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ANALYZING AGRICULTURAL TRADE LIBERALIZATION WITH SINGLE-COUNTRY COMPUTABLE GENERAL EQUILIBRIUM MODELS

by

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Abstract

This paper surveys recent work with single-country computable general equilibrium (CGE) models to analyze issues of agricultural trade liberalization. This work has drawn heavily on earlier work with CGE models of developing countries designed to analyze issues of "structural adjustment" to external shocks. The paper argues that most trade-focused, single-country CGE models are based on the Salter-Swan "Australian" trade model, which incorporates non-traded goods. A two-sector, three-commodity analytic model is presented which incorporates imperfect substitution and transformability between goods produced for the domestic and world markets. This model represents an extension of the Salter-Swan model and provides the anlytic core for most trade-focused CGE models. The empirical work with these models has followed two strands. The first has sought to improve the model specification with regard to agriculture, but stay close to standard neoclassical theory. The second strand has sought to extend the models to include phenomena such as rent seeking, imperfect competition, scale economies, and externalities. The survey discusses examples of work in both strands.

Introduction

The current round of multilateral trade negotiations, the Uruguay Round of the GATT, has focused policy interest on questions of the structural impact of different trade regimes in developed and developing countries. Given that the GATT negotiations, at the request of the U.S., started with agriculture, there has been active work using multisectoral models to explore the impact of different domestic and international agricultural policy regimes on various economies. While linear models can capture many of the important linkages between agriculture and the rest of the economy, most recent work has used nonlinear, price endogenous, computable general equilibrium (CGE) models.

In both developed and developing countries, CGE models have become part of the standard tool kit of policy analysts. One strand of work has focused on efficiency questions in neoclassical welfare analysis --what might be called triangle counting. These models, by design, have stayed close to the neoclassical paradigm. A second strand of work, largely applied to developing countries, has focused on structural issues. What is the impact of different choices of development strategy on growth, structural change, and the distribution of income? Given macroeconomic shocks, how do different choices of "structural adjustment" policies affect the economy? Given various rigidities, distortions, and market imperfections characteristic of developing countries, how do these countries react to different policy instruments? These models have introduced a variety of "structuralist" features designed to capture institutional rigidities characteristic of developing countries. In analyzing the impact of different trade liberalization scenarios, CGE models have been built that draw on both strands of work.

While the neoclassical paradigm has provided the fundamental theoretical underpinning for trade-focused CGE models, there has also been work to extend the empirical models to include recent theoretical advances in trade theory. In this paper, I review some of the recent work using CGE models to address issues of trade policy, especially the analysis of liberalization scenarios. The review is more issue-centered than country-centered and will discuss work on both developed and developing countries. After presenting a core CGE model, I discuss the limitations of models which stick to the neoclassical paradigm and some examples of models that incorporate rent seeking, externalities, and imperfect competition.[1] I next review the empirical results from existing models used to analyze the impact of agricultural liberalization. Given these results, and the evolution of the GATT negotiations, I discuss recent developments in the formulation and use of policy-focused CGE models. The review is selective, discussing examples of recent work rather than trying to provide a broad survey.[2]

[1]This part of the review draws heavily on Robinson (1989a).

[2]Robinson (1989b) provides a general survey of work with multisector models of developing countries. De Melo (1988), Roland-Holst and Tokarick (1989), and Whalley (1989) provide complementary surveys of trade-focused CGE models. Devarajan (1989) surveys CGE models of taxation and natural resources applied to developing countries. Hertel (1989b) surveys recent work on including agriculture in CGE models. Shoven and Whalley (1984) review earlier work with tax and trade models applied to developed countries.

A Single-Country, Two-Sector, Three-Good, Trade Model

De Melo and Robinson (1989a) present a simple single-country, two-sector, three-good model that can be seen as an extension of the Salter-Swan (or Australian) trade model.[3] In this "1-2-3" model, the country produces two commodities: (1) an export good, E, which is sold to foreigners and is not demanded domestically, and (2) a domestic good, D, which is only sold domestically. The third good is an import, M, which is not produced domestically. The model has no factor markets. The country is small in world markets, facing fixed world prices for exports and imports.

The 1-2-3 CGE Model

The model equations are set out in Table 1. Equation 1 defines the domestic production possibility frontier and gives the maximum achievable combinations of E and D that the economy can supply. The function is assumed to be concave. In multisector CGE models, it is specified as a constant elasticity of transformation (CET) function for each sector. The constant $\bar{X}$ defines aggregate production and is assumed fixed. Since there are no intermediate inputs, $\bar{X}$ also corresponds to real GDP. The assumption that $\bar{X}$ is fixed is equivalent to assuming full and efficient employment of all primary factor inputs in a model with factor markets.[4] In addition to the production possibility frontier, the economy faces a second constraint: the value of imports cannot exceed the value of exports plus exogenous foreign borrowing. This balance-of-trade constraint is given by equation 18.

