CGE-Microsimulation Modelling: A Survey

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1. INTRODUCTION

The incorporation of distributional issues in the macroeconomic models has never been a regular feature. In fact there came a period when theoretical neo-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 behaviours. No deliberate effort was made to empirically keep track of changing inequality dynamics until the later part of the last decade 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 in fact settled down on the more commonly known *Kuznet* view that the inequality will only decline in the later stages of development and growth maturity. 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. Despite the timely identification of issues no specific initiative was forwarded to investigate the feedback effects originating from distributional maladjustments that ultimately paralysed the socio-economic structures in countries that were already in a nascent stage of recovery and rebuilding. See Bertola *et al.* (2004), Atkinson and Bourguignon (2000) for further details.

During the 1970s and 80s, the global economy witnessed the different forms of recessionary cycles, macroeconomic imbalances, debt traps, failed currency adjustments and unsuccessful privatization programmes. These failures and the need for experimentation with new reforms brought poverty and inequality issues on the forefront. During 1990s economic meltdown occurred at a pace unprecedented in the history. The East Asian crises at the end of the last century exposed the operational inefficiencies of a globalised economic system. For a detailed analysis on global changes in inequality see Sala-i-Martin (2001).

Today the huge task of accomplishing the United Nation's 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 in fact important, in that they provide a clear strategic path towards sustainable development. The basic list includes 8 goals, sub-categorised by 18 targets and about 40 indicators. Dealing with such a diverse set of indicators with ambitious targets and their simultaneous tracking poses a great challenge for the national governments.

It is often emphasized that the methods for channelling funds into social safety nets and social spending are (without exception) never chalked out in detail[2]. 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 200 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 (see Walmsley 2005), and 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 (see Morrissey 1997).

On the applied front there has been an 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 (for a detailed review see Tripathi 2003, World Bank 2003).

Figure 1 summarises the methods for analysing policy impacts on income distribution and poverty[3]. These 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 SIAs are not nationally representative and provide highly subjective results (for details on SIA, see Barrow

[2] For economic analysis of MDG's see SRDS website: *Introduction to Millennium Development Goals and Targets,* www.srds.co.uk/mdg/poverty/htm.
[3] For details see World Bank 2003.

2000). 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 (for details on PPA, see Norton 2001).

Social Capital Assessments (SCA) makes use of a household survey based on the detailed community or region-wide questionnaires, to assess the socio-economic success of reform process in mobilising the productivity of the 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, labour markets, and devolution. But at the same time conducting SCAs can be expensive to a challenging extent (for details see Brune *et al.* 2005).

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 categorised 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 also beneficial, when applied to the analysis of region-specific reforms or those reforms, which bring about regionally distinguished impacts. This exercise requires the combined use of the household survey and census data, and is time-intensive in the sense that just the mapping process, which incorporates the spatial distribution, can take more than a year.

The behavioural incidence analysis combines the benefit incidence approach with econometric estimations for explaining the distributional changes (for details see van de Walle 2003). 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 abovementioned methods.

The partial equilibrium analysis can take two forms. First is the reduced form models, where supply and demand equations are solved to obtain reduced form equations. These equations can be used for examining determinants related to growth, inequality, and poverty. These models have been used in the past for estimating effects of the structural adjustment reforms. Second are the multi-market models that can be used to assess distributional outcomes of policy changes in any selected sector (see Suleiman and Mosley 2006). These do not require the complete general equilibrium specifications or the macro balances.

For any detailed and in-depth policy debate that incorporates exhaustive trade-off options the last two methods in figure 2.1 i.e. general equilibrium analysis and integrated modelling analysis have become imperative[4]. This paper carries out a survey of the linked macro-micro models used in the evaluation of issues related directly or indirectly to income distribution. The next section provides an insight in the characteristics and methodology of general equilibrium models. As a matter of reference, it may 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. Section 3 will focus on the structure and application of static and dynamic tax-benefit microsimulation frameworks. There is also a brief discussion on how microsimulation models have been extended to take account of behaviour. In section 4 a detailed analysis has been carried out at length on how and why to link the CGE - microsimulation frameworks and this is followed by a survey of the application of such linked models for the analysis of income distribution issues. Finally in appendix we provide methodological details and simulation results from selected CGE-microsimulation models.

2. General Equilibrium Modelling

There has been a large growth in the literature on CGE modelling over the past four decades. This technique has come a long way in becoming standardised as well as generalised. There are three main streams in the existing literature. First is the application of these models for developed countries. These strongly follow the Walrasian general equilibrium conventions and initial efforts include the multisectoral growth model for Norway developed by Johansen in 1960 and the model developed for the UK economy under the Cambridge Growth Project. The later has been refined and updated and its new form today is the E-3 (Economy-Energy-Ecology) model.

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

For details see Fontela (2000). This approach has been generalised over the years and applied for a number of countries using the ORANI prototype developed for the Australian economy. This combined with other efforts under the MONASH-series resulted in the development of the Global Trade Analysis Project (GTAP) database and model. The GTAP model now includes data on over 100 countries and is being used for the global trade, environment and energy analysis. For details on the generic ORANI model see Horridge *et al.* (1998). For details on GTAP see Hertel (1997). For extention of GTAP and related analysis for energy and environment see Burniaux *et al.* (2002).

