the sensitivity of the AIDS demand system to the price index and explains that in the dynamic context in which prices and income move in opposite directions, the measure of welfare with which it is associated becomes highly sensitive.

[17] This result corresponds to those observed in Savard (2004) for various versions of the model.

Table 4: Results of variations in the incidence of poverty P_0 (EV)

	Code	Base	Sim 1: TD/BU (LES)	Sim 1: RA (AIDS)	Sim 1: IMH (AIDS)
National		31.09	-1.95	2.23	-4.96
Education level of household head	0	53.52	-0.50	0.77	-3.40
	1	48.88	-1.85	2.15	-4.36
	2	39.24	-1.51	2.66	-4.75
	3	33.95	-3.35	1.98	-5.52
	4	21.43	-2.69	2.56	-6.87
	5	12.09	-2.63	2.78	-7.98
	6	2.72	-2.84	0.00	-3.78
Regions	1	34.09	-0.87	3.09	-4.68
	2	30.2	-2.91	1.62	-6.05
	3	14.94	-3.23	2.86	-9.08
	4	24.46	-3.34	3.90	-7.48
	5	46.43	-2.09	1.97	-4.39
	6	35.05	-2.55	2.87	-4.88
	7	30.06	-1.45	1.90	-4.02
	8	38.27	-1.17	2.02	-3.90
	9	32.62	-1.42	1.87	-4.61
	10	41.78	-1.70	0.75	-4.56
	11	34.27	-1.83	2.48	-4.20
	12	45.39	-1.56	1.21	-3.89
	13	6.22	-7.41	6.98	-13.93
	14	38.01	-1.06	1.52	-3.75
	15	58.2	0.04	2.08	-3.65
	16	49.02	-2.14	1.10	-3.45

First, we can see that the two microsimulation approaches (TD/BU and IMH) produce decreases in poverty at the national level, while the CGE-RA version generates an increase in poverty at the national level. The poverty increase of 2.23% for the CGE-RA approach changes to a decrease of 4.96% for the IMH approach. In addition, the results are completely inverted for the analysis of decomposed poverty indices.

If we examine the contribution of the AIDS (IMH versus TD/BU), we see that it amplifies the positive results for the whole of groups in the case of decomposition according to education level; moreover, the IMH model modifies the classification of impacts on poverty. With the TD/BU approach, the classification of effects on poverty is (0, 2, 1, 5, 4, 6, 3) and this classification becomes (0, 6, 1, 2, 3, 4, 5) for the IMH approach.[18]

In the two multi-household models (TD/BU and IMH), we observe decreases in poverty at the national level and in the CGE-RA model, it is rather an increase of 2.23%. This difference remains valid when we consider only the income effect. An examination of the effects decomposed by household group according to the education level of the household head reveals that the group undergoing a stronger decrease in poverty is the group of scholars without degrees (group 5) with a decrease of 7.98% for the IMH model, and the group of persons who attended but did not graduate from high school (group 3) with 3.35% for the TD/BU-LES model; the strongest increase in the CGE-RA is in group 5 (scholars without degrees) with a poverty increase of 2.78%

---

[18] The classification is increasing.

It is also worth comparing the results obtained using only the income effect for the two multi-household models (TD/BU and IMH). Indeed, this highlights the fact that the income effect is similar for most households with the exception of groups 1 and 3, but that the price effect seems to be principally responsible for increasing the amplitude of effects between the two models. However, the differences with the model with representative agent are similar to tendencies we have observed with the *EV* described above.

Table 5: Results of variations in the incidence of poverty P_0 (income effect)

	Code	Base	Sim 1: TD/BU (LES)	Sim 1: RA (AIDS)	Sim 1: IMH (AIDS)
National		31.09	-0.60	0.38	-0.27
Education level of household head	0	53.52	0.00	0.77	-0.35
	1	48.88	-0.75	0.21	0.02
	2	39.24	-0.21	0.47	-0.35
	3	33.95	-1.53	0.35	-0.56
	4	21.43	-0.37	0.37	-0.33
	5	12.09	-1.10	0.89	-0.80
	6	2.72	-1.29	0.00	-2.55
Regions	1	34.09	0.23	0.72	0.44
	2	30.2	-1.89	0.00	-0.01
	3	14.94	-0.67	0.67	-0.53
	4	24.46	-1.01	0.75	-0.45
	5	46.43	-0.16	0.23	-0.27
	6	35.05	-1.01	0.60	-0.05
	7	30.06	-0.56	0.60	-0.50
	8	38.27	-0.36	0.19	-0.83
	9	32.62	-0.70	0.16	-0.58
	10	41.78	-0.46	0.12	-0.89
	11	34.27	-1.10	0.29	-0.56
	12	45.39	-1.32	0.34	-0.28
	13	6.22	-0.64	0.96	-0.64
	14	38.01	-0.17	0.00	1.37
	15	58.2	1.76	0.45	0.64
	16	49.02	-0.73	0.00	0.36

