Measuring Poverty and Inequality in a Computable General Equilibrium Model

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Summary

This paper aims to evaluate the relevance of different types of macroeconomic general equilibrium modelling for measuring the impact of economic policy shocks on the incidence of poverty and on the distribution of income. In the literature three approaches are identified. The first is based on a traditional form of the CGEM which specifies a large number of households. In this case, we can only observe inter group income inequalities. The next uses survey data to estimate the distribution function and average variations by group, which allows one to estimate the evolution of poverty. The third approach, which we present in detail, includes individual data directly in the general equilibrium model according to the principles of micro simulations. This treatment provides a more reliable picture of income distribution but is also more complex. Given this, we develop, within a co-ordinated statistical framework representing an archetypal economy, the three types of model described above. More precisely, this exercise allows us to break down the contribution of average income variations, of the poverty line, and of income distribution in the evolution of the main poverty indicators. The results obtained show the importance of intra group information and therefore the relevance of micro simulation exercises.

Key Words : General Equilibrium Models, Micro Simulation, Poverty, Inequality

JEL Classification : D58, I32, D31

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Abstract

This article assesses the relevance of Computable General Equilibrium Models (CGEM) for highlighting and addressing issues related to income distribution and poverty. CGE Models have been widely used to simulate the impact of macroeconomic policies on income distribution and poverty. Good examples of such exercises are those that were built in connection with the OECD research program on 'Structural Adjustment and Poverty' (see e.g. Thorbecke –1991 for Indonesia or Morrisson –1991 for Morocco).

One can identify three types of applied General Equilibrium Models that try to address this question. First, the traditional model that relies on the representative agent assumption and thus can not produce any kind of result in terms of poverty. It can only help to evaluate the evolution of inequalities between groups. The second type of exercise is grounded on the previous one but includes information on intra group income distribution. Using income and expenditure surveys, it is possible to generate the within income distributions prevailing in the same base year as that of the Social Accounting Matrix used to calibrate CGEM (see e.g. de Janvry et al. –1991, Decaluwé et al. –1999). Assuming that the income distributions are stable and by endogenising the poverty line, we are able to produce counterfactual results on poverty. However, in this type of model, it is still impossible to analyse intra group inequalities even if it is well known that they contribute much more to the total inequalities than inter group income disparities. Furthermore, in terms of poverty analysis, the results could be misleading if within income distribution was subject to quantifiable variations.

In order to avoid such discrepancies a third type of modelling has been developed which relies directly on statistical information at the household level (micro simulation Model). The principle is to construct a CGEM with as many agents as there are in the survey in order to keep all the information about the heterogeneity with regards to endowment and consumption. As a matter of fact, in each socio-economic group, we have several individuals. Because the simulation produces new income features for each of them, it is now possible to endogenise the intra group distribution. Micro-simulation Models are undoubtedly one of the best tools to infer poverty and inequality analysis. However, the large amount of work and statistical information that it requires, compared to the traditional CGEM, casts doubts on the practical aspect of such modelling. The question remains, is the task worthwhile?

In this article, we test the three types of modelling in a co-ordinated statistical framework in order to judge the value-added of each specification compared to others for poverty analysis. Based on an archetypal economy, this exercise allows us to isolate the contribution of average income variations, poverty line changes and income distribution modifications on the evolution of the main poverty indicators. The results clearly highlight the importance of intra group information and thus the relevance of micro simulation models. Furthermore, we are able to show that the effect of income distribution changes is qualitatively uncertain. Still, it is important to point out that poverty line evolution counts for a major part of poverty fluctuations.

Our results advocate taking into account within dimension for poverty analysis and therefore, shed some light on the relevance of Micro-simulation Models and on the limitations of previous exercises.

I Introduction

During the last thirty years, developing countries have faced major macroeconomic shocks associated with, among others, fluctuations in the world price of raw materials and agricultural exports or economic policy reforms such as structural adjustment programs and the liberalisation of commercial trade. These shocks have had significant repercussions on the economies of these countries in particular in terms of the level of poverty and on the distribution of income. Even if these questions have led to serious debate, the absence of appropriate macroeconomic tools has penalised quantitative analyses. More generally, it must be recognised that there are few instruments which can relate macroeconomic policy and microeconomic behaviour. Computable General Equilibrium Models (CGEM) are however, the exception in this area. In this article we present and compare different approaches which allow to assess poverty and inequality questions in a general equilibrium framework.

During the 1980s and at the beginning of the 1990s several authors used CGEM to study the impact of economic reforms on the distribution of income. The pioneers in this area were certainly Adelman and Robinson (1979) in Korea, as well as Dervis, de Melo and Robinson (1982) and Gunning (1983) in Kenya. Later, under the aegis of the OECD, studies were done by Thorbecke (1991) for Indonesia, de Janvry, Sadoulet and Fargeix (1991) for Equador, Morrisson (1991) in Morocco and more recently Chia, Wahba and Whalley (1994) applied the same type of model in the Côte d'Ivoire.

In the literature, we generally distinguish between two approaches with respect to the use of CGEMs for the analysis of distributional questions. The first consists in simply disaggregating as much as possible the household agent according to socio-economic or location criteria. The hypothesis of the representative agent is however, kept, so that all takes place as if we had a single representative household for each identified group. In this case, it is possible to evaluate and compare the impact of economic policies on the income and well-being of different groups. This approach, which has been implemented the most often, can only however, be used to study inter group inequalities and does not in any way allow for the evaluation of either the level of poverty or the inter group inequalities which are nevertheless known to be the most significant.

This first method can be amended to permit the evaluation of poverty indicators. In practical terms, the modelling exercise remains unchanged but it is completed by information from survey households. From the disaggregated data, compatible with the microeconomic information on which the CGEM is based, we estimate the prevalence of poverty. The simulation of the general equilibrium model thus provides new values with respect to the average income level of each of the groups. Assuming that the intra group distribution is unchanged, and applying average variations onto it, we can then calculate the indicators of poverty. Furthermore, it is also possible to use the CGEM results on relative prices to re-evaluate the cost of a basket of necessary goods and therefore the level of the line of poverty. However, as Dervis, de Melo and Robinson (1982) point out, the greatest challenge in the analysis of income distribution with CGE Models is in endogenising the intra group variance.

Although relatively complex in its technical implementation, the solution for endogenising the intra group variance is basically simple. It is sufficient, in fact, to introduce a considerable number of households into each category using survey information (e.g. Budget Consumption Surveys - BCS), within the CGEM. In practical terms, in the model we take into account as many representative agents as there are persons being surveyed. From this fact, the individual heterogeneity acts beyond all aggregation hypotheses, be they in initial endowments or preferences. This type of work is included in a more general group which covers the topic of micro simulation.

