Combining Microsimulation with CGE and Macro Modelling for Distributional Analysis in Developing and Transition Countries

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ABSTRACT This paper overviews recent work that has attempted to bring together microsimulation, Computable General Equilibrium (CGE) and macro models to perform distributional analysis in developing and transition countries. Particular attention is paid to applications relating to aspects of economic growth and political economy. Applications in which macro, CGE and microsimulation models are either layered or integrated are considered. It is demonstrated that different combinations of such models, including those where only a single model-type is used, are appropriate for different problems. For short-run impact analysis, microsimulation on its own may be appropriate. For longer-run analyses, where interest is in the interrelationship between changes in disposable income, consumption and labour supply, these models need to be supplemented a combination of microsimulation on the one hand, and general equilibrium price changes or changes in macro variables on the other hand. In the case of national subregions, or countries embedded in free-trade areas, it is argued that microsimulation may adequately be combined with pure macro models. That is, CGE modelling may not be necessary. For distinct national economies, however, the first step beyond microsimulation should likely be integration with CGE modelling. Whilst much promising work has been undertaken on dynamic integrated CGE microsimulation work in developing countries, CGE work is most advanced for Less Developed Countries. At present several groups of development researchers are found to be putting these two approaches together, and in some cases are adding macroeconomic and financial modelling as well. In contrast, with a few conspicuous exceptions, little such work is being done for the transition economies.

Keywords: CGE; political economy; growth

1. INTRODUCTION

The purpose of the paper is to explore how microsimulation can be combined with CGE and macro modelling techniques to study distributional issues in transition and developing countries. This is an area of great current interest. (See, for example, Agénor *et al*., 2006; Cockburn, 2006; Cogneau and Robilliard, 2006; Bourguignon and Savard, 2008.) While microsimulation is essential in modelling the distributive effects of taxes and transfers, it is limited by the fact that it is often non-behavioural and by its inability to model prices, wages and macro variables. CGE and macro models, on the other hand, have in the past generally lacked the rich distributional detail found in microsimulation. The solution that is increasingly being advocated is to combine these different forms of modelling, either through 'layering' the models, or through their integration.

Different combinations of models are needed when dealing with different issues. For some purposes it is sufficient to stick with just one of the standard model types. For example, in some cases there may be little reason to expect complex distributional impacts and standard CGE modelling, with its representative household groups, may be enough. Conversely, if interest centres on distributional impacts and there is reason to believe that general equilibrium price effects will be unimportant, then conventional microsimulation may be sufficient. But there are cases where combining the approaches is necessary to get an accurate picture. A prototypical case is that of removing agricultural protection in developing countries. Tariff removal leads to lower food prices, benefitting poor consumers. On the other hand, lower agricultural prices reduce the wages of agricultural labourers, many of whom are also poor. The result is that some of the poor will benefit and others will lose. CGE is needed to capture the wage and price effects, and microsimulation is needed to net out gains and losses for individual households, allowing accurate distributional analysis to be performed.

Currently, in the developing world, the leading distributional issues surround the impact of factors like trade liberalisation, adjustment policies and financial crises on poverty and overall income inequality. In the transition economies similar issues are also important, but there are features that give some of these countries important aspects in common with higher income countries. Russia and the East European transition countries, although still poor relative to the West, are highly urbanized and industrialized. The portion of the economy in the informal sector is also relatively small compared with many developing countries. These aspects mean that food price and agricultural issues, for example, are less important than in many developing countries. Also, the tax, benefit and pension issues that face members of a formal-sector industrial workforce are more important. Conventional microsimulation has been developed to analyze policy issues and distributional impacts in highly urbanized and industrialized societies, and may therefore be more applicable and relevant in these transition countries than in many developed countries (DCs).

While there have been a few important contributions, neither microsimulation nor CGE modelling are so far very advanced in most transition countries.[1] Part of the reason may lie in data requirements and lack of modelling resources. And part may lie in the uncertainty about how to model these economies. But it may also be that the pace of change has been so rapid as to restrict the payoff to, and applicability of, such modelling. CGE models in particular assume that the base year is one of equilibrium, which is problematic. If transition begins to proceed in a more orderly way, better data become available, and more consensus develops about how to model these economies, improved prospects for microsimulation and CGE work will arise.

CGE and standard macro models provide static analyses. Ultimately, one is interested in the connection between growth and other phenomena including income distribution. There has been some interesting work in this area, but it is to be hoped that micro-macro links will extend more to dynamic modelling in the future. Tax and benefit changes can affect growth, for example through impacts on saving and investment, human capital formation, fertility, innovation, and incentives for the adoption of new technology. And trade reforms can stimulate growth through the expansion of export industries and FDI, as well as through capital accumulation/technology effects – at the same time generating possibly complex distributional impacts.

The rest of the paper is organized as follows. Section 2 briefly discusses the history and development of microsimulation. Next, in Section 3, we look at the basic aspects of SAM and CGE techniques. Section 4 then reviews recent attempts to merge or layer CGE and microsimulation models. Section 5 looks at work that has added explicit macroeconomic content to CGE, while growth is discussed in Section 6. Section 7 briefly discusses political economy aspects, while Section 8 concludes.

2. MICROSIMULATION

The originator of microsimulation, Guy Orcutt, believed that one day rigorous and useful modelling of the overall economy could be done by aggregating the carefully modelled behavior of individual consumers and firms (see Orcutt, 1957 and Orcutt *et al*., 1976).[2] This is still the vision of many practitioners of microsimulation. However, the majority have taken it as a long-range objective and have mostly limited themselves to a more practical approach for the present. The focus is generally on distributional issues. The aim is to construct reliable models of individuals and households that will allow careful analysis of the impact of policy changes. While modelling the overall behaviour of the economy has not been the main agenda, from time-to-time attempts are made to graft macroeconomic content onto microsimulation models.[3] And today, with many researchers attempting to combine microsimulation and CGE models in various ways, the achievement of Orcutt's original vision is coming closer to reality in some cases.[4]

The foundation of microsimulation today is still found in models of household income distribution and consumption that take detailed account of taxes and transfers but leave household behaviour exogenous. The basis of a good accounting model of this type must be a rich database on a large representative sample of households. Constructing such a database is far from a trivial enterprise. No single household survey comes close to providing the required data. The best available household survey will be used as the 'host', but even the best surveys will not cover all the necessary variables, and the estimates they provide will be affected by reporting errors and differential response problems. This means that corrections need to be made to the data in the host survey, and that the host needs to be augmented by imputing values of omitted variables from other surveys or from administrative (for example social security or revenue authority) data. Totals for all kinds of income, consumption, transfers received, taxes paid, and other variables must reconcile with those available from independent sources, for example the National Accounts.

