Using CGE and Microsimulation Models for Income Distribution Analyses: A Survey

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Abstract

This paper carries out a survey of CGE and Microsimulation models used in the evaluation of issues related directly or indirectly to incomes distribution. Different model structures are discussed which have been employed for country-specific, multi-country and region-specific studies. The paper considers the relevance of a relatively recent approach in modeling_linking CGE frameworks with microsimulation models, for the incomes distribution and poverty analysis. Finally we discuss the practical application of this methodology along with a detailed picture of some active CGE-microsimulation models.

Keywords: Microsimulation, CGE Models, Income Distribution, Poverty, Inequality.

JEL Classification: D58, C81, C82,

1. INTRODUCTION

The incorporation of distributional issues in macroeconomic models has never been a regular feature. Infact there came a period when theoretical new classical economics completely ignored income distribution and considered it as a more or less expected outcome and by-product of overall macroeconomic performance governed by market forces, and competitive behaviors. No deliberate efforts were made to empirically keep track of changing inequality dynamics until the later part of last century brought a striking divide, where coexistence of have and have-nots became a norm all over the globe. Economists presented comforting justifications for such a trend, that a trade-off between growth and distribution may be inevitable. Many countries infact settled down on the more commonly known *Kuznet* view that inequality will only decline in the latter stages of development and growth maturity. Thus no initiative was forwarded to investigate the feedback effects originating from distributional mal-adjustments that ultimately paralyzed the socio-economic structures in countries that were already in a nascent stage of recovery and rebuilding[2]. Consensus was also drawn on the basis of Lewis dual-structure hypothesis, which identified the initial displacement shift of workers from agriculture sector to manufacturing that contributed towards inequality.

Today the huge task of accomplishing the UN Millennium Development Goals (MDG's) again points towards the need for stepping up the efforts needed for incorporating precision in poverty/inequality measurement, evaluation and analysis. MDG's are infact important, in that they provide a clear strategic path towards sustainable development. The basic list includes 8 goals, sub-categorized by 18 targets and about 40 indicators. Dealing with such diverse indicators and their simultaneous tracking poses a great challenge for the national governments. It is often emphasized that the methods for channeling wealth into social safety nets and social spending are (without exception) never chalked out in detail[3].

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[2] See Bertola *et.al*(2004), See also Atkinson and Bourguignon (2000)

[3] For economic analysis of MDG's see SRDS website: *Introduction to Millennium Development Goals and Targets,* www.srds.co.uk/mdg/poverty/htm.

This does not come as a surprise because most countries often fail to make proper use of analytical frameworks now available with the social science. A simple barometer such as the *poverty line* has above 210 definitions across the globe. Most of them are country-specific, however the reliance upon these definitions has often led to the downfall of otherwise well-intentioned policies. Without further delay governments have to: a) improve the data quality standards, b) analyze and evaluate issues such as poverty, hunger, reduction in mortality, environmental sustainability and gender inequality in a framework which not only explains the macro changes but also captures the micro tremors of these changes.

On the applied front there has been a quantum leap effort to develop analytical frameworks for the evaluation of socio-economic and demographic issues. Research methods have been developed to an extent where computational difficulties are no more a matter of concern. For the income distribution, inequality and poverty assessment several methodologies have surfaced over the past few decades. Following chart shows a schematic presentation of these.

The above-mentioned tools basically augment our ability to understand *microeconomics of income distribution*. Social Impact Assessments (SIA) due to their open-ended nature, are usually very effectual in gauging the grass root impact of any given reform; especially the ones involving lesser feedbacks. The data collected is in the form of semi-structured interviews, stakeholder views and sometimes, targeted surveys. Time required for this exercise largely depends on the sample size and the ability of field researchers. This is why most of the times the social impact assessments are not nationally representative and provide highly subjective results. Similar is the case with Participatory Poverty Assessments (PPA), which are useful in evaluating depth rather than incidence of poverty. However PPA is more quantifiable if compared to SIA. Sociologists team up with local research groups, who also have necessary combination of anthropology skills.

Methods for Analysing Policy Impacts on Income Distribution & Poverty

Tools from Sociology

- **Social Impact Analysis** (Analytical methods that use a range of open-ended, semi-structured and closed data collection techniques to desaggregate the impact of policy changes on different stakeholder groups).
- **Participatory Poverty Assessments** (Incorporating the views of poverty ridden population in the corrective policy measures).
- **Social Capital Assesment Tool** (Survey based instrument that measures: a) opportunities and constraints faced by poor, b) lack of social assets, c) access to resources).

Tools from Economics

- **Benefit Incidence Analysis** (e.g. ranking individuals into welfare quantiles, then multiplying the population in each quantile by public unit cost of providing annual health care, we can derive the distribution of state health expenditures across the welfare distribution.)
- **Poverty Mapping** (provides visualization of incidence of welfare across space, also known as spatial distribution of poverty)
- **Behavioral Incidence Analysis** (Combines simple incidence analysis with econometric household behavior)
- **Partial Equilibrium Analysis** (a: Multi-market models, that allow combined estimation of supply and demand relationships, b: Reduced-form estimation)
- **General Equilibrium Analysis** (a: SAM and I/O frameworks, b: CGE models)
- **Integrated Modeling Analysis** (a: Linking Macro framework with Reduced form estimations b: Linking Macro framework with representative households c: <u>Linking CGE model with Micro-simulation</u>)

Social Capital Assessments (SCA) makes use of household surveys and detailed community or region-wide questionnaires, to assess the socio-economic success of reform process in mobilizing the productivity of society as a whole. SCA has the ability to capture the impacts of a wide variety of reforms such as those related to pensions, land, labor markets, devolution etc. But at the same time conducting SCAs can be expensive to a challenging extent.

On the economics side, benefit incidence analysis may be useful for evaluating the impact of for example, tax-benefit or financial reforms, by measuring the direct incidence on households categorized by their incomes. Although this exercise is fairly manageable within a few weeks time with minimal manpower, however the results normally provide only average impact estimations whereas the marginal analysis is ignored. Poverty mapping is beneficial, when applied to the analysis of region-specific reforms or those reforms, which bring about regionally distinguished impacts. This analysis usually requires the combined use of household survey data and census data, and is time-intensive in the sense that just the map building process, which incorporates the spatial distribution, can take more than a year.

The behavioral incidence analysis combines the benefit incidence approach with econometric estimations for explaining distributional changes. This is usually employed in the evaluation of government policy contribution at the grass root level mostly in social sectors such as education and health. This approach may require the use of an econometric model, however it can be accomplished in a lesser time than the other abovementioned methods. The partial equilibrium analysis can take the form of: a) reduced form model, where supply and demand equations are solved to obtain reduced form equations. These equations can be used for examining determinants related to growth, inequality, poverty etc. These models have been used in past for estimating effects of structural adjustment reforms. b) Multi-market models can be used to assess distributional outcomes of reforms/policy changes in any selected sector. These do not require the complete general equilibrium specifications or the macro balances. However for any detailed and in-depth policy debate that incorporates exhaustive trade-off options the last two methods i.e. general equilibrium analysis and integrated modeling analysis have become imperative[4].

This paper carries out a survey of CGE and Microsimulation models used in the evaluation of issues related directly or indirectly to income distribution. Different model structures are discussed which have been employed for country-specific, multi-country and region-specific studies. The paper considers the relevance of a relatively recent approach in modeling_linking CGE frameworks with microsimulation models,

[4] For further information on the tools and methods used in poverty and inequality analysis see: lnweb18.worldbank.org/.../$FILE/ AnnexEconomicandSocialToolsforPovertyandSocialImpactAnalysis(90KbPDF).pdf

for the income distribution analysis. The next section provides an insight in the characteristics and methodology of CGE models. As a matter of reference, it may kindly be noted that the aim of this paper is not to provide a survey on the entire literature on applied CGE or microsimulation models, which certainly is a near impossible task now. However we will only be discussing those models, which have been applied for studying issues regarding distribution in particular at the household level. Section 3 will focus on the working and application of static and dynamic microsimulation frameworks. A discussion has also been made on the efforts that have tried to make microsimulation behavioral. In section 4, detailed analysis has been carried out at length on how and why to link CGE and microsimulation frameworks and this is followed by the application of such merged frameworks towards the analysis of income distribution, poverty and inequality issues. Finally in appendix we have provided methodological details and simulation results of some active CGE-microsimulation models.

2. COMPUTABLE GENERAL EQUILIBRIUM (CGE) MODELS

The theory behind CGE models is fairly known to the applied science by now. These models provide numeric simulation of the economy under general equilibrium conditions/assumptions. With quite detailed microeconomic foundations, CGE models exhibit a transparent specification of functional forms wherein complete set of interdependent relations is envisaged. Similarly feedback mechanisms are devised so as to keep the updating and evaluation procedure logical. These models are traditionally known to be constructed on a Walrasian system, with the central assumption of general equilibrium keeping market demand equal to supply for all commodities at a matrix of relative prices. Due to their inbuilt feedback structure CGE framework has the advantage of making an explicit assessment of changes in policy and structure on micro level resource allocation. Given these properties of these model structures, their frame and size can be extended into a multi-nation mode to study for example the effects of trade policy, where several countries are gaining and losing simultaneously. Table 1 illustrates in plain words the characteristics of CGE models which some of the preceding forms of modeling lack.