If we compare the approaches in terms of regional decomposition, we observe tendencies similar to the results obtained with decomposition according to education level. That is, we see an increase in poverty for the whole of groups with the CGE-RA model and a decrease in poverty for the whole of groups with the two other approaches. One exception to this observation can be observed concerning the Autonomous Region of Muslim Mindanao (group 15) of the TD/BU model with a slight poverty increase of 0.04%. Specifically, at the regional level in the IMH model, we see the strongest diminutions in poverty in the region of the national capital (region 13) with a decrease of 13.93% and the central region of Luzon (region 3) with a decrease of 9.08%. The weakest diminutions in the P_0 index are in the region of Caranga (region 16) with a decrease of 3.45% and the Autonomous Region of Muslim Mindanao (region 15) with a decrease of 3.65%. When considering only the income effect for the IMH model, the greatest diminutions in poverty can be found in the regions of Northern Mindanao (region 10) with a decrease of 0.89%, and the Eastern Visaysas (region 8) with a diminution of 0.83%. In this case, we observe increases in the incidence of poverty in four regions. The strongest increases are in the

administrative region of Cordillera (region 14) with an increase of 1.37% and the Autonomous Region of Muslim Mindanao (region 15) with an increase of 0.64%. Finally, the strongest negative effects are in regions with poverty rates above the national average. The same is true of the strongest positive effects. There is therefore no particular tendency to highlight.

We briefly present the results of the impact of the reform on the depth and severity of poverty. Generally speaking, the comments we made for index P_0 are valid for P_1 and P_2. The results of the changes in the index of the depth of poverty (P_1) are presented in table 6 below and those for the severity of poverty (P_2) are presented in table 8 of the appendix. The main differences are that the pro-rich tendency of the reform appears to be more pronounced for these two indices in the case of the two multi-household models (TD/BU and IMH). Moreover, the difference in the amplitude of the effects is more pronounced between the TD/BU and IMH models. Index P_1 is more sensitive than index P_0 in the case of the IMH model. At the regional level, the classifications depending on impact amplitude are modified compared to what we observed with the P_0 index. In the case of the analysis of the severity of poverty (P_2), the tendencies are fairly similar to the results of the analysis of the depth of poverty (P_1).
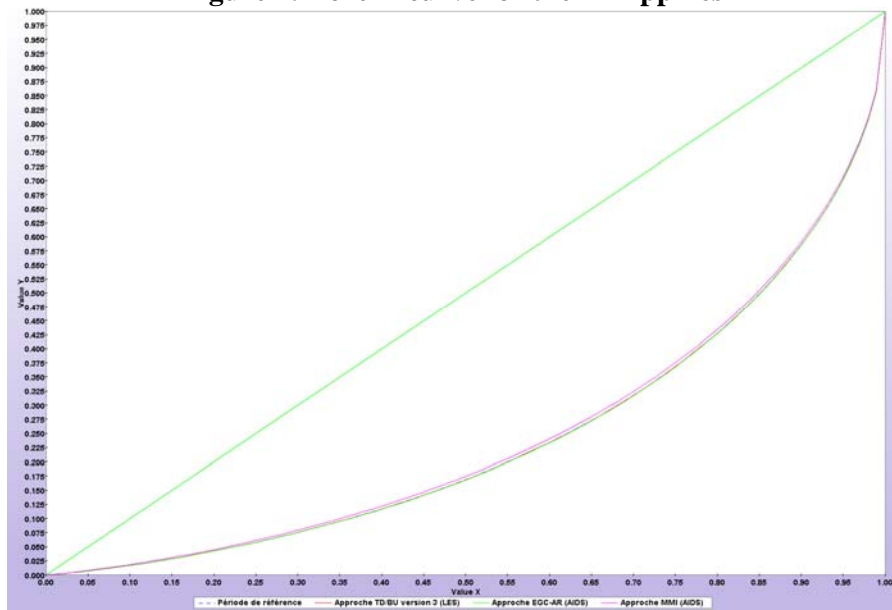
Table 6: Results of variations in the depth of poverty *(P_1)*