In addition to a highly developed database a microsimulation model for policy analysis needs to have a detailed and accurate tax and transfer simulator. Again this is far from trivial. Modern governments levy a cornucopia of taxes and provide a rich array of transfers. Moreover each is very complex. Just modelling the deductions, exclusions, exemptions and credits provided under the personal income tax is challenging in itself. Problems are multiplied when, as in many transition countries, there are substantial differences across different households in terms of eligibility for pensions and other transfers. Finally, tracing the impact of indirect taxes and tariffs is complicated by the fact that these are sometimes levied on intermediate goods, and therefore 'cascade' through the economy, producing a larger impact on consumer prices than if they were levied only at the final stage.[5]

In addition to the above, a microsimulation model must include sophisticated software to present and analyze results. Considering impacts of tax/transfer changes on inequality – both overall and within and across subgroups, poverty in all its nuances, progressivity, and benefit concentration is rich and complex. Lorenz curves and other concentration diagrams, Foster-Greer-Thorbecke (FGT) measures of poverty, and a battery of inequality indexes are brought to bear in the best current work.[6]

Examples of sophisticated microsimulation models of the accounting type are found in most OECD countries: for example, STINMOD in Australia, SPSD/M in Canada, TRIM3 in the United States, and TAXMOD and POLIMOD in the United Kingdom. Further, the European Union has spent several years funding the development of such a microsimulation model, EUROMOD, for 15 core member countries (c.f. Sutherland, 2001).

Current microsimulation is not confined by any means to static non-behavioural modelling. Models that endogenize labour supply and saving behaviour on the basis of econometric estimates of the relevant relationships are not uncommon. The methodology of such studies is discussed, for example, in Bourguignon *et al*. (2001) and Robilliard *et al*. (2008). (See also Section 4 below.) These are, of course, partial equilibrium models. Further, there has been substantial development of dynamic microsimulation models (see Section 6), which model demographic evolution over time, so that the impact of policy changes that will impose costs on, or deliver benefits to, particular age groups/household types can be traced more accurately into the forseeable future.[7]

Another area where microsimulation has played a role in the study of the overall economy is in the simulation of technological change and growth, which is discussed in section 6 below.

3. SOCIAL ACCOUNTING MATRICES AND COMPUTABLE GENERAL EQUILIBRIUM

Social Accounting Matrices

The starting point for the development of any CGE model is the construction of a micro-consistent benchmark dataset. Such a dataset must specify aggregate factor endowments, outputs by industry, factor usage by production activities, exports, imports, and the input-output structure of the economy. In addition, it may disaggregate by type of economic agent (households, firms etc.), and detail the factor use, receipts and expenditures of public and external sectors of the economy.

Since the pioneering work of Pyatt and Thorbecke (1976) the benchmark dataset needed for a CGE model has generally come to be specified in the form of a 'social accounting matrix' or SAM.[8] The columns of this matrix represent expenditures and the rows show receipts. These expenditures and receipts are made or received by factors, institutions, production activities, and the rest of the world (ROW). Institutions include households, companies, government and a combined capital account.

In addition to providing a description of the structure of an economy, a SAM can be used for multiplier analysis, as detailed in Davies (2004). (See also Bautista *et al*., 2001.) Calculations can be made to show how an exogenous change in expenditure, say from government or the ROW, would affect incomes in the various endogenous accounts if the structure of the SAM were unchanged in the process. In a closed economy with little excess capacity, or even in an open economy that is not a price-taker, such an exercise is of limited interest, since we would expect general equilibrium price changes and a damping of multiplier effects due to factor scarcity.[9] Still, in such a world the multiplier analysis can give some idea of the pressures created by exogenous shocks, and in a small open economy with excess capacity it might even provide reasonable predictions. In the case of a transition economy with a high level of unemployment, for example, it could plausibly be argued that SAM-based multiplier analysis might give a reasonable idea of the effects of trade or fiscal shocks.

The construction of an accurate SAM is challenging.[10] The raw materials take the form of the National Accounts, input-output tables, household surveys, and a variety of other data. Concepts and definitions typically differ between these data sources. And even after adjustments have been made to make definitions consistent, the estimates for what are conceptually the same totals coming from different sources will generally differ. This leads to the need to adjust the data further in order to achieve consistency.[11]

While some of the data needed for a SAM will be available on an annual basis, household surveys are not always conducted annually and input-output tables are generally available at even less frequent intervals. The inevitable result is that the most recent SAM will tend to be several years out of date. For stable economies this may not be a serious problem. But for rapidly growing or changing economies, such as those of transition countries, this lag may be a significant limitation.

CGE modelling

CGE modelling allows the behaviour of firms and households to be analyzed in a general equilibrium environment. The result is that the effects of particular policies, or external conditions, on prices and outputs can be studied. Distributional effects are implied, and have generally been analyzed by considering the impacts on representative household groups. Conventional CGE modelling is both static and long run. The aim is to picture what the present economy, with its given factor endowments, tastes and technology, would look like if different policies had been in place, or external conditions had differed in a particular way, for a long time. This is interesting and important, of course, but departs considerably from simulating the effect of policy or other changes in real time.

In the 1950's Arrow, Debreu and Mackenzie proved the existence and uniqueness of general equilibrium in competitive markets. Scarf (1967) provided an algorithm that made it possible to compute the static equilibrium of a competitive economy. This led to the onset of a literature on Computable or Applied General Equilibrium (CGE or AGE) modelling, with initial contributions being made by Shoven and Whalley in the early 1970's. (See Shoven and Whalley, 1984, for references.)

Shoven and Whalley pioneered the purely microeconomic or 'Walrasian' type of CGE model, which, unlike many later CGE models, does not contain any macroeconomic elements. These models are intended to be computational versions of strict general equilibrium models. As such, they are real models. Money, price levels, and nominal exchange rates do not figure in these models. Unemployment can be modelled by imposing imperfections that keep wages for, say, unskilled labour above the market-clearing level; but underutilization of resources cannot arise for *macro*economic reasons.

Since the 1970's CGE modelling has come to be used very widely in less developed countries (LDCs), where the market-clearing assumption and abstraction from macro problems found in Walrasian CGE models are generally considered to be too limiting. CGE models that incorporate some macro features have therefore spread and are in widespread use for LDCs.[12]

Shoven and Whalley (1984) outline the setup of a typical CGE model. In order to specify such a model we must first decide on the level of disaggregation that will be used for factors, production activities, and household types. In some cases these decisions may be affected by data availability, but often the data will allow more disaggregation than is considered necessary by the researcher for the particular issue at hand. Shoven and Whalley point out that the level of disaggregation should suit the research question being asked. Thus, while one may want a high level of detail on consumer products in an experiment where complex sales and excise taxes are replaced by a uniform value added tax, more aggregated consumer products would generally be used if the focus is, say, on labour markets.

From the distributive viewpoint a crucial decision concerns the treatment of households. In conventional CGE models, as outlined by Shoven and Whalley, a relatively small number of representative household (RH) groups is chosen. In less developed countries these may be specified, for example, as being rural or urban, skilled or unskilled, and landed or landless. In developed countries the rural/urban split is less likely to be recognized and representative households are more likely to be identified in terms of income or expenditure groups. In both LDCs and DCs the fact that each household type may receive income from any of the factors will of course be recognized. The obvious limitation is that heterogeneity within household types is not accounted for, which is a serious limitation when studying, for example, poverty impacts.