Equation 2 defines a composite commodity, Q, made up of domestic goods and imports, which is consumed by a single consumer. In CGE models, Q is usually a constant elasticity of substitution (CES) function of D and M at the sectoral level.[5] Assuming that the single consumer in the model gains utility from Q, welfare is maximized when the amount of Q in the economy is maximized. In this model, Q defines total absorption.[6]

Equations 1, 2, 16, 18 together suffice to define a simple CGE model. Equation 16 adds the assumption that supply equals demand on the market for the domestic good, D. Figure 1 presents the model in graphs. The production possibility frontier is given in quadrant IV. The balance of trade constraint is given in quadrant I, setting $\pi^m = \pi^e = 1$ and $\bar{B} = 0$ for convenience. Quadrant III captures equation 16. The consumption possibility frontier in quadrant II is the locus of points that satisfy the three constraint equations in quadrants I, III, and IV. The market equilibrium is given at point C, where absorption Q is maximized. Solution prices are given by the slopes of the tangent lines at the production point P and the consumption point C.

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[3]See Salter (1959) and Swan (1960).

[4]Indeed, it can be shown that if we were to specify separate Cobb-Douglas production functions for D and E which depend on, say, capital and labor, then the implied production possibility frontier is locally a CET function. See Devarajan, Lewis, and Robinson (1989).

[5]In a multisector model, we disaggregate by sectors and assume that imports and domestic goods in the same sector category are imperfect substitutes, following Armington(1969).

[6]The model would be unchanged if we defined a utility function with total absorption, Q, as the only argument.

