Microsimulation, CGE and Macro Modelling for Transition and Developing Economies

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1. INTRODUCTION

The purpose of the paper is to explore the relationship between conventional microsimulation and modelling techniques that incorporate relative price and/or aggregate economic responses. The latter include CGE models and various macroeconomic approaches - - for example multiplier models based on social accounting matrices (SAM's), IS-LM type models, and macro-econometric models. For clarity we will not use the "macro" label for CGE models, although many CGE studies incorporate some macro elements.

Complementing microsimulation with CGE or macroeconomic models has come to be referred to as making "micro-macro" links. This is an area of great current interest. (See e.g. Ag**J**nor et al., 2002; Bourguignon et al., 2002; Cockburn, 2001; and Cogneau and Robilliard, 2000.) Approaches and techniques are still under development, and in some cases (e.g. with regard to economic growth) are in their infancy. This literature is still at a stage where it is not clear what links are most appropriate and feasible.

While microsimulation is essential in modelling the distributive effects of taxes and transfers, it is limited by the fact that it is often non-behavioral 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. Fortunately, the division between the two types of models is beginning to break down. In some cases the different model types have been merged or integrated. In other cases the models have been treated in a "layered" manner.

In recent literature it has become clear that different combinations of model types are needed when dealing with different issues. For some purposes it may still be best to use just one of the standard model types. For example if one is interested in the medium term impact of tax reform or trade liberalization on relative factor rewards then a standard CGE model may be sufficient. On the other hand, if the issue is the effect on poverty then an integrated or layered CGE/microsimulation model may be needed. Another kind of "two-layer" model would combine CGE and macro modelling, e.g. when monetary and financial phenomena play a key role in the analysis but distributional detail is not required. Finally, one can imagine using three-layer models (microsimulation/CGE/macro) if both monetary/financial and distributional detail are needed. (See Bourguignon et al, 2002.)

Currently, in the developing world, while tax/benefit reforms receive some attention, the leading issues surround the impact of factors like globalization, adjustment policies and debt reduction on growth and (especially) poverty. CGE/macro analysis has been widely used to analyze these impacts. In the transition economies similar issues are also important, but in addition there are concerns that echo more those in the developed world. In OECD countries the focus is often on the distributional impact of tax and transfer reforms, and expenditure changes. Similar concerns are found in transition countries. For these purposes a sophisticated microsimulation may be sufficient.

While there have been interesting recent developments, 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. Since CGE models in particular relate most to the medium or long run, rather than to the short-term, there may simply have not been enough stability to make them appear relevant. As transition begins to proceed in a more orderly way, better data become available, and more consensus develops about how to model these economies, rich possibilities 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. Thus, in the future it is to be hoped that micro-macro links will extend more to dynamic modelling. Tax and benefit changes can affect growth e.g. through

[1] WIDER has recently put online an innovative tax/benefit simulation model for Russia, DART. It can be accessed 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) and Sulamaa and Widgren (2002). Special purpose CGE work has been done for some other European transition economies, e.g. Lensink (1999) and Galinis and van Leeuwed (2000). There have also been a number of CGE studies of trade-related issues for the Asian transition economies. See e.g. and Shantong and Fan (2001) and Diao et al. (2002) on the effects of WTO accession for China.

impacts on saving and investment, human capital formation, fertility, innovation, and incentives for the adoption of new technology. These influences may be analyzed either in the context of neoclassical or endogenous growth models, as some recent literature in development economics has begun to explore.

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 could be done by aggregating the carefully modelled behavior of individual consumers and firms. (See Orcutt, 1957 and Orcutt et al., 1976.) This is still the guiding vision of most practitioners of microsimulation. However, while a minority have tried to implement the grand vision, the majority have taken it as a long-range objective and have mostly limited themselves to a more practical approach for the present. The latter group has its eye mainly on distributional issues.[2] Its members want to construct reliable models of individuals and households that will allow careful analysis of the impact of policy changes. While modelling the overall behavior of the economy has not been the main agenda of this group, from time-to-time attempts are made to graft macroeconomic content onto these models.[3] And

[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 e.g. Cameron and Ezzedin (2000), who add a regional input-output model to a standard Canadian microsimulation model.

today, with many researchers attempting to join microsimulation and CGE models in various ways, the achievement of Orcutt's original vision is coming closer to reality.