Micro simulations were inspired by the pioneering work of Orcutt (1957,1961). In the middle of the 1970s, different groups of researchers developed survey-based models (cf. Bergmann, Eliason and Orcutt –1980 for a review of these studies), but these works were essentially in partial equilibrium. They took on very specific questions mainly related to the distributive impact of social transfer programs or fiscal policies. Since then, numerous applications have been put into place, particularly in developed countries to evaluate the impact of reforms to retirement systems, the financing of health-care systems or for other questions related to the demographic dynamic (A. Harding 1993). The application in developing countries is still very limited (Bourguignon, Fournier, and Gurgand -1998). Furthermore, it should be noted that micro simulation research into general equilibrium is still very rare and often rudimentary. None limit themselves to the task of linking the micro simulation to a macroeconomic model, from which they extract the price system, across a finite number of interactions (Dixon, Malakellis & Meagher -1996), and others simply include a macroeconomic closure without disaggregating the sectors.

To our knowledge, only two studies applied to developing countries have been put into place in the framework of general and multisectorial equilibrium. Cogneau (1997) thus proposes an Antananarivo Conglomeration Model where more than 2000 households dividing their activities between two sectors, traditional and modern, are identified. However, the author concentrates his efforts on the analysis and treatment of the labour market, and in the end shows very little interest in questions of poverty and inequality. Cogneau and Robillard (1999) on the other hand, do explore this. With the help of a micro simulation model of the Malagasy economy, where the agricultural sector is especially detailed, they show that if the effects of liberalisation policies are significant in terms of average income, the impact on inequality is possibly less considerable than might have been expected.

Finally, if today we see an advance in micro simulation exercises applied to developing countries, we can question the interest of implementing such work given the considerable effort required, as much in terms of data collection and analysis, as in modelling. Stated another way, does the fact that intra group variance is endogenised in a general equilibrium model bring new light to the evaluation of the effect of economic policy on the level of poverty and inequality?

In this article we implement the three types of model previously described in a co-ordinated statistical framework, so as to evaluate the added value of each specification in the analysis of questions of poverty and income distribution. More precisely, this exercise allows us to break down the contribution of average income variations, of the poverty line and of income distribution in the determination of the poverty rate. Our work is based on an archetypal economy. The results obtained clearly show the importance of intra group information and therefore the relevance of micro simulation exercises.

The next section describes the principal characteristics of the general equilibrium model used, as well as the type of data on which it is based. Section III will present the results of aggregated and disaggregated simulations detailing the evolution of poverty and inequality indicators in each case. The last section concludes and proposes several avenues for future research (Section IV).

II Construction of an Archetypal Micro Simulation in General Equilibrium.

The model from which the analysis flows is quite standard. It concerns a static and real CGEM with government in an open economy (Decaluwé, Martin and Souissi –1995). The model includes four areas of activity (agriculture, industry, marketable and non-marketable services), each producing a single product, three factors of production (capital, skilled and unskilled labour) and four agents (rest of the world, government, firms, households).

1. Income

Households receive income from labour, from capital and from government transfers. Two types of labour are distinguished: unskilled (*LDN*) and skilled (*LDQ*). In the base year the wage of the first is half that of the second. Labour is mobile between sectors but we make the hypothesis that labour markets are perfectly segmented with full employment of resources. Each labour market reaches equilibrium independently through wage rate adjustments that correspond to it. Physical capital is assumed to be sector specific. Household endowments for each type of capital are detailed.

Firms receive a portion of income from capital, pay direct taxes on production and save the balance of their income. Finally, government receives direct and indirect taxes, makes transfers and demands non-marketable services (moreover, it is the only agent which does this).

2. Household Expenditures

The model assumes a Stone-Geary type utility function from which we derive a “Cobb-Douglas Linear Expenditure System” (CD-LES). The particularity of this function is that it allows the introduction of fixed expenses. In general, the fixed share of total expenditure is inversely proportional to the level of income.

$$C_m^i = \alpha_m^i + \beta_m^i \cdot \left(CTM_m - \sum_j pq^j \cdot \alpha_m^j \right) \cdot \frac{1}{pq^i}$$

$\alpha_{i,m}$ minimal consumption of good *i* by household *m*
$\beta_{i,m}$ the share that household *m* dedicates to the consumption of good *i* once the fixed expenditure is deducted

It must be clear that the level and the composition of the fixed expenses can differ from one household to another and in that sense it is distinct from the basket used to define the poverty line.

The savings rate, assumed to be constant, applies to disposable income net of fixed expenses. Sequentially, the household receives its income, pays its direct taxes, makes its fixed expenditures and then saves a fixed rate of what remains.

An important comment must now be made with respect to the aggregation properties of functional forms. In fact, we can easily show that in the general case none of the usual consumption functions (Linear, LES- AIDS) aggregate perfectly. This implies that the results of the simulations, arising from a classic aggregated General Equilibrium model, won't be comparable with those produced by a disaggregated micro simulation model. This is a very important point and certainly by itself, justifies in part the interest in micro simulations.

However, because our objective, in the end, is to confront the different forms of modelling in general equilibrium in terms of poverty analysis, and because we are using fictive data, we have chosen to return to a very specific case where the aggregation of the CD-LES is perfect[1]. The results that we will later obtain must be analysed in this perspective and the differences between the aggregated and disaggregated models treated with care.

3. Other Specifications

The total production XS of the branches is determined by a Leontief function between total intermediate consumption *(CI)* and value-added (*VA*). The latter is represented by a

[1] The aggregation of SLD-CD is perfect when all households have the same parameters β_i, that is once all the dicretionary expenses have been subtracted, households each dedicate the same portion of their final expenses to the consumption of each good.

Cobb-Douglas function between capital and labour. The latter of these is seen as a factor composed of two types of qualification. These are combined in an elasticity function with constant substitution (function CES)[2]. The producer therefore arbitrages between skilled and unskilled labour taking into account his production technology (substitution capacity) and the relative price of the labour factors.

Investment is assumed to be exogenous. Household and firm savings being determined moreover, government expenditures adjust to ensure I=S equilibrium. Finally, exchanges with the exterior are classically defined using the Armington function with the small country hypothesis. The exchange rate is taken as numerate and the Current Account Balance is exogenous.

4. Disaggregation and Numeric Hypotheses

The aggregate social accounting matrix is presented in the Appendix. It illustrates the case of a semi-industrialised economy suffering a relatively significant current account deficit and where the government gets the majority of its income from imports.