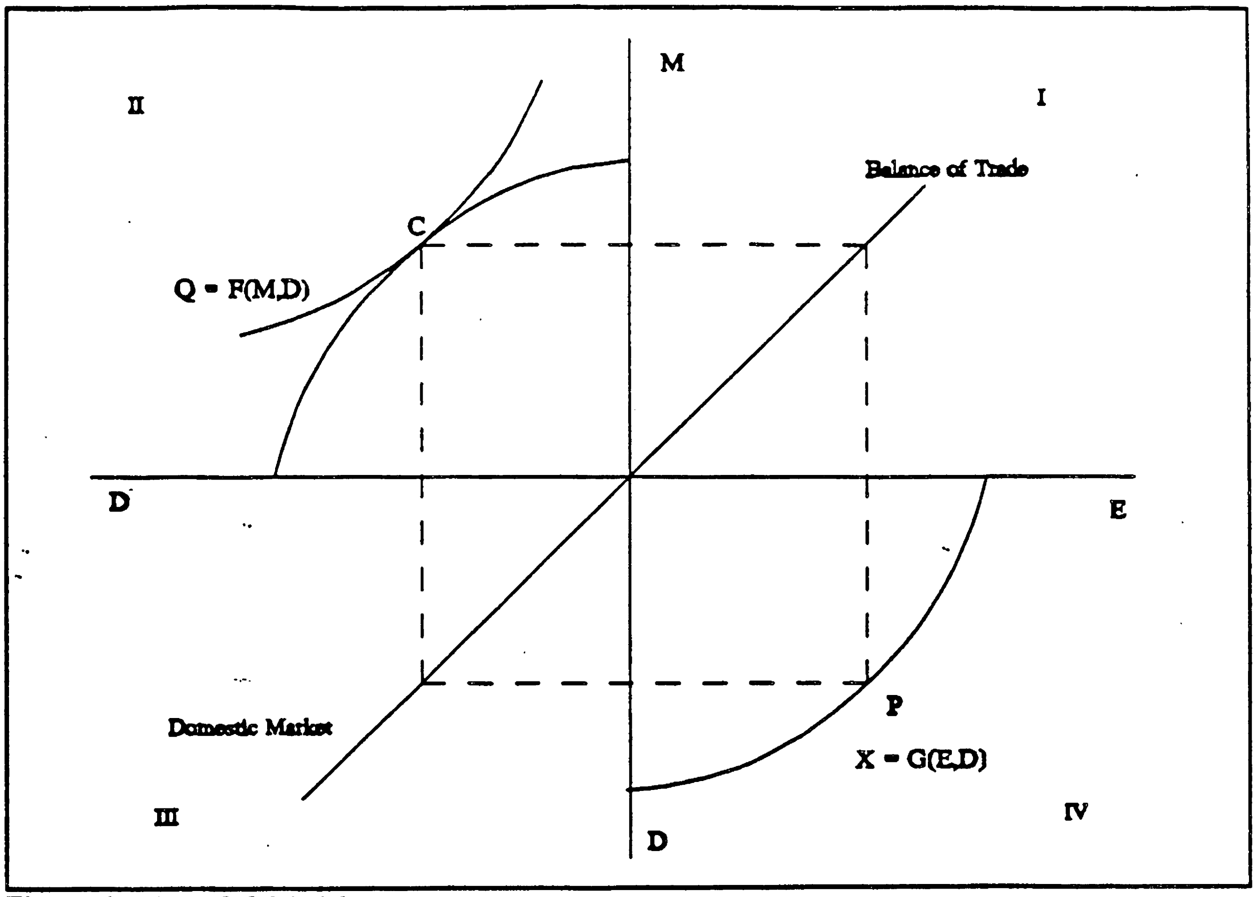

Figure 1: The 1-2-3 Model

The rest of the equations in Table 1 complete the description of the model, including prices as endogenous variables and explicit income and expenditure constraints for the single household, government, and the rest of the world. To complete the macro specification, the model adds savings and investment, with all savings done by the single household. There are also three price-wedge tax instruments. The government collects indirect taxes and tariffs, pays export subsidies, and transfers any net balance in a lump-sum fashion to or from the single household.

Equations 4 and 5 give the efficient export and import ratios as functions of relative prices. Equations 13 and 14 define the corresponding prices (P^x and P^q) of aggregate output X and the composite good Q. They are the cost-function duals to the first-order conditions embodied in equations 4 and 5. P^x essentially defines the GDP deflator, while P^q defines the consumer price index for the CES composite good, which will also be a CES function.

Equation 3 defines consumer and investment demand for the composite good. In this model, it merely states that all income is spent on the single composite good, and could be omitted. However, in a multisector model, this equation defines how consumers allocate consumption expenditure across goods and how aggregate investment is spent on capital goods. There is a vast literature on systems of consumer demand as functions of relative prices and income. In the simple model, equation 3 can stand in for a more complex system of expenditure equations and does reflect an important property of all complete systems --the value of the goods demanded must equal aggregate expenditure.

Equations 6 to 9 determine the income flows in the economy. The model has four actors: a producer, a household, government, and the rest of the world. Equation 6 determines government revenue and Equation 7 determines household income. Equations 8 and 9 divide household income between consumption and savings. The nominal flows among the actors can be tabulated in a Social Accounting Matrix (or SAM), which is presented in Figure 2.[7] The SAM shows the circular flow of income and expenditure in the economy. Each cell represents a payment from a column account to a recipient in a row account. The SAM is square and, following the conventions of double-entry bookkeeping, each actor's accounts must balance --income must exactly equal expenditure. Thus, column sums in the SAM must equal the corresponding row sums.

The SAM defines six accounts, one for each actor, one for savings and investment, and an additional "commodity" account. The commodity account keeps track of absorption, which equals the value of domestic products sold on the domestic market, D, and imports, M. The producer account pays out total revenue to households and government down the column and sells goods on the domestic and foreign markets along the row. The column sum equals gross domestic product (GDP) at market prices, which includes indirect taxes. GDP at factor cost equals $P^x \cdot X$. Export subsidies are seen as a payment by government to producers. Exports and imports in the account for the rest of the world are valued in world market prices times the exchange rate.

In Table 1, the price equations define relationships among eight prices. There are fixed world prices for E and M; domestic prices for E and M; producer and consumer prices for D; and prices for the two composite commodities, X and Q. Equations 1 and 2 are linearly homogeneous, as are the corresponding dual price equations, 13 and 14. Equations 3, 4, and 5 are homogeneous of degree zero in prices --doubling all prices leaves real demand and the desired export and import ratios unchanged.[8] Since only relative prices matter, it is necessary to define a numeraire good whose price is set exogenously. Equation 15 defines the numeraire price as the GDP deflator, a common choice in applied models.

Equations 16 to 20 define the market-clearing equilibrium conditions. Supply must equal demand for D and Q, the balance of trade constraint must be satisfied, aggregate savings must equal aggregate investment, and the government account must balance. The complete model has 20 equations and 19 endogenous variables. The five equilibrium condition equations, however, are not all independent. The model satisfies Walras' Law and it can be shown that if any four of the five equations are satisfied, then the fifth must also hold. So, any one of them can be dropped, and the resulting model is exactly identified.