The specification of firms is much simpler than that of households in standard CGE models. These assume perfect competition and constant returns to scale in production. Under those assumptions, the firms in an industry are essentially identical, and their behaviour can be captured by analyzing that of a single representative firm. Firms in different industries of course use different production functions, and relative factor intensity varies between industries. This is crucial to the results of the experiments performed. Policies that result in the expansion of labour intensive sectors, for example, will tend to bid up real wages and the size of the change will be greater the larger are the differences in factor intensity across industries.

The next step is to specify technology and preferences. Production of intermediate goods is often specified as Leontief, making direct use of available input-output data. Value added in the production of final goods is generally the output of a Cobb-Douglas or constant elasticity of subsitution (CES) production function, and intermediate goods and value-added may be combined either in fixed or flexible proportions.[13] Firms are generally assumed to be competitive profit maximizers, although imperfect competition is sometimes modelled in non-standard models.

On the household side preferences may also follow the CES specification, but typically this is considered to be insufficiently flexible. One limitation can be seen by considering the case where there are many consumer goods and all are 'small'. In that case the compensated own-price elasticity for each good converges on the common elasticity of substitution between all goods, reflecting excessive symmetry between goods in the CES formulation (see Shoven and Whalley, 1984). If CES forms are to be used they therefore tend to be used in nested form, with, for example, sub-functions being defined for food, housing, transportation, services etc.

A currently popular specification for consumer preferences is the linear expenditure system (LES) pioneered by Richard Stone. Like the CES form this assumes a constant marginal propensity to spend out of income on any particular good. However, average propensities to spend change systematically with income level since each good is assumed to be subject to a minimum subsistence requirement.

Full specification of non-Walrasian CGE models requires 'closure'. Closure is not an issue in Walrasian models since they are self-contained fully specified general equilibrium models. However, when CGE is applied to the real world it becomes difficult to fully endogenize the behaviour of all agents. One must say how savers, investors, governments, and agents in the rest of the world will behave in order to close the model.[14] Three closures must be specified, determining the degree to which balance is achieved between saving and investment, government revenues and expenditures, and exports vs. imports. The behaviour specified does not go back to the fundamental determinants of behaviour seen in the modelling of consumers and firms. Assumptions are unavoidably somewhat *ad hoc*, and care must be taken to ensure that the choice of closure does not bias results.[15]

Since the pioneering work of Adelman and Robinson (1978) it has been common to graft more distributional content onto standard CGE modelling by allowing a distribution of income within household types. This is generally assumed to be lognormal, and it is assumed that the variance of logarithms remains constant during the CGE experiments.[16] Changes in overall inequality can then only occur as a result of redistribution *between* groups. Changes in poverty, on the other hand, can occur due to some purely intra-group changes. For example, if all incomes fall equi-proportionally, relative inequality of the society is unaffected but absolute poverty will increase. And the extent of the increase within each household group will depend on the relative density of population in the neighbourhood of the poverty line, which will generally differ between groups.

While assuming constant relative inequality within household groups might appear mechanical the assumption would be justifiable under certain conditions. Suppose that each household group received all, or almost all, its factor income from one source. Then a change in factor returns would affect everyone within a household group in the same proportion, and relative inequality within a group would be unchanged. Non-proportional changes in taxes or transfers, of course, would not give this neutrality, but this could be handled without too much difficulty in simple cases.[17] Difficulties arise in the real world since household groups that have homogeneous relative composition of factor incomes cannot be readily specified. Typically one finds that within household groups defined by income, location, or occupation there is still considerable variation in the relative importance of different income sources. In the next section we will discuss attempts to add distributive detail to CGE modelling that can deal with this heterogeneity.

Calibration

What method should be used to determine the parameter values needed in the production and utility functions? In other words, how is the model calibrated? A common assumption is that the economy observed is in equilibrium in its base year, that is the year to which the SAM applies. Calibration boils down to the problem of selecting expenditure or income share parameters, elasticities of substitution, and, in the case of LES preferences, Frisch parameters. Share parameters can be taken from the SAM, but elasticities and Frisch parameters must come from other sources. The ideal approach involves a review of relevant econometric studies, but this often produces a wide range of estimates. And, over time, conventional ideas about what are realistic elasticities evolve and become somewhat entrenched – so that values may be chosen by reference to earlier CGE studies rather than to primary sources. A focal case is, of course, that of unitary elasticity, which is a reasonable value to use where there is no good theoretical or empirical reason to expect the true value to be either higher or lower.

If one assumes that imported and exported manufactured goods (even those in an apparently homogeneous subcategory such as cars) are perfect substitutes then implausibly large swings in trade flows may readily occur in CGE models. A common solution is to recognize that in most cases imports and domestically produced goods are imperfect substitutes – the 'Armington' assumption. This then requires demand elasticities for exports to be specified. Since one generally does not wish to explicitly model the full behaviour of the ROW, this means that export demand elasticities and demand functions need to be specified on the basis of available econometric studies or other evidence.

Recently exercises have been performed that feature 'double calibration'. (See, for example, Abrego and Whalley, 2005.) This is done when CGE is used in an *ex post* fashion to attempt to understand past changes. Suppose, for example, that one would like to explain the changes in patterns of trade, wages and production in Canada, the U.S. and Mexico over the decade after the onset of NAFTA. Decomposition analysis is called for, in which alternative variables can be varied, others being held constant, to estimate independent impacts. For such purposes a model whose consumer preferences and production elasticities are unchanged over the period is arguably best. If so, the model needs to be calibrated not to the data for a single year, but to data for the beginning and end of the period studied. In this case exact calibration can clearly not be performed. Abrego and Whalley discuss alternative procedures for the required inexact calibration. These methods may become fairly widely applied in developing countries, since there is often great interest in the developing world in the *ex post* analysis of the impacts of major policy changes.

4. CGE MICROSIMULATION

CGE and microsimulation are being merged in current work in two different approaches. In the first approach the two types of models are 'layered'. Second, the two kinds of models can be completely integrated. While the latter approach may appear to be the ideal, for some purposes the layered approach has advantages, as we shall see.

Layered Approach

While the layered approach is interesting and promising, it makes large demands on modellers, and is still in an exploratory stage. A leading example is provided by Robilliard *et al*. (2008), who model the effects on poverty and inequality of the financial crisis that hit Indonesia in 1997. This study has two layers: a CGE model meant to capture price, exchange rate, and macro changes; and a 'household income micro-simulation' (HIMS) incorporating reduced-form econometric modelling of occupational choice and income determinants.

The CGE model in Robilliard *et al*. has 38 sectors, 14 goods, 14 factors of production and 10 household types. It is meant to incorporate realistic structural features of the economy, including binding macro constraints. This model is solved first, and provides required inputs for the microsimulation in the form of prices, wages, and employment levels. This is an example of the 'top-down' approach to bringing together CGE and microsimulation.[18]

The microsimulation captures heterogeneity in income sources, area of residence, demographic composition of households, human capital endowments, and consumer preferences. Its most important elements are a log earnings equation for each household member of working age, an equation for the household's self-employment income (again with the dependent variable in log form), and equations for the utility each individual gets from being self-employed or inactive, relative to working. All these equations are linear functions of variables taken as exogenous to the individual or household – for example age, schooling level and region in the case of labour earnings. The equations are regarded as reduced forms and are estimated econometrically. The idiosyncratic errors for individuals or households are noted and are used as fixed effects in the microsimulation.