In the aggregated version of the model, households are gathered into three groups that represent, for example, rural households (*Group 1*), urban households where the head of the household is inactive or employed in the informal sector (*Group 2*) and urban households where the head of the household has a formal salaried job (*Group 3*). If the groups are not directly defined along income criteria, the average income in Group 1 is clearly inferior to that of Group 2 which itself below that of the third group. Nevertheless, we find poor people in the first two groups even if the poverty line is above the average income of the second group. In the disaggregated version of the model we distinguish 150 households distributed as follows : 60 in Group 1, 50 in Group 2 and 40 in the last group.

The following tables show the main characteristics which apply to each group of households.

[2] Implicitely we assume that the two types of labour are identically substitutable with physical capital

Table 1 : Income By Group

	Group 1	*Group 2*	*Group 3*
Average Income	103.28	249.57	583.10
Median Income	84.85	235.7	602.3
Minimum Income	13.7	27.7	304.4
Maximum Income	292.2	501.7	817

Table 2 : Distribution of Expenditures and Income for Each Group

	Unskilled labour in Total Labour	*Skilled Labour in Total Labour*	Structure of Income in %			
			Total Labour	Capital	Dividends	Transfers
Group 1	77.5	22.5	0.862	0.111	0.025	0.002
Group 2	48.2	51.8	0.757	0.203	0.036	0.003
Group 3	22.4	77.6	0.603	0.338	0.055	0.004

	Structure of Expenditures in %				
	Agriculture	Industrial	Service	Savings	Taxes
Group 1	0.26	0.315	0.296	0.097	0.031
Group 2	0.142	0.339	0.356	0.131	0.031
Group 3	0.064	0.381	0.395	0.132	0.028

Households in the first group essentially have agricultural capital and unskilled labour. They consume a large part of their income on food and save little. Households of the third group, however, possess most of the skilled labour and consume more services.

III Presentation of Results

In order to show the importance of the intra group variance from economic policy simulations (or exogenous shocks), we have maintained the following two scenarios :

1. The first consists in an increase by 20% of the unskilled labour endowment (Simulation 1). This simulation can be interpreted either as an increase in the labour supply, or as the result of an inflow of unskilled immigrants (for example following troubles or a war in a neighbouring country).
2. Simulation 2 illustrates the elimination of customs duties for industrialised goods combined with an increase in the world price of agricultural goods by 30%.

which is without any doubt a somewhat strong hypothesis but not fundamental in this case.

The aggregation hypotheses that we have made for the consumption function allows us to smooth the disparities between the aggregated and multi-household versions of the model. The detailed results of the simulations are presented in Table 3.

Table 3 : Simulation Results

			Simulation 1		***Simulation 2***	
			+ 20% of Lnq		-100% tim (ind) and +30% Pwe (agr)	
Variables	Branch	Reference	Level	Variation in %	Level	Variation in %
S		1	1.1	10.05	0.86	-13.73
SN		0.5	0.41	-18.92	0.56	11.66
E		1	1	0.00	1	0.00
PINDEX		1	1	-0.33	0.99	-0.51
YM	Group 1	6197.1	6264.05	1.08	6491.58	4.75
	Group 2	12478.7	12852.28	2.99	12623.38	1.16
	Group 3	23324.2	24615.9	5.54	22590.56	-3.15
YG		10549.46	10882.94	3.16	6629.82	-37.15
SG		1709.46	816.16	-52.26	1127.99	-34.01
IT		17355.46	17355.46	0.00	17355.46	0.00
BAC		7424	7424	0.00	7424	0.00
R	AGR	1	0.99	-1.02	1.17	17.14
	IND	1	1.05	5.13	1.03	2.53
	SER	1	0.99	-0.72	1.06	6.39
PQ	AGR	1.03	0.95	-7.09	0.96	-6.30
	IND	1.11	1.13	0.92	0.98	-11.78
	SER	1.03	0.98	-4.39	1.03	-0.21
	SERNM	1	1.08	7.94	0.87	-12.88
XS	AGR	9000	9619.78	6.89	10088.44	12.09
	IND	54400	55415.7	1.87	56437.16	3.74
	SER	22000	23362.51	6.19	22444.23	2.02
	SERNM	8700	9196.75	5.71	6154.88	-29.25
LDQ	AGR	2150.83	2009.17	-6.59	2826.72	31.42
	IND	5236	5094.98	-2.69	6122.99	16.94
	SER	2789.23	2674.51	-4.11	3262.45	16.97
	SERNM	6960	7357.4	5.71	4923.91	-29.25
LDN	AGR	7218.34	8609.64	19.27	7717.65	6.92
	IND	4648	5774.9	24.24	4421.82	-4.87
	SER	11581.54	13752.91	18.75	11308.41	-2.36
Poverty Line		175.712	165.143	-6.01	164.964	-6.12

The effect of Simulation 1 is a substantial decrease of almost 19% in the remuneration of the factor for whom availability increases, that is, unskilled labour (*LDN*). The other type of labour (*LDQ*) therefore becomes relatively more rare and we see an increase in its remuneration of about 10%. With regard to the branches of production, it is the branches most intensive in unskilled labour that profit the most from this shock (marketable services -*sm* and agriculture -*agr*). The agriculture branch increases its production by 6.89% and the production of marketable services increases by 6.19%. The remuneration of capital of these branches subsequently falls by 1% and 0,7 % whereas it rises by 5.13% for the industrial branch. Thus, it is via the introduction of variations in the remuneration of factors that the shock is transmitted to household income and to the rest of the economy. Logically, this is to the benefit of households in the third group which obtain their income from skilled labour and non agricultural capital. We therefore observe an **increase in inter group inequalities** in this scenario.

The second shock, which shows a reform in customs duties combined with an increase in the world price of agricultural goods (Simulation 2), is transmitted to households mainly by a direct route, which is to say through the intermediary of a fall in skilled wages *S*. This depreciation is caused by the reduction in public expenditures and therefore in the production of non commercial, skilled-labour intensive, services which follow the drastic drop in government income (*YG* - 37.15%). The effects on the wage rate are thus related to the first simulation (*S* decreases and *SN* increases). The remuneration of capital rises in all sectors but most strongly in the agricultural branch. In this scenario it is essentially the households of the first group which benefit from the shock, in particular because they possess a significant proportion of the agricultural capital and they offer little skilled labour. We thus see a **reduction in inter group inequalities**.

A traditional computable general equilibrium model would be constrained to stop at the analysis of inter group inequalities. To go beyond this and evaluate poverty indicators or intra group inequality, disaggregated data must be used.

Because we have a low number of observations, the evaluation of the poverty indicators requires the estimation of a distribution function[3]. This procedure must be done both on the base data and on the post simulation results. In practical terms, this allows us to move from a discrete to a continuous representation of the distribution of income.