	Code	Base	Sim 1: TD/BU (LES)	Sim 1: RA (AIDS)	Sim 1: IMH (AIDS)
National		10.2	-2.73	3.37	-10.94
Education level of household head	0	19	-1.98	1.42	-9.67
	1	17.5	-2.48	3.34	-10.24
	2	12.5	-2.85	4.09	-11.09
	3	9.8	-2.94	2.25	-11.78
	4	5.3	-3.46	4.16	-12.33
	5	2.4	-3.97	3.56	-13.74
	6	0.5	-3.82	2.91	-13.67
Regions	1	9	-3.33	3.99	-12.36
	2	10.3	-3.36	4.28	-11.49
	3	2.8	-4.71	5.57	-15.31
	4	5.3	-3.45	4.48	-13.02
	5	17.1	-2.98	3.32	-10.89
	6	12.2	-3.08	3.62	-11.41
	7	16.9	-2.81	2.84	-10.50
	8	19.1	-1.96	2.85	-9.66
	9	16.3	-2.81	2.71	-10.60
	10	16	-2.57	3.03	-10.09
	11	12.6	-2.26	3.31	-10.53
	12	17.9	-2.19	2.65	-10.09
	13	0.3	-7.69	8.72	-21.57
	14	11.2	-1.22	3.17	-8.44
	15	14.6	-1.19	3.53	-9.03
	16	19.5	-2.27	2.84	-9.64

To analyse the change in inequality, we have chosen to use the Lorenz curves and the S-GINI index. To begin with the Lorenz curves, we notice that the TD/BU model does not produce visually observable effects on inequalities. This is also the case with the CGE-RA model. In these two cases, it is difficult to distinguish the curves of the

reference situation over the two scenarios presented below (for the national level in figure 1 and for the non-educated group in figure 2).[19]

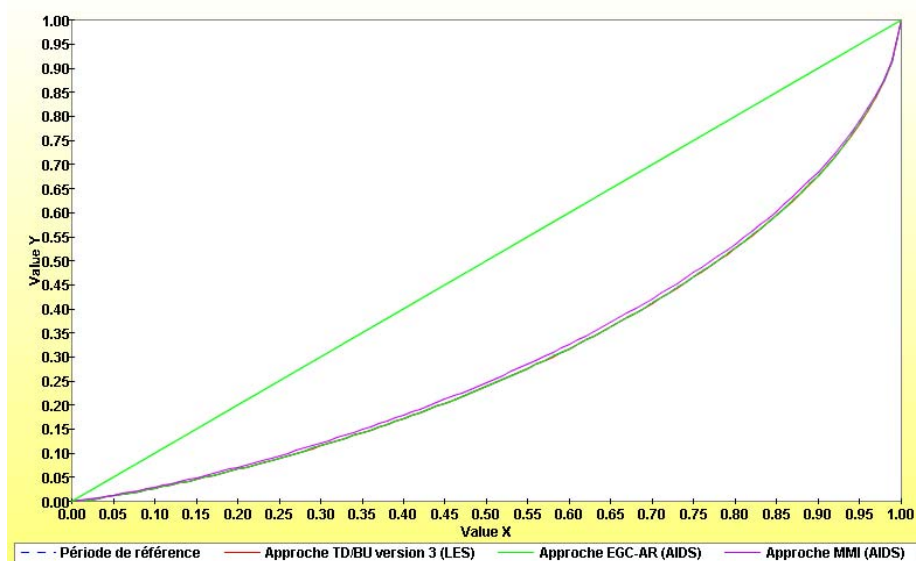**Figure 1: Lorenz curve for the Philippines**

It it nonetheless interesting to note that the Lorenz curve for the IMH model is certainly different from the other curves. We clearly see a reduction in inequalities at the national level and at the sub-group level without education, presented in figure 2.

---

[19] We have chosen to present the curve for the group presenting the most significant effects.