Table 1

Model Type	Features not available
Input-Output Models	*Economic agents do not respond to price changes. For details on these models, see Bromley (1972), also see Shapiro and Halabuk (1976).*
Partial Equilibrium Models	*They are simply not economy-wide. You won't know "who gained and who lost". See Brannlund and Kristrom (1996)*
Macroeconomic Models	*They are not multisectoral, thus lacking the required depth for policy debate and simulation. See O'Brien (1982), also see Diebold (1998).*
Financial Programming Models	*Cannot capture in detail the quantitative flow of for example goods and services. See Mikkelsen (1998).*
SAM based Models[5]	*The disaggregation is not flexible enough for repeated simulations at micro level. See Subramanian and Sadoulet (1990).*

Traditionally CGE models were brought to usage as a much needed alternative if not replacement to econometric frameworks. This was precisely the time when policy-oriented model builders realized that econometric models are not transparent enough to highlight the intricate economic flows. As is more commonly said: *everything could be made to hide behind the error term.* By this time there was a realization that the econometric forecasts of macro aggregates were not fulfilling the much desired objective of studying the deeper impacts of stabilization and structural adjustment policies. Consequently SAM based CGE models surfaced. It was noticed that unlike the econometric models the CGE models did not require lengthy time series on economic variables and secondly the calibration process was only around the base year SAM. Infact the instant fame of CGE models in developing countries was due entirely to the fact that these countries face a serious dearth of data stock, which implied that instead of checking the reliability of econometric results one had to first

[5] Excluding applied general equilibrium models, which can also be built on SAM.

check the reliability of data sources, possibly through administrative channels. With the estimated parameters available one could now easily obtain the sectoral elasticities of transformation or substitution, without having the constraints of linearity. Table II indentifies some of the main methodological issues to be considered for setting up a CGE framework.

Table II

Issues	Details
Dimensions of Model	- *Deciding upon the level of aggregation.* - *No. of Markets and Products.* - *No. of Factors of Production.*
Data Set (Benchmark)	*Adjusting the data sets to fulfill the consistency requirements. .*
Parameters of Model	*Calibration to produce and then reproduce (if required) the dataset corresponding to an equilibrium state.*
Functional Form	*Numerical specification e.g. demand/supply functions and the choice between linear expenditure system (LES), constant elasticity of substitution (CES) or the Cob-Douglas form.*

CGE models since their inception have been subject to continuous change and variations. It would certainly be useful to list some of the main variations carried out on these models:

a. Imperfect competition (Harris 1984).

b. Explicit financial markets (Thissen 1999).

c. Monetary policy features (Altig, Carlstrom and Lansing 1995).

d. Open model incorporating trade (Panagariya and Duttagupta 2003).

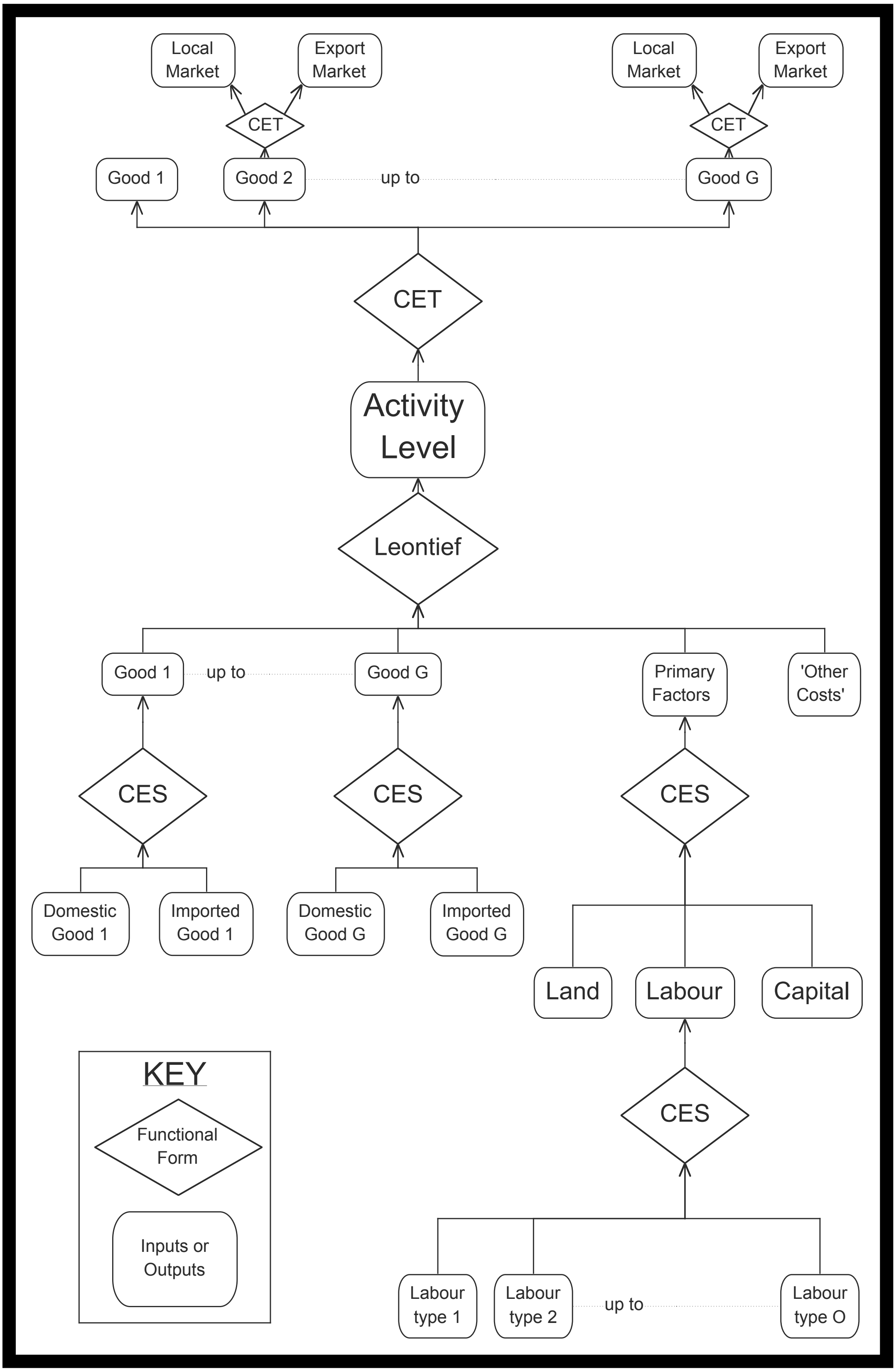
e. Interregional trade options (Haddad and Domingues 2003).

f. Dynamic models with lags (Ianchovichina and McDougall 2000).

It was infact the application of CGE frameworks to trade analysis that triggered the debate about these models being handicapped to an extent due to their static nature. Producers and consumers were making optimal decisions about production and consumption within a single period, whereas the preposition of rationality states that no decision is optimal for an economic agent if it ignores the future. Secondly, because the capital stock was fixed, one could not study for example the welfare effects of decrease in investment due to increase in capital import tariff. Thirdly economists were becoming increasingly interested in the analysis of intertemporal behavior of trade balances, foreign/domestic investment, which was not possible under the static form. Making the CGE models dynamic involves basically a four-step procedure. First we establish the assumptions about utility functions of consumers and the production functions. Consumer's utility function is taken to be separable across time, thus we allow the maximization of present value of utility subject to 'intertemporal' budget constraint. For the producers case we maximize the present value of the net income, which is actually the value of the firm. In the second step we have to define our time limits as the model is not being designed to run for an infinite time period, which in turn implies that model is assumed to be in a steady state. Third, we need to make the capital accumulation work in the dynamic framework. This can be done by specifying/assuming the level of capital stock at which the marginal product of capital is equal to a given interest rate. However this approach may lead to wide fluctuations in our projections, therefore it becomes imperative that before closing the model we impose a functional adjustment cost on the perpetually accumulated capital stock[6]. Our objective here is to adjust the economy to a desired capital stock along a pathway which is smooth in the medium to long run. For more details on Dynamic CGE models see Devarajan and Go (1998) and Devarajan (2001).

[6] This can be done by placing an assumption that there is a particular cost to investment that is quadratic in the ratio of investment to capital stock.

General Equilibrium Structure of Production



Source: ORANI-G: A General Equilibrium Model of the Australian Economy

The above flow diagram highlights the interaction between labor and goods market in an open economy[7]. Different combinations of intermediate inputs and value addition are mixed through CES/leontief functions. The choice of production function (utility function) and the extent by which this function has to be generalized entirely depends upon the nature of analysis and type of technology/preferences at hand.

