

CGE Models and Development Policy Analysis: Problems, Pitfalls, and Challenges

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The purpose of this paper is to specify characteristics of computable general equilibrium (CGE) models that are most likely to be useful for policy analysis in developing countries. In the first part of the paper, alternative criteria for distinguishing CGE models are assessed. We suggest that CGE models with clear microeconomic structure contribute the most to sound policy formulation by helping analysts to understand essential relationships relevant to particular policy configurations. The second part of the paper describes how a neoclassical economic model can be extended to address a variety of policy issues in developing countries.

Choosing a CGE Model

Economic modelers apparently do not agree regarding what elements of general equilibrium models are essential (Shoven and Whalley). This is evident in the variety of CGE models that are currently used for policy analysis, particularly in developing countries. For our purposes, we define a CGE model to be a multisectoral supply and demand model with prices being computed endogenously to clear markets.

Several criteria may be proposed to distinguish between types of CGE models. One common criterion is the solution algorithm. An earlier approach, pioneered by Johansen, involves restricting the model so that it is linear in its derivatives and solving for perturbations of endogenous variables due to exogenous changes using matrix inversion. Dixon, Parmenter, and Rimmer have developed a

technique of piecewise linear approximations so that the Johansen method can also be applied to models with nonlinear derivatives.

Another computational approach regards the equilibrium conditions of a CGE model as a simultaneous set of nonlinear equations and solves such equations for the equilibrium values of endogenous variables using a fixed point algorithm (e.g., Scarf, Broadie) or an alternative method of numerical iteration. As these algorithms become more widely available, computational methods are less important in choosing a CGE model.

Another way to classify CGE models is based on how such models are numerically specified. The best-known method involves deterministic calibration of the model. The procedure entails choosing a benchmark equilibrium time period, constructing a general equilibrium data set of the period, selecting the functional configuration of the model, and generating model parameters from the benchmark data set or from independent econometric works (Mansur and Whalley). One problem with calibration is the general unavailability of social accounting matrices and of econometric estimates of key model parameters in developing countries. A partially related problem is the lack of statistical confidence intervals for the results of general equilibrium simulations.

An alternative approach is to estimate CGE models econometrically. The primary difficulty with the econometric approach is the lack of a data set sufficiently large for estimating the parameters of a fair size model (Mansur and Whalley). Although they can be reduced by separate estimation of production and demand systems (Lau), data requirements may still be severe depending on the level of model aggregation. Thus while either calibration or econometric estimation could be used for a particular model, the actual choice will

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be motivated primarily by data availability and level of aggregation.

A more useful way of classifying CGE models is according to their structural framework. In particular, it is useful to distinguish models that have clear neoclassical structure of the Arrow-Debreu type, from eclectic models that include nonneoclassical relationships. Eclectic modeling seems to be largely motivated by an attempt to design a multipurpose policy analysis tool. It is typically the case with composite models that the modeler appends a macroeconomic model onto the microeconomic general equilibrium model, often producing a structurally inconsistent hybrid. For example, a modeler describes a neoclassical economy with neutral money but then adds a financial exchange rate in the balance-of-payments equation, making the artificial exchange rate become a critical part of the equilibrium process but providing no consistent interpretation regarding its meaning. Similarly, other macroeconomic relationships have found their way into such composite models. Cautioning against grafting macroeconomic relations onto microeconomic models, McKinnon argues that "too much excess baggage must be carried along when the two (microeconomic and macroeconomic models) are joined for analyzing any specific problem. There is much to be said for the implicit traditional wisdom that has, hitherto, kept micro and macro analysis separate" (p. 274).

Moreover, the conventional macroeconomic paradigm has been assailed recently on both theoretical and empirical grounds (see, e.g., Evans). Many of the shortcomings of aggregate macroeconomic analysis can be traced to "a failure explicitly to integrate transaction costs into the theory of unemployment" (Howitt). Sound welfare analysis may be better served by including microeconomic foundations of those macroeconomic phenomena that we understand and abstracting from others rather than including alleged "reduced-form" relationships whose underlying structure is unknown. Since the apparent parameters of reduced-form equations are themselves affected by policy changes, they could hardly serve as the basis for policy analysis.

Eclectic models have other problems as well. First, once the door is open to drawing relationships from a variety of theories, the model structure becomes highly arbitrary. While the composite model may appear to "fit

the data," there may be several other models that do as well but which have entirely different policy implications. Given the lack of confidence intervals for CGE results, as mentioned above, it would be difficult to distinguish between these models. Second, adding nonneoclassical relationships undermines the welfare economics of general equilibrium models, e.g., the theoretical foundations underlying estimates of excess burden. Third, appended relationships render the mechanics of the model nontransparent. It may be difficult to discern just what is "running the model." In summary, eclectic modelers are trading neoclassical structures for more "realistic" empirical results whose statistical and welfare-analytic properties remain unknown.