Second stream focuses again on the analysis for the developed countries. This approach has its origins in the works of Harberger, Scarf, Shoven and Whalley. Today these models are refered to as the applied general equilibrium (AGE) models and have been applied to the US economy and other developed countries. Conventionally these models employ the Scarf algorithm for finding the numerical solution (see Scarf 1969). For the survey of AGE models see Borges (1986); for application see Kehoe *et al.* (2005), Kehoe (2003), Scarf *et al.* (1984), Harberger (1962). For Herbert-Scarf algorithm see Scarf (1969). For the discussion on closure rules see Ezaki (2006).

The third stream in the literature stems from the Adelman and Robinson model developed for the Korean economy (see Adelman and Robinson 1978). This specification has been found suitable for the case of middle and low income economies, and therefore applications of this approach are found in the country-specific research carried out by the International Food Policy Research Institute (IFPRI) and the World Bank. For details see Dervis *et al.* (1982), Lofgren *et al.* (2002)[5]. With in this stream there are further two sub-approaches. First is the traditional neo-classical methodology (see Robinson 1989) and second is the structuralist methodology (see Taylor 1990). The differences between these two sub-approaches lie in the specification of market equilibrium and the behavioural equations. Finally another approach to economy-wide modelling is the Hudson-Jorgenson method which is often described as the econometric approach to CGE modelling. For details see Hudson *et al.* (1975).

[5] Both follow neo-classical structuralist modelling tradition.

One of the main reasons for the growth in the application of the CGE models has been the success in software development and prototyping. Today CGE models do not impose huge computational/software related costs. They have been programmed using packages such as General Algebraic Modelling Software also called GAMS (see Lofgren *et al.* 2002, Keyzer 1997 and Hosoe *et al.* 2004), General Equilibrium Modelling Package also called GEMPACK (see Harrison *et al.* 1994, Codsi *et al.* 1988), MATLAB (see Savard 2003) and E-Views (see Essama-Nssah 2004)[6]. The CGE models pose lesser data-related costs in comparison to other forms of large-scale modelling. Typically these models are calibrated around a single year's Social Accounting Matrix (SAM) derived from a country's documented input-output tables and institutional accounts. Hence we bypass the need to have a time-series record for each and every variable under consideration. There has been a lot of progress in making the SAM compilation, programming and balancing both transparent and user-friendly. For details see Stone (1978), Byron (1978), Keuning *et al.* (1988), Robinson *et al.* (2001) and Round (2003). For details on analysis relating to input-output methodology see Bulmer-Thomas (1982). We discuss the structure of Pakistan-SAM in chapter 5.

General equilibrium models can be static and dynamic. The dynamic models are further sub-grouped into models that allow adaptive expectations and models that allow rational expectations. Fully integrated dynamic general equilibrium models (rational expectations) can also be divided into two types: a) Ramsey model, and b) overlapping-generations models (OLG). The OLG models traditionally can be further grouped into: a) Blanchard-Cass-Yaari model, and b) Auerbach and Kotlikoff model. The primary advantage of working with fully integrated dynamic general equilibrium models is that these models can accommodate uncertainty and idiosyncratic risk.

There are three main areas where the applications of CGE models are concentrated: a) trade, b) taxation, and c) energy/environment. The trade-oriented CGE models have grown primarily due to the developments on the WTO front. Researchers have looked at issues related to the macroeconomic and welfare impacts of reduction in tariff rates/slabs, elimination of production/export subsidies (particularly by the developed countries) and terms of trade shocks arising possibly as a result of global price

[6] Simple and stylized CGE models have also been developed using Excel that serves as a useful teaching and analytical tool. For details see (http://www.uvm.edu/~wgibson/).

changes. Most of the trade-focused CGE models are static and have also been linked with household budget models to get a greater depth in results. For details see Piermartini *et al.* (2005), Shoven and Whalley (1984).

The tax-focused CGE models have been popular in studying the impacts of economy-wide impact of distortionary taxes. These models are a good tool for the assessment of equivalent/compensatory variations. In the context of personal income taxation, their detailed treatment of work-leisure trade-off is important in analysing labour force participation issues. In the case of indirect taxation, these models provide a linkage with the utility functions of the households and then indicate the welfare loss due to for example an increase in the VAT rate. For details see Shoven and Whalley (1984), Ballard *et al.* (1985), and Baylor *et al.* (2004).

The energy/environment models in the CGE literature can be divided into: a) top-down, b) bottom-up, and c) hybrid models. While the bottom-up models are mainly used for the single country technology assessment, the top-down models can be applied to the single country as well as multi region analysis. These two types can be linked to obtain a single hybrid framework through the conventional macro optimisation procedure (see Kemfert 2003).

Despite of a being recognised as a reliable tool for economic impact analysis CGE models have been subjected to a great deal of pros and cons debate. These models have the advantage of taking into account the economic flows in a flexible manner, the specifications can be changed according to the analytical needs. Similarly one can pick and choose amongst the choice of closure rules for these models. Unlike the other forms of economy-wide modelling (such as a simple I-O model) a CGE model can incorporate explicitly the price effects and probably the most important feature is that these models are strongly founded in microeconomic theory. However they are not without operational drawbacks. First a CGE model may not be a good tool for forecasting. Even the dynamic models will not tell us about the time it takes to reach the changed values. It may tell us the number of periods, without letting us know the length of the period itself[7]. Another reason that a CGE model may be regarded as a poor forecasting tool is the fact that most of the parameters are derived from a single-year's SAM. Hence the expected structural changes overtime are ignored. Finally the

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[7] Certain constraints may be placed in order to for example derive annual changes.

results from these models are very sensitive to the specification form, closure rules and the choice of base-year. The general equilibrium theory itself has been under scrutiny for a long time. Researchers have been sceptic about the uniqueness and stability of Arrow-Debreu equilibria. The fact that money or monetary units cannot be incorporated into these models is another area of contention that remains unresolved. For a detailed discussion on the pros and cons of CGE models see Charney (2003).