Figure 2: Lorenz curve for the group without education (groupe 0)

We present the results of the S-Gini index in table 7 below. By definition, we see no variation of the S-Gini for the CGE-RA model.[20] The first observation is that the results of the IMH model are much stronger than those observed in the TD/BU approach. The strongest effect for the TD/BU model is +0.22% for the group of university graduates (6) while the weakest effect is –0.55% for the same group in the IMH model. However, the strongest effect in the IMH model is 3.24% for the group without education (0), or almost 15 times greater than the strongest effect for the TD/BU model!

Table 7: Results for the decomposed Gini index

	Code	Base	Sim 1: TD/BU (LES)	Sim 1: RA (AIDS)	Sim 1: IMH (AIDS)
Country		0.52	0.12	0.16	-1.68
Inter-group		0.45	0.12	0.21	-1.68
Intra-group		0.06	0.08	-0.14	-1.69
Education level of household head	0	0.4	0.17	0.00	-3.24
	1	0.41	0.10	0.00	-3.13
	2	0.41	0.03	0.00	-2.59
	3	0.42	0.09	0.00	-2.30
	4	0.41	0.14	0.00	-1.63
	5	0.46	0.02	0.00	-1.10
	6	0.49	0.22	0.00	-0.55
Inter-group		0.47	0.11	0.16	-1.68
Intra-group		0.05	0.16	0.20	-1.69
Regions	1	0.46	0.02	0.19	-2.06
	2	0.43	0.14	0.19	-2.21
	3	0.39	-0.03	0.15	-1.64
	4	0.45	0.03	0.16	-1.59
	5	0.47	0.04	0.23	-2.87
	6	0.45	0.01	0.20	-2.35

[20] The income variation of the representative agent generated by the CGE model is applied to the whole of households of the sub-group, which implies that there is no change in terms of intra-group inequality for this approach.

	7		0.5		-0.19	0.19	-2.53
	8		0.46		0.12	0.19	-2.80
	9		0.48		0.01	0.12	-2.65
	10		0.52		0.08	0.20	-2.18
	11		0.47		0.15	0.17	-2.16
	12		0.46		0.12	0.18	-2.79
	13		0.51		0.14	0.18	-0.77
	14		0.5		-0.02	0.16	-1.40
	15		0.38		0.11	0.05	-2.39
	16		0.46		0.20	0.17	-2.87

It is also interesting to note that the TD/BU model produces weak increases in inequality for the whole of household groups with the decomposition according to education level, while the IMH model produces opposite results, with a decrease in inequalities for the whole of groups with greater effects for the least educated groups. In addition, the contribution of the inter- and intra-group inequalities are almost equal for the IMH model, while in the TD/BU model the inter-group inequality contribution is greater. At the regional level, in the case of the IMH model, we can see that the decrease in inequalities is fairly uniform around 2.3%, except at the level of the national capital, in which the decrease is only –0.77%.[21]

Conclusion

In this work, we have presented a macro-micro modelling approach allowing for the introduction of a demand system richer than what is generally used in this modelling context. The properties of the demand system make its use slightly more difficult, but allow for the addition of heterogeneity between households (income and price elasticities specific to each household in the model). This enables a richer analysis of poverty and inequalities. The system implies the inclusion of a part of the equation system related to household behaviours in the general calculable equilibrium model, which allows for the consideration of the element of non-aggregation related to the AIDS demand system.

One of the interesting results of this application is that with the demand system and the form of the resulting equivalent variation, we obtain effects on poverty and income distribution much greater than are usually observed in CGE microsimulation modelling (see Cockburn (2001), Cororaton (2003) and Boccanfuso et al. (2003)). The other unexpected result is to have underscored the problems concerning the use of the AIDS system in a representative agent (macro) and microsimulation context. Certain authors have already mentioned problems encountered, such as the consumption shares becoming negative or superior to one (Descoster, 1995) and the sensitivity of the price index (Ng, 1997).