Neoclassical CGE models, on the other hand, are well suited to facilitating intuitive understanding of economic adjustments. They tend to be more transparent and policy-specific than all-purpose, composite models. They help in identifying the essential relationships which are relevant to the particular policies being examined. The numbers generated are important to the extent that they reveal the important causal mechanisms linking policy and economic changes. (For a related attempt to classify CGE models, albeit one more sympathetic to the composite approach, see Robinson.)

The choice between neoclassical and eclectic models may reflect the analyst's view of economic science. Economists who see themselves as positivists tend to view economic theory as an instrument for generating hypotheses or organizing data. In this view, a model may be seen to have "proved" itself by replicating a data series or by using parameters that have been independently estimated. In this tradition, it may seem reasonable to use a CGE model as a management tool by predicting the outcome of a variety of policy experiments.

Those who view economics as an inductive (Samuelson) or policy (Laswell) science, however, are likely to perceive a different role for CGE models. In the inductive/policy view, a theory is conceived as a logically sound model, sufficiently restricted so as to be consistent with certain stylized facts. The theory is then used not to predict outcomes but to provide an input to the policy dialogue. In Whalley's words, "The contribution of policy sciences is not seen as establishing empirical laws as in the natural sciences but in raising

the level of policy debate, increasing the level of understanding of how institutions may affect outcomes, challenging received wisdom, . . . and ultimately offering judgments on issues where there may be conflicting claims . . ." (p. 34).

There is a natural tendency for policy discussion to become polarized into opposing points of view. Economic theory can be extremely useful in facilitating a productive debate by clarifying the nature of the causal relationships that support those views. Pure models tend to provide the highest value added in such a dialectical process. They help to isolate essential differences in opposing views and to elevate the level of the debate from a war of identification (about which side is more closely allied with angels), to a dialogue about which model conforms best to our general understanding of economic systems and the stylized facts as we know them.

More than any other subdiscipline, development economics has failed to learn from its mistakes. In succeeding decades, there has been a close correspondence between the fads of development policy and the fancy of development modelers. In the 1950s and early 1960s, development economists talked about incremental capital-output ratios, further encouraging development planners to emulate the accouterments of modern industrial economies (such as steel mills) in direct conflict with the principle of comparative advantage. This thrust was modified somewhat in the 1960s as development economists, inspired by the concept of economic dualism, advocated subsidizing the modern sector, even via distortionary policies such as import tariffs and cheap credit. The problem with the underlying models was that the most critical differentiating feature of the model, be it a fixed capital-output ratio or a fixed nonagricultural wage, was entirely ad hoc and exogenous to the model. When it became apparent that the policy implications of these models were wrong, economists substituted new forms of ad hocery (e.g., urban employment as a product of random selection) instead of pursuing more fundamental models.

The tendency of development economists to graft ad hoc relationships or exogenous constraints onto neoclassical models instead of developing fundamental theories of distinguishing features of developing economies

continued in the 1970s and 1980s. In the 1970s, employment and "redistribution with growth" were the order of the day. The agricultural sector was targeted for a variety of subsidies and institutional reforms, including expenditures on research, extension, infrastructure, crop insurance, land tenancy reform, ceilings on farm size, land consolidation, rotational irrigation, marketing cooperatives and parastatals. These reforms were based on incomplete theories of market failures and institutional constraints. The evolution of a comparative institutions approach in Industrial Organization was not recognized in Economic Development.

In the 1980s, the pendulum has swung too far to the opposite extreme. Development policy as practiced by international donors and lending agencies appears to be heavily influenced by a naive version of supply-side economics as encapsulated in the catchwords of "privatization" and "getting the prices right." These slogans emulate from models which fail to account for sequencing and institutional issues that are at the very heart of feasible reform.

This retreat from microeconomic foundations has been especially pronounced in the field of agricultural development. Farmers are alleged not to maximize expected profits on account of risk preferences, but the sources of risk aversion are not explored. The inverse relationship between farm size and productivity is said to be evidence of labor market dualism, but the institutional impediments to market clearing are not modeled. Share tenancy and landlessness have been castigated as *prima facie* evidence of feudalism, exploitation, and inefficiency; but their origin, perseverance, and resistance to potentially profitable opportunities for recontracting have not been properly explained.

Evidence from developing countries does indeed provide a host of stylized facts that are not immediately explainable by the standard theories of supply and demand. But rather than append ad hoc constraints and relationships onto existing theory, the microeconomic sources of these phenomena need to be fully explored and properly integrated into the core of economic analysis. Specific suggestions for this research agenda are given in the following section after a brief description of a basic neoclassical model of a developing country.