In each sector of the CGE model there is a formal and an informal activity, producing the same good but using different types of factors. Capital is sector-specific and fixed. Land is allocated among different crop sectors according to its marginal value-added in those sectors. There are eight labour categories, giving all combinations of urban/rural, male/female, and skilled/unskilled. In the formal sector labour markets, real wages are assumed to be indexed to total formal labour demand, for all labour categories. Informal labour markets absorb any labour not employed in the formal sector. Wages adjust to clear the informal labour markets, while employment adjusts in the formal sector.

Having computed changes in wage rates, average self-employment income, and employment in the CGE model, Robilliard *et al*. turn to the microsimulation to determine the impacts on the size distribution of income and poverty. In order to achieve consistency with the CGE results, all individual wage rates within a labour-market segment, and all self-employment incomes, are adjusted by the same percentage. Similarly, the utility from working or being self-employed is adjusted in such a way as to produce employment changes equal to those found in the CGE calculations.[19]

Robilliard *et al*. find that their modelling of full distributional detail generates quite different results from a representative household approach. The latter produces changes in inequality and poverty that are much too small. This argues convincingly in favour of adding microsimulation to CGE, but there remains a question of how best to do this. Robilliard *et al*. (2008) represents one approach, where a structural CGE model provides price and other inputs into a microsimulation based on reduced form behavioural relations. What happens in the microsimulation can be made consistent with the CGE modelling by judiciously adjusting parameters in the HIMS, but it would be more satisfying from a theoretical viewpoint to obtain consistency by modelling behaviour identically in the CGE and HIMS. That is, a 'cleaner' approach would be to have the same structural model of behavior in the HIMS as in the CGE. For a number of reasons Robilliard *et al*. do not believe this is a better approach in practice. We will have a look at those reasons below, after looking at some of the integrated CGE/microsimulation work that has been done

Integrating CGE and microsimulation

As mentioned earlier, interest in integrating microsimulation and CGE is currently running high. Early studies included Slemrod (1985), referred to above, Tongeren (1994), and Cogneau (1999). Tongeren's simulation was for firms rather than households. Cogneau (1999) dealt with a single city, Antananarivo, and was mostly concerned with labour market issues. Full-blown studies include Plumb (2001), Cororaton (2003), Cogneau and Robilliard (2006), Cockburn (2006), and Rutherford *et al*. (2007).[20] The Cogneau and Robilliard (2006) and Cockburn (2006) studies may be taken as representative of current fully integrated economy-wide models. Rutherford *et al*. (2007) is of special interest here since it is the first CGE microsimulation model for a transition country.

Cogneau and Robilliard (2006) is concerned with the impact of growth shocks on income distribution and poverty in Madagascar – an issue focus that is representative of current concerns in development economics. The model is built on household survey data with a sample size of 4,508. Both labour market characteristics and consumer preferences are defined at the household level. Since Madagascar is heavily agricultural much attention is focused on production activities in rural areas. There are three sectors: agriculture, the formal sector, and the informal sector. Two agricultural goods are distinguished: cash and traditional crops. The other sectors each produce just one good. There are three factors: labour, land, and capital. Capital is used in the formal sector and in agriculture. It is sector-specific and fixed. (Fixed and specific capital is used implicitly in the informal sector, but its returns are assumed tied to those of labour.) Output and labour demand in the formal sector are taken as exogenous. Cash crops may be exported. Consumers have LES preferences, which are calibrated at the household level making use of micro-data on their recorded expenditures on different goods.

In a preliminary exercise Cogneau and Robilliard use their micro data to estimate the agricultural production function, and human capital-type wage equations for the informal and formal sectors. Household (informal sector) or individual (formal sector) wage residuals from the estimated equations are noted. They then calibrate the remainder of the model using standard techniques. A range of experiments are performed to examine the impacts of various growth shocks: expansion of the formal sector, wage and dividend increases in the formal sector, increases in total factor productivity (TFP) in the production of the two crops, and an increase in the world price of cash crops.

For our purposes it is most interesting to know how the results of the Cogneau and Robilliard exercise compare, alternately, with those of pure microsimulation and a representative household (RH) version of the CGE model. The comparison with microsimulation is particularly interesting since the simulation here allows full behavioural responses. The only difference between microsimulation and full CGE results is thus due to the fact that prices are endogenous in the CGE runs.

Allowing endogenous price changes alters the results significantly. For example, when total factor productivity rises throughout agriculture, value added in the informal sector plunges 19% when prices are fixed, but rises 5% with price changes (in which case the drop in agricultural prices caused by the productivity improvement causes households to reallocate labour from agriculture to the informal sector). Most of the simulated changes in overall inequality and poverty (although not within and between components) go in the same direction in the microsimulation and CGE exercises, although in most runs endogenous prices result in either significantly larger inequality and poverty reductions, or smaller increases. In the case of a TFP rise in cash crops overall inequality (as measured by the Theil index) and both the poverty gap and severity changes are in the opposite direction when prices are endogenized.

While it is very clear that endogenizing prices has an important impact on results, it is somewhat less clear that integrating the microsimulation and CGE exercises, as opposed to assuming lognormal distributions with constant inequality within household groups, greatly affects the results. Cogneau and Robilliard examine the effects on the poverty headcount ratio both overall and within 14 different household groups, again using the six different growth shocks. For the overall poverty headcount, results of the CGE microsimulation vs. lognormal approaches are fairly similar, except for a TFP increase in agriculture. In that case the headcount rises by 2.6% with the lognormal assumption but by 3.7% with the microsimulation/CGE.

The Cogneau and Robilliard results for overall poverty headcounts should provide some comfort for those who wish to inject distributive detail into CGE modelling without going the full microsimulation route. However, while there is no systematic direction of bias, Cogneau and Robilliard also find that the poverty headcount impacts within specific household groups are typically quite different in the two approaches. Cockburn (2006) feels strongly that this is an indication that the lognormal approach is not good enough and further efforts should be channeled into CGE microsimulation.

Cockburn (2006) is concerned with the impacts of trade liberalization on poverty in Nepal. His work is based on a sample survey of 3,373 households, and has 15 factors of production, 15 sectors, and 3 regions. He studies the impact of replacing all import tariffs with an equal-yield uniform consumption tax. The major impact of eliminating tariffs is that imported food becomes cheaper. This helps urban households and hurts those engaged in agriculture. Poverty declines in the cities, but rises in the rural areas and overall.

Cockburn's results, like those of Cogneau and Robilliard, support the position that microsimulation adds substantially to the quality of the distributive detail produced in CGE. He finds, for example, that in the rural areas the increase in poverty is greatest among the moderately poor rather than the very poorest. At the opposite end of the spectrum he is able to trace increases in inequality in the urban and hills/mountains regions to very strong positive income changes for the very richest individuals. This type of distributional detail is unavailable using the lognormal approach.