The few studies which have taken this approach estimate Pareto or lognormal distribution functions. Bordley, McDonald and Mantrala (1996), as well as a part of the literature on income distribution modeling, show nevertheless, that more flexible functions are preferable. Here, we follow Decaluwé, Patry, Savard and Thorbecke (1999) in estimating a Beta type function. The density function associated with this distribution is determined from maximum (*mx*) and minimum (*mn*) income levels as well as characteristics of asymmetry and smoothing (*p*,*q*).

$$I(y;p,q)=\frac{1}{B(p,q)}\frac{(y-mn)^{p-1}(mx-y)^{q-1}}{(mx-mn)^{p+q-1}} \qquad \text{with } B(p,q)=\int_{mn}^{mx}\frac{(y-mn)^{p-1}(mx-y)^{q-1}}{(mx-mn)^{p+q-1}}\mathrm{d}y$$

The model retained is more flexible than the usual functions, because it permits the representation of asymmetric distributions right or left, as well as symmetric income distributions[4]. If p and q are less than one and that $p\rangle q$ ($q\rangle p$ respectfully), the distribution is asymmetric to the right (left respectfully). The greater the difference between the two parameters, the greater the degree of asymmetry. The values of the parameters can easily be estimated[5] from an ordered income vector. The results obtained from the base data are presented in the following table :

Table 4 : Estimation of Parameters before Simulation

Parameters estimated for the Beta type distribution function			
	Group 1	*Group 2*	*Group 3*
P	1.076	2.436	1.707
Q	2.257	2.713	1.444
Number of observations	60	50	40

[3] It is clear that this is not absolutely necessary once a very large number of households has been surveyed in each group.
[4] The Beta can also represent a bi-modal distribution. For more details on the characteristics of the Beta function the reader is directed to consult Chapter 14 in Johnson and Kotz (1970).
[5] For example by using computer software such as MATLAB.

Knowing the shape of the distribution functions, as well as the level of the poverty line, we can calculate all the relevant poverty indicators before and after simulation. Here we follow current practice by proposing the use of the poverty indices (FGT) of Foster, Greer and Thorbecke (1984). These measures, denominated P_α, belong to a class of poverty indicators which are additively decomposable. The P_α allow the measurement of the proportion of poor people as well as the difference (P_1), the depth (P_2) and the severity (P_3) of the poverty. In the case of a Beta type distribution function, with the preceding notation, P_α is given the following expression :

$$P_\alpha = \int_{mn}^{z} \left(\frac{z-y}{y} \right)^{\alpha} \cdot I(y; p, q)\, dy$$

where α represents aversion to poverty and z is the poverty line.

When $\alpha = 0$, the index represents the proportion of the poor within the group which fall below the poverty line : the poverty rate. When $\alpha = 1$, the relative importance given to individuals under the poverty line is proportional to their level of income. This measure gives us the average poverty gap . For values above 1, the more α increases (the more society is averse to poverty), the more the importance given to the very increases in the poverty index[6].

We are also interested in indicators of inequality. These are all deduced from the Lorenz curves which represent along the horizontal axis the cumulative proportion of the population (by group or total) beginning with the poorest and on the vertical axis the cumulative proportion of resources. The indicator most frequently used is the Gini index. If the number of observations is sufficient, it can easily be calculated using discrete data (i.e. with having to use the analytical distribution function equation). The formula is given in the following equation :

$$Gini = \frac{1}{\mu N(N-1)} \sum_{i \rangle j} \sum_{j} \left| x_i - x_j \right|$$

[6] We could, for example, refer to Ravallion (1994) to obtain more complete information on the characteristics of different poverty indicators in and FGT in particular.

We also use another inequality indicator which has the property of being perfectly decomposable into intra and inter dimensions. Its equation is given by :

$$Theil\ total = \frac{1}{N}\sum_i \frac{x_i}{\mu}\log\left(\frac{x_i}{\mu}\right)$$

In the aggregated case, we use the vector of initial income to which we apply the rate of variation observed at the sample average for each group. By proceeding in this way we obtain a new income vector, distinct from that which comes from the disaggregated model, from which we can estimate the distribution parameters. In the disaggregated case we simply have to use the income vector produced by the simulation when all households are explicitly differentiated in the model. The estimation results are given in Table 5.

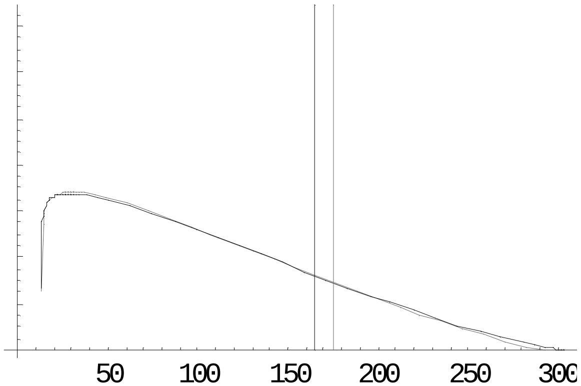
Table 5 : Parameters estimated for the Beta distribution function after the Simulation

		Aggregate Model			Disaggregate Model		
		Group 1	*Group 2*	*Group 3*	*Group 1*	*Group 2*	*Group 3*
Simulation 1	*p*	1.076	2.436	1.707	1.073	2.356	1.656
	q	2.258	2.713	1.444	2.323	2.671	1.405
	Ym min – max	13.85 - 295.4	28.5 – 516.7	321.3 - 862.3	13.34 - 303.2	27.0 - 522.4	316.2 - 868.2
Simulation 2	*p*	1.076	2.436	1.707	1.042	2.506	1.705
	q	2.258	2.713	1.444	1.998	2.625	1.507
	Ym min – max	14.3 - 306.0	28.0 - 507.5	294.8 - 791.3	15.3 - 288.3	30.9 - 491.0	306.3 - 788.5

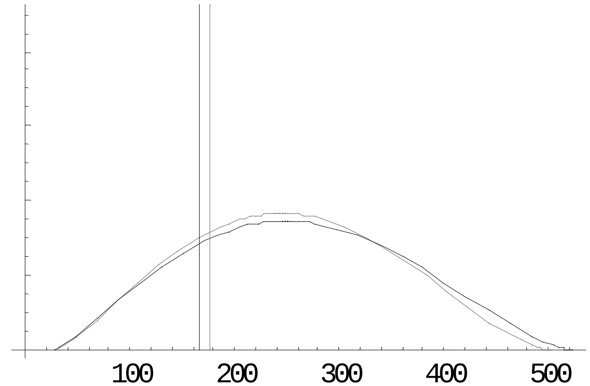
A graph of the results obtained is presented in Figures 1 and 2. The curves shown as dotted lines represent the situation in the base year, whereas the solid line curves represent the post-simulation results. The vertical lines indicate the level of the poverty line. In all the simulations the level of the poverty line decreases. This indicates that the cost of a basket of essential goods has dropped and that it is therefore easier to acquire.