3. Tax-Benefit Microsimulation Modelling

Since Guy Orcutt's pioneering work in the field of socioeconomic micro-analysis during the late 1950s, microsimulation modelling has seen an explosion in its literature and application. Pechman (1965) applied the models developed during the 1950s for the analysis of individual income taxation in the US. Later a similar exercise was conducted by Bossons (1967) for Canada. During the same time period another model was developed and used to study the status of labour force retirement in US (Schulz 1968). While the later model was dynamic in its specifications, the former were all static models and fundamentally provided an accounting exercise. Wilensky (1970) developed the Reforms in Income Maintenance (RIM) model for income maintenance and social security related analysis in US. This model set the foundation for further developments in the field and eventually this resulted in the development of Transfer Income Model (TRIM). TRIM has the ability to simulate the major government taxes and benefits and produce their impact on individuals, families, state and also at the national level. This model is still being updated and administered by the Department of Health and Human Services in the United States. TRIM3 is the most advanced version in this series and has been used to analyse supplemental security income, food stamps program, child care/support and subsidised housing, besides the conventional tax and benefit instruments which were already operational under TRIM2.

Orcutt (1976) developed DYNASIM that incorporated an expanded version of the household sector[8]. The DYNASIM research group focused on incorporating cost and time related efficiency in microsimulation exercises. Model development involved the usage of a host of software programs and also addressed the need to make the model building process generic. By mid-80s Statistics Canada had also managed to develop

[8] For details see Sadowsky (1991).

its own microsimulation model (SPSD/M) and this was followed by other European countries and Australia joining the efforts towards bringing microsimulation into mainstream economic and social policy analysis[9].

Traditionally income taxation was the main interest of microsimulation modellers. Tax incidence analysis of changes in marginal and average income tax rates, allowances and exemptions remain an expanding area of research interest even until today. For details see Wagenhals (2004). These accounting models were further developed to capture the impact of indirect taxation (see Decoster 1995). Policy issues that aimed at a change in VAT rates, for example can change the commodity-specific budget shares. This was captured in (behavioural) microsimulation models using linear expenditure system as well as the estimation of Engle relationships. However consumption changes were not the only reason for the rise of behavioural microsimulation. A lot of credit for making these models behavioural also goes to the incorporation of labour supply and leisure considerations to evaluate the incentive effects of policy reforms (see Creedy and Duncan 2002).

Another important stream in the microsimulation literature is where the research focused on evaluating the impact of certain policy measures overtime by aging the present population structure. This implied that one needed to go beyond the static accounting framework and develop dynamic microsimulation models. These models can be sub-divided into population and cohort models. The application of dynamic microsimulation models is not limited to tax-benefit analysis, but has also been done for social sectors such as education (see Grimm 2002) and health (see Cogneau and Grimm 2002). For dynamic models we require penal data which can be used to obtain the characteristics required for ageing the population. We make use of transition probabilities to define the socio-demographic characteristics which are then applied to a cross-section of individuals, usually from the household budget surveys. There is some debate as regards the efficiency and accuracy of these models and whether they should rely on the actual or synthetic penal datasets. The reason that conventionally these models would be based on the synthetic penal comes from the fact that no actual penal survey is conducted from the view point of catering the needs of a detailed and dynamic microsimulation exercise. Hence in a synthetic penal the researcher has the flexibility to generate the required data on which the changes in government policies

[9] See Statistics Canada (1989).

and programs can be applied. This above mentioned exercise may be sufficient for a dynamic arithmetic microsimulation, however for a dynamic behavioural microsimulation, the transition probabilities to some extent, have to be made: a) endogenous, and b) responsive to changes in budget constraints. For a detailed discussion on dynamic microsimulation see Harding (1993, 2000), O' Donoghue (2001). For general surveys on microsimulation technique see Merz (1991), Cogneau *et al.* (2003), Bourguignon *et al.* (2006). Such models are now also being tailored for spatial analysis (see Ballas *et al.* 2005).