With regard to the comparative analysis of the results of the various approaches presented in this paper, we have observed that the macro results are fairly similar for the three approaches (TD/BU,CGE-RA and IMH). However, the sectorial results are

---

[21] To ascertain the robustness of the types of results obtained, we have also carried out another simulation, namely a 10% increase in the world price of agricultural products. The results obtained for the poverty analysis were similar, that is, fairly strong results and the intra-group contribution as strong as the intra-group contribution to changes in the total inequality index.

different from one approach to another. This allows us to obtain greater heterogeneity at the household level, amplified by the fact that the measure of equivalent variation corresponding to the AIDS demand system is much more sensitive to changes in price and income. As a result, the results of the poverty and inequality analysis are both stronger and more diversified. We have observed several cases of changes in qualitative effects and significant differences in terms of qualitative effects. Moreover, it is interesting to highlight that the contribution of changes in intra-group inequality to the total variation of inequality is greater than the inter-group contribution.

References

Banse, M. (1998), *«A CGE Model to Analyse the impact of EU-Accession on Agricultural Employment in Solvenia and Poland»,* Miméo, Institute of Agriculture Economics, University of Gottingen,

Benjamin, N., et P. Pogany (1998) *« Modeing Competitiveness in Hemispheric Trade Liberalization: An Application to Chile»* Quadernos Economicos, Ano 35, No.104, pp. 127-38.

Blanciforti, L.A., R.D. Green, et G. A. King (1986) *« US Consumer Behaviour Over the Postwar Period: An Almost Ideal Demand System Analysis»* Giannini Foundation, Monograph Series no. 40.

Boccanfuso, D., F. Cissé, A. Diagne et L. Savard (2003), *« Un modèle CGE-Multi-Ménages Intégrés Appliqué à l'Économie Sénégalaise »* Cahier de recherche CIRPE, Université Laval no. 03-33.

Bourguignon, F., A.-S Robillard et S. Robinson (2002) *«Representative versus real households in the macro-economic modeling of inequality*», mimeo, World Bank.

Burfisher, M. E., S. Robinson, et K. Theirfelder (2000), *«Small Countries and the Case for Regionalism vs. Multilateralism»* TMD Discussion Paper no. 54, IFPRI, Washington.

Bussolo, M. et J. Lay (2003), «Globalization and Poverty changes in Colombia», Miméo, présenté à la conference ABCDE, May (2003), Paris.

Christenson, L. R., D. W. Jorgenson, et L. J. Lau (1975) *« Transcendental logarithmic utility functions»* American Economic Review, Vol. 65, pp. 367-83.

Cockburn, J. (2001), *« Trade liberalization and Poverty in Nepal: A Computable General Equilibrium Micro-simulation Analysis* », Working paper 01-18. CREFA, Université Laval.

Cororaton, C. (2003), *«Analysis of Trade, Income Inequality and Poverty: Using Micro-simulation approach, the Case of the Philippines»* Papier présenté à la conference de PEP-Networ, Hanoi, Vietnam, Novembre 2003.

Deaton, A. et J. Muellbauer (1980), « An Almost Ideal Demand System», American Economic Review, Vol. 70, 312-36.

Decaluwé, B., A. Patry, L. Savard et E. Thorbecke (1999a), « *Poverty Analysis Within a General Equilibrium Framework* » Working Paper 99-09, African Economic Research Consortium.

Decaluwé, B., J.C. Dumont et L. Savard (1999b), « *How to Measure Poverty and Inequality in General Equilibrium Framework* », Laval University, CREFA Working Paper #9920.

Decaluwé, B., A. Martens et L. Savard (2001), « *La politique Économiques du Développement*, Université Francophone-Presse de l'Université de Montréal, Montréal. pp. 1-509.

Decoster A. et Schokkaert E. (1990), *« Tax Reform Results with Different Demand Systems»,* Journal of Public Economics, 41, 277-296.

Decoster A. (1995), *« A Microsimulation Model for Belgian Indirect Taxes - with a Carbon-Energy Tax Illustration for Belgium»,* Tijdschrift voor Economie en Management, 40(2), 133-156.

Decoster A. et Vermeulen F. (1998), *« Evaluation of the Empirical Performance of Two-Stage Budgeting AIDS, QUAIDS and Rotterdam Models Based on Weak Separability»* , Discussion Paper Series, Center for Economic Studies, Leuven.

Foster, J., J. Greer et E. Thorbecke (1984), « *A Class of Decomposable Poverty Measures* », Econometrica, 52(3), pp. 761-766.

Lee C. and Pashardes P. (1988), *«Who pays indirect taxes? »*, London, IFS IFS Report Series No. 32

Mitton, L., H. Sutherland et M. Weeks (2000*), «Microsimulation Modelling for Policy Analysis: Challenges and Innovations, »* Cambridge University Press, Cambridge.