Another way in which Orcutt's original vision is being realized is seen in the development of modern 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, as is well-known, macroeconomists at Minnesota and other "freshwater" North American economics departments began to develop dynamic general equilibrium models of the economy. These were initially 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 e.g. Huggett, 1996; Krusell and Smith, 1998; Quadrini, 2000; and Ventura, 1999.) In addition to savings, these models have endogenized labor 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.

What is meant by microsimulation today is often the modelling of household income distribution and consumption, taking detailed account of taxes and transfers but leaving 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 (e.g.

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. [4]

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.[5]

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 U.S., and TAXMOD and POLIMOD in the U.K. Further, the EU has spent several years developing such a microsimulation model, EUROMOD, for 15 core member countries. (See Sutherland, 2001.)

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[4] 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).

[5] With the help of such measures analysts can look further and ask, e.g., 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).

Current microsimulation is not confined by any means to static non-behavioral modelling. Models that endogenize labor supply and saving behavior on the basis of econometric estimates of the relevant relationships are not uncommon. The methodology of such studies is discussed e.g. in Bourguignon, Fournier and Gurgand (2001) and Bourguignon, Ferreira and Leite (2001). (See also Section 4 below.) These are, of course, partial equilibrium models. Further, there has been substantial development of "dynamic" microsimulation models, 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.[6]

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

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. Table 1 illustrates the structure of a representative

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[6] 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.

SAM.[7] The columns 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. The *ij*'th entry in this table, which we will denote T_{ij} indicates the receipt of account *i* originating from expenditure account *j*. Disaggregation within accounts to produce a more detailed SAM is possible, in which case some of the T_{ij}'s would become matrices. With such disaggregation note that T_{55} becomes the economy's input-output table.

In addition to providing a description of the structure of an economy, a SAM can be used for multiplier analysis. 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.[8] 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.

It is not hard to see how the SAM can be used for multiplier analysis. First we must identify and segregate the exogenous accounts. Define a new SAM that excludes these exogenous accounts, and consolidate exogenous expenditure into the vector *x*. Normalize the SAM entries by the column expenditure totals to give a matrix

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[7] This figure is a slightly simplified version of that shown by Decaluw**J** et al. (1999) who in turn based it on Thorbecke (1988). The following discussion uses largely the same symbols and definitions as Decaluw**J** et al. See also Pyatt and Round (1985).

[8] 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.

of average expenditure propensities for the endogenous accounts, A. The vector of receipts or expenditures for the endogenous accounts, y, is then given by:

(1) $y = Ay + x$

yielding:

(2) $y = (I - A)^{-1} x$
$= Mx$

where M is known as the accounting multiplier matrix. Equation (2) can be used to predict the impact of changes in exogenous expenditures on all the endogenous accounts in the economy.[9] While it is limited by the assumption of unitary expenditure elasticities, the technique can be made more sophisticated by using marginal rather than average expenditure propensities for households. (See Decaluw**J** et al., 1999.)

The actual construction of a 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. Various techniques have been used to do this, and this aspect remains an area of current research. An early method was the "Row and Sum" or RAS method. (See Bacharach, 1971.) Least squares methods can also be used. The state-of-the-art is represented by entropy methods. (See Robinson, Cattaneo and El-Said, 2001.) Whatever the numerical method used, it is clearly best to adjust least those estimates in which researchers have greatest confidence. Thus, for example, in most OECD

[9] An example of such an exercise is provided by Bautista et al. (2001) who model the impact of three different industrial development strategies on the Indonesian economy. While this study performs a CGE analysis, it begins by looking at the SAM multiplier effects of increased expenditure on agriculture, food processing or light manufacturing, showing that an exogenous increase in the demand for agricultural output would have the largest effect. This prediction is confirmed in the CGE analysis.
[10] An interesting illustration of these challenges is provided for Russia by Nakamura (1998).

countries it would be inadvisable to adjust the government's own reports of its receipts and expenditures.[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 less frequent intervals. In Russia, for example, the latest input-output table available is for 1995. The inevitable result is that the most recent SAM will tend to be at least a few 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

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 macro 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, and there are no "macro closures". Savings are just another good over which consumers have preferences. Unemployment can be modelled by imposing imperfections that keep wages for, say, unskilled labor above the market-clearing level; but underutilization of resources cannot arise for *macro*economic reasons.