CGE models had not been applied to income redistribution issues until recently. This subject surprisingly received relatively little attention, even though many CGE models were in operation even in the developing counties. Traditionally these models were being employed for sectoral analysis, for example energy, infrastructure, transport sector etc. the main interest in this area began out of a general perception that the structural adjustment programmes during the last two decades have lead to an adverse impact on poverty and the state of income distribution. Questions were raised, whether or not the poor segment of the population is being made worse as a result of these programmes. Secondly the sequencing and timing of these programmes also came under severe inquiry in many countries. However in the end the studies using CGE framework for analyzing income distribution came out with varying and mixed conclusions across the countries.

Khan (2004) identifies three generations of CGE modeling for the developing countries case, where the first and the second generation models included distributional issues but did not take it further to highlight the issues of poverty explicitly, which was consequently done by the third generation models. It is difficult to actually tell that who went first, however general consensus reveals that it was Adelman & Robinson (1978) who in a disaggregated form tried to use an implicit Social Accounting Matrix (SAM) for analyzing household income distribution in Republic of Korea in 1978.

Dervis, de Melo and Robinson (1982) and de Melo and Robinson (1982) explore policy issues using Archetype models. These models were used for three distinct economies; a) closed economy, b) primary exporter economy, c) manufacturing exporter economy. For all the three cases they concluded that it was; a) the initial

[7] For detailed discussion on CGE structural flows see Horridge et.el (1998).

structure of the economy and, b) choice of adjustment policies available; that actually determined the distributional impacts of an external shock.

A unique exercise on the application of CGE models was carried out in 1991 under the auspices of OECD. The team developed a common CGE framework, which was then put to application in six different countries. Thorbecke (1991) used this framework for Indonesian economy. Five different policies were simulated and the results identified that the impact of policy initiatives targeted under stabilization and adjustment programme restored equilibrium and improved the status of income distribution. The polices simulated included; reduction in expenditure, increase in public investment, devaluation of exchange rate, monetary expansion and monetary contraction. Same CGE model was applied to Chile by Meller (1991) who employed two different policies for simulation; devaluation of exchange rate and expenditure reduction to assess the impact of 1980s structural adjustment in Chile. The results however are contradictory if compared to Indonesian case explored by Thorbecke (1991). Conclusion was that devaluation of exchange rate had increased the general cost of living, due to which poor were the worst effected. Secondly the expenditure side analysis explains that the considered adjustment package was regressive in nature, led to an increase in unemployment rate and decreased the per capita budget in the social sectors like health and education.

In the same series Demery and Demery (1991) used the applied general equilibrium framework for Malaysia. Results concluded that preemptive adjustment, milder fiscal restraint and stiffer taxes intended to raise tax revenue, had a negative impact on poor particularly those associated with the agriculture sector, however exchange rate devaluation and expenditure reduction polices did safeguard the poor. Janvry, Sadoulet and Fargeix (1991) explored alternatives available to Ecuador for protecting the rural poor and restoring the overall economic growth. Reducing current expenditure in this Ecuador’s case was found to fulfill both the objectives.

Morrison (1991) highlighted that for the case of Morocco the adjustment programme was well timed for the exogenous shocks which Morocco confronted. The programme actually supplemented in keeping the cost of adjustment at a minimum. Furthermore he emphasized that a medium term adjustment package combined with short-term stabilization policy diminished the increasing rate of poverty besides maintaining a healthy overall growth trend. Finally a reduction in external balance (deficit) was a much needed relief in Morocco's case.

With a similar CGE framework Lambart, Schneider and Suwa (1991) analyzed the case of Cote d'Ivoire and concluded that using a reduction in wages of public employees as the principal instrument (for reduction in overall current expenditure), remained ineffective in reducing poverty, however a reduction in income inequality could be observed. Increasing export taxes was also found to be distributionally regressive[8].

Recent efforts to model collective issues involving poverty, inequality and income distribution have been termed by Khan (2004) as the third generation CGE modeling. Amongst this class the paper by Decaluwe′, Bernard, Patry, Savard and Thorbecke (1999) simulates the impact of; a) a fall in the export crop price and, b) import tariff reform, on poverty levels. A CGE model is calibrated on an African SAM (archetype). Paper intends to devise a methodology where a comparison can be made of the incidence of poverty in the pre and post shock scenarios. Stifel and Thorbecke (2003) present another archetype African economy, putting into use a CGE model to study the effects of trade liberalization on poverty in specific and welfare in general. Both the intra-group income distributions and the nominal poverty line have been endogenized. This approach not only provides assessment of overall poverty in the country but can also render insight into poverty levels relevant to specific groups/regions inside a country. This approach has been recognized by many to be more useful in the income distribution and poverty analysis as it recognizes the coexistence of formal and informal type of activities in both the rural and urban areas.

Decaluwe′, Dumont and Savard (1999) identify three types of Computable General Equilibrium models used to simulate the impact of macro policies on poverty and income redistribution. First are those relying upon representative assumption, second is using income and expenditure surveys and calibrating CGE model. By endogenizing the poverty line in this second type one can produce counterfactual

[8] For a detailed review of these models constructed under the OECD Project see Iqbal and Siddiqui (2001).

results on poverty. However in both the aforementioned types it is impossible to study intra-group inequalities. Therefore for poverty analysis this paper suggests the third type, which directly relies on statistical details at the household level[9]. We discuss this paper in greater detail in Section 5.

On a more methodological note, Boccanfuso, Decaluwe′ and Savard (2003) provide an overview of approaches used in modeling of income distribution in a CGE framework. Six functional forms with parametric and non-parametric estimations are compared with the conclusion being that no single form was found to be suitable in all household categories/groups. This conclusion is supplemented by Metcalf (1972) suggesting that three to four parameter functions might be more appropriate to capture economic changes[10]. Secondly more flexible functional forms might provide better insight while analyzing the effects of CGE modeling on income variables.

Finally any survey on the usage of CGE models in income distribution analysis would be incomplete without the discussion on country-specific models build under the aegis of International Development Research Center[11] and Ontario Economic Association. Harris (1984) using an industrial organization based CGE model showed four times higher welfare gains from trade liberalization as compared to a normal competitive model. The CGE framework, due to its industrial orientation incorporates micro level industry/firm components like economies of scale, differentiation of products, price maker/taker assumptions in export/import markets etc. Two factors of production are considered; Capital services as the mobile factor and labor as the fixed factor. The overall industrial structure is divided into two broad categories; non-competitive industry with increasing returns and competitive industry with constant costs. The crux of Harris (1984) approach is that the inclusion of such organizational features into CGE models can lead to increasing reliability of final results.

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[9] This is precisely microsimulation modeling.
[10] See also Singh and Maddala (1976).
[11] These models were part of IDRC's Micro Impact of Macroeconomics and Adjustment Policies (MIMAP) Programme. For details see http://www.mimap.org. We over here only discuss those MIMAP models which were made under the objective of analyzing welfare effects or issues related to income distribution and poverty. Review on other MIMAP models including some sectoral ones can be seen in Dasanayake, S.W.S.B. (2001).

Following the framework of Dervis, de Melo and Robinson (1982), Sapkota, R and Sharma, K. (1998) developed a neoclassical real sector model to analyze the socio-economic effects of tariff changes and the poverty reform measures in Nepal. One of the more interesting result that came from this model was that devaluation benefit poor households and hurts non-poor. Furthermore increases in skilled labor wages and government employee's salaries hurt poor households. However on the trade liberalization side the results indicated that a decrease in tariff rates for competitive imports and elimination of import duties on intermediate imports would increase the welfare of poor in comparison to non-poor. The paper is a good exercise in examining the factors that can bridge the gap between rich and poor across the board. However the model itself exhibits certain deficiencies, primal of which is the absence of a monetary sector.

For the case of Vietnam Chan, Dao, Hai, *et.al.* (1998) studied the effects of taxation reforms at national as well as household levels. With the help of a CGE model the redistributive effects of indirect taxation reforms have been shown to be anti-poor, and those who spent larger proportion of their portfolio on previously high taxed products were the main beneficiaries. Thus any overall gains arising from the reform process are infact at the cost of the poor households. It is to the credit of this exercise that authors have modeled complete set of prevalent taxation structures with three non-tradable and six tradable sectors. Five individual household groups have been ranked in order of their respective incomes. The demand level of each of these household groups is thus obtained by CES utility function maximization, which indeed is constrained by household budget. Another study done for Pakistan under the MIMAP project, by Kemal, Siddiqui and Siddiqui (2001) employs the neo classical framework of Decaluwe′ *et. al.* (1996) CGE model, to explore the impact of tariff reduction on income distribution. The analysis of Siddiqui and Iqbal (1999) is also extended in this paper to assess the impact on income distribution at both rural and urban household levels. As in the case of Vietnam this model also suggests the worsening of income distribution. There is a clear indication that gap between the rich and the poor widens. The authors suggest the decline in government revenue as the main source of deterioration of macro level indicators such as decreased investment and overall resource generation. Going into the conceptual details of this model developed for Pakistan, domestic production is disaggregated into agriculture, industry, other, health and education sectors. Assuming perfect competition and market clearing the labor demand function is being derived from CES production function. Underlying assumption is that changes in factor prices play a strong role in explaining the functional income distribution[12].