Cockburn also emphasizes that there were neither great computational nor conceptual problems in performing his simulations. It can thus be argued that integrated CGE microsimulation has come of age, and we may look forward to seeing more such work in the future. On the other hand, Robilliard *et al*. (2008) and Bourguignon *et al*. (2003) provide strong arguments for also working with layered rather than integrated models. These arguments are most persuasive when, as in their work for Indonesia, it is regarded as very important to simulate realistically variation in labour supply and occupation choice responses to changing prices, wages, and employment conditions. For realism, it is likely best to base one's equations on econometric estimation using micro data. There is then a choice between the popular reduced form approach, and the more challenging and problematic structural approach. The latter requires making assumptions about the functional form of preferences and specifying constraints facing households and individuals carefully, in a world where these steps may be arbitrary and difficult. It is also argued that there is tendency toward assuming full information or perfect markets in structural estimation.

A reasonable conclusion may be that integrated models are best for some purposes and layered models for others. The integrated models appear cleaner and more transparent. They may have the advantage where the goal is to understand the direction and relative magnitude of distributional and other effects in terms of a full microeconomic analysis. The layered models, in contrast, perhaps have an advantage where the concern is about short-term distributional impacts in a setting where realism is at a premium and theoretical niceties are not so important. In analyzing the impacts of a serious crisis, as in Indonesia, a layered approach may get the job done best, whereas in doing more long-run analysis the luxury of an integrated approach may be more affordable.

The result of the pioneering work reported in Cogneau and Robilliard (2006) and Cockburn (2006) was a large stimulus to CGE microsimulation work. A mounting number of such studies are now available for developing countries. (See, for example, Savard, 2005; Cororaton and Cockburn, 2007; Cockburn *et al.*, 2008, and Bourguignon and Savard, 2008.) The method has also now been applied to a major transition country. Rutherford *et al*. (2007) use a small open economy CGE microsimulation model for Russia to study the impact of global free trade and implementation of the Doha Development Agenda under the WTO, which would reduce domestic food subsidies. They compare those results with the impact of Russian accession to the World Trade Organization (WTO) on income distribution and the poor. The microsimulation uses data from the Russian Household Budget Survey, which covers 55,000 households. Given the importance of foreign direct investment (FDI) liberalization as part of Russian WTO accession, the authors also study the productivity effects of liberalizing import barriers against FDI in services. This study is particularly noteworthy as the first major application of CGE microsimulation to a transition country.

The Rutherford et a. results illustrate the value of CGE microsimulation in augmenting estimates of overall welfare gains from trade reforms with results on distributional impacts. It is estimated that, in the medium run, WTO accession by Russia would produce an average gain for households equal to 7.3 percent of consumption, with a standard deviation of those gains of 2.2 percentage points and almost all households experiencing a gain. Global free trade generates an average gain of only 0.2 percent with a standard deviation of 0.2 percent, indicating that the variation in household impacts is very large and that many individual households would lose from this (very) hypothetical development. Adoption of the Doha Development Agenda would produce even worse results, with an average loss of 0.3 percent and a standard deviation of 0.2 percent. Russia, as a net food importer, would lose from the elimination of food subsidies under this agenda, and the gains to Russia from tariff cuts in other countries would be too small to offset these losses. Rutherford *et al*. Conclude that unilateral liberalization by Russia, in particular reduction of barriers against FDI in business services, would produce larger and more uniform gains for households than hoped-for improvements in market access as a result of reforms in tariffs or subsidies in the rest of the world.

5. MICROSIMULATION, CGE AND MACRO MODELS

In this section we look at modelling exercises that provide pairwise links between microsimulation and macro models and between CGE and macro models, as well as efforts to link all three types of models.

Microsimulation and macro models

It has been unusual to link microsimulation and macro modelling without bringing CGE into the picture, although many microsimulations use macro simulation results as inputs. This may be due partly to the assessment that if we want to introduce macro aspects it is important to include the endogenous prices one gets via CGE, and not just endogenous quantities. But it is likely also due to the fact that CGE and microsimulation are both fundamentally micro approaches and therefore have more in common with each other in terms of structure and data requirements than either does with macro models. We have already referred, for example, to Cameron and Ezzedin (2000) who add a regional input-output model to a standard Canadian microsimulation model. Another way of adding macro detail, without doing CGE, is to complement a microsimulation with a full SAM-based multiplier analysis. Such an exercise is carried out for the Tuscan region of Italy by Lattarulo *et al*. (2002).

In both the Cameron and Ezzedin analysis and the Lattarulo *et al*. model there is a process of iteration between the microsimulation and macro models. Suppose the government makes a change in taxes or transfers. The microsimulation models the first-round impact on disposable income and consumption. The macro model can then be used to derive resulting impacts on production and factor income which then can be fed back into the microsimulation.[21] Iteration continues until convergence is obtained.

Lattarulo *et al*. (2002) is of special interest because it applies its microsimulation/SAM multiplier model to a relatively small region within a large country. The usual objection to this style of analysis is that it neglects general equilibrium price effects. But for a subregion of a country the latter can plausibly be neglected, and usual CGE assumptions of fixed factor supplies would be inappropriate. The markets for labour and consumer products are highly integrated with those in the rest of the country and it is unlikely that significant changes in relative prices for most products or factors would be caused by fiscal experiments in Tuscany alone. (Changes in real estate prices could of course occur, for example, if the Tuscan economy grows more slowly or more rapidly than that of the country as a whole.)

Since we are living in a time of greater international economic integration it may be that for some problems microsimulation/SAM may turn out to be more appropriate than, say, the CGE microsimulation discussed above. As labour and capital mobility throughout the EU becomes more perfect, and as consumer markets become more highly integrated, the analysis of long-run fiscal impacts in some European countries may come to be better modelled via SAM than CGE. This is more likely to be true the smaller the country, and the stronger its economic integration with its neighbours. EU-wide fiscal innovations, however, will continue to be better addressed via CGE.

CGE and macro models

Given the ascendancy of dynamic GE analysis in modern macroeconomics one might expect that integration of CGE and macro modelling would by now be far advanced. While many CGE models now have some macro elements, full integration of the two approaches is rare. In part the reason is that CGE modellers are much more interested in sectoral disaggregation than are macroeconomists.[22] And in part, on the grounds of realism CGE modellers have been reluctant to assume the sophisticated and highly rational behaviour of households and firms that is incorporated, for example, in new classical macroeconomics. (See, for example, Annabi *et al*., 2005, for a discussion of this point.) Attempts to augment CGE with macro models have thus, so far, largely united CGE models with Keynesian macro models.

One way of combining macro modelling and CGE is to 'layer' existing macro and CGE models. The alternative is full integration of the two kinds of models. An advantage of the layering approach is that proven, existing models that have been developed independently can sometimes be productively harnessed together. There is a long tradition of such work in Australia, for example, where the ORANI CGE model was layered with a variant of the Reserve Bank's RBII model by Cooper *et al*. (1985) and with the 'Murphy model' by Breece *et al*. (1994). Although this work does not have important distributional content it made pioneering technical contributions to the layering approach.