Changes observed in income distribution following the shocks considered can be significant as shown in the graphs which relate to the third group. For Simulation 1, however, the differences between the aggregated and non-aggregated versions of the model are not very pronounced.

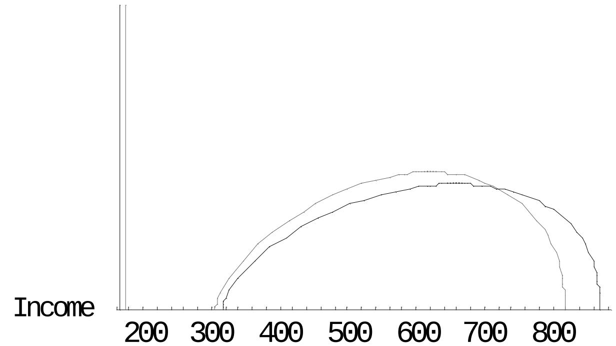
<u>Figures 1</u> **Distributional function : Disaggregated model simulation 1**



Group 1

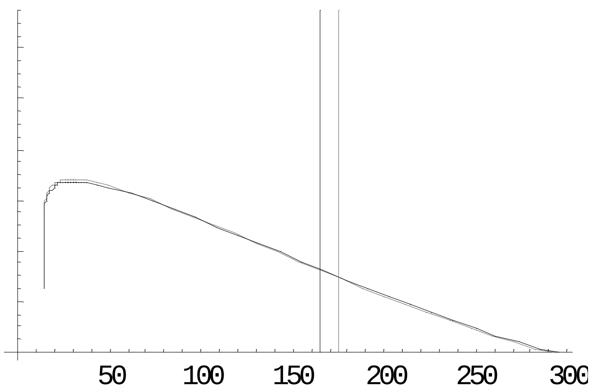


Group 2

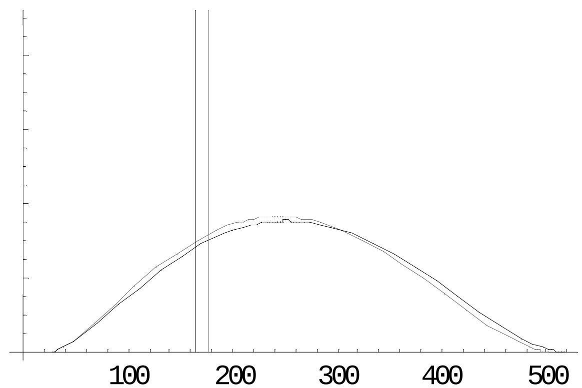


Group 3

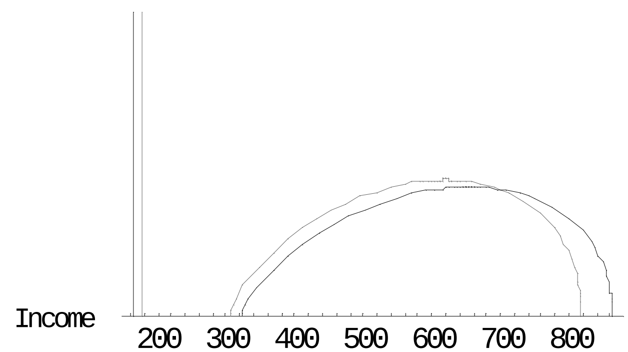
Distributional function : Aggregated model simulation 1



Group 1

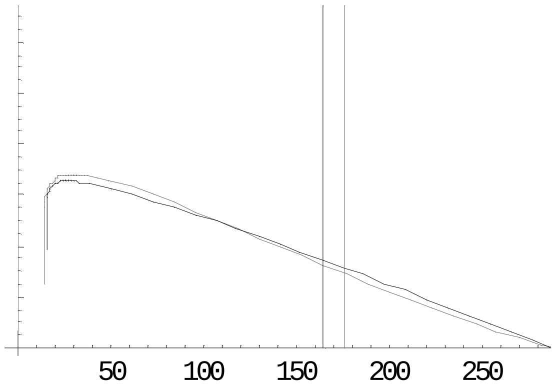


Group 2

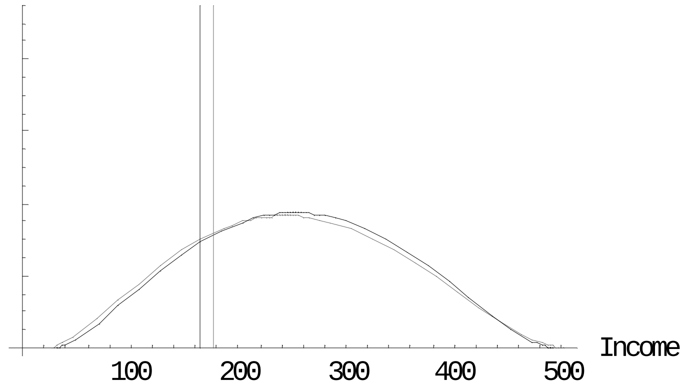


Group 3

<u>Figures 2 :</u> **Distributional function : Disaggregated model simulation 2**



Group 1



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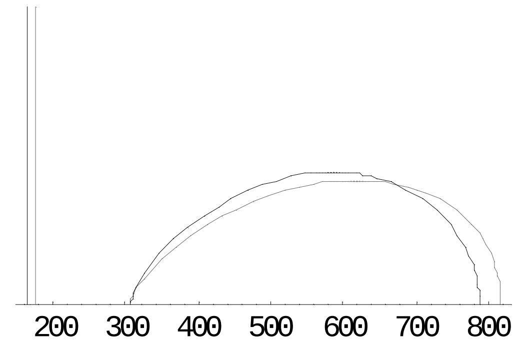
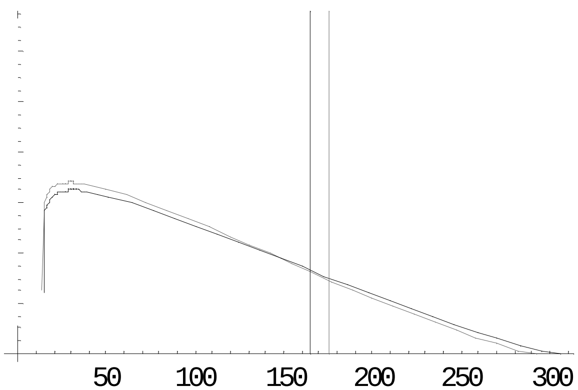
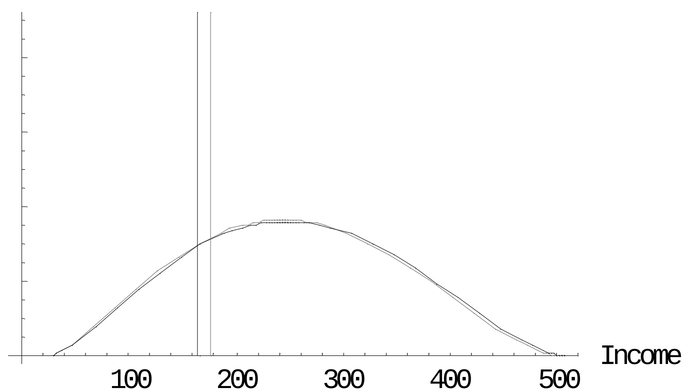