3. Microsimulation Models

Microsimulation today is more commonly know for the modeling of household behavior, consumption pattern, micro-level income distribution etc. These models are infact very rich in details pertaining to taxes and transfers. The distinguishing characteristic of microsimulation models is that they are usually based on individual records from cross-sectional surveys, making it possible to deal with adequate heterogeneity. Before we discuss the construction of these models it would be important to note that these models base their working on representative sample of households. However no household survey suffices the huge amount of representative data required. Secondly no household survey is particularly designed and carried out for the modeling of say tax and benefits. So the most prudent household survey is usually taken up as a *host*[13]. Even with this *host* survey corrections have to be carried out along with the inclusion of omitted variables. Despite their importance in policy issues the output from microsimulation models should still be treated with caution (see Creedy 2001). Methodological surveys hint at the static nature of most presently used microsimulation models, which fail to capture the over-time behavioral responses to policy shifts. However the interest in dynamic microsimulation modeling is on the rise and several dynamic models listed in Appendix, have been designed. For the survey relating to current theory and practice in microsimulation see Klevmarken (1997). On the methodological survey of dynamic microsimulation models see O' Donoghue (2001). On the particular application of microsimulation to Public Policy/social issues see Brown and Harding (2002).

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[12] Bourguignon et. al. (1991) also explain that there are three channels that affect income distribution: first, changes in factor rewards directly affect household income. Second, the changes in relative product prices also affect household income. As the consumption expenditure is specified at the micro/household level thus the changes in prices may lead to quite diverse effects on individual income. Finally the capital gains and losses also ultimately affect the income levels.

[13] See Davies (2004).

Main Differences between Static and Dynamic Microsimulation Models

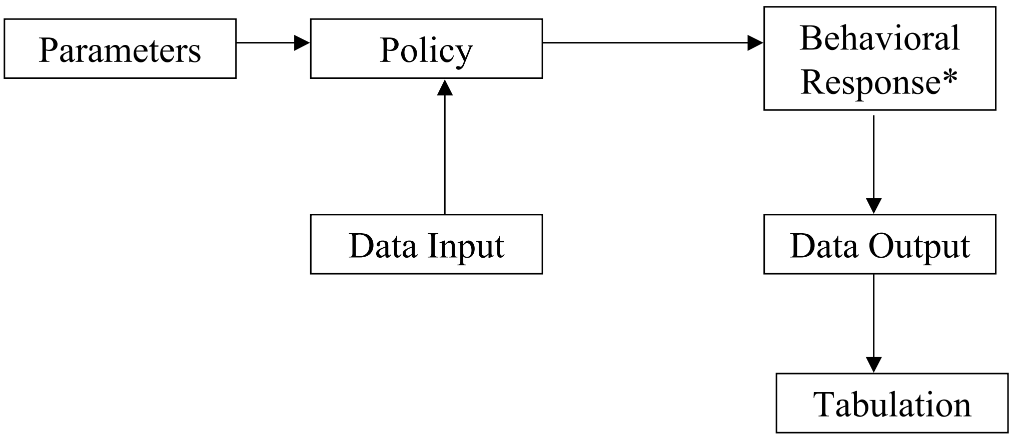
Difference	Static MM	Dynamic MM
Behavioral Parameters	Constant parameters	Changes in behavior (e.g. changes in labor market dynamics such as wages, type of work).
Time Horizon	Near-term effects (e.g. day after effects)	Longer-term projected effects[14].
Aging Process	Change of the demographic structure of the model population is performed by reweighting the age class according to external information.	Change of the demographic structure of the model population is performed by aging the model persons individually (and by having them give birth to new persons, and by having them die) according to life tables[15].
Equilibrium Nature	Stock	Flow
Objective of Exercise	Treating data as an end in itself.	Treating data as clues to underlying process.
	Static Modelers are interested in whether an historical *sample* accurately represents the population at one point in time.	Dynamic models are interested in discovering the underlying process generating a *sample*[16].

At this point it would be appropriate to explain further the conceptual difference between static and dynamic microsimulation. First, both types have relevance to the application of income distribution analysis and the benefits of any of them cannot be ruled out. The static model will take a cross section of the population at a specified point in time and apply the tax-benefit rules for example to see the effects of policy changes. Usually the impact shown by these models is also known as the "first round" effect showing the gains and losses, before the individuals set to adjust themselves to the now changed policy environment. Although not very different in their ultimate analysis, the dynamic models differ in the technique by which they simulate the

[14] Chollet and Mays (2000).
[15] Troitzsch and Gilbert (2004).
[16] Caldwell (1996). See also Wolfson (1991) and Zedlewski et al., (1990).

effects of time on population. They can model an individuals transition based upon the occurrence probabilities of real life events, thus allowing the previous (set of) population to be projected in future time period. This exercise can be done for both ex-post and ex-ante analysis. It is in this respect that dynamic microsimulation models have gained importance in the recent literature related to income distribution and poverty. Dynamic microsimulation frameworks can further be divided into two types, population and cohort models (see Harding 1993). Dynamic Population models have opted to simulated many cohorts over a medium term time period ranging between 20 to 40 years. Contrarily the cohort models have simulated single cohorts over an entire lifetime[17].

How a Microsimulation Model Works



* A static model is will not incorporate the behavioral response.

Immervol et al. (2003) simulate Brazil's tax-benefit system using a static microsimulation model, BRAHMS[18]. The exercise originates from the concerns that even after achieving a 37% tax to GDP ratio and spending more than 50% of total revenues on social programmes, the problems of poverty and inequality could not be diminished. The model bases its estimations on the nationally representative household survey of Brazil for 1999. the tax module has, personal income tax,

[17] See Caldwell et al. (1999).
[18] Brazilian Household Microsimulation Model.

employee and employer social security contributions, as the main revenue sources, apart from the four categories of indirect taxes. The transfer's side encompasses pensions, old age assistance benefit, unemployment benefits, wage bonus and family benefit. The non-cash social spending such as cost of public education and health has not been directly dealt in this model. Results expose Brazil's weakness in driving the tax-benefit policies towards reduction in inequality. According to the per capita gross income measure, richest 10% of households, are receiving 46% of overall initial income, and the income taxes and social security contributions only bring this share down to 44.8%. However the regressive nature of indirect taxes again increases this figure to 46%, thus maintaining; a) wide rich-poor divide and, b) negative total redistributive effect of taxes.

O' Donoghue (2001) shows an application of a prototype dynamic microsimulation model to the redistribution pattern over the lifetime in the Irish tax-benefit system. While examining the effects of different cyclical patters, the lifetime income has been decomposed. The model is intended to generate overall income streams to ultimately assess the distribution of lifetime income and the overall degree of this redistribution. While characterizing this model as a steady state cohort, the author concludes that the Irish tax-benefit system in its overall sense redistributes from rich to poor, however recognizing the fact that the degree of redistribution declines as the accounting periods over which the income is based, shorten in time. Secondly there is lifetime redistribution taking place from men to women, attributable to the income disparity between genders in Ireland.

Another multi-country comparison of tax-benefit systems has been studied by Bourguignon, O' Donoghue, Descals, Spadaro and Utili (1997). A static microsimulation model is built to study cross national differences in the fiscal systems that in turn lead to income distributional differences in Italy, UK and France. The model is prototype in nature, however it studies the possibility of several collective policy options that ultimately lead to a consolidated redistribution drive. Amongst these options is the possible introduction of national basic incomes, a Europe-wide child support reform and a reduction in social insurance contributions for the low paid[19].

Cogneau and Grimm (2002) use a dynamic microsimulation model for Cote d′ Ivoire and link income distribution with the AIDS epidemic. A detailed labor income model shows a *weakly competitive* picture, as no equalization of returns is associated with inter-sectoral labor mobility[20]. The composition and location of households is being determined exogenously. Every new entrant into the labor market has been modeled with three initial opportunities; family work, self-employment and wage work. A profit function derived from Cobb-Douglas Technology has been associated with farm households. It is the hierarchical relation, between the household head and other members, that is shown in the labor decision model[21].

Paper offers two kinds of simulations; one where risk of dying of AIDS in each year only varies with age and sex and the other where the chances of getting AIDS base on within each sex and age group dynamics. Simulations show that AIDS has a greater impact on the population growth, which slows down by 2007. Considering a 4% per capita increase, poverty reduces, however inequality goes unchecked. Under 15 year projections the weight corresponding to agricultural workers declines by 2% points, and the overall economy shrinks by 6%. The incidence of epidemic has been termed highest for the lower middle class.