Ng, S. (1997) *«Accounting for Trends in an Almost Ideal Demand System», mimeo,* Université de Montreal.

Nichèle V. et J.M. Robin (1995), *«Simulation of indirect tax reforms using pooled micro and macro French data»*, Journal of Public Economics, 56, 225-244.

Pashardes, P. (1993), *«Bias in Estimating the Almost Ideal Demand System with the Stone Index Approximation »* The Economic Journal, Vol. 103, no. 419, pp. 908-15.

Rimmer M. T., et A. A. Powell (1996) *«An Implicitly,Directly Additive Demand System »* Applied Economics, Vol. 28, pp. 1613-22.

Savard, L. (2003) *" A Segmented Endogenous Labour Market for Poverty, Income Distribution Analysis in a CGE-Household MS model: A Top-Down/Bottom-up approach"* Cahier de recherche CIRPEE, Université Laval # 03-43.

Savard, L. (2004) "Poverty and Inequality Analysis within a CGE Framework: A Comparative Analysis of the Representative Agent and Micro-Simulation Approaches". À paraitre dans *Development Policy Review*

Stone, R. (1954) "Linear expenditure system and demand analysis: An application to the pattern of British demand". *The Economic Journal*, vol. 64, n° 255, p. 511-527.

Thiel, H. (1965), *«The information approach to demand analysis»*, Econometrica, Vol 33 pp. 67-87.

Yu, W. T.W. Hertel, P. V. Preckel, et J. S. Eales (2002) *«Projecting World Food Demand Using Alternative Demand Systems»* GTAP Working Paper 1270.

Appendix

When comparing equations 15 and 16, we see that the only difference between these two equations is the *log* of the income over the Stone price index. These two terms do not aggregate perfectly, hence the following inequality:

$$(22)\ \sum_h \log\left(\frac{Ym_h}{P_{Stone}}\right) \neq \log\left(\frac{YM}{P_{Stone}}\right)$$

In fact, we can calculate the difference between these two terms to obtain the average logarithmic deviation that is an index of income inequality. We therefore have:

$$(23)\ ELM = \log\left(\frac{YM}{P_{Stone}}\right) - \sum_h \log\left(\frac{Ym_h}{P_{Stone}}\right)$$

Table 8: Analysis of severity (P_2) with equivalent variation

	Code	Base	Sim 1: TD/BU (LES)	Sim 1: RA (AIDS)	Sim 1: IMH (AIDS)
National		4.5	-3.28	4.15	-15.97
Education level of household head	0	8.8	-2.58	1.82	-14.79
	1	8.2	-3.04	4.20	-15.30
	2	5.5	-3.45	5.04	-16.22
	3	4.1	-3.50	2.72	-16.88
	4	2.1	-3.94	4.88	-17.38
	5	0.8	-4.68	4.31	-19.06
	6	0.2	-3.87	3.20	-17.75
Regions	1	3.7	-4.05	4.86	-17.79
	2	4	-4.09	5.28	-16.81
	3	1	-4.98	6.21	-19.98
	4	2.1	-4.22	5.34	-18.43
	5	7.5	-3.79	4.37	-16.40
	6	5.1	-3.67	4.55	-16.44
	7	8.2	-3.39	3.55	-15.78
	8	9.1	-2.44	3.71	-14.52
	9	7.9	-3.45	3.46	-15.82
	10	7.5	-3.12	3.80	-15.38
	11	5.6	-2.69	4.02	-15.34
	12	8.8	-2.72	3.46	-15.14
	13	0.1	-7.57	8.44	-25.13
	14	5	-1.42	3.97	-12.54
	15	5.3	-1.67	4.70	-13.69
	16	9.4	-2.65	3.58	-14.81

Table 9: Definition of regional codes

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

Table 10: Codes for education levels

Education Code	Education Level
1	Primary without diploma
2	Primary with diploma
3	One to three years of secondary (high school) without diploma
4	Secondary (high school) with diploma
5	Post-secondary or university without diploma
6	Post-secondary or university with diploma
0	Without education