Group 3

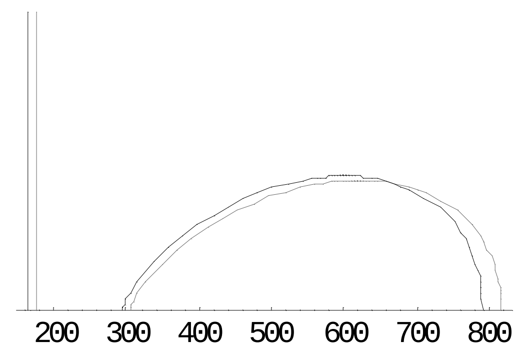
Distributional function : Aggregated model simulation 2



Group 1



Group 2



Group 3

The following table (Table 6) compares the estimations of the first three poverty indicators FGT for the first two groups in different types of simulations (there are no poor people in the third group). The results basically distinguish six cases according to whether or not they come from the aggregated model, whether the poverty line is endogenous or not, whether or not the distribution is assumed to be unchanged (to isolate the effect of the variation in the poverty line). In all cases we observe a significant reduction in the incidence of poverty. Contrary to the idea that can arise from the preceding graphs, this reduction is notable for the first group due to the drop in the poverty line. The very nature of the shocks that we have considered explain in part this fact.

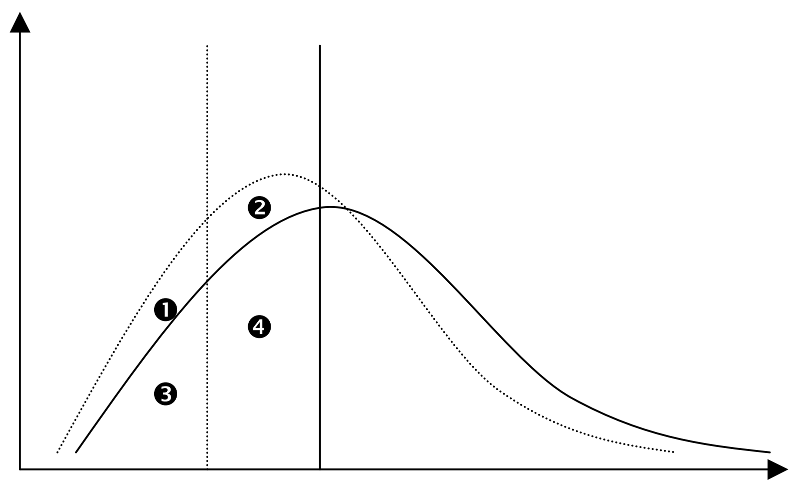
Table 6 : Poverty Indicators

	Simulation 1		**Simulation2**	
	+ 20% of the LNQ endowment		-100% tm(ind) and + 30% Pwe(agr)	
	Group 1	*Group 2*	*Group 1*	*Group 2*
Po – Reference	84.68	23.92	84.68	23.92
Aggregated – Exogenous Threshold	84.13	22.32	82.27	23.29
Disaggregated - Exogenous Threshold	83.81	23.09	82.14	22.01
Aggregated – Endogenous Threshold	80.85	19.23	78.85	20.04
Disaggregated - Endogenous Threshold	80.58	20.01	78.61	18.77
Aggregated – Endogenous Threshold – Fixed Distribution	81.42	20.66	81.36	20.60
Disaggregated – Endogenous Threshold – Fixed Distribution	81.42	20.66	81.37	20.61
P1 – Reference	44.18	6.52	44.18	6.52
Aggregated – Endogenous Threshold	41.26	5.08	39.81	5.32
Disaggregated – Endogenous Threshold	41.40	5.46	39.39	4.77
P2 – Reference	28.53	2.64	28.53	2.64
Aggregated – Endogenous Threshold	26.30	2.00	25.22	2.11
Disaggregated - Endogenous Threshold	26.53	2.21	24.84	1.82

Fundamentally three elements can contribute to the variation in the poverty rate : (i) variations in the poverty line, (ii) changes in average income and (iii) changes in the distribution at constant average income.

The calculation of the relative contribution of these elements is not however immediate, because the breakdown is not perfect. The following graph illustrates the nature of the problem. The solid lines represent the distribution curve and the poverty line after a shock. Initially the poverty rate could be determined by ❶+❸. After the simulation it establishes itself at ❸+❹. The contribution of the variation of the fixed distribution poverty line is therefore determined as ❷+❹, whereas if we take into account the change in distribution, it is simply equal to ❹. Moreover, if we wish to isolate the effect of the transformations of the distribution we must distinguish the cases where the poverty line is assumed fixed or endogenous. In the first case the contribution is equal to -❶, in the second it is equal to -❶-❷. The average income effect is isolated from the counterfactual results of the model aggregated at the poverty line.

<u>Figure 3 :</u> **Breakdown of the Sources of Variation of Poverty**



In the case of our archetypal economy, using the results described in Table 6, we are able to calculate the contribution of the variations of the poverty line, of the distribution and of average income in the different cases mentioned above. The results of the breakdown are given in Table 7.

Table 7 : Contribution of different elements affecting the poverty rate

	Simulation 1		**Simulation 2**	
	Group 1	*Group 2*	*Group 1*	*Group 2*
Variation in the poverty rate (in percentage points)	-4.10	-3.91	-6.07	-5.15
Variation in the poverty line – Endogenous Distribution ❹	-3.24	-3.08	-3.53	-3.24
Variation in the poverty line – Fixed Distribution ❹+❷	-3.26	-3.26	-3.31	-3.31
Variation in average income ◎	-0.55	-1.60	-2.41	-0.63
Change in intra Group distribution – exogenous threshold -❶-◎	-0.32	0.77	-0.13	-1.28
Change in intra group distribution – endogenous threshold-❶-❷-◎	-0.30	0.95	-0.35	-1.21

As stated earlier, the variation in the poverty line contributes in a dominating way to the growth in poverty (50% in all cases). However, we note that the variations in average income can also influence in a significant way the variations of the index P_0 (-2.41% - Simulation 2, Group 1).