The same model has been used by Grimm (2003) to study the expansion of education in Cote d′ Ivoire, and its distributional effects in the medium and long run. Modeling of schooling decisions involves the information regarding current and past year's enrollment as given in the household survey and then using this for the estimation of transition rates in and out of schooling structure. Taking into account variables such as Ivorian citizenship, matrimonial status, land owned by the households, educational standard of parents, household composition, educational level attained previously, relation to the head of household and region of residence. Separate estimations are

[19] Andreassen, Fredriksen and Ljones (1996) for the study of pensions in microsimulation framework.
[20] For the details on model framework as used in this paper, also see Cogneau and Grimm (2002b). For a survey on Dynamic Microsimulation of health care demand, health care finance and the economic impact of health behavior, see Spielauer (2002).
[21] For the labor income model as used in this paper, see Heckman and Sedlacek (1986) and Roy (1951). Infact Heckman and Sedlacek provide a formalization of Roy's work.

made for boys and girls population, whose age ranges between 5 to 25 years. Another issue discussed is the modeling of class repetitions, which as the author points out, is very frequent in Cote d′ Ivoire. Therefore the repetition rates have been fixed at 20% for the fifth year of primary school, at 50% in case of 6th year of primary school and for all other classes, the rate is fixed at 10%. The dynamic process of this microsimulation model updates the enrolment status of each student in every period. However to incorporate the probabilistic component in the transition of a student, either a Monte Carlo lottery is used (where each child is allotted a probability of passing/failing[22]) or a fixed progression rate is imposed[23].

Amongst the other countrywide examples of microsimulation modeling used for income distribution analysis, Bourguignon, Fournier and Gurgand (2000) use the decomposition technique on a microsimulation model to apply on the income distribution in Taiwan since 1979. Decomposition coupled with microsimulation can actually allow us to study the isolated and distinct impacts of structural and policy changes on distributional patterns. This paper in particular analyses the impacts of changes in labor force participation, earnings structure, demographic structure of population etc. Methodology on a similar line is observable for Bourguignon, Ferreira and Leite (2001). Both these models part from the static non-behavioral modeling and try to endogenize functions such as the labor supply and savings through econometric estimations.

Canadian Department of Finance is presently using a static microsimulation model TTSIM, which simulates the distributional impacts of tax-transfer programs such as federal goods and services tax, payroll tax, elderly benefits, refundable sales tax credit, provincial and federal income taxes, child benefits etc. the model takes into account data from three sources: Survey of Consumer Finances, family expenditure data and individual tax data. The model is in frequent usage by the department of finance, however the department also uses a personal income tax Model (T1) to validate the results obtained by microsimulation model[24]. Similarly Inland Revenue

[22] Thus if the number of students is high, the total number of children passing and moving on to the next class should be almost equal to the summation of estimated probabilities of all individuals.
[23] A similar study has been done by Ferreira and Leite (2002).
[24] For details on models used by the department of Finance, Government of Canada, see Gupta and Kapur (1996).

Department at the United Kingdom has been using four microsimulation models during the past 15 years. These include the Personal Tax Model (PTM), the Corporation Tax Model (CTM), the North-Sea Oil Model (NSOM) and the inter-departmental group on tax/benefit modeling (IGOTM) model. The last model IGOTM first simulated in 1986 avails data from the Family Expenditure Survey and analyses in detail the 'relationship between entitlement to social security benefits and liability to income tax'. A review on these models is given in Eason (1996).

De Lathouwer (1996) using static microsimulation model for social security and taxation (MISIM[25]) compares the unemployment schemes in Belgium and Netherlands. This paper is amongst the examples that have used microsimulation model for comparative research[26]. Another comparative study in the context of lifetime redistribution has been done in Falkingham and Harding (1996). They compare the Australian tax-benefit system with the one in Britain and suggest that the latter, with emphasis on social insurance results in lesser lifetime inter-personal redistribution if compared to the former with direct emphasis on poverty alleviation.

Recent work has also seen the incorporation of behavioral responses in the microsimulation models. Such responses include important details regarding savings patterns, labor market dynamics, household preferences etc. To assess the behavioral impact of 1991 Swedish tax reform on income distribution, Klevmarken and Olovsson (1994) use a Swedish household sector dynamic microsimulation model (MICROHUS[27]). In the labor market block, the estimates of the youngest cohorts are used for simulating the behavior of future cohorts. Transition probabilities are used to characterize the entries into the labor force. All behavioral additions in different modules have been estimated on constant price basis. All changes in housing and labor supply are determined after the prior determination of demographic changes. This model however does not account for *joint decisions* regarding jobs and houses, which is a fundamental behavioral phenomenon in geographical setting. The behavioral effects on income distribution are infact the indirect effects of tax reform process. Therefore a behavioral result would be a combination of labor supply

[25] Developed by Center for Social Policy Belgium.
[26] Salomaki (1996)_for details on Finnish Static microsimulation model (TUJA) which is in use since 1987 for tax-benefit analysis.
[27] For details on MICROHUS structure see Klevmarken et al. (1992).

responses and the overall second/subsequent round impact. Although the simulation results reveal that Swedish tax reform led to an increase in income[28] inequality, however the authors recognize that behavioral adjustment effects could not be fully captured possibly due to the present form of model specification. For a revised version of this paper, see Klevmarken and Olovsson (1996).

4. Linking CGE and Microsimulation Models

In this section we first have to justify the need for linking CGE and microsimulation models. For this purpose once has to start by having a good look at the present state of poverty, inequality and income distribution indicators and datasets. The redistribution of for example public expenditure, works through several different channels: the progressive or regressive nature of direct/indirect tax collection, transfer rules, distribution of public spending on the bases of income, age, need and may be urban and rural considerations as well[29]. Secondly the analysis on distribution remains incomplete until and unless the equalizing effects of taxes and transfers have not been estimated through a set of different methodologies. One has to measure combined impacts of changed rules, keeping in view any demographic alterations. Therefore a particular range of modeling frameworks to analyze the intricate details is required, and besides simply providing analysis, the results obtained from one model can also be used for validating the conclusion made by the other. Its like passing your data set into counter check mechanism. The issue becomes easier to understand when we see that the poverty and Gini indicators and FGT indices are all based on detailed household survey data. However models such as the CGE only provide limited household categories and that also in a relatively aggregate manner. Thus the need arise for constructing a CGE model that explicitly incorporates individual units from the detailed household survey i.e. we would be building a model in CGE form with the household categories equivalent to the ones in a representative survey.

Economy-wide capital flows pose a similar challenge. Inflow of foreign direct investment or an increase in remittances can lead to a quantum leap effect on household employment patterns. However it may be easy to see the effect of such inflows on macro variables, whereas the impact on households actually becomes

[28] Disposable income per equivalent adult.
[29] See Jorgensen and Pedersen (1998), See also Lindholm and Eklind (2000).

intractable particularly in the presence of a simple analytical framework with lesser disaggregation. For longer term the effects of technology transfer or an increase/decrease in debt servicing pose similar problems[30]. Bourguignon, Silva and Stern (2002) argue for adopting several combination of models for Poverty Incidence analysis. For the assessment of distributional effects the paper recommends a three-layer structure; macro, meso-disaggregated, and micro. A detailed discussion of about four levels of household income microsimulation exhibits how it is possible to simulate directly say the impact of taxation on redistribution at household level through labor supply behavioral response. It is the incorporation of such behaviors that excuse the model builder's ardent task of importing these responses from outside the framework.

Once we have established the need for a macro-micro modular approach, the next point should be to see how the two models in our case CGE and microsimulation are merged or linked in a manner, which preserves the logical composition of both structures. Factors such as prices and wages act as the bridge variables. These are the variables that transmit the response from one model to the other. Table 3 below shows a step-wise integration process.

Table III: Integrating CGE and Microsimulation Models

Step I	Create link between the Income and Expenditure accounts in SAM with the Income and Expenditure data provided in household survey.
Step II	Simply introduce entire set of weighted households directly into the CGE model (instead of multiplying household data with sample weights to be aggregated into household categories, as is the case in traditional CGE models).
Step III	Now running the software programme (e.g. GAMS) will balance the SAM data for establishing equilibrium.
Step IV	Get the new (balanced) SAM into a normal spreadsheet file (e.g. in Excel) from where the data can then be imported by the software (GAMS).
Step V	Once the new data has been imported and tested by running an aggregate form/category, we can now replace the household data (aggregate form) into weighted data (individual form) taken from the household survey.
Step VI	Ensure that the software code has been aligned to incorporate an equivalent number of households in the model structure.
Step VII	We now test the linked CGE-microsimulation model[31].

[30] For detailed analysis on *Capital Flows and Economy-wide Modeling* see Roland-Holst (2002).
[31] See also Clutier and Cockburn (2002) for illustrative exercises on integrating CGE-microsimulation models.

In addition to these fundamental steps there are certain consistency requirements, necessary to ensure the coherence between CGE models and microsimulation. Following may be a checklist for a consistent merger:

- Changes in any variable that corresponds to the microsimulation *benchmark* should equal the change is the corresponding market (module) in the CGE model.
- Absolute change in the individual units (e.g. number of household workers in any sector) in a microsimulation should match the changes in CGE model as well.
- Changes in any of the vectors (acting as a bridge between two structures) such as prices and wages in microsimulation must be inline with the assumptions laid down in CGE framework.

Due to the colossal size of the CGE-microsimulation models and the degree of non-linearity involved problems of convergence can also arise at times. Savard and Annabi (2004) provide some useful suggestions for dealing with this problem:

- Solve the model with only one household category to ensure that the model itself is functioning well. Also ensure that there are no infeasibilities in the first iteration.
- Try scaling the model, i.e. dividing all values by 1000 or more.
- The smaller values in CET and CES functions can be put equal to zero.
- If factor immobility is thought as a source of problem, then try with all factors kept mobile.
- Reduce the number of goods in the model[32].