Cooper *et al*. provide a careful discussion of the practical problems in creating an interface between macro and CGE models. Some of the key problems may be a lack of explicit dynamics in the CGE model, temporal aggregation problems, and the presence of variables that are endogenous to both models or 'doubly endogenous'.[23] Investigating these issues, Cooper *et al*. found that on average it takes about two years for the impact of exogenous changes to become as large in the macro model as in the static CGE model. (This rule of thumb was confirmed in the work of Breece *et al*, 1994.) They also found that inconsistency in the predictions of doubly endogenous variables from the macro and CGE sides could be reduced to an acceptable level by reasonable adjustments in the vector of adjustment speeds for different variables in the macro model and by careful choice of the length of time over which the macro model was run. The technical lessons from this work should be helpful to researchers pursuing the layered Macro/CGE modelling approach for developing or transition countries along the lines discussed, for example, by Bourguignon *et al*. (2002).

Bourguignon *et al*. (1989) designed an *integrated* CGE-macro model for use in developing countries. The specific goal was to facilitate the modelling of the distributional impacts of adjustment policies. The macro component of the model was the standard IS-LM framework for an open economy where asset prices are endogenously determined. This model is capable not only of capturing the usual distributional effects studied in CGE models (taking into account possible price and wage rigidities) but also can be used to study the distributional effects of capital flight. Household and agricultural production, as well as the informal sector are accommodated.

It would appear that the Bourguignon *et al*. type model could be applied fairly readily to transition as well as to developing countries. The model was set up as a simulation package that the authors refer to as a 'maquette'. It could be applied to different countries by changing the institutional characteristics that describe commodity, financial, and labour markets.

Taylor (1990) provided a 'new structuralist' CGE model with important macro content. Agénor and Montiel (1996) examined the contributions of Bourguignon *et al*. (1989) and Taylor (1990) carefully, and identified some common areas where progress could be made. They found a contrast between the sophisticated optimizing behaviour within periods and the relatively simple and *ad hoc* dynamic behaviour and pointed out that 'intertemporal optimization on the part of either households or firms based on forward-looking expectations' remained absent. Their conclusion was that although these models presented an advance in their modelling of microeconomic phenomena such as the effects of trade liberalization on the allocation of resources, they were not yet satisfactory for the study of stabilization and growth.

Since the pioneering work of Bourguignon *et al*. (1989) others have provided improved versions of work along these lines. Dorosh and Sahn (2000) have made applications to African countries, and Agénor, *et al*. (2006) at the World Bank have constructed their 'Integrated Model for Macroeconomic Poverty Analysis' or IMMPA. Their framework attempts to integrate a financial sector and other macroeconomic features and endogenous growth modelling in a representative household CGE approach.

6. GROWTH

Microsimulation has increasingly become dynamic in developing countries (see, for example, the surveys by Harding, 1996, and Kelly, 2004). Sophisticated techniques have been developed in several countries to simulate the evolution of age cohorts or entire populations over time, examining, for example, the lifetime consequences of public pension arrangements or taxes and transfers. The consequences for the economic well-being of cohorts and income groups generated by varying economic growth records, and by differences in income growth for different elements of the population, have been carefully studied. This kind of work is unfortunately very costly and has substantial data and modelling requirements. We therefore find that these techniques are yet to be applied in developing or transition countries, although it is to be hoped that dynamic microsimulation models may begin to be seen in those countries before too long.

While dynamic microsimulation is still some way from arriving on the scene in development and transition studies, concern about growth has always been central in those areas and interest in the distributional effects of growth has been high for many years. There has therefore, unsurprisingly, now been significant attention to the development of dynamic versions of CGE microsimulation models and other micro-macro approaches.

A representative example of the kind of dynamic modelling that is now being performed is given by Annabi *et al*. (2005), who use an integrated dynamic CGE microsimulation model to study the potential poverty and inequality effects of unilateral trade liberalisation in Senegal. The model is based on a 1996 SAM and a 1995 survey of 3,278 households. In contrast to static CGE work, which provides long-run analysis without allowing factor accumulation and can therefore be criticized as lacking realism, this work allows both capital accumulation effects and the transition from the initial situation to the post-reform world to be modelled. The hope is clearly that the results will have more predictive value than those of ststic CGE microsimulation.

Annabi *et al*. find that full tariff removal in Senegal would lead to a small increase in poverty and income inequality in the short run. The formerly protected elements of agriculture and industry would also contract. In the long run, however, trade liberalisation would lead to substantial accumulation, particularly in services and industry, bringing significant overall welfare improvements and decreases in poverty. Interestingly, however, inequality in income distribution is predicted to increase, as urban residents and the non-poor benefit more, in relative terms, than the poor.

While the results of the Annabi *et al*. analysis are interesting, it is important to note that the dynamics being introduced on the CGE side are not matched by a movement towards a more dynamic approach on the microsimulation side. A beginning could be made in that direction in current work by following the first steps that were made in this area by microsimulation researchers in developed countries. In particular, it would not be too difficult to implement static ageing – the reweighting of households as the simulation proceeds to mimic predicted changes in demographic composition and labour force characteristics. One appealing aspect is that a dynamic CGE model itself generates predicted changes in the sectoral composition of the labour force, including rural-urban split, producing a key input into the static ageing of the microsimulation.

While there are thus interesting possibilities for integrated dynamic CGE microsimulation work in developing and transition countries, Bourguignon *et al*. (2002) cautions that substantial difficulties would be faced in extending the 'layering' approach to a dynamic setting. Achieving consistency between separate macro, CGE and microsimulation models running over time would multiply considerably the complexity involved in layering these models consistently in a static setting.

There are other strains of microsimulation work that could, in principle, be applied to the study of growth processes in developing and transition countries. An example is provided by the contributions of Wolfson (1996, 1999), Elliason (1996, 1997), and Ballot and Taymaz (1996). These authors were stimulated by Nelson and Winter (1982), who presented an evolutionary simulation model of firms producing with fixed coefficients production functions. These firms were subject to stochastic depreciation, but also could search for better techniques of production, either in a neighbourhood of their existing technique or imitatively by trying to copy the technique of a more successful firm. Nelson and Winter started their simulation in an initial state meant to mimic the U.S. in 1909. They argued that the evolution of technology and output they produced was as good as that provided by neoclassical growth models in most ways, and better in some.

Wolfson (1996) reported initial work on a model for Canada in the Nelson and Winter spirit, XECON, and Wolfson (1999) provided results from the completed model. Technology is much richer than in Nelson and Winter. There is an input-output structure and many commodities. The same commodity can be produced by different firms using different technologies. Learning and search for better techniques produce an evolution of the system over time.

Eliasson (1996) and Ballot and Taymaz (1996) report on simulations with the Swedish micro-to-macro model, MOSES (Model of the Swedish Economic System). MOSES has very realistic detail on firms. In the 1982 database there are 225 manufacturing firms, of which 154 are real firms, whose characteristics are specified on the basis of survey data. While Wolfson's XECON is largely a theoretical tool, MOSES is meant to be a model of an actual economy. It incorporates bounded rationality and the accumulation of 'competence capital' through organizational learning in a heterogeneous environment. There is constant technological competition, ongoing learning, and both entry and exit of firms.

Eliasson (1996) stresses the importance of entry in the growth process. He finds that, over a period of 50 years, if free entry is allowed manufacturing output rises about 50% compared to a no-entry base run (about 45% for GNP). Eliasson is concerned about the dampening effect on growth of the strong restrictions on entry in even our advanced industrial economies. He indicates that only about 30% of the Swedish economy, for example, could be characterised as having free entry.