De Melo and Robinson (1989a) analyze the properties of this model in some detail and argue that it is a good stylization of most recent single-country, trade-focused, CGE models. The assumption of product differentiation on both the import and export sides is very appealing for applied models, especially at the levels of aggregation typically used. The specification is a theoretically clean extension of the Salter-Swan model and gives rise to normally shaped offer curves. The exchange rate is a well-defined relative price (the shadow price on the balance of trade constraint). If the domestic good is chosen as

[7]Pyatt and Round (1985) provide a good introduction to SAM's and a number of examples of their uses.

[8]For the demand equation, one must show that nominal income doubles when all prices double, including the exchange rate. Tracing the elements in Equations 6 and 7, it is easy to demonstrate that nominal income goes up proportionately with prices.

numeraire, setting P^d equal to one, then the exchange rate variable, R, corresponds to the "real" exchange rate of neoclassical trade theory: the relative price of tradables (E and M) to non-tradables (D). Trade theory models often set R to one, with P^d then defining the real exchange rate. For other choices of numeraire, R is a monotonic function of the real exchange rate.[9]

In Table 1, the balance of trade is specified exogenously. The model then determines the equilibrium value of the real exchange rate. Alternatively, one could specify the exchange rate as an exogenous variable and solve for the equilibrium value of the balance of trade. What the model determines is an equilibrium relationship between the balance of trade and the real exchange rate. The model, however, can only determine relative prices. The implication is that a macro economist is free to specify any two, but only two, of the following three variables: the balance of trade, the nominal exchange rate (R), and any price index (the numeraire in the CGE model).

Extending the CGE model to include many sectors, sectoral production functions, intermediate goods, factor markets, many consumers, and macro balances is relatively straightforward. For example, to move to many sectors, just add sector subscripts to all the output and price variables. The CET production possibility frontier is now interpreted as a sectoral export transformation function describing the relative degree of difficulty in producing goods for the domestic market versus the export market. Similarly, the import aggregation function describes the degree of substitution in demand between imports and domestically produced goods within the same sectoral category. The CGE model can also easily accommodate downward-sloping world demand curves for sectoral exports by adding an equation specifying a functional relationship between E and π^e.[10]

Product Differentiation and Trade Theory

The standard neoclassical trade model, with all goods tradable and all tradables perfect substitutes with domestic goods, has long been a staple of trade theory, but yields wildly implausible results in empirical applications.[11] Empirical models that reflect these assumptions embody "the law of one price," which states domestic relative prices of tradables are set by world prices. Such models tend to yield extreme specialization in production and unrealistic swings in domestic relative prices in response to changes in trade policy or world prices. Empirical evidence indicates that changes in the prices of imports and exports are only partially "transmitted" to the prices of domestic goods in the same sector categories. In addition, such models cannot exhibit two-way trade in any sector ("cross hauling"), which is often observed in empirical data at fine levels of disaggregation.

The addition of nontradables, as in the Salter-Swan model, is a theoretical improvement, but with limited empirical applicability. Even looking at an input-output table with over five hundred sectors, there are very few sectors which are purely non-traded; i.e., with no exports or imports. So defined, non-traded goods are a very small share of GDP; and, in models with 10-30 sectors, there would be at most only one

[9]Dervis, de Melo, and Robinson (1982), Chapter 6, discuss this relationship in detail.

[10]This approach can be seen as a reasonable approximation for a single-country model. In multi-country models, of course, endogenizing world prices presents a number of problems.

[11]Empirical problems with this specification have been a thorn in the side of modelers since the early days of linear programming models. For a survey, see Taylor (1975).

or two non-traded sectors. Furthermore, the link between domestic and world prices does not depend on the trade share, only on whether or not the sector is tradable.

The picture is quite different in models with imperfect substitutability and transformability. In this case, all domestically produced goods that are not exported (D in Table 1) are effectively treated as non-tradables. The share of non-tradables in GDP now equals one minus the export share, and all sectors are treated symmetrically. A pure non-traded sector is one in which the share parameters in the import aggregation and export transformation functions are both zero. In effect, the specification extends and generalizes the Salter-Swan model, and makes it much more empirically relevant.

As de Melo and Robinson (1985) show, the link between domestic and world prices depends critically on the trade shares, both for exports and imports. For given substitution and transformation elasticities, domestic prices are more closely linked to world prices the greater are export and import shares. The net effect of this specification is a very realistic insulation of the domestic price system from changes in world prices. The links are there, but they are not nearly as strong as in the standard neoclassical trade model. Also, the model naturally accommodates two-way trade, since exports, imports, and domestic goods in the same sector are all distinct.