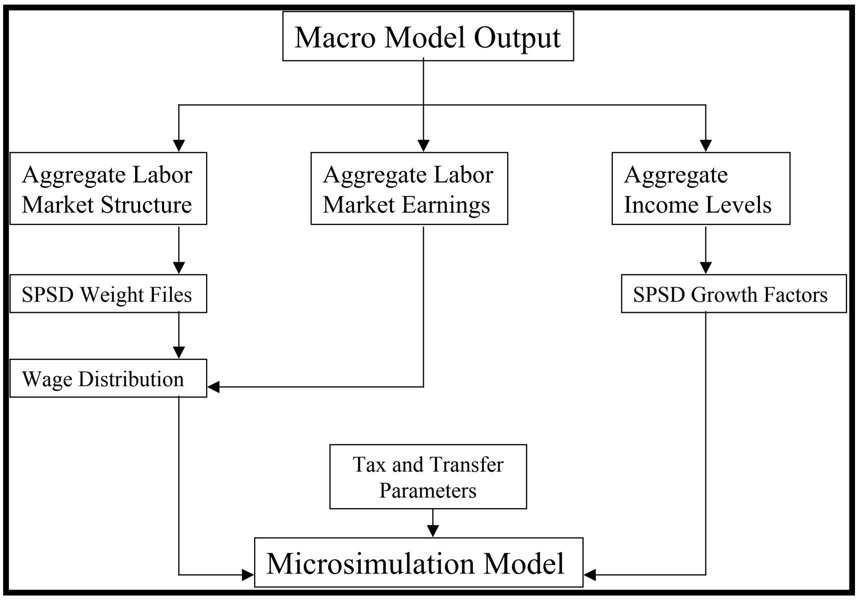
[32] For further remedial measures regarding the convergence and resolution problems see the GAMS users manual, www.gams.com

The approach towards merging CGE and microsimulation actually differs across literature but only on a conceptional account. Examples such as Robilliard, Bourguignon and Robinson (2001) and Savard (2003) have taken a sequential approach for integrating CGE and microsimulation frameworks. Others like Cockburn (2001) and Cogneau and Robilliard (2000) have opted for a complete merger of two frameworks into one. We see in detail the application of both methodologies in the next section.

As a practical example we may also see the next flow diagram, which exhibits the linking of Canada's static microsimulation model Social Policy Simulation Model (SPSM)[33] with the macroeconomic model. However this macro-model is econometric in nature with substantial degree of disaggregation. It provides individual estimates for more than 70 categories of consumer expenditure, above 80 export categories and about 95 import categories[34]. For the aggregated labor market structure the macro model provides information regarding province-wise population, participation rate, unemployment rate, share of population employed etc. This information is then used to reweight the Social Policy Simulation Data (SPSD)[35]. Adjustment is also required in the SPSD weight files, for example the weights corresponding to the elderly group will be increased relative to the rest of the population, if an increase in the number of elderly people is being expected. Aggregate labor market earnings have also been linked with the wage distribution.

The computed average age by the macro model and the microsimulation model are then compared; after which an industry-wise adjustment factor is applied to the wage information contained by SPSD[36].

[33] based on Social Policy Simulation Data (SPSD).
[34] For detail see Allie and Murphy (2000)
[35] This also implies that same definitions of industries and occupations are being used in the macro model and the static microsimulation model (SPSM).
[36] Statistics Canada has also integrated input-output and tax microsimulation models, see Cameron and Ezzeddin (2000).



Source: Allie and Murphy (2000)

5. Applications of Linked CGE and Microsimulation Models

Cogneau and Robilliard (2000) have focused on the experience of Madagascar and tried to evaluate the income distribution and poverty position. The impact of several shocks originating from the economic growth process in Madagascar has been studied. As Davies (2004) terms it: "Cogneau and Robilliard (2000) appears to be the first CGE microsimulation to explore a typical range of CGE exercises". The determination of inter-sectoral relative prices has been endogenized and the usual assumption of representative agent is not considered, as it is unable to capture the effects of growth strategies on multidimensional positions taken by households. It is not usual to relax the representative agent assumption from general equilibrium models however under this approach it has been done in a manner where firstly the information on micro variables is being collected/used from the individual/household level, and secondly the household behavioral equations have been estimated econometrically. These econometric estimations when imputed into the overall model allow the behavior to be endogenized. Thirdly the importance of error term is recognized for assessing the unexplained heterogeneity. Infact the models strength lies in its treatment of heterogeneity, which is quite explicit in terms of consumption preferences of individuals, set of opportunities available, skills and labor preferences. The basic structure of this framework is built on Cogneau (1999)[37] model, which along with Tongeren (1994) are the only prior examples of complete merger of CGE and microsimulation models. The authors have termed their approach as 'bottom-up' because it is the microeconomic specifications that define the model foundations, which in turn focus on the household level labor allocation and consumption behavior. Actual emphasis is on the details of labor allocation at agricultural household tier. However the traditional model of labor demand and supply; one where the labor market exists and functions and the other without a formal market, do not explain Madagascar case. Fundamentally for Madagascar's case the requirement indicates towards an asymmetric treatment of off-farm and hired labor. The paper regards hired labor as complimentary to family labor. The underlying reason for this is the seasonal pattern of increased hiring during the rice plantation periods. On the off-farm side however there may exist other opportunities to work for the households. For specification purpose these activities have been termed as labor intensive, which would imply that 'households that do not supply work off-farm have a marginal productivity of on-farm labor higher than their potential off-farm wages…, households that supply off-farm labor have a marginal productivity that is equal to their off-farm wages…'

All sources of income have been endogenized accept the ones accruing from transfer payments and the formal sector of Madagascar. Savings rate as usual is also endogenized and has been represented as an increasing function of overall income stream. For the general equilibrium framework the assumptions regard exchange rate as fixed, however investment, foreign plus government savings as flexible. Production encompasses agriculture, informal and formal activity, with agriculture sector producing one export good and one non-tradable. The factors of production are land, labor and formal capital, where labor and capital through a Cobb-Douglas specification are substitutable in agriculture technology. Consumption is represented by linear expenditure system and the labor supply function has not been estimated,

[37] Cogneau (1999) proposes a micro macro model of labor market of a developing city, and its empirical application on the case of the capital town of Madagascar. The model shows the existence of measured and unmeasured heterogeneity of skills, preferences and opportunities within even narrowly defined social-demographic groups. (English version not available).

thus making way for a calibration of both functions. The calibration is based on estimates from SAM and household survey data. As each agricultural household has been specified with a CES function, therefore the usual assumption of imperfect substitutability between agricultural goods produced for local and export market applies[38]. For the descriptive analysis Theil index has been adopted for inequality measurement because of its decomposable properties[39]. For poverty analysis three indicators; a) poverty rate, b) poverty depth, and c) severity of poverty, have been considered[40].

The results declare 67 percent of Madagascar's population as poor with rural poverty being in a more severe state. Inequality has been termed higher on the urban front. Towards the simulation of growth shocks, 6 different policies have been simulated[41]. The first two simulations indicate towards an increase in value addition of formal sector, four simulations relate to agricultural sector with one simulating increase in formal wages and dividends. Both ex-ante and ex-post impacts of shocks have then been exhibited[42]. It is this bifurcation that highlights the importance of GE-microsimulation frameworks for assessment of income distribution analysis. The sensitivity analysis of results in the end shows the dire need for Madagascar to integrate its urban and rural sectors, before the divide becomes too large to bridge. Finally this paper is at present a rare example that uses true data of an economy with a sample size equaling 4500.

Several comments have since surfaced about the methodology of Cogneau and Robilliard (2000). Cockburn (2001) in his review, questions the household disaggregation in this model, which comes about by forgoing the sectoral disaggregation. Furthermore Davies (2004) identifies that there exists no assumption on closure rules and the formal sector's response is being regarded exogenous. In addition, it is 'less clear that merging the microsimulation and CGE exercises, as

[38] More commonly known as Armington assumption.
[39] This implies that it becomes easier to observe specific proportion of; a) intra-group inequality and, b) inter-group inequality, as part of the overall national level inequality.

[40] All three indicators depend on the actual definition of poverty line, which in many cases may be country-specific.
[41] Simulation table in Appendix.
[42] "The ex-ante results correspond to the results of a microsimulation model with microeconomic behaviors and fixed prices, whereas the ex-post results correspond to a microsimulation model with microeconomic behaviors and endogenous relative prices".

opposed to assuming log normal distributions with constant inequality with in the household groups, greatly affects the results.