Ballot and Taymaz (1996) add a training and human capital block to MOSES. In contrast to the usual case, firms in their model invest in the general human capital of their workers, because when they find a useful innovation they earn short-run rents, including rents on the general human capital of their workers. And an important change is made in how firms search for innovations. Rather than using adaptive rules, genetic algorithms are used. This makes the modelling truly evolutionary, and leads to discussion of the simulation as a complex system.

It is interesting to ask what value there could be in applying this kind of growth simulation to developing and transition economies. The environment facing firms in these countries is generally more severe and less predictable than in, for example, Canada or Sweden, but this may make the kind of modelling performed by these authors more rather than less relevant. For example the restrictions faced by business in a country like Russia represent severe entry barriers – just what Eliasson is worried about, and a phenomenon that his style of model is designed to address.

Another area of work on growth processes that cannot be ignored here is the contributions made by 'new classical' macroeconomics. Models with rigorous micro underpinnings and in some cases rich detail on heterogeneous consumers and firms have been generated. In the 1970s and 1980s, macroeconomists at Minnesota and other 'freshwater' North American economics departments began to develop dynamic general equilibrium models of the economy. These were initially quite controversial since they modelled unemployment as an equilibrium phenomenon, assumed rational expectations, and neglected the monetary side of the economy. However, as the models became more sophisticated they began to be more widely accepted. Today, a growing group of young researchers are working with dynamic GE models with heterogenous consumers and workers whose characteristics they specify by reference to microdata. (See for example the pioneering contributions of Huggett, 1996; Krusell and Smith, 1998; Quadrini, 2000; Ventura, 1999.) In addition to savings, these models have endogenized labour supply and human capital investments. The researchers not only examine simulated distributions of earnings, consumption, and income, but have also shown interest in the distributions of wealth generated. Experiments have been done to replace progressive income taxes with consumption taxes, or with proportional income taxes. Studies of the impact of altering pension regimes have also been performed.

7. CGE, MICROSIMULATION AND POLITICAL ECONOMY

It has been recognized for some time that CGE models have important potential applications in political economy analysis.[24] (See for example Dervis *et al*., 1982:401-402.) Much of the output concerns distributional effects of alternative policies, and the tussle over distribution is of course the bread and butter of politics. To the extent that voters or, say, regional or other subnational governments, act in their self interest, their behaviour may be predicted from distributional analysis. Examples of research applying this kind of insight can be found in Groenewold *et al*. (2000) who model the reaction of regional governments to redistributive policies imposed by a federal government, and in Yeldan (1998) who examines the role of different interest groups in the 1994 Turkish economic crisis in the light of CGE analysis.

Some authors have been very imaginative in their application of CGE to political economy questions. A good example is provided by De Janvry *et al*. (1991b). (See also De Janvry and Subbarao, 1986; and De Janvry *et al*., 1991a.) De Janvry *et al*. argue that in Ecuador traditionally the coastal agricultural interests had controlled the political process, but that in the 1980's oil boom an elite of the more highly educated members of the population took over. However, since either elite formed a minority of the population, it needed the support of another group to hold power. The rural poor provided the most promising political ally for both groups, in view of their relatively large numbers.

De Janvry *et al*. analyzed the effects of alternative stabilization policies on the incomes of the alternative voter groups. However, they went beyond mere analysis of the possible political effects of given policy changes. They determined the policies that particular political coalitions could adopt if they wished to achieve or maintain power.

This immediately suggests the possibility of using CGE political economy analysis not just by social scientists but by political parties and leaders themselves. One could, in fact, observe that the proof of whether the technique has predictive power will lie in whether it receives such use in the future.

In the standard CGE model the choice of factor and household disaggregations has an impact on the political insights that can be obtained. If one differentiates labour only according to the categories skilled/unskilled, male/female, and urban/rural, for example, then it is impossible to study the effects of policies that discriminate between workers in different cohorts, regions, or industries, or between, say, skilled blue collar workers and the university educated. Similarly, if representative households are defined, say, according to income group, then many politically-relevant dimensions are missed. The solution advocated, for example, by De Janvry *et al*., is to choose groupings carefully, in the light of one's political analysis. However, this approach imposes limits at the start that may be difficult to correct in the light of evolving insights about the political process.

It seems clear that this is an area where integrated CGE microsimulation would have great advantages. It is not necessary to adopt any prior grouping of households or individuals. There is no limit to the alternative ways in which people can be grouped, and the sensitivity of results to a wide variety of changes in the details of tax and benefit proposals can be investigated. A possible downside is that the tool could be 'hijacked' for political purposes. While the economist may wish to focus attention on state-of-the-art inequality and poverty measures, for example, there may be pressures from policy-makers and governments to focus on redistribution between key groups of voters instead. Use of CGE microsimulation to perform political economy analysis may therefore turn out to be something of a two-edged sword.

While there do not appear to be any political economy studies that have yet used CGE microsimulation, the latter field is young and it seems very likely that such studies will be forthcoming. Already, one can look at the losers and gainers from policy changes and proposed reforms in CGE microsimulation work and make informal guesses about the likely extent and composition of voter support for such initiatives. In the Cockurn (2006) study of Nepal, for example, one sees that a projected gain from trade liberalisation for a majority that includes most urban dwellers and higher income rural residents, suggesting that such liberalisation is politically feasible. Or in the work of Rutherford *et al*. (2007) for Russia one can see possible majority alliances in favour of domestic reforms but one will also search in vain for such a grouping that would support the Doha Development Agenda. It would seem that a reasonable guess can be made about which of these policies would 'fly' with voters. It would be naive, of course, to think that the existence of majorities modelled to gain from particular policies means that the latter will necessarily be adopted, even in fully democratic countries. The identification of the size and composition of gaining and losing groups is only an input into political economy analysis. Outcomes depend on the nature and details of political institutions and strategic interactions between the relevant groups of political actors.

8. CONCLUSION

This paper has overviewed recent work that has attempted to bring together microsimulation, CGE, and macro models to perform distributional analysis in developing and transition countries. We have seen that different combinations of such models, including those where only a single model-type is used, are appropriate for different problems. For short-run impact analysis, microsimulation on its own may be appropriate. However, we naturally want to know about the interrelationship between the changes in disposable income, consumption and labour supply found in a sophisticated microsimulation on the one hand, and general equilibrium price changes or changes in macro variables on the other hand. In the case of national subregions, or countries embedded in free-trade areas, it can be argued that microsimulation may adequately be combined with pure macro models. That is, CGE modelling may not be necessary. For distinct national economies, however, the first step beyond microsimulation should likely be integration with CGE modelling. Ultimately, structures in which macro, CGE and microsimulation models are either layered or integrated can also be pursued.

There has now been considerable research on combining microsimulation with CGE and macro models in developing countries. This research shows both that distributional results from microsimulation tend to change significantly when CGE is added, and that the converse is true as well. Further, avoiding microsimulation by assuming that income distribution follows an assumed functional form within household categories in CGE exercises produces significantly different results from full CGE microsimulation. Taking such shortcuts has been shown to minimize estimated poverty and inequality impacts in some important cases. Also, the impacts of growth shocks, trade liberalisation and other shocks on distribution are shown to be much more complex in exercises that add full microsimulation to CGE and macro modelling. Such insights as the Cockburn (2006) finding that trade liberalisation will tend to reduce poverty for the urban poor in Nepal, while increasing it for the rural poor but especially the moderately poor in that group, are not to be found in more aggregated models.