[11] In developing and transition countries there may not be sufficient confidence in the government's accounts to warrant giving them "protected" status in this exercise. Nakamura (1998), for example, adjusts the government's accounts along with other data in constructing his SAM for Russia.

Since the 1970's CGE modelling has come to be used very widely in LDC's, 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 LDC's.[12]

In order to specify a CGE model we must 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. 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, say, a complex system of sales and excise taxes is replaced by a more uniform VAT, more aggregated consumer products would generally be used if the focus is on labor markets.

From the distributive viewpoint a crucial decision concerns the treatment of households. In conventional CGE models a relatively small number of representative household (RH) groups is chosen. In less developed countries these may be specified e.g. 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 LDC's and DC's 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 e.g. poverty impacts.

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

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

the CGE experiments.[13] 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.[14] 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.

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 Cobb-Douglas or CES, and intermediate goods and Value Added may be combined either in fixed or flexible

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[13] A variant was provided by Decaluw**J** et al. (1999) who assumed within-group distributions followed the beta distribution rather than the lognormal. (See also Boccanfuso et al., 2003.) This allows greater flexibility in the shape of the distribution. Decaluw**J** 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 Decaluw**J** et al.

[14] 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.

proportions.[15] Firms are generally assumed to be competitive profit maximizers, although imperfect competition is sometimes modelled.

On the household side preferences may be pure CES, but typically this specification 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 e.g. sub-functions being defined for food, housing, transportation, services etc.

A currently popular specification for consumer preferences is the linear expenditure system (LES). 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, where saving and investment is not treated simply as another good purchased by consumers, or fiscal or trade imbalances are allowed, it is necessary to close the CGE model by specifying how the various macro balances are determined. Assumptions are unavoidably somewhat ad hoc, and there is often a fear that the choice of a particular closure may unduly influence results.[16] There is an art involved in the choice of closure. Often, an attempt is made to err on the side of

[15] 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.

[16] For example, referring to the early generation of CGE models that produced distributional results, Dervis et al. (1982, p. 406) say "It is perhaps a pity that these first models all mixed macroeconomic and relative price relationships in their CGE framework, because it has led to some confusion in interpreting their results."

assuming a relatively “neutral” or “balanced” closure, in order to avoid extreme results.[17]

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 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.

In many cases it is also necessary to implement an "Armington assumption". For example, 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. Also, the widely observed phenomenon of "cross-hauling" cannot be generated.[18] A common solution is to recognize that in some cases imports and domestically produced goods are imperfect substitutes. This then requires demand elasticities for exports to be

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[17] An example is provided by the model of crisis and income distribution in Indonesia proposed by Robilliard et al. (2001). 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”.

[18] Cross-hauling refers to the case where countries sell goods or services in the same category to each other. For example, many European countries sell wine to each other. This would not occur in the standard trade model if all wines were perfect substitutes.

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 e.g. Abrego and Whalley, 2002.) This is done when CGE is used in an *ex post* fashion to attempt to understand changes that have occurred in the past. 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 the best CGE framework to employ. 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 that can be adopted to perform the required inexact calibration.

It should perhaps be pointed out that in the case of transition economies there may be much interest in *ex post* analysis of distributional and other changes that occurred during periods of major policy change. It may be that doubly calibrated CGE models will begin to play a role in such work.

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. The best example is provided by Robilliard, Bourguignon and Robinson (2001), who model the effects on poverty and inequality of the financial crisis that hit Indonesia in 1997. This study, which we will refer to as RBR, 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 RBR has 38 sectors and 15 factors of production. It is meant to capture 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.[19]

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 - - e.g. age, schooling level and region in the case of labor 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-

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[19] 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.

added in those sectors. There are eight labor categories, giving all combinations of urban/rural, male/female, and skilled/unskilled. In the formal sector labor markets, real wages are assumed to be indexed to total formal labor demand, for all labor categories. Informal labor markets absorb any labor not employed in the formal sector. Wages adjust to clear the informal labor markets, while employment adjusts in the formal sector.