Cockburn (2001) is another case study where a complete linkage/merger takes place between CGE and microsimulation models. Each and every household unit as given in the national survey is integrated into a CGE model. This model is then applied for analyzing the introduction of a uniform value added tax in Nepal. Once again this paper is amongst the few ones employing true data for any case study. An existing CGE model based on 1986 SAM is used, with total 50 accounts. The sample size is 3373. Household behavior is represented by the usual LES function, where differences in marginal shares of goods consumption determine the positions taken by the households. Investment and savings are held constant for welfare comparisons. Four sources of household income have been identified: a) remuneration of factors of production, b) government transfers adjusted for taxes, c) transfers from firms and, d) rest of the world. The government and firm transfers have been assumed fixed, while the income tax has been set at 0.35 percent of total income. Dividends also form a fixed share of incomes accrued to firms[43].

As discussed above the policy chosen for simulation is the introduction of a value added tax (VAT), considering the less distortionary properties of this type of taxation. However this VAT is replacing the existing production tax in Nepal, whose levy varies and differentiates between sectors. Results indicate that there is a decline in absolute number of poor people, which is taken to imply that welfare in the country has increased, however the inequality level rises especially for the urban regions[44].

Cockburn (2001) shows the importance and efficacy of combining microsimulation and general equilibrium framework for the depth required in the distribution analysis. The overall impact of tax reforms on poverty has been termed small and at places questionable. As the indicators used are the most common ones like Foster-Greene-Thorbecke (FGT) indices. These indicators are computed for before and after-shock results, however as the author recognizes that depth and severity indicators are largely a matter related to the choice of poverty line. This has been shown that as this line is

[43] Firm transfer may include payments such as periodic dividends.
[44] Poverty and income distribution analysis has been done using DAD software, whereas the general equilibrium program is coded with GAMS.

increased from 6 to 12, VAT's introduction leads to a reduction in absolute poverty. Cockburn has emphasized that it is mainly a matter of data availability that may pose challenges to CGE-microsimulation models, otherwise there are no computational or methodological difficulties in the adoption of this linked framework for income distribution analysis.

As an example of sequential approach towards linking CGE-microsimulation models, Decaluwe′, Dumont and Savard (1999) have constructed an archetypal microsimulation in general equilibrium. The model has four sector; agriculture, industry, marketable and non-marketable services, with each sector producing a single product. Factor endowments include capital, skilled labor and unskilled labor, with government, firms, households and rest of the world, being the agents involved. Resources are fully employed and labor markets are perfectly segmented, which in turn implies that each labor market reaches the equilibrium position independent of the other market, however the sectoral mobility of labor has been allowed.

The sequential income flow has been defined where 'household receives its income, pays its direct taxes, makes its fixed expenditure and then saves a fixed rate of what remains'. The overall savings rate is assumed to be constant (as in the previously discussed models) and on the expenditure side Stone-Geary type utility function has been assumed to derive a 'Cobb-Douglas linear expenditure system'. The reason for adopting this particular function is the ease of incorporating fixed expenses[45].

This actually provides a much needed escape from the traditional poverty line where a defined basket is set for the estimation. However in this approach the authors are recognizing that for every household the composition and the level of expenses (fixed) can differ. The disaggregate form of model identifies three distinct groups characterized by agricultural capital, unskilled labor, higher food consumption as proportion of total income, and the last with the skilled labor and more consumption of services.

Two separate economic shocks are now simulated: a) 20% increase in unskilled labor supply and, b) eliminating customs duties for industrialized goods in combination

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[45] Where the fixed share of total expenditure is inversely proportional to the level of income.

with a 30% increase in agricultural world prices. The results of the former policy simulation indicate an increase in inter-group inequalities with the latter showing a decrease in inter-group inequality. The disaggregate data is then employed to assess the poverty scenario and parameters for bi-modal or Beta type distribution function have been estimated for evaluating before and after simulation poverty levels. Variation of poverty has been evaluated through a breakdown analysis where contributions towards poverty rate have been calculated for: a) endogenous distribution, b) fixed distribution, c) exogenous threshold, d) endogenous threshold and, f) variation in average income. Variations in terms of inequality have been shown through traditional Lorenz curve construction (for both simulations), the theil index and the Gini index variance. Lorenz curve analysis actually validates the earlier results where the first policy shock generates greater inequality compared to the second one.

Recently it has been felt that in a standard CGE-microsimulation framework, the feedback from the household level is not taken into account in the macro-setup defined by the CGE model. Secondly CGE-microsimulation approach does not guarantee a definite coherence between micro and macro structures. Highlighting this view, Savard (2003) introduces a bi-directional link and proposes a Top-Down/Bottom-up CGE-Household Microsimulation Model. In an earlier draft of this paper, this model has also been called a Sequential CGE-HH Model. As an example of the feedback mechanism, the household microsimulation model shows the availability of workers willing to work in the qualified sector of labor market, and in the CGE model the demand for labor is being bridged by either the unemployed entering the market or the unqualified labor already waiting to enter the qualified sector. However in case of a decline in labor demand in the qualified segment, the reverse process will take place i.e. 'the worker will be pushed towards either the unqualified market or unemployment'.

This approach lends the introduction of balancing hypothesis redundant because there is no need for a perfect balance between income and expenditure accounts at the individual level. A two-step process defines the sequential linkage where at first the CGE model is computed and household microsimulation model is run. The resultant consumption vector obtained from the household microsimulation model is then employed for looping the combined model. Now to maintain the previously mentioned bi-directional link, the second run is considered to ensure that consumption vector has been transformed into an exogenous vector, thereby changing the hypothesis of standard CGE model.

Two policy effects have been simulated for Philippines case. The first where a 50% reduction in overall import tariff leads to a drop in import prices and a decrease in poverty threshold. However the negative effect on informal wages is also evident. Second simulation is where qualified sector wages are increased by 20%. This dampens demand for qualified workers resulting in an increased unemployment level. However this policy also indicated a poverty threshold reduction via decreased prices.

Bourguignon, Robilliard and Robinson (2003) have also raised the issue of model specification and data reconciliation in an integrated microsimulation-CGE model. They stress that research efforts still have a long way to go in satisfactorily linking micro-macro approaches for addressing distributional issues. Authors develop a framework to estimate impact of real devaluation on the distribution of household income in Indonesia. For the linking of CGE and microsimulation framework, a top-down approach is adopted and both structures are being worked separately. In the first phase, the standard CGE model is solved and in the second phase the microsimulation is worked out to attain the changes in variables such as wages and employment pattern. In this model household income is being explained by collective observed and unobserved characteristics of household members. For further disaggregation, provision for; labor market segmentation, self employment income (farm and non-farm), demographic grouping; has been allowed. Thus the overall individual income generation not only incorporates the occupational choice determinants, but also the determinants related to micro-level earnings. Self-employment has been distinguished from wage work to show imperfectly competitive nature of labor market in Indonesia. All wage workers have been assumed to be fully employed. Criterion values are then set in accordance with the alternatives available to individuals namely; being self-employed, a wage worker or being an inactive member of the labor force. Thus the individual's preferences towards wage work or self-employment will depend on the criterion value being greater for that specific activity.

A sub-sample of 9800 households is considered from Indonesia's 1996 household survey. The CGE framework is based on the 1995 SAM, having 38 sectors, 14 goods, 14 factors of production, 10 household categories and the accounts relevant to government, rest of the world, firms etc. the disaggregation exercise for SAM has been done through cross-entropy estimation methods. For explanation on these methods see Robinson, Cattaneo and El-Said (2001). Most of the CGE assumptions are standard as the model has been termed 'trade focused' built on the lines of Lofgren, Harris and Robinson (2001), which gives the ease of; a) allowing one activity to produce many commodities and, b) many activities producing the same commodity. This is an important element as a dualistic form defines Indonesian economy and the production activities are segregated in terms of being formal or informal. Similarly the labor markets are also distinguished in the same order.

The first simulation in this framework shows the effects of a reduction in foreign price for; a) crude oil, b) processed oil products[46]. The overall export level declines thus cutting on the foreign exchange earnings and ultimately leading to a downward pressure on the equilibrium exchange rate. In the second simulation a 30 percent drop in exogenous foreign savings again result in devaluation, however in this case there is also a change in relative prices before the actual devaluation occurs.

The effects of these shocks are then studied for their distributional impacts 'after feeding the microsimulation model with values for the linkage variables provided by the CGE counterfactuals'. Generally the results obtained from microsimulation show a rise in inequality, however this paper compares these results with the Representative Household Groups (RHG) approach, which actually shows a drop in inequality. This comparison sums up the conclusion where authors believe that the details embedded in microsimulation approach are no guarantee of the superiority of this approach[47].

Avitsland and Aasness (2004) treating pre-tax incomes and consumer prices as exogenous, offer a more detailed microsimulation model than Bourguignon et al. (2003), however complete consistency is not offered when integrating the two models, which authors feel is unimportant as suggested by the sensitivity results.

[46] See simulation table in Appendix.
[47] For an extended version of this CGE-microsimulation model see *preliminary draft:* Robilliard et. al (2001), where this framework is being used to decompose the effects of financial crises in Indonesia.

Effects on equality of VAT reforms have been studied using a 'microsimulation model of the Norwegian economy subsequent to a CGE model'.