For a single-country model, the CES and CET functions capture the reasonable notion that it is not "easy" to shift trade shares in either export or import markets. Given that each sector has eight associated prices, the model provides for a lot of product differentiation. The assumption of imperfect substitutability on the import side has been widely used in empirical models. Note that it is equally important to specify imperfect transformability on the export side. Without imperfect transformability, the law of one price would still hold for all sectors with exports. In the 1-2-3 model, both import demand and export supply depend on relative prices.[12]

The specification of imperfect substitutability on the import side has been criticized in the context of multi-country models because it implies that every country has market power, leading to the potential for national welfare gains from imposing trade restrictions. What is a reasonable approximation for a single-country model has become something of an embarrassment in multi-country models designed to analyze the gains from trade liberalization. While attention has focused on the elasticities of substitution, the share parameters in the CES functions are really at the root of the problem. In a multi-country model, the assumption of fixed sectoral share parameters in every country largely determines the volume and direction of world trade, with price changes only affecting shares at the margin. It is probably more correct to view trade shares as evolving over time in response to shocks and policy changes, with short-run import aggregation functions sliding along long-run functions that have much higher substitution elasticities. The problem for multi-country models is to understand why and how these shares change over time in ways that do not depend only on shifts in relative prices.

In single-country models, the CES formulation for the import-aggregation function has been criticized on econometric grounds.[13] It is certainly a restrictive form. For example, it constrains the

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[12]Dervis, de Melo, and Robinson (1982) specified a logistic export supply function in place of equation 4 in Table 1. It can be shown that their logistic function is locally equivalent to the function that is derived from the CET specification.

[13]See, for example, Allston et al. (1989).

income elasticity of demand for imports to be one in every sector. In both single-country and multi-country models, it is probably time to explore other formulations, while maintaining the fundamental assumption of imperfect substitutability. Other functional forms are certainly available. For example, Hanson, Robinson, and Tokarick (1989) estimate sectoral import demand functions based on the almost ideal demand system (AIDS) formulation. They find that sectoral expenditure elasticities of import demand are generally much greater than one in the U.S., results consistent with estimates from macroeconometric models. Factors other than relative prices appear to affect trade shares, and it is important to start doing research on what they might be and how they operate.

Trade Policy and Welfare

Since Adam Smith, much of the literature in trade theory has explored the benefits of free trade and the welfare costs of protection. The development of CGE models permitted the empirical estimation of the welfare costs of protectionist policies in a general equilibrium framework. In analyzing the implications of agricultural liberalization, it is important to keep in mind the lessons learned from past work with trade-focused models. In this section, I review recent work with such models.

One of the intriguing results from the now rather large body of empirical work is that the costs of engaging in protectionist policies, or the gains from removing them, are relatively small. In a recent conference volume, Srinivasan and Whalley (1986) compare studies of trade liberalization in a variety of single-country and multi-country CGE models. In their summary, they note that the welfare gains from trade liberalization are relatively small, seldom amounting to as much as one percent of GNP. They cite Harberger's discussion of the welfare costs of distortions, which can be summarized in the often-quoted proposition that "triangles are smaller than rectangles." They also note that, at least in developed countries, the reforms being modelled are not really dramatic. In the conference volume, for example, each paper explored the impact of a fifty percent cut in tariffs. Since the initial levels of tariffs in many countries such as the U.S. are fairly low, one might expect that aggregate welfare effects of halving them would be small. However, more dramatic changes in protection also yield small welfare effects. In a recent thirty-sector CGE model of the U.S., Hanson, Robinson, and Tokarick (1989) explore the impact of a protectionist policy where the U.S. adds an across-the-board fifty percent tariff to existing tariffs in all sectors. The experiment is designed to measure the structural impact of a complete failure of the current round of GATT talks, with the U.S. imposing protection similar to the 1930 Smoot-Hawley tariff. The structural results are dramatic, but aggregate GDP falls by only about 0.25 percent.

The result that the static welfare costs from misallocation of resources due to price-wedge distortions are small in a competitive general equilibrium model represents one of the robust properties of CGE models. Substitution possibilities in production, consumption, and trade endow the economy with a great deal of adjustment flexibility. When markets work and factors are fully employed, even large price-wedge distortions can be vitiated by substitution possibilities, with little effect on aggregate welfare.

Two points should be noted about this result. First, the term "small" must be evaluated in terms of the problem being analyzed. Work with CGE models focusing on tax issues indicates that welfare losses from "inefficient" tax systems can be a large share of total tax revenue. Consider a "project" which involves redesigning the tax system to raise the same amount of revenue more efficiently --that is, with less dead-weight losses. Such a project can easily have a social rate of return of 20-50 percent, where the denominator is aggregate tax revenue. For the U.S., such welfare gains amount to billions of dollars, which should certainly justify work with CGE models in the U.S. Treasury.