Finally, with the help of this exercise we are precisely able to show that the changes in the intra group distribution, which can only be taken into consideration by micro simulation exercises, exert a potentially significant influence (-1.28% -Simulation 2, Group 2) and for which the direction is *a priori* undetermined (-0.32% vs. 0.77%- Simulation 1, Groups 1 and 2). For example, in the case of Simulation 2, the fact that changes in intra group distribution are not taken into account brings about an overestimation in the reduction of the poverty rate in the second group of more than 25%[7].

In other words, these results show the relevance of committed efforts for developing modelling exercises including the maximum individual heterogeneity, at least with respect to the analysis of questions of poverty.

Finally, we use the results of our simulations to study the variations in terms of inequality. We start by constructing the Lorenz curves that correspond to the initial data and to the results of different simulations. Visually the differences seem weak but the Gini and Theil indices presented in Table 8 provide a whole new light on the situation.

Figure 4 : Lorenz Curves

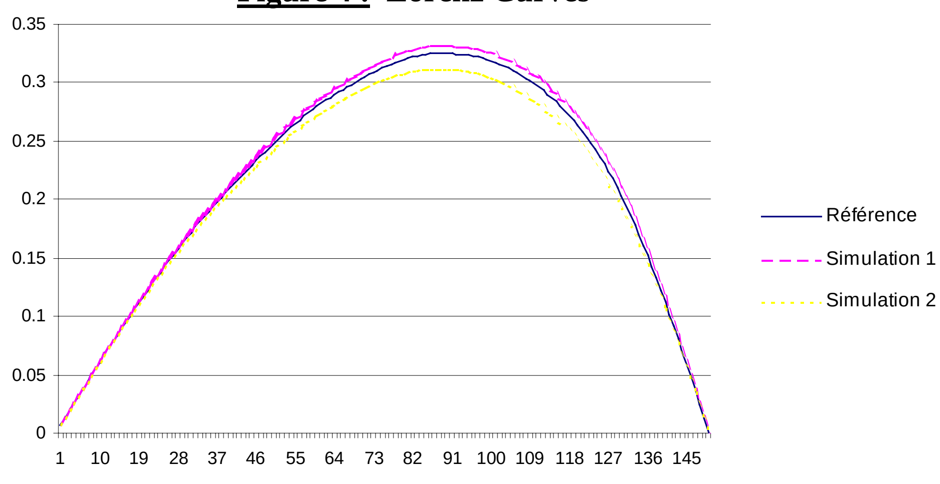


Table 8 : Gini Coefficients

[7] Furthermore, it should be remembered here that we have assumed that consumption functions aggregate perfectly. Without this very strong hypothesis the differences would undoubtedly be greater still.

Sample	Reference	Simulation 1	Variation Sim 1	Simulation 2	Variation Sim 2
Total	0.435	0.444	+2.00%	0.420	-3.54%
Group 1	0.374	0.379	+1.33%	0.368	-1.70%
Group 2	0.243	0.250	+2.70%	0.232	-4.64%
Group 3	0.142	0.147	+2.94%	0.136	-4.14%

Table 9 : Theil Index

Sample	Reference	Simulation 1	Variation Sim 1	Simulation 2	Variation Sim 2
Total	0.1312	0.1367	+4.19%	0.1218	-7.16%
Inter	0.0982	0.1027	+4.57%	0.0902	-8.10%
Intra total	0.0331	0.0341	+3.05%	0.0316	-4.35%
Intra Group 1	0.0936	0.0962	+2.80%	0.0901	-3.72%
Intra Group 2	0.0400	0.0422	+5.44%	0.0364	-9.18%
Intra Group 3	0.0132	0.0140	+5.71%	0.0122	-8.15%

Three observations can be made :

1) The variations in the Gini index are clearly not negligible because they are systematically greater than 1% and they can even reach 4,64% (Simulation 2, Group 2). Similarly the modifications in the Theil index appear to be significant as much in the intra as in the inter dimension.

2) Although we were able to state that the poverty rate systematically decreased in the two simulations, it appears here that the inequalities vary **in opposite directions** according to the case. In reality we can even show that there is dominance between the Lorenz curves, which is to say that independent of the inequality indicator considered, the first simulation (respectively the second) generates more (respectively less) inequality[8]. This observation can be explained by the fact that the return on physical capital and skilled labour evolve in an antagonist and opposite way in the two simulations. The smoothening of the corresponding distribution functions (cf. graphs) provide an illustration.

3) Finally, the analysis of the results in terms of intra group inequality, show that in spite of a relatively weak contribution in our archetypal data, the variations in the intra dimension can be significant. The is the case in particular for Groups 2 and 3 where the gap in percentage is greater than that estimated for the total inequality.

[8] For analyses of dominance the reader should refer to Bishop, Formby and Thistle (1989) or Davidson and Duclos (1998).

We observe therefore that the consideration of heterogeneity is essential to capture the effect of economic policy on poverty and inequality. Micro simulations, even though they can appear arduous to implement, seem to be justified here.

IV Conclusion

This article was concerned with the analysis of questions of poverty and inequality in general equilibrium models. Three approaches have been developed in the literature which allow the study of all or part of these questions. The standard framework once it has been adequately disaggregated at the household level allows the observation of relative variations in income between households. To be able to estimate variations in the poverty indicators, it is necessary to complete this exercise with an analysis of the distribution functions using survey data. By proceeding this way, we neglect however changes in intra group distribution. In fact to be able to take completely into account individual heterogeneity it becomes necessary to integrate the information from the survey directly into the model. This finally becomes the development of a general equilibrium micro simulation. Very little work of this kind has yet been applied to developing countries, mainly because of the apparent complexity of the procedure.

The three types of model developed here in a co-ordinated statistical framework represent an archetypal semi-industrialised economy. The results detailed in Section II show the potential influence of changes in intra group distribution on the evaluation of poverty. This influence is neither negligible nor foreseeable a priori. Furthermore, the shocks considered exert a substantial effect on the total inequalities and even more on those which are expressed within each group.

These observation favour the taking into account of intra group distributive effects and their endogenisation within the same modelling exercise. Only general equilibrium micro simulations allow this level of coherence to be obtained. In consequence, it seems that in spite of the efforts their implementation require, as much in terms of statistical analysis as in modelling, micro simulations are most relevant for the analysis of questions of poverty and inequality.