Bourguignon and Spadaro (2006) summarise the survey and techniques in conventional microsimulation modelling. As mentioned above the first stage of microsimulation is tax incidence analysis using an arithmetic structure of algorithms. The flaw in this limited framework of analysis is the embedded assumption that tax changes are completely passed on to the final consumers. Secondly the inaccuracy of these models may also come from the non-consideration of tax evasion and non take-up of benefits. None the less arithmetic models have been used in the literature to obtain an approximation of the first round effects. Applications of these models can be found in Atkinson and Sutherland (1988), Merz (1991), Citro and Hanusheck (1991), Harding (1996), Sutherland (1998), Gupta and Kapur (2000). The second stage of microsimulation is the social welfare analysis using behavioural microsimulation models. Traditionally the tax-benefit models with labour supply responses fall under this category. As a result of a change in tax rate, it is not only the disposable income that is influenced, but the individual's labour supply decision is also allowed to change. The labour supply in microsimulation models can be modelled using either the continuous or discrete approach. The former is backed by strong theoretical conventions from the microeconomic theory, however its estimation is rarely easy, because of non-linearity of budget constraint and other issues related to the functional forms. For a detailed discussion on continuous labour supply modelling see Hausman (1980), MaCurdy, Green and Paarsch (1990). In the discrete approach, the specification becomes easier as the choice of values that the labour supply can take is limited. This methodology is used more widely in the literature despite its obvious weaknesses. For details see van Soest (1995), Hoynes (1996), Keane and Moffitt (1998), Spadaro (2005). Finally the third stage focuses on linking a behavioural microsimulation model with a macro model. This linkage can take three different forms: a) Incorporating multiple households in a CGE model i.e. fully integrating CGE and microsimulation (Cockburn 2001), b) top-down approach i.e. transmitting the changes in macro variables from a CGE model to a microsimulation model (Bourguignon *et al.* 2003) , and c) top-down/bottom-up iterative approach i.e. the change in the consumption levels and labour supply obtained from the microsimulation model are then transmitted back to the CGE model and the linked CGE-microsimulation model is allowed to iterate until the convergence is reached (Savard 2003). Hence there is a bi-directional feedback between both models.

Microsimulation models still have a long way to go before they can be made generic, user-friendly, cost and speed efficient. There are a number of softwares that are being used to construct these models. Some of the main ones include SAS (see Lloyd 2003), STATA (Banks and Dawkins 1998), GAUSS (Llopis 2002), Microsoft C++ (Immervoll 1999) and Excel-VB (O' Donoghue 2005). For detailed discussion on computing strategies for tax benefit modelling see Hancock (1997).

The basic computational infrastructure of a microsimulation model includes several interdependent components. First we have to structure the input files derived from the household budget surveys, labour force survey and population census. Depending on the requirements of the study, these files have to be structured at the individual or household level, showing their detailed information on incomes, expenditures, labour force participation, employment characteristics, educational/health portfolio and other demographic variables. Second we introduce a separate module for programming country-specific tax and benefit obligations/entitlements. These tax-benefit parameters are then applied to each individual to calculate their tax liabilities and benefit entitlements. Third for making the model behavioural we would need to have a set of wage equations from where we could obtain the predicted incomes. Forth these predicted earnings are then transmitted into an occupational choice module which will provide information on labour market choices and employment preferences. Fifth behavioural microsimulation models typically have an expenditure module that allows us to see the impact of indirect taxes on consumption of various goods and services. For doing so we incorporate the VAT, excise duty and customs duty obligations explicitly into our expenditure system (see Decoster 1995, O' Donoghue 2005). Programming these different indirect taxes would require information on: a) the manner in which these taxes are being levied i.e. ad valorem or specific duty, b) stage of imposition, c) commodity-specific producer prices, and d) the rate/amount of duty. Finally we would require an operational and sequencing algorithm structure which could perform the process of picking out each family separately from the input sheet, apply tax, benefit and expenditure related parameters and then record the values of the changed variables in an output file. The abovementioned steps have been programmed in the literature using a choice of different computing settings. For details see Hancock (1997), see also the XLSIM documentation in O' Donoghue (2004).

4. Linking CGE and Microsimulation Models

In this section we first have to justify the *multi-ethnic marriage* between CGE and microsimulation models[10]. For this purpose one has to start by making an assessment about how best the details in the available household micro dataset could be exploited. The distribution mechanism for example works through several different channels such as; 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[11]. Secondly the analysis on distribution remains incomplete until and unless the equalising effects of taxes and transfers have not been estimated through a set of different methodologies. One has to measure combined impacts of changed rules in the legislation as well as compare them with effective rates. Therefore a range of modelling frameworks to analyse 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. It is like passing the results into a counter check exercise. The issue becomes easier to understand when we see that the poverty and Gini indicators are all based on a 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 arises 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.

The capital inflows and outflows pose a similar challenge. Inward foreign direct investment or a change in remittances from abroad can influence household

[10] Phrase in italics from Reneto (2007).
[11] See Jorgensen and Pedersen (1998), See also Lindholm and Eklind (2000).

employment patterns. However it may be easy to see the effect of such inflows on macro variables, whereas the impact on households actually becomes intractable particularly in the presence of a simple analytical framework with lesser disaggregation. In the longer term the effects of technology transfer or an increase/decrease in debt servicing pose similar problems[12]. Bourguignon, Silva and Stern (2002) argue for adopting several combinations of models for Poverty Incidence analysis. For the assessment of distributional effects they recommend a three-layer structure; macro, meso-disaggregated, and micro. A detailed discussion (in the above cited paper) on household level microsimulation exhibits how it is possible to simulate directly say the impact of taxation on redistribution at household level and labour supply behavioural response.