Second, while price-wedge distortions may generate small aggregate welfare losses, their impacts on the sectoral structure of resource allocation, production, and trade tend to be more significant. In general, political pressure groups are organized by sector and care about the impact of policy on the relative position of their sector in the economy.[14] The closer one gets to actual policy makers, the more evident is the interest in measures of the structural impact of policies, rather than measures of aggregate welfare. Any positive analysis of policy needs to take this concern into account.

Especially in developing countries, much of the work with CGE models evaluating the impact of policies in an operational environment has tended to reflect these concerns about structure. For example, the extensive work on CGE models of "structural adjustment" at the World Bank has tended to focus on issues of resource allocation and "expenditure switching" rather than aggregate welfare. This concern for analyzing the structural impact of policy changes is also evident in the recent work on trade liberalization.

<u>Optimal Tariff Policy</u>

Some of these problems with neoclassical CGE models are nicely illustrated by work on optimal tariff policy in the presence of a government revenue constraint. A standard rule of thumb in policy analysis is that countries should equalize their tariff rates across sectors. A policy of equal tariffs across sectors is best, getting the prices right and yielding a level playing field. Given the existence of differentiated tariffs and a revenue constraint, it is desirable to move in the direction of equalizing tariffs. This "uniformalist" position certainly represents the conventional wisdom at the World Bank and has been forcefully advocated by writers such as Harberger (1988), Balassa et al. (1982), and Krueger (1985).

From the public finance literature, we know that in the presence of non-removable distortionary taxes, equalizing tariff rates is not optimal. Chambers (1989) provides a good survey of the theoretical arguments.[15] Dahl, Devarajan, and van Wijnbergen (1986) discuss a theoretical model of the issue and provide an empirical application with an eight-sector CGE model of Cameroon. Devarajan and Lewis (1989) discuss a similar application using a thirteen-sector CGE model of Indonesia and Devarajan, Lewis, and Robinson (1989) illustrate the empirical issues using an extension of the two-sector, three-good model described above that includes a fourth good, an imported intermediate input.

In these models, the method used is to include the CGE model as constraint equations in a nonlinear programming model. The objective function is the utility function of the single consumer and is defined to be consistent with the expenditure functions in the CGE model. Then, various tax

[14]Recent work with "specific factors" models in international trade also tends to support this view. See, for example, Magee (1978) who argues that political pressure for import protection in the U.S. is organized along industry lines rather than, say, by ownership of factor of production (as would be predicted by the Stolper-Samuelson model). Work with CGE models supports this view. Empirically, even large shocks tend to have little effect on economywide wage-rental ratios, but large effects on the sectoral composition of value added. Hanson, Robinson, and Tokarick (1989) discuss the issue in a model of the U.S.

[15]He is the one that used the term "uniformalist." Dixit (1985) and Mitra (1986) also discuss the theory as applied to trade policy in open economies.

instruments are specified as variables rather than fixed parameters, so the CGE model no longer has a unique solution. The programming problem is solved by finding the set of tax instruments that yields a market equilibrium with maximum welfare.

From these studies, the answer is that, in a second-best world, a policy of equal tariffs across sectors is not optimal. The results from the theory of public finance carry over into empirical models. Moreover, a policy of moving toward equal tariffs from an existing situation of unequal tariffs is not generally welfare improving. Based on the empirical results from the latter two studies, a better rule of thumb would be to recommend that tariff rates for intermediate and capital goods be very low or zero, and certainly much less than the tariff rates for consumer goods.[16]

These empirical results do not imply that the World Bank should cease recommending that countries move toward equalizing tariff rates. In a world of rent seeking and administrative capacity constraints, it is probably a good idea to simplify tariff rate structures. However, tariff equalization cannot be justified on the basis of static efficiency gains in the neoclassical model, either theoretical or empirical, once realistic second-best constraints are introduced. The neoclassical competitive general equilibrium model is a powerful tool, but it is also important to describe how the world actually works, not just how it would work in some first-best Platonic form.

In these optimal-policy applications, large variations in policy instruments yield small changes in aggregate welfare. While it is clearly optimal to use differentiated tariffs, the improvement in aggregate welfare is not all that large. One might argue that simplifying the structure of tariffs would save a lot of administrative costs and reduce rent seeking, and that the resulting benefits might well exceed the welfare losses arising from tariff equalization. While persuasive, this argument turns the neoclassical model on its head and would probably not appeal much to the proponents of uniform taxation. It would appear that they are being hoist on their own petard.