The research to come, in particular that which concerns developing countries, could certainly profit from orienting itself in this direction. This would profit from use of statistical information, taken from household surveys, which is often considered to be underused.

The development of dynamic micro simulation exercises could also prove to be useful for studying problems of the persistence of poverty and inequality which constitute, in the recent literature, one of the fundamental questions in this area.

Bibliography

Adelman, I, S. Robinson (1979), *Income Distribution Policy: A Computable General Equilibrium Model of South Korea*, in Adelman, I, The selected essays of Irma Adelman. Volume 1. Dynamics and income distribution. Economists of the Twentieth Century Series. Aldershot, U.K., pp. 256-89.

Armington, P.S. (1969), *"A Theory of Demand for Products Distinguished by Place of Production"*, IMF Staff Paper n° 16, pp. 159-176.

Atkinson, A. B. (1987), *"On the Measurement of Poverty"*, Econometrica, vol. 55, n° 4, pp. 749-764.

Bergmann B., Eliasson G. & Orcutt G., (1980), *" Micro simulation models, methods ans applications by the Industrial Institute for Economic and Social Research "*, Almquist and Wiksell International, Stockholm.

Bishop J., Formby J. et Thistle P. (1989), *" Statistical inference, income distributions and social welfare. "*, Research on Economic Inequality vol. 1, pp. 49-82.

Blackwood, D. L. and R. G. Lynch (1994), *"The Measurements of Inequality and Poverty: A Policy Maker's Guide to the Literature"*, World Development, 22(4), pp. 567-578.

Blaizeau D. & Dubois JL (1989), *" Connaître les conditions de vie des ménages dans les pays en développement "*, 3 volumes, Published by the Department of Cooperation and Development.

Bordley, R. F., J. B. McDonald and A. Mantrala (1996), *"Something New, Something Old: Parametric Models for the Size Distribution of Income"*, Journal of Income Distribution, 6(1), pp. 97-102.

Bourguignon, F. and G. Fields (1997), *"Discontinous Losses from Poverty, Generalized P_α measures, and optimal transfers to the poor"*, Journal of Public Economics, 63, pp. 155-175.

Bourguignon, F., Fournier, M. and Gurgand M. (1998), *" Distribution, development and education : Taiwan, 1979-1992 "*, mimeograph.

Bourguignon, F., Fournier, M. and Gurgand M. (1998), *" Labor incomes and labor supply in the course of Taiwan's development, 1979-1994 "*, mimeograph.

Cogneau D. (1997), *" Le marché du travail, la pauvreté et les inéfalités à Antananarivo : une microsimulation en équilibre général "*, mimeograph.

Cogneau D. and Robillard AS. (1999), *" Income Distribution, Poverty and Growth in Madagascar: Micro simulations in a General Equilibrium Framework "*, mimeograph.

Chia, N. -C., S. Wahba and J. Whalley (1994), *"Poverty-Reduction Targeting Programs: a General Equilibrium Approach"*, Journal of African Economies, 3(2), pp. 309-338.

Davidson R. and JY. Duclos (1998), *" Statistical Inference for Stochastic Dominance and for the Measurement of Poverty and Inequality. "*, Cahiers de recherche du CRÉFA n°9805.

Deaton A. (1997) *" The analysis of household surveys. A microeconometric approach to development policy "* The John Hopkins University Press.

Decaluwé, B., A. Patry, L. Savard and E. Thorbecke (1999), *" Poverty Analysis Within a General Equilibrium Framework "* Cahier de recherche n° 99-06, CRÉFA, Université Laval.

Decaluwé, B., M. –C. Martin and M. Soussi (1995), École PARADI de Modélisation des Politiques Économiques de Développement, 3ième Édition, Université Laval. Québec.

De Janvry, A., E. Sadoulet and A. Fargeix (1991), *Adjustment and Equity in Ecuador* OECD Development Center, Paris.

Dervis, K, J. DeMelo and S. Robinson (1982), *General Equilibrium Models for Development Policy*, Cambridge University Press, London, pp. 1-526.

Duclos JY., A. Arrar and Carl Fortin (1999), *"DAD : a software for distributional analysis"*, MIMAP Project, International Development Research Centre, Government of Canada.

Fortin, B., N. Marceau and L. Savard (1997), *"Taxation, wage controls and the informal sector"*, Journal of Public Economics, 66, pp. 293-312.

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

Grootaert C. & Cheung KF, (1985), *" Household Expenditure Surveys. Some Methodological Issues "*, LSMS Working Paper n°22.

Gunning, W.J., (1983), *" Income Distribution and Growth: A Simulation Model for Kenya "*, in D.G. Greene (principal author), Kenya: Growth and Structural Change, 2 vols., Washington, DC: World Bank, pp. 487-621.

Harding A., (1993), *" Lifetime Income distribution and redistribution. Application of a Microsimulation model "*, North Holland, 408p.

Huppie, M. and M. Ravallion (1991), *"The Sectoral Structure of Poverty During an Adjustment Period: Evidence for Indonesia in the Mid-1980's"*, World Development 19(12).

Johnsons, N. L. and S. Kotz (1970), *Continuous Univariate Distribution*, Vol. II, Wiley, New York.

Morrisson, C. (1991), *Adjustment and Equity in Morocco*, OECD Development Center, Paris.

Orcutt G. (1957), *" A new type of socio-economic system "*, Review of Economics and Statistics, 58, pp 773-797.

Orcutt G., Greenberg M., Korbel J. & Rivlin A. (1961), *" Microanalysis of socioeconomic systems : A simulation study "*, Urban Institute Press, Washington.

Ravallion, M. (1994), *Poverty Comparisons*, Harwood Academic Publisher.

Ravallion, M. and S. Chen (1997), *"What Can New Survey Data Tell Us About Recent Changes in Distribution and Poverty?"*, World Bank Economic Review, 11.

Shoven, J.-B. and J. Whalley (1984), *"Applied General Equilibrium Models of Taxation and International trade: An Introduction and Survey"*, Journal of Economic Literature, 22, pp. 1007-1051.

Shoven, J.-B. and J. Whalley (1972), *"A General Equilibrium Calculation of the Effects of Differential Taxation of Income from Capital in the U.S."*, Journal of Public Economics, 1, pp. 281-322.

Thorbecke, E. (1991), *Adjustment and Equity in Indonesia*, OECD Development Center, Paris.

Thorbecke, E. and D. Stifel (1998), *"Comparative Statics and Growth with a Dual-Dual Model"*, Department of Economics, Cornell University.

United Nations (1986), *" Manuel des méthodes d'enquêtes sur les ménages "*, Études méthodologiques série F, n° 31.