Having computed changes in wage rates, average self-employment income, and employment in the CGE model, RBR 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 labor-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.[20]

RBR 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. RBR 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 RBR 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

[20] This step involves the simulation of occupational choices. Bourguignon et al. (2002, p. 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.

Integrating CGE and Microsimulation

As mentioned earlier, although interest in integrating microsimulation and CGE is currently running high, there are still only a small number of completed studies. These include Slemrod (1985), referred to above, Tongeren (1994), Cogneau (1999), Cogneau and Robilliard (2000), Cockburn (2001), Plumb (2001), Boccanfuso et al. (2003) and Cororaton (2003).[21] Tongeren's microsimulation was for firms rather than households. Cogneau (1999) dealt with a single city, Antananarivo, and was mostly concerned with labor market issues. Cogneau and Robilliard (2000) - - abbreviated here to CR - - and Cockburn (2001) may be taken as representative of current fully integrated economy-wide models.

CR 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 labor 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: labor, 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 labor.) Output and labor 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 CR 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. CR then calibrate the remainder of the model using standad 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 CR 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 labor 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. CR 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

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[21] Also included in this genre should be village-level CGE models that model the behaviour of

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 CR 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, CR also find that the poverty headcount impacts within specific household groups are typically quite different in the two approaches. Cockburn (2001) 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 points out that CR's exercise had a fairly high level of aggregation - - three sectors and four goods. I would also point out that the behavior of one of these sectors (the formal sector) is taken as exogenous, and that government expenditure, investment, and the foreign sector are all treated as part of one account. There is no explicit assumption on closure. Households have a constant marginal propensity to save, and it is implicitly assumed that the various forms of expenditure lumped together into the residual account adjust so that total demand from this sector is unchanged.

Cockburn (2001) is concerned with the impacts of trade liberalization on poverty in Nepal. His work is based on a sample survey of 3373 households, and has 15 factors of production, 15 sectors, and 3 regions. He studies the impact of eliminating all import tariffs with a compensatory uniform consumption tax being levied to maintain government revenues. 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 once again 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

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individuals and households separately. See Taylor and Adelman (1996).

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. (2001) 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 labor 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.

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 current efforts to link all three types of models.

Microsimulation and Macro Models

It is unusual to link microsimulation and macro modelling without bringing CGE into the picture. However, such attempts have been made. We have already referred, e.g., to Cameron and Ezzedin (2000) who add a regional input-output model to a standard Canadian microsimulation model. A more full-blown 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 Camron 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.[22] 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 labor 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

[22] 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.

Tuscany alone. (Changes in real estate prices could of course occur, e.g. 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 labor 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. This is not the case. In part the reason is that CGE modellers are much more interested in sectoral disaggregation than are macroeconomists.[23] And in part it would seem that CGE modellers have not generally taken up the tools of full intertemporal optimizing behavior that are incorporated in modern macroeconomics. Attempts to augment CGE with macro models have thus, so far, largely united CGE models with "old style" or "Keynesian" macro models.

Two alternative ways of adding conventional macro models to CGE work are represented by Cooper et al. (1985) and Bourguignon et al. (1989). Cooper et al. married existing Australian CGE and macro models - - ORANI and a variant of the Reserve Bank's RBII model, respectively. They provide a careful discussion of the general problems of integrating CGE and macro models, and develop methods for doing so that they refer to as the IMPACT paradigm. This "allows a macrodynamic model to determine all of the major monetary, financial and macroeconomic

[23] 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.

aggregates simultaneously with the determination by a computable general equilibrium (CGE) model of relative prices and the commodity and factor composition of the economy along strictly Walrasian lines" (p. 412).