There is a growing literature now that highlights the importance of linking macro, meso and micro models (see Davies 2004, Ahmed & O' Donoghue 2004). The primary reason for linking models stems from the need to conduct the micro analysis of: a) changes in macroeconomic policies, and b) external shocks. Several layers of models are being introduced, with the recent addition being the linkage of a single country model with the global models such as GTAP and LINKAGE (Hertel 1997, Barbier *et al.* 2005). In this case a change in any of the external factors such as global energy prices is transmitted to the national level models to see the general equilibrium and distributional impacts. Alternatively one could see the effects of a terms of trade shock on poverty and inequality levels. For application of such an approach see Horridge and Zhai (2006). At the national level there are several types of linkages depending upon the need of analysis and the objectives of research. For a regional analysis Rey and Dev (1997), integrate an econometric and input-output model. Having an explicit econometric component is useful if one needs to conduct a forecasting instead of a morning-after or what-if impact exercise. Parris (2005) discusses the possibility of an interface between Agent-based models and CGE models as both models have different strengths which can be shared in a single augmented framework. Devarajan and Go (2002) develop a middle ground between the conventional consistency models and disaggregated CGE models by linking an IMF style financial programming model with trivariate vector autoregression (VAR) and a simple static CGE model. The results obtained from this framework are then

[12] For detailed analysis on *Capital Flows and Economy-wide Modelling* see Roland-Holst (2002).

transmitted to a household poverty module to obtain the micro level results. The model was developed with the view to assist the on-going exercise in many developing countries where Poverty Reduction Strategy Papers (PRSP) was being furnished. These models start by satisfying the conditionalities programmed in the financial programming models. Probably the most important assumption in these models is the inflation rate. By setting the prices at a certain level these models then work backwards to calculate the growth and investment requirements. The VAR is used to obtain the short run impact of policy changes or external shocks on growth. The CGE model then captures the usual meso level changes in the income, consumption, investment and prices.

As a practical example we may also see the flow diagram in figure 2, which exhibits the linking of Canada's static microsimulation model (Social Policy Simulation Model) with a macroeconomic model[13]. 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[14]. For the aggregate labour 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 reweigh the social policy simulation data (SPSD)[15]. 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 labour market earnings have also been linked with the wage distribution. The computed average age by the macro model and the microsimulation model are compared; after which an industry-wise adjustment factor is applied to the wage information contained by SPSD[16].

In the conventional macro-micro literature, integration of CGE and microsimulation models has received the largest share of exposure and discussion. This is still a relatively new field however the interest in the area is growing due to the flexibility and disaggregative properties of such a structure (see Davies 2004). The transmission

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

between a general equilibrium and a partial equilibrium framework is not without technical and theoretical challenges. One has to see the demands of mapping, consistency and convergence (see Savard and Annabi 2004). These conditions are at times met at a cost of operational efficiency of the overall model. To address these issues in detail we discuss three main approaches for linking CGE and microsimulation models.

CGE-Integrated household method

In the first approach we can integrate a large number of households in the CGE model. The number of households can be as many as found in the household budget survey. This approach has been used in Cockburn (2001), Cororaton and Cockburn (2005), Rutherford *et al.* (2005), Anabi *et al.* (2005), and Cogneau *et al.* (2000).

Cogneau and Robilliard (2000) have focused on the experience of Madagascar and tried to evaluate the income distribution and poverty situation. 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 endogenised 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 used from the household level, and secondly the household behavioural equations have been estimated econometrically. These econometric estimations when imputed into the overall model allowing the behaviour to be endogenised. Thirdly the importance of the error term is recognised for assessing the unexplained heterogeneity. In fact the model's strength lies in its treatment of heterogeneity which is quite explicit in terms of consumption preferences of individuals, set of opportunities available, skills and labour preferences. The basic structure of this framework is from Cogneau (1999)[17], which along with Tongeren

[17] Cogneau (1999) proposes a micro macro model of labor market of a developing city, and its empirical application for the capital town of Madagascar. The model shows the existence of measured

(1994) are the seminal examples of a 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 labour allocation and consumption behaviour. Emphasis is on the details of labour allocation at agricultural household tier. However the traditional model of labour demand and supply; one where the labour market exists and functions and the other without a formal market, do not explain Madagascar's case. Fundamentally for Madagascar the requirements indicate towards an asymmetric treatment of off-farm and hired labour. The paper regards hired labour as complimentary to family labour. 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 labour intensive, which would imply that 'households that do not supply work off-farm have a marginal productivity of on-farm labour higher than their potential off-farm wages and households that supply off-farm labour have a marginal productivity that is equal to their off-farm wages'.

All sources of income have been endogenised accept the ones accruing from transfer payments and the formal sector of Madagascar. Savings rate as usual is also endogenised and has been represented as an increasing function of overall income stream. For the general equilibrium framework the assumptions take exchange rate as fixed, however investment, foreign and government savings are 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, labour and formal capital, where labour and capital through a Cobb-Douglas specification are substitutable in agriculture technology. Consumption is represented by linear expenditure system and the labour supply function has not been estimated thus making way for a calibration of both functions. The calibration is based on estimates from the SAM and household survey data. As agricultural households have been specified with a CES function, therefore the usual assumption of imperfect

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and unmeasured heterogeneity of skills, preferences and opportunities within narrowly defined socio-demographic groups (English version not available).

substitutability between agricultural goods produced for local and export market applies[18].

Authors show 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. For evaluating the impact of changes in growth levels, six different policies have been simulated. The first two simulations indicate towards an increase in value addition of formal sector, while the rest relate to the agricultural sector with one simulating increase in formal wages and dividends. Both ex-ante and ex-post impacts of shocks have then been exhibited[19]. It is this bifurcation that highlights the importance of CGE-microsimulation framework for assessment of income distribution analysis.

Several comments have since surfaced about the methodology of Cogneau and Robilliard (2000). Cockburn (2001) 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 opposed to assuming log normal distributions with constant inequality with in the household groups, greatly affects the results'.