We have also seen that promising work has now been done in dynamic integrated CGE microsimulation work in developing countries. Refinement of CGE microsimulation dynamics, at least exploiting the possibilities for static ageing, is one fruitful direction in which his work can be further developed. Macroeconomic or financial aspects can conceivably also be explored in this context, but again the most productive approach is likely to be an integrated one.

Much microsimulation work has been done in developed countries. CGE work is most advanced, on the other hand for LDCs. Currently, several groups of development researchers are putting these two approaches together, and in some cases are adding macroeconomic and financial modelling as well. In contrast, with a few conspicuous exceptions, little such work is being done for the transition economies. It is to be hoped that increased modelling efforts will be seen for the transition countries, yielding strong microsimulation, CGE and macro models, separately and in combination.

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Notes

1 In 2004 UNU-WIDER produced a tax/benefit simulation model for Russia, DART. The public could perform a range of policy experiments using this model at http://www.wider.unu.edu/darts_web/. There has been a burst of CGE work modelling the results of WTO accession and EU expansion for Russia; see Jensen *et al*. (2002), Sulamaa and Widgren (2002), and Rutherford *et al*. (2007). Special purpose CGE work has been done for some other European transition economies, for example Lensink (1999) and Galinis and van Leeuwen (2000). There have also been a number of CGE studies of trade-related issues for the Asian transition economies. See, for example, Shantong and Fan (2001) and Diao *et al*. (2002) on the effects of WTO accession for China.

2 Orcutt and those he influenced in the 1960's and 1970's wanted to implement his vision as quickly as possible, and made very ambitious efforts in that direction. The Bergmann *et al*. (1980) volume, which covers three highly developed microsimulation models of the day, shows this research agenda in full flower. Ultimately, the attempt to put macroeconomics on new foundations via microsimulation was, however, not recognized by mainstream macroeconomists. The index to the recently published three volume North-Holland handbook on macroeconomics (Taylor and Woodford, 1999), for example, contains no references to Orcutt or to microsimulation. A check of a couple of leading current advanced macroeconomic textbooks also showed no references.

3 See for example Cameron and Ezzedin (2000), who add a regional input-output model to a standard Canadian microsimulation model.

4 Another way in which Orcutt's vision is beginning to be realized is in the development of "new classical" macroeconomics. See the discussion in Section 6.

5 Such cascading is avoided under a properly administered value added tax. Accounting correctly for cascading is an important task in modelling the impacts of replacing conventional sales taxes by VAT. See Jenkins and Kuo (2000).

6 With the help of such measures analysts can look further and ask, for example, whether post tax/benefit distributions can be ranked according to welfare dominance criteria. For an example of such methods applied to microsimulation see Davies and Hoy (2002).

7 Kelly (2004, Ch. 4) surveys such studies, which have been especially important in modelling retirement saving and state pension plans. The models include CORSIM, based at Cornell University in the U.S.; DYNACAN, initially modelled on CORSIM and developed by Statistics Canada; PENSIM, begun by the UK Department of Social Security; and DYNAMOD, developed by the National Centre for Social and Economic Modelling (NATSEM) in Australia.

8 See Table 1 in Davies (2004) for illustration of the structure of a representative SAM.

9 An important reference here is Robinson and Roland-Holst (1988), which compares SAM and CGE multipliers for the U.S. economy. Perhaps surprisingly, the authors find that about 60% of the CGE multipliers are negative (whereas all the SAM multipliers are positive). This reflects the fact that a spending injection in a particular area of a full-employment economy will lead to increases in activity in the areas most directly affected, but reductions in many other areas. The difference between SAM and CGE multipliers is sufficient to indicate that great care must be taken in deciding on one's modelling approach.

10 An interesting illustration of these challenges is provided for Russia by Nakamura (1998).

11 Various techniques have been used. An early method was the 'Row and Sum' or RAS method proposed by Bacharach (1971). For more discussion see Davies (2004).

12 An excellent treatise on the application of CGE to the developing countries is Dervis, De Melo and Robinson (1982).

13 Perroni and Rutherford (1998) have explored the possibilities for using a variety of functional forms in CGE that allow greater flexibility than the CES (translog, generalized Leontief, and normalized quadratic). These are shown to be globally irregular and inferior in preserving local calibration information over the domain of modelling exercises.

14 See Robinson and Lofgren (2005) for a good discussion of this aspect.

15 An example is provided by the model of crisis and income distribution in Indonesia proposed by Robilliard *et al*. (2008). They assume that

investment and government spending are fixed proportions of total absorption (GDP plus imports minus exports). Under this assumption, the effects of a contraction of the economy will be shared proportionately by investment, government spending, and private consumption. As Robilliard *et al*. say, this "effectively assumes a 'successful' structural adjustment program whereby a macro shock is assumed not to cause particular actors…to bear a disproportionate share of the adjustment burden".

16 A variant was provided by Decaluwé *et al*. (1999) who assumed within-group distributions followed the beta distribution rather than the lognormal. (See also Agénor *et al*., 2006; Boccanfuso *et al*., 2008.) This allows greater flexibility in the shape of the distribution. Decaluwé *et al*. assumed that the *variance* of income within a household group remained constant. Bearing in mind that the ratio of the variance to the mean is a measure of relative inequality, we see that this implies that inequality falls in any group that experiences an increase in mean income and that the opposite occurs if mean income in the group declines. These changes in intragroup inequality help to explain some apparently non-intuitive results reported by Decaluwé *et al*.

17 For example, it would be easy to compute the distributive impact of a basic income/flat tax proposal like that explored by Atkinson and Bourguignon (1991).

18 For an innovative example of a layered CGE microsimulation that is not 'top-down' see Savard (2003). Savard runs his CGE and microsimulation iteratively until the two produce consistent results. He refers to this as a 'top-down, bottom up' approach.

19 This step involves the simulation of occupational choices. Bourguignon *et al*. (2002:35) make clear that the parameter adjustments needed to achieve consistency with the CGE results are more complicated than for wages or incomes. This is because the functions involved are not linear. A process of tatonnement "on specific parameters of these functions" is performed until the employment structure coming from the HIMS is the same as generated by the CGE model.

20 Also included in this genre should be village-level CGE models that model the behaviour of individuals and households separately. See Taylor and Adelman (1996).

21 In the SAM-based analysis of Lattarulo *et al* the altered income/consumption structure produced by the microsimulation is used to alter the entries in the SAM, and associated multipliers, at each iteration.

22 Davies, Hamilton and Whalley (1989) explored the impact of making the minimal advance beyond the typical one-sector model used in OLG models of tax reform, moving to two sectors. They found significant differences in results.

23 For a more complete list see Cooper *et al*. (1985:417.) See also the discussion in Davies (2004).

24 There is a large literature on the political economy aspects of macroeconomics. See Drazen (2001). Surveying that literature is beyond the scope of this paper.

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