Cooper et al. identify the following problems in developing an interface between the two models (p. 417):

(i) the lack of explicit dynamics in the CGE model,
(ii) temporal aggregation problems,
(iii) the presence of variables that are endogenous to both models,
(iv) differing variable definitions,
(v) the presence in the macro model of macrorelations that cannot be derived as explicit aggregates of microrelations in the CGE model (e.g. an overall production function),
(vi) the difficulty of preserving homogeneity properties (e.g. of excess supply functions with respect to the monetary stock and nominal prices) in the interfaced system.

The authors argue that problems (v) and (vi) cannot be dealt with when interfacing a static CGE model and a dynamic macromodel. This is an area where they conclude that the "extended Walrasian paradigm" has the advantage. On the other hand, they feel that they succeed in dealing with the first four problems.

Cooper et al. address the lack of dynamics in the CGE model by identifying what they refer to as the "ORANI short-run". The ORANI model is used to compute the static general equilibrium effects of some policy change on a selection of endogenous variables that it has in common with the macrodynamic model. It is then determined how many periods must pass before the macro model produces an equal adjustment in the endogenous variable. This length of time is the ORANI short-run. In simulation, computations using the macro model are then done over this timespan.[24]

[24] A complication is that the CGE and macro models have more than one endogenous variable in common. In the case considered by Cooper et al. the common endogenous variables are aggregate

The temporal aggregation problem is as follows. Consider a shock to a variable *z* that is exogenous to both the CGE and macro models. Suppose that it impacts on a variable *y* that is endogenous to the macro model, but exogenous to the CGE model. In the macro model *y* will typically adjust gradually over the "ORANI short-run", *t**. One cannot therefore simply compute *y(t*)* and plug that into the CGE model, since that would implicitly assume the new value of *y* had had the whole period *(0, t*)* to work its effects. The solution adopted is to divide *t** into discrete subperiods, and compute successive values of *y(t)* produced by the macro model. These values are then used in the calculation of successive ORANI equilibria over the period *(0, t*)* that can be aggregated to get average or total results for the period *t**.
A byproduct is a "within-short-run adjustments coefficient vector" that describes how quickly each of the variables of type *y* adjust.

The problem of doubly endogenous variables is addressed by "choosing the within-short-run adjustment coefficients vector and the length of the ORANI short run *t** which minimize the inconsistencies between the MACRO and ORANI sides of the model". The joint model can either be run in simplified form with macro effects passing over into the CGE model and no feedback, or with feedback.

Cooper et al. illustrated their methods by considering the impact of a 25% tariff increase. The ORANI model on its own predicted a 12.3% decline in output, but when interfaced with the macro model this impact falls to 8.9%. Similar dampening is shown for employment, imports and exports. No distributional results are shown. No explanation is provided for the dampening effect of interfacing the CGE model with the macro model, but the effect can perhaps be taken as evidence that it is dangerous to rely on stand-alone CGE models for macro predictions.

Breece et al. (1994) continued in the Cooper et al. tradition, marrying the ORANI model to the "Murphy Model", which incorporated rational expectations in financial markets. One result is confirmation of the Cooper et al. conclusion that the ORANI short-run is about 2 years. If this result can be extended to other CGE exercises, it gives some idea of the timespan over which the results from static CGE models in

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output, prices, employment and imports. Clearly, some compromise has to be reached between the their short-run versions apply. (The short-run version of a static CGE model has fixed capital in each industry.)

Meagher (1996) pushed Australian CGE/macro modelling further, working with MONASH, which is a dynamic version of ORANI. The goal was to explore the ability to forecast patterns of employment by region, industry, and occupation, as well as income distribution by decile and region. The approach is simpler than that of Cooper et al. or Breece et al. Macroeconomic variables that are exogenous to MONASH are taken from outside sources, including a macro model run by a private firm (Syntec). Interestingly, unreasonably high growth rates of income are predicted for the bottom decile. This is because that decile includes a disproportionate number of investors and business people who experienced low incomes in the survey. The simulation forecasts strong income growth for these people, on the basis of their asset ownership, but apparently has no way of assigning bad luck to some others and making them fall into the bottom decile. This highlights that it may be important to model income mobility carefully in a dynamic simulation.