The method used by Cockburn (2001) fully integrates the CGE model with the microsimulation process. The first step is to create link between the income and expenditure accounts in the SAM with the income and expenditure data provided in household survey. Then 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). Now running the software programme (e.g. GAMS) will balance the SAM data for establishing equilibrium. We can now obtain the new (balanced) SAM into a normal spreadsheet file (e.g. in Excel) from where the data can then be imported by GAMS. Once the new data has been imported and tested by running an aggregate form, we can now replace the household data (aggregate form) into weighted data (individual form) taken from the household survey. At this point one may ensure that the code has

[18] More commonly known as Armington assumption.

[19] "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".

been aligned to incorporate an equivalent number of households in the model structure. Finally we can test the linked CGE-microsimulation model. See 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 in the corresponding 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 the CGE model as well.
- Changes in any of the vectors (acting as a bridge between two structures) such as prices and wages in the microsimulation must be in line with the assumptions laid down in the 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 the source of our problem, then try with all factors kept mobile.
- Reduce the number of activities/commodities in the model[20].

Cockburn (2001) applies an integrated CGE-microsimulation model for analysing the introduction of a uniform value added tax in Nepal. An existing CGE model based on

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

1986 SAM is used, with 50 sectors. There are 3373 households in the sample. Household behaviour is represented by LES function, where differences in marginal shares of goods consumed determine the household behaviour. 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 the firms[21].

As mentioned above the policy chosen for simulation is the introduction of a value added tax (VAT), due to 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 the absolute number of poor people, which implies that welfare in the country has increased, however the inequality level rises especially for the urban regions[22].

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. The indicators used are the usual Foster-Greene-Thorbecke (FGT) indices. These indicators are computed for before and after-shock results, however as the author recognises that depth and severity indicators are largely a matter related to the choice of poverty line. It has been shown that as this line is increased, 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.

Cororaton and Cockburn (2004) analyse the poverty effects of tariff reforms, which led to a reduction in the consumer prices in Philippines. A CGE-microsimulation model is used to capture these effects through the varying household incomes and prices. The 1994 Family Income and Expenditure Survey consists of 24797

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[21] Firm transfer may include payments such as periodic dividends.
[22] Poverty and income distribution analysis has been done using DAD software, whereas the general equilibrium model is in GAMS.

households. All these households have subsequently been integrated into the CGE model, which incorporates 12 activities with labour and capital as the factors of production. Activity sub-sectors include four agricultural, five industrial and three services sectors. Labour has also been sub-divided into skilled agriculture labour, unskilled agriculture labour, skilled production labour and unskilled production labour. Total government income and real government spending have been held fixed, however the post tariff-reduction decrease in government revenue is being bridged by direct taxes or indirect taxes or a combination of both.

The experiment shows 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 on the rise especially for the rural households.

CGE-microsimulation top-down approach

The second approach is where CGE and microsimulation models are integrated sequentially in a top-down manner. So that a shock to the CGE model then transmits the changes in wages, prices and employment levels to the microsimulation model. Examples of such applications can be found in Robilliard *et al.* (2001), Bourguignon *et al.* (2003), Hérault (2005) and Bussolo and Lay (2003).

Bourguignon, Robilliard and Robinson (2003) have raised the issue of model specification and data reconciliation in a fully integrated microsimulation-CGE model. They stress that research efforts still have a long way to go in suitably 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 linking the CGE and microsimulation framework, a top-down approach is adopted. 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 the household income and consumption. In this model household income is being explained by collective observed and unobserved characteristics of household members. Model allows disaggregation for; labour market segmentation, self employment income (farm and non-farm), and demographic grouping. Self-employment has been distinguished from wage work to show imperfectly competitive nature of labour markets 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 labour force.

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, and 10 household categories. The disaggregation exercise for the 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 Indonesian economy is dualistic and the production activities are segregated in terms of being formal or informal. Similarly the labour markets are also distinguished in the same order.

Simulations show the effects of a reduction in foreign price for crude and processed oil products. The overall export level declines thus slashing the foreign exchange earnings and ultimately leading to a downward pressure on the equilibrium exchange rate. In the next simulation a 30 percent drop in exogenous foreign savings again results in devaluation, however in this case there is also a change in the 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. 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[23].

Top-down/bottom-up CGE-microsimulation approach

The third approach is the iterative top-down/bottom-up approach that provides a bi-directional feedback between CGE and microsimulation models. Examples of this approach are Savard (2003), Ferreira Filho and Horridge (2004), Avistland *et al.* (2003).

Decaluwe′, Dumont and Savard (1999) have constructed an archetypal microsimulation in general equilibrium. The model has four sectors; agriculture, industry, marketable and non-marketable services, with each sector producing a single product. Factor endowments include capital, skilled labour and unskilled labour. Resources are fully employed and labour markets are perfectly segmented, which in turn implies that each labour market reaches the equilibrium position independent of the other market, however the sectoral mobility of labour 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 where the fixed share of total expenditure is inversely proportional to the level of income. 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 for every household the composition and the level of expenses can differ.

Two separate economic shocks are simulated: a) 20% increase in unskilled labour supply, and b) eliminating customs duties for industrialised goods in combination with a 30% increase in agricultural world prices. The results of the former policy indicate an increase in inter-group inequalities while the later shows a decrease. The disaggregate data is then used to assess the poverty scenario and parameters for the bi-

[23] For an extended version of this CGE-microsimulation model see Robilliard *et al.* (2001), where this framework is being used to decompose the effects of financial crises in Indonesia.

model and beta type distribution function has been estimated for evaluating before and after change poverty levels.