Designing a CGE Model for Economic Policy Analysis in LDCs

We illustrate here how a real static neoclassical economic model can be designed to address some of the policy issues in developing countries such as trade taxes, price controls, and irrigation policy. (For modeling details, see Clarete and Roumasset 1986, 1987, and Clarete and Whalley.) A useful starting point is the small open economy model with home goods. Production technology is described by production functions, and consumer preferences are given by utility functions. Given profit and utility maximization, the economy's output supplies, derived demands for factors, and consumer final demands can be derived. Consumer resource endowments are taken as given.

With fixed world prices, corner solutions are avoided by the inclusion of sector-specific factors. Without sector-specific factors but with as many mobile factors as traded goods, the model reduces to the standard n -factor, n -good neoclassical trade model. Thus, the framework outlined here can be viewed as a generalization of some of the well-known trade models.

Hicks' aggregation theorem (Diewert) is invoked to define a composite commodity of traded goods aggregated at the fixed world prices. The composite good has its own price, and market clearing implies trade balance. If the numeraire of the model is a collection of home goods, the price of the composite good can be interpreted as the real exchange rate, i.e., the relative price of home goods and traded goods. Trade balance obtains by solving for the equilibrium relative price of traded and nontraded goods. An implication of Walras' Law, that trade balance holds if the rest of the economy is in equilibrium, is thus achieved without the contrivance of a financial exchange rate.

General equilibrium for this formulation of the model is obtained by simultaneously solving a system of nonlinear equations depicting market clearing conditions for factors and home goods and trade balance. In the process, the equilibrium prices of factors, home goods, and of the composite good are calculated using a fixed point, such as OCTASOLV (Broadie) or any other appropriate algorithm.

Suppose the model is used to evaluate trade taxes. What modification of the above formu-

lation is necessary to equip the model? Where ad valorem tariffs and export taxes are considered, domestic prices of traded goods differ from the corresponding world prices. The fiscal surplus which trade taxes generate for the government (and assumed transferred to consumers in a lump-sum fashion to accommodate the balance budget condition) becomes the additional "price" which must be solved to obtain general equilibrium for this distorted economy.

Where quantitative trade restrictions are present, additional conditions are imposed to clear the markets of traded goods with binding restrictions. As in the case of home goods, domestic prices of these trade-restricted traded goods are calculated. In equilibrium, these prices differ from world prices due to the import premia and export discounts. Who gets the rents generated from these quantity restrictions depends upon how the government allocates the limited amount of trade licenses.

For evaluation of agricultural policy, it is useful to allow for alternative strategies for attaining targets such as a cheap food objective. For traded goods, consumer price ceilings and producer price supports are readily accommodated in the basic model, with government subsidies defending such policies. In the import (export) case, the government finances the wedges between consumer and producer prices for the quantity that is locally produced (consumed) and between consumer (producer) and world prices for the imports (exports) needed to sustain the domestic price differential. It is also possible to allow for subsidies of agricultural inputs including nontraded goods such as irrigation.

Fundamental extensions can be worked out to enable the model outlined here to address more complex policy issues. One extension is to allow for savings and capital accumulation in various sectors using a multiperiod model. This will facilitate the analysis of economic consequences of various policy reforms for dynamic comparative advantage. Another potential role of CGE models is to prescribe appropriate sequencing of economic liberalization involving financial, exchange rate, trade, and agricultural pricing policies by incorporating asset markets into the model.

Many of the critical issues in agricultural development policy depend on various aspects of economic organization. For example, designing appropriate land reform depends on

a number of institutional factors that explain the existing distribution of farm sizes and organizational forms. Creating incentives for privatization of marketing parastatals will depend on the advantages and disadvantages of alternative marketing systems. Similarly, improving the efficiency of agricultural credit markets requires an understanding of the role of existing policies in segmenting the formal and informal sectors of the market. All of these issues require a framework with endogenous transaction costs in order to facilitate meaningful comparisons of alternative organizational structures. Neither the microeconomic analysis of these individual markets nor the theory of general equilibrium with transaction costs are currently developed sufficiently to render the simultaneous analysis of price and institutional distortions a productive exercise. (However, the reader is referred to Foley for a theoretical development in the area of endogenous transaction costs in general equilibrium.)

These theoretical developments will not occur overnight. In the meantime, it is important to recognize the limitations of abstract neo-classical models (designed to illuminate the nature of essential economic relationships) and eclectic models with incomplete microeconomic foundations and to interpret results with appropriate caution. Perhaps we should all bear in mind Keynes' fatherly advice on the need for humility in economics and remind ourselves that confessing ignorance is essential for the attainment of truth.

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