Meagher's modelling provides an example of the "top down" approach to layering discussed earlier. The approach is perhaps deceptively easy. Exogenous macroeconomic and other variables are taken from the best available macro models and applied to a standard CGE model. There may be many countries in which such an approach could be pursued with models that are already available and would require relatively little modification for the purpose. Unfortunately, this statement does not apply in the case of the transition economies.

The Cooper et al./Breece et al. approach, or something similar, could be pursued to formally marry previously developed CGE and macro models in other countries where these are available. This has some distinct advantages. Established models have passed relevant tests among their respective user groups. There may therefore be some faith and optimism about the results of putting them together. An alternative, and in principle cleaner, approach is to develop a unified CGE-macro model from scratch, as done e.g. by Bourguignon et al. (1989).

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short-run periods that would be computed using the alternative criterion variables.

Bourguignon et al. 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 accomodated.

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 labor markets.

Ag**J**nor and Montiel (1996) make interesting comments on Bourguignon et al. (and also on Taylor, 1990, who provided a "new structuralist" CGE model with macro content):

> "While these innovations significantly enrich the macro dynamics exhibited by CGE models, the macroeconomics of these models remain relatively simple. In contrast to the static optimizing behavior assumed for within-period supply and demand functions, dynamic behavior is left rather simple and ad hoc. Intertemporal optimization on the part of either households or firms based on forward-looking expectations remain absent. Thus, while recent CGE models are better equipped than standard macroeconometric models to handle the microeconomic phenomena for which they were designed, such as the effects of trade liberalization on sectoral resource allocation, they do not yet provide a satisfactory vehicle for the study of stabilization and growth."

Since the pioneering work of Bourguignon et al. (1989, 1992) others have provided some improved versions of work along these lines. Dorosh and Sahn (2000) have made applications to African countries, and AgJnor, Izquierdo and Fofack (2002) 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 macreconomic features and endogenous growth modelling in a representative household CGE approach.

Recently, Bourguignon et al. (2002) have argued for a less integrated way of bringing together microsimulation, CGE and macro modelling in a layered approach. Meagher (1996) provided a "two layer" example, but Bourguignon et al. point out that three layer versions, in which all three types of model are solved sequentially can be imagined. Care must of course be taken to achieve consistency between the models.

6. DYNAMICS

The term "dynamic microsimulation" is today generally used to refer to ageing static microsimulations. But there remains active interest in doing microsimulations that have true economic dynamics, i.e. that simulate processes of growth and technological innovation. Examples are provided by Wolfson (1996, 1999), Elliason (1996, 1997), and Ballot and Taymaz (1996). These authors were all 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.

Here is an abridged version of Eliasson's description of the key features of MOSES (Eliasson, 1996, p. 408):

> "The model assumes that firms face such a varied menu of economic choices as to make even barely informed decisions at the micro level impossible. Under such circumstances, decisions must be characterised by *bounded rationality*… Bounded rationality in a complex economic environment also defines the *competence* of agents… If this competence is accumulated through organizational learning in heterogeneous environments…the 'competence capital' becomes extremely heterogeneous. …..
>
> The…model…is structured on technological competition…that constantly upgrades itself through the competitive process. … Economic development is seen as an ongoing learning process through the immense investment opportunity set, creating new resources and new technologies. Free entry creates competition which drives the growth process, forcing reorganization, rationalisation or 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 innovative simulation of growth processes to developing and transition economies. The environment facing firms in these countries is generally more severe and less predictable than in, e.g, 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.

A further recent example of adding true dynamics to microsimulation is provided by Townsend and Ueda (2001) who simulate the dynamics of income, consumption and labor supply of cohorts of households facing uncertainty and an imperfect credit market.

Bourguignon et al. (2002) argue that it is difficult to maintain a multi-layer structure of microsimulation, CGE and macro modelling in a dynamic framework. They therefore suggest that the most fruitful avenue may be to build on microsimulation exercises with endogenous behavior, by making them properly dynamic. The efforts to do truly dynamic microsimulation reviewed in this section may be seen as attempts to move in that direction.