Rent Seeking, Imperfect Competition, and Externalities

Quantitative controls on imports have been a characteristic feature of trade regimes in many developing countries. The seminal article on rent seeking by Krueger (1974) was motivated by her experience in Turkey, where pervasive quantitative controls generated enormous gains to particular groups. Those developing trade-focused CGE models of developing countries were strongly influenced by these "stylized facts." The first of the World Bank "structural adjustment" CGE models, the Dervis-Robinson model of Turkey, incorporated quantity rationing of imports and rent-seeking behavior.[17] In the last decade, the majority of CGE models applied to developing countries have focused on issues of trade and structural adjustment, and many of them have incorporated quantitative restrictions and rent seeking.

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[16]This particular result depends on the nature of the second-best initial situation. In the small model, we assume that the indirect tax rate on the domestic good is less than optimal.

[17]That model was developed in 1978 for a World Bank mission to Turkey, and is described in Dervis, de Melo, and Robinson (1982).

The empirical results from this literature indicate that the rents generated by policies to restrict imports are indeed large, sometimes amounting to 10-15 percent of GDP.[18] These results raise a number of issues for policy analysis and modelling: (1) Who gets the rents?; (2) How do we model the trade regime?; and (3) What are the efficiency losses due to rent seeking?

The first two questions are closely related. Dervis, de Melo, and Robinson (1981) compare the distributional impact of two import rationing regimes: a fixprice regime where import demanders receive a direct allocation of imports which they cannot sell and a flexprice regime where there is, in effect, a market in quota certificates.[19] In their model, typical of semi-industrial countries, imports consist largely of intermediate inputs and capital goods, with very few consumer goods. Thus, producing sectors are the agents most directly affected by the trade regime. Under fixprice rationing, sectors receive fewer imported intermediate inputs and capital goods than they desire, but get them at far lower prices than they would be willing to pay. Producers thus receive the rents, since they pay less than market-clearing prices for the imports they use, and so are subsidized by the trade regime. In an environment where imports must be reduced (say, in response to a decline in foreign investment or a balance of payments crisis), import-dependent producers will tend to favor quantity rationing over a flexible exchange rate regime because they gain a great deal from the implicit subsidies.

Under flexprice rationing, all users are assumed to pay the premium-ridden price for imports, so rationed imports are efficiently allocated across competing uses. The rationing is implemented by an ad valorem equivalent premium. However, the allocation of the premia rents must be handled separately. In a CGE model, they appear as an explicit flow which must be allocated to agents in the economy. They are computed by applying a supplemental tariff whose proceeds must be allocated to agents other than the government. Figuring out who gets these rents in the first instance is important for policy analysis, since it largely determines the impact effect of any change in policy. The CGE model also traces out the indirect effects, which will work themselves out through changes in equilibrium prices and quantities.

The existence of quantitative restrictions raises the issue of spillover effects. How do agents in the economy behave, given the quantity rationing? Is the rationing scheme incentive compatible? Dervis, de Melo, and Robinson (1982) note the problem and argue that because of the special characteristics of their model it is relatively unimportant in their case. Grais, de Melo, and Urata (1986), drawing on the notion of "virtual prices" introduced by Neary and Roberts (1980), solve explicitly for the agents' behavior on the non-rationed markets. By "reoptimizing" given the quantity constraints, their model captures the spillover effects in a theoretically satisfying way.

The final question is whether the existence of "chaseable rents" induces efficiency losses through rent-seeking behavior. Bhagwati and Srinivasan (1980) generalize the notion, using the term "revenue seeking," and argue that the magnitude of the efficiency losses will equal the value of the rents. Grais, de Melo, and Urata (1986) make this assumption, and find that rent-seeking efficiency losses amounted to over five percent of GDP in Turkey in 1978, in the midst of their foreign exchange crisis. In the

[18]Representative studies include: Dervis, de Melo, and Robinson (1982) (Turkey); Lewis and Urata (1984) (Turkey); Condon, Robinson, and Urata (1985) (Turkey); Grais, de Melo, and Urata (1986) (Turkey); Ahmed et al. (1985) (Egypt); Clarette and Whalley (1986) (Philippines); Kis, Robinson, and Tyson (1989) (Hungary); and Robinson and Tyson (1985) (Yugoslavia). See also de Melo (1988).

[19]In their model, the fixprice regime is modelled directly, not by using an ad valorem equivalent.

references cited in footnote 18, a variety of assumptions are made about efficiency losses as a share of total rents. There is no obvious answer, since one can easily think of quota allocation schemes that will generate no rent seeking. In general, one would expect that there would be an initial period of intensive rent seeking while the institutional rules determining the allocation of rents are settled.[20] After that, there should be no more efficiency losses from rent seeking associated with import quotas than with any other government entitlement program.[21]

The literature on rents and rent seeking when there is extensive import rationing has certainly identified an effect where the numbers are large. Pervasive import rationing, however, occurs rarely. In the studies cited earlier, such rationing was usually a short to medium-term policy response to a crisis situation. More common, in developing and developed countries, is sectoral protection over a long period which is intended to restrict foreign competition. In this environment, there are potential welfare losses because protection induces non-competitive behavior. If, in addition, the affected industries are subject to scale economies, then potential welfare losses from protection, and the potential benefits from liberalization, can be quite large.