Recently it has been realised 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) extending on the abovementioned Decaluwe *et al.* (1999) introduces a bi-directional link and proposes a top-down/bottom-up CGE-household microsimulation model. The household microsimulation model shows the availability of workers willing to work in the qualified sector of the labour market, and in the CGE model the demand for labour is being bridged by either the unemployed entering the market or the unqualified labour already waiting to enter the qualified sector. However in the case of a decline in labour 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'.

Two policy effects have been simulated for the case of Philippines. 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.

Avitsland and Aasness (2004) treating pre-tax incomes and consumer prices as exogenous, offer a more detailed microsimulation model however complete consistency is not offered when integrating the two models, which authors feel is unimportant as suggested by the sensitivity results. 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 commodities. On the supply side all factors are mobile, and all producers are price takers in the world market. On the consumption side intertemporal utility is being maximised with perfect foresight. Aggregation across all households defines the aggregate demand functions. Government expenditure is kept exogenous, increasing only at a constant rate[24]. The microsimulation model is the one developed and used by Statistics Norway. The model captures savings, expenditures and distributional effects on the 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[25]. 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.

5. Conclusion

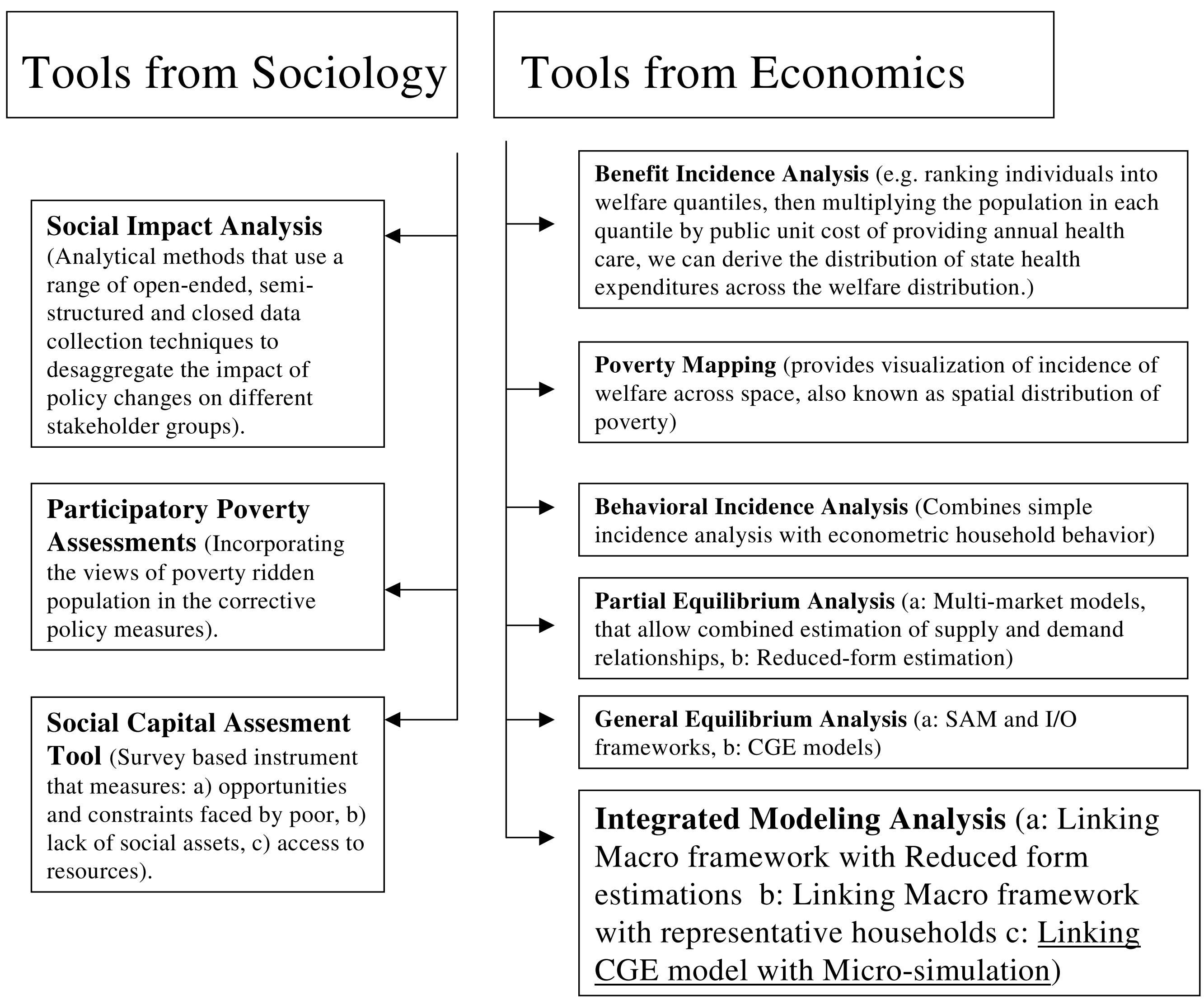
The future course of CGE-microsimulation models will be influenced by the following three considerations: a) the quality of household income and expenditure data, b) the stability of results over longer time period (particularly in the case of dynamic CGE-microsimulation models), and c) the developments in software/computational capabilities. As poverty and inequality have become a major concern in the developed world as well, therefore there is a need now to introduce detail and depth in the presently available quantitative techniques. The recent efforts in building regional and multi-country CGE models linked with microsimulation models for region-specific trade policy and distributional analysis are certainly the

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

building steps in the required direction. This paper provides a brief discussion of the application of CGE and microsimulation techniques. The recent debate on linking the two models is important given that from a methodological point of view a merger between the general equilibrium and partial equilibrium models can be technically challenging. However the effort made in some seminal applications suggest the benefits of such linked models in poverty and inequality evaluation.