7. POLITICAL ECONOMY ASPECTS

It has been recognized for some time that CGE and microsimulation have important potential applications in political economy analyses. (See e.g. Dervis et al., 1982, pp. 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.[25] A good example is provided by De Janvry, Sadoulet and Fargeix (1991). 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 labor 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 e.g. 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 is clear that this is an area where integrated CGE microsimulation has 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. The only downside is that the tool becomes so flexible that it can 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.

8. **CONCLUSION**

This paper has overviewed recent work that has attempted to bring together microsimulation, CGE, and macro models. We have seen that different combinations of such models, including those where only a single model-type is used, are appropriate for different kinds of problems. For short-run impact analysis microsimulation on its own may be quite appropriate. However, when we move beyond such analysis we soon want to know about the interrelationship between the changes in disposable income, consumption and labor supply found in a sophisticated microsimulation and general equilibrium price changes or changes in macro variables.

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[25] See e.g. De Janvry and Subbarao (1986); De Janvry, Fargeix and Sadoulet (1991); and De Janvry,

In the case of national subregions, or countries embedded in large well-functioning common markets (like the EU), it can be argued that microsimulation is best combined with pure macro models - - multiplier models based on social accounting matrices (SAM's) or more sophisticated models with endogenous macro and financial behavior. For distinct national economies, however, the first step beyond microsimulation should probably be integration with CGE modelling. Ultimately, three-layer structures in which macro, CGE and microsimulation models are linked can be envisaged.

While it is natural to want to develop truly dynamic distributional models, important challenges are involved in producing dynamic versions of multi-layer models. It therefore appears that, for the forseeable future at least, the best approach is to attempt to produce dynamic microsimulations with endogenous behavior without attempting to add CGE or macro/financial detail.

Much microsimulation work has been pursued by official agencies in developed countries. CGE work is most advanced, on the other hand for LDC's. Currently, several groups of development researchers (MIMAP, World Bank etc.) are putting these two approaches together, and in some cases are adding macroeconomic and financial modelling as well. In contrast, very little such work is being done for the transition economies. I would argue that the first priority in these countries should be to put together good accounting models for tax/transfer/expenditure analysis, like WIDER's DART model for Russia. The rate of fiscal innovation in some transition countries has been high, but even rudimentary estimates of the impact effects on income distribution have often been unavailable. If respected models had been available to illustrate the distributional effects of some of the sweeping tax and transfer changes that have been made, one is tempted to believe that more distributionally successful initiatives would have been adopted in some cases. CGE and macro models may be added to the mix as greater stability in the behaviour of transitions economies is achieved.

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Table 1
A basic social accounting matrix (SAM)

			Expenditures							
			1	2a	2b	3	4	5	6	
				Institutions						
			Factors of production	Households	Companies	Government	Combined capital account	Production activities	Rest of the world combined account	Totals
Receipts	1	Factors of production						Value added payments to factors	Net factor income received from abroad	Incomes of the domestic factors of production
	2a	Institutions: Households	Allocation of labour income to household	Current transfers between households	Profits distributed to domestic households	Current transfers to domestic households			Net non-factor incomes received from abroad	Incomes of the domestic institutions after transfers
	2b	Institutions: Companies	Allocation of operating surplus to companies			Current transfers to domestic companies				
	3	Institutions: Government		Direct taxes on income and indirect taxes on current expenditures	Direct taxes on companies plus operating surplus of state enterprises		Indirect taxes on capital goods	Indirect taxes on inputs	Net non-factor incomes received plus indirect taxes on exports	
	4	Institutions: Combined capital account		Household savings	Undistributed profits after tax	Government current account surplus			Net capital received from abroad	Aggregate savings
	5	Production activities		Household consumption expenditures on domestic goods		Government current expenditure	Investment expenditures on domestic goods	Raw material purchases of domestic goods	Exports	Aggregate demand – gross outputs
	6	Rest of the world combined account		Household consumption expenditures on imported goods			Imports of capital goods	Imports of raw materials		Imports
		Totals	Incomes of the domestic factors of production	Total outlay of households	Total outlay of companies	Total outlay of government	Aggregate investment	Total costs	Total foreign exchange receipts	

Source: Thorbecke (1988)