Table 11: Ratios extracted from the social accounting matrix

Sectors	Ldi/Ldf	Ld/Va	Kd/Va	Ex/Xs	M/Q	Cm/Q	Di/Q	Inv/Q	G/Q
Paley & corn	24.22	0.105	0.895	0.000	0.019	0.005	0.993	0.000	0.002
Fruits and vegetables	16.73	0.133	0.867	0.091	0.015	0.658	0.271	0.071	0.000
Coconut	24.96	0.299	0.701	0.021	0.000	0.029	0.954	0.017	0.000
Livestock	6.27	0.156	0.844	0.000	0.005	0.178	0.706	0.116	0.000
Fishing	23.39	0.136	0.864	0.128	0.022	0.602	0.398	0.000	0.000
Other agriculture	25.32	0.314	0.686	0.113	0.250	0.118	0.882	0.000	0.000
Wood and forestry	44.00	0.189	0.811	0.041	0.070	0.157	0.843	0.000	0.000
Mining	2.34	0.442	0.558	0.276	0.699	0.008	0.992	0.000	0.000
Manufacturing	0.97	0.515	0.485	0.267	0.306	0.251	0.637	0.095	0.017
Rice industries	5.69	0.278	0.722	0.000	0.036	0.532	0.427	0.041	0.000
Meat industries	5.69	0.318	0.682	0.000	0.006	0.596	0.351	0.054	0.000
Food industries	5.99	0.316	0.684	0.055	0.079	0.448	0.282	0.269	0.000
Electricity-Gas-Water	0.35	0.278	0.722	0.037	0.000	0.265	0.675	0.000	0.061
Construction	7.77	0.625	0.375	0.001	0.001	0.264	0.063	0.671	0.002
Business	0.99	0.497	0.503	0.000	0.000	0.000	1.000	0.000	0.000
Trans. & comm.	7.94	0.467	0.533	0.046	0.127	0.370	0.608	0.000	0.022
Finance	0.49	0.366	0.634	0.015	0.180	0.062	0.843	0.000	0.095
Real estate	0.01	0.424	0.576	0.010	0.005	0.854	0.136	0.000	0.010
Services	1.75	0.578	0.422	0.279	0.077	0.373	0.528	0.000	0.099
Public services	0.48	1.000	0.000	0.000	0.000	0.003	0.000	0.000	0.997

Table 12: Parameter $\gamma_{i,j}$ of the AIDS demand system

	Fr & veg	Fishing	Aut-agr	Manufac	Rice	Meat	Ind-Food	EGE	Constr	Transp	Services
Fruits and vegetables	-0.00709	0	0	0.005543	0	0	0.00085	0	0	0	0.0007
Fishing	0	-0.0091	0.00005	0.005051	0.0014	0	0.0008	0	0	0.00005	0.0017
Other agriculture	0	0.00005	-0.00828	0.00096	0.0008	0.0008	0.001176	0.0013	0.0013	0.001	0.0009
Manufacturing	0.005543	0.00505	0.00096	-0.01423	0.00017	0.00015	0.000581	0.00023	0.00055	0.00045	0.00055
Rice industries	0	0.0014	0.0008	0.000168	-0.0054	0.0012	0.0001	0.00044	0	0	0.001353
Meat industries	0	0	0.0008	0.00015	0.0012	-0.0072	0.00095	0.00115	0.00112	0.00112	0.00075
Food industries	0.00085	0.0008	0.001176	0.000581	0.0001	0.00095	-0.00903	0.00104	0.00079	0.00075	0.002
Electricity-Gas-Water	0	0	0.0013	0.000231	0.00044	0.00115	0.001039	-0.0056	0.00028	0.00045	0.000751
Construction	0	0	0.0013	0.00055	0	0.00112	0.000788	0.00028	-0.0075	0.00194	0.001481
Transport. & comm.	0	0.00005	0.001	0.00045	0	0.00112	0.00075	0.00045	0.00194	-0.0063	0.000591
Services	0.0007	0.0017	0.0009	0.00055	0.00135	0.00075	0.002	0.00075	0.00148	0.00059	-0.01078

Table 13: Parameter β_i of the AIDS demand system

	Beta
Fruits and vegetables	-0.097
Fishing	-0.0954
Other agriculture	-0.031
Manufacturing	0.176
Rice industries	-0.099
Meat industries	0.053
Food industries	-0.0946
Electricity-Gas-Water	-0.018
Construction	0.054
Transport. & comm.	0.059
Services	0.093