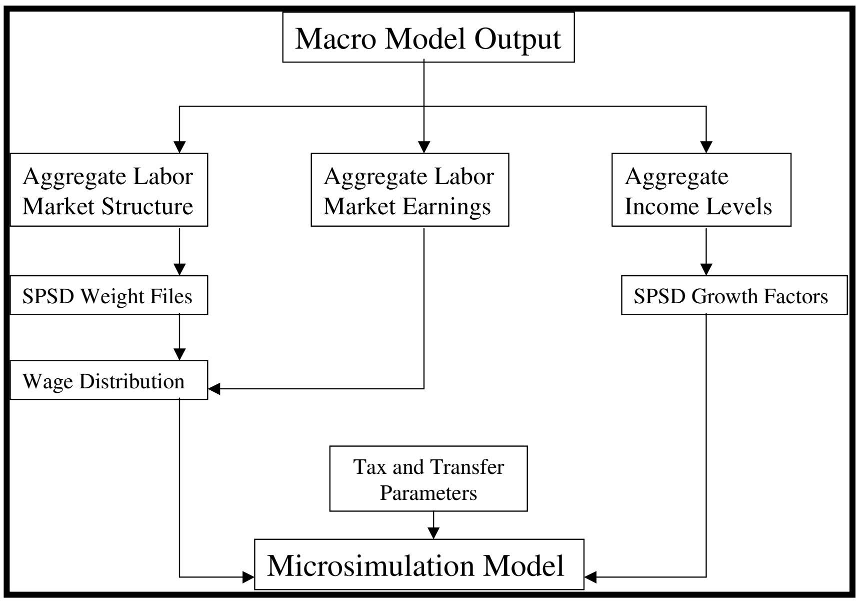
6. Tables and Figures

Figure 1 Methods for Analysing Policy Impacts on Welfare[26]



[26] For details see World Bank 2003.

Figure 2 Linking Macro-Econometric Model with Microsimulation Model



Source: Allie and Murphy (2000)

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APPENDIX 1

Table A-1 Linked CGE and Microsimulation Models

Model[27]	Country	Uses/application	Data	Sample size
Cogneau & Robilliard (2000)	Madagascar	Labour allocation at household level, impact of different growth strategies on poverty.	SAM (1995), and household budget 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 and SAM (1986)	3373
Cororaton & Cockburn (2004)	Phillippines	Poverty effects of tariff reduction.	1994 family income & expenditure survey, SAM (1994)	24979
Robilliard, Bourguignon & Robinson (2001)	Indonesia	Decompose effects of financial crises, analyse alternate social policy packages.	1996 SUSENAS survey, SAM (1995)	9800
Bourguignon, Robilliard & Robinson (2003)	Indonesia	Analyse impact of trade balance changes.	1996 SUSENAS survey, SAM (1995)	9800
Decaluwe, Dumont & Savard (1999)	Archetype	Breakdown analysis 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, SAM (1990), labour force survey 1997-98	
Avitsland & Aasness (2004)	Norway	Equality effects of VAT reforms		15000

[27] This is not an exhaustive list of applications, however it represents the main streams of work on linking CGE and microsimulation models.

Table A-2 Policy Simulation Matrix

Model	Country	Policy Simulations
Cogneau & Robilliard (2000)	Madagascar	a. Formal hiring and increase in dividends. b. Increase in formal wages. c. Increase in the total factor productivity in the agricultural sector. d. Increase in the total factor productivity in the food-crop sector. e. Increase in the total factor productivity in the cash-crop sector. f. Increase in the world price of cash crops.
Cockburn (2001)	Nepal	a. Introduction of VAT in place of the existing production tax (which varies between sectors).
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: i) additional indirect tax, ii) additional direct income tax, iii) various combinations of indirect taxes.
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 in total factor productivity in the agricultural sector.
Bourguignon, Robilliard & Robinson (2003)	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 of 20 % in the unskilled labour endowment. b. Elimination of customs duty for industrialized goods combined with an increase in the world price of agricultural goods by 30 %.
Savard (2003)	Philippines	a. Reduction across the board in import tariffs by 30 %. b. An increase of 10 % in the qualified sector fixed wage.
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.

Table A-3 Simulation Result Matrix

Model	Country	Results
Cogneau & Robilliard (2000)	Madagascar	a. The hiring stock 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. This policy leads to an increase in production and agricultural income. d. Reduction in the relative prices of the traditional goods leads to the reallocation of labour among traditional activities. 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. f. This shock leads *ex ante* to a reduction in the production of non-tradable goods and to an increase in the demand for these same goods. *Ex post* 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. The decline is however marginal.
Cororaton & Cockburn (2004)	Philippines	a. Import prices in local currency terms drop, this leads to a fall in consumer 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 GDP. 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	Indonesia	a. Trade shock reduces foreign exchange receipts resulting in devaluation. b. Results in devaluation, however there is a decline in relative prices prior to actual devaluation.
Decaluwe, Dumont & Savard (1999)	Archetype	a. Increase in inter-group inequalities. b. Reduction in inter-group 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.
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.