The CGE model is drawn from Bye et al (2004), which is an intertemporal general equilibrium model, having 41 activities and 24 commodity categories. On the supply side all factors are mobile, and all producers are price takers in world market, with having power only in the home market. On the consumption side intertemporal utility is being maximized with perfect foresight. Aggregation across all households defines the aggregate demand functions. Government expenditure is kept exogenous, increasing only at constant rate[48]. The microsimulation model is the one developed and used by Statistics Norway. The model captures savings, expenditures and distributional effects on the entire Norwegian population. Keeping personal tax payments endogenous, the model treats personal pre-tax incomes, wealth and transfers as exogenous. For measuring the standard of living, total consumption expenditure by a household is divided equally between all the consumption units and also allowing for the economies of scale at the household level i.e. the number of consumption units in a household is smaller than the number of persons in the households. However for estimating number of consumption units in the households an equivalence scale is used, the choice of which, authors believe, can be controversial[49]. Merging both the models involves the multiplication of consumer prices, nominal pre-tax incomes, wealth and transfers in the microsimulation model by the percentage change in the same variables present in the CGE model. Both microsimulation and CGE models have been adjusted to have the same demand structure with the same commodity groups, however the structure of income and wealth differs. Microsimulation, for example, only considers the wage income whereas the CGE model incorporates total wages and salaries after adjustment for social taxes for employees. The three reforms simulated by this framework include general VAT reform, abolition of the investment tax and political VAT reform, where only the last one leads to increased equality.

Cororaton and Cockburn (2004) analyze the poverty effects of tariff reforms, which led to a reduction in consumer prices in Philippines. A CGE-microsimulation model is

[48] Detailed description of this model is given by Bye (2000) and Faehn and Holmoy (2000). On the modeling of producer behavior in this framework see Holmoy and Haegeland (1997).
[49] Discussed by Deaton (1997), Nelson (1993), Atkinson (1992), Buhman, Rainwater, Schmaus and Smeeding (1988).

used to capture these effects through the varying household incomes and prices. The 1994 Family Income and Expenditure Survey consist of 24797 households. All these household have subsequently been integrated into the CGE model, which incorporates 12 activities with labor and capital as the factors of production. Activity sub-sectors include four agricultural, five industrial and three services sectors. Labor has also been sub-divided into skilled agriculture labor, unskilled agriculture labor, skilled production labor and unskilled production labor. Total government income and real government spending have been held fixed, however the after-tariff reduction decrease in government revenue is being bridged by direct taxes or indirect taxes or a combination of both. However this compensation is being endogenously determined.

Simulating the model indicates a reduction in poverty due to the tariff reduction taking place between 1994 and 2000. The spatial distribution of gains is however, a matter of concern as the reduction in poverty is greater in the capital region, where the incidence of poverty was already the lowest. On the production side, the costs of production decrease as the tariffs are slashed; therefore there is a direct growth effect in the non-food manufacturing sector, which brings in the highest export receipts in Philippines. Finally the inequality is exhibited on the rise especially for the rural households.

6. CONCLUSIONS

The future course of CGE-microsimulation models will be increasingly influenced by the following three considerations: a) the quality of poverty and income distribution data, b) stability of results over longer time period (particularly in the case of dynamic CGE-microsimulation models), c) the developments in computational capabilities. As poverty and inequality has become a major concern in developed world as well, therefore there is a need now to introduced diversification in the presently available techniques. Most of the models mentioned above have been applied to the developing countries case studies; the structure of which would definitely differ, if one applies this integrated modeling approach for the industrialized countries and countries with higher than average output levels.

The recent efforts in building regional CGE models and microsimulation models for region-specific trade policy and distributional analysis are certainly the building steps in the required direction, however their efficiency would also rest upon the three main influences mentioned above.

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APPENDIX 1: LINKED CGE AND MICROSIMULATION MODELS

Model	Country	Uses/Application	Data	Sample Size
Cogneau & Robilliard (2000)	Madagascar	Labor allocation at Household Level, Impact of different growth strategies on poverty.	SAM (1995), Household Survey	4508 (of which 3500 are agricultural Producers)
Cockburn (2001)	Nepal	Analysing the replacement of distortionary production tax by a value-added tax.	1995 Living Standards Survey, SAM (1986)	3373
Avitsland & Aasness (2004)	Norway	Equality effects of VAT reforms.		15000 households (with 40000 individuals)
Cororaton & Cockburn (2004)	Philippines	Poverty effects of tariff reduction.	1994 Family Income & Expenditure Survey, 1994 SAM	24979 households
Robilliard, Bourguignon & Robinson (2001)	Indonesia	Decompose effects of financial crises, analyze alternative social policy packages.	1996 SUSENAS Survey, 1995 SAM	9800 households
Bourguignon, Robilliard & Robinson (2003) (Abridged version of above-mentioned model)	Indonesia	Analyze impact of trade balance changes.	1996 SUSENAS Survey, 1995 SAM	9800 households
Decaluwe, Dumont & Savard (1999)	Archetype	Breakdown analysis of contribution of average income variation, poverty line, and income distribution		
Savard (2003)	Philippines	Computation of decomposable poverty analysis and income distribution.	1997 Family Income & Expenditure Survey, 1990 SAM, Labor Force Survey 1997-98.	

POLICY SIMULATION MATRIX

Model	Country	Policy Simulations
Cogneau & Robilliard (2000)	Madagascar	a. Formal hiring and increase in dividends. b. Increase in formal wages and in dividends. c. Increase of the Total Factor Productivity in the agriucultural sector. d. Increase of the Total Factor Productivity in the food-crop sector. e. Increase of the Total Factor Productivity in the cash-crop sector. f. Increase of the world price of cash crops.
Cockburn (2001)	Nepal	a. Introduction of VAT in place of the esisting production tax (which varies between sectors).
Avitsland & Aasness (2004)	Norway	a. All goods and services subject to uniform VAT rates. b. Abolition of the investment tax. c. A non-uniform VAT system on the lines of Norwegian VAT reform 2001.
Cororaton & Cockburn (2004)	Philippines	a. A compensatory tax on direct income applied uniformly to all households who pay income taxes in 1994. b. Set of experiments on the composition of compensatory taxes: - an additional indirect tax. - additional direct income tax, and indirect tax in various combinations.
Robilliard, Bourguignon & Robinson (2001)	Indonesia	a. 25% cut in the availability of foreign working capital combined with real devaluation. b. 20% cut in the availability of domestic credit. c. 5% decrease of total factor productivity in the agricutltural sector.
Bourguignon, Robilliard & Robinson (2003) (Abridged version of above-mentioned model)	Indonesia	a. A terms of trade shock that reduces the foreign price of both crude oil and exports of processed oil products. b. A 30% drop in exogenous foreign savings.
Decaluwe, Dumont & Savard (1999)	Archetype	a. An increase by 20% of the unskilled labor endowment. b. Elimination of customs duties for industrialised goods combined with an increase in the world price of agricultural goods by 30%.
Savard (2003)	Philippines	a. Reduction across the board of import tariffs by 30%. b. An increase of 10% in the qualified sector fixed wage.

SIMULATION RESULT MATRIX

Model	Country	Policy Simulations
Cogneau & Robilliard (2000)	Madagascar	a. The hiring shock decreases the quantity of working time available for the traditional activities, thus leading to a reduction in informal and agricultural value addition. However the demand for consumer goods increases. b. This policy results in an increase in household incomes receiving formal wages/dividends. This increase again leads to growth in the demand for consumer goods. c. Leads to an increase in production and agricultural income. d. Reduction in the relative prices of the traditional goods leads to the reallocation of labor among traditional activites. e. The shock in terms of overall income growth is much smaller than in the two preceding simulations, because only a minority of households produce cash crops. g. This shock leads exante to a reduction in the production of nontradable goods and to an increase in the demand for these same goods. Expost these imbalances lead to a rise in the relative prices of the traditional goods.
Cockburn (2001)	Nepal	a. Welfare increases and the number of poor declines but poverty depth, severity and income inequality increases, although the changes are small.
Avitsland & Aasness (2004)	Norway	a. Change in equality concerning the uniform reform is close to zero. b. Abolition of the investment tax…again changes in equality are close to zero. c. A non-uniform VAT reform leads to an increase in equality.
Cororaton & Cockburn (2004)	Philippines	a. Import prices in local currency terms drop, this leads to a fall in comsumer prices and the local cost of production drops…which also leads to an increase in export volume.
Robilliard, Bourguignon & Robinson (2001)	Indonesia	Credit Crunch shocks are important driving forces explaining the collapse of Gross Domestic Product. Relative increase in the prices of food items with respect to non-food is explained by devaluation combined with increased marketing costs.
Bourguignon, Robilliard & Robinson (2003) (Abridged version of above-mentioned model)	Indonesia	a. Trade shock reduces foreign exchange recieptsresulting in devaluation. b. Again results in devaluation, however there is a decline in relative prices prior to actual devaluation.
Decaluwe, Dumont & Savard (1999)	Archetype	a. Increase in Intergroup inequalities. b. Reduction in intergroup inequalities.
Savard (2003)	Philippines	a. Unemployment rises having negative impact on informal sector wages. Due to lesser import tariffs the government income reduces sharply. b. Unemployment increase is greater than the first simulation, however the effect on the government side is lesser.