The interaction between oligopolistic behavior, scale economies, and import protection in developed countries is an area of active research in trade theory. There are some CGE models of developed countries incorporating these effects.[22] Work in developing countries is surveyed by de Melo (1988) and Devarajan and Rodrik (1989). Condon and de Melo (1986) build a stylized three-sector CGE model loosely based on Chile to illustrate the potential effects. In their model, with import rationing, scale economies in manufacturing, and imperfect competition (but no rent seeking), the welfare costs of import rationing in the manufacturing sector amount to 13-17 percent of national income. In a similar, but more disaggregated, model of Cameroon, Devarajan and Rodrik (1989) generate a much smaller number for welfare costs, around 2-3 percent of GDP.

The models appear to provide a reasonable description of parts of the manufacturing sector in a number of developing countries. In addition to coexisting firm-level scale economies and imperfect competition, many developing countries are also characterized by scale economies that appear to be external to the firm. There is some very recent work with theoretical long-run growth models incorporating Marshallian externalities that attempt to explain long-run development. See, for example, Lucas (1988) and Romer (1986). These models, in effect, introduce increasing returns to scale at the economy-wide level, while maintaining constant returns to scale at the level of the firm. They thus do not require any assumptions about imperfect competition to generate equilibrium growth paths.[23] While much of

[20]Robinson and Tyson (1985) argue that the disruption caused by the introduction of extensive import rationing in Yugoslavia may well have led to short-term efficiency losses that exceeded the value of the rents.

[21]Note that one has to be careful in defining what constitutes an efficiency loss. A bribe is a lump-sum transfer and involves no efficiency loss. When James Watt lobbied HUD, some part of his fee represented a bribe. The only efficiency loss was the social opportunity cost of his time, which was probably not that large.

[22]See Harris (1985), Cox and Harris (1985), de Melo and Tarr (1989), and work in progress by Burniaux and Waelbroeck (1989). Dixon (1978) was an early contributor to this literature and provided some suggestive calculations for Australia, although not in a full CGE model.

[23]Although see Romer (1988) who specifies a model with imperfect competition and externalities arising from investment in R&D. See also the survey by Krugman (1989).

this literature appears to be inspired by long-run historical industrialization in the currently developed countries, some of the externality mechanisms they discuss are potentially relevant for developing countries, especially when considering the role of manufacturing exports.[24]

Agricultural Trade Liberalization

The earlier work on trade-focused CGE models yields a number of lessons for those analyzing agricultural trade liberalization. First, do not expect to find large welfare gains from models sticking close to the neoclassical paradigm. In the long run, with flexible prices and all factors fully employed, market economies appear able to substitute around most problems and distortions. The welfare gains, however, may be large in comparison to the "costs" of the policy change (e.g., the change in government revenue). Second, the sectoral structure of resource use, output, exports, imports, and income will be very sensitive to policy choices. Third, existing structural rigidities which limit the capacity of the economy to adjust will generate significant differential returns or rents and also affect the sectoral structure of income. For example, existing distortions in the operation of factor markets or quantitative constraints on trade may generate significant potential gains from changes in policy. Analysis of the impact of policy should incorporate any existing institutional rigidities. Welfare analysis will then necessarily involve comparisons among second-best situations.

Work on using CGE models to analyze the impact of agricultural trade liberalization has been underway for a few years. In this section, I provide some background on the policy environment that motivated much of this research, briefly review the empirical results, and discuss where the next generation of models is heading, given the current state of the GATT negotiations.

Policy Environment and Empirical Results

At the beginning of the Uruguay round of GATT negotiations, the United States insisted that agriculture be discussed first and that domestic policies, as well as border policies, should be brought under the GATT. The initial U.S. proposal was that the major trading partners should dismantle all domestic agricultural programs --i.e., complete liberalization. The underlying view was that liberalization would generate higher prices on world markets, which would offset the losses to farmers from the removal of the programs. Trade liberalization, at least for agricultural exporters, would be a substitute for domestic farm programs.

The initial round of modelling work sought to analyze the impact on various countries and on the world economy of complete agricultural liberalization. Work focused on two scenarios: unilateral liberalization (in which the country removes all programs, but no one else does) and multilateral liberalization. These scenarios were analyzed with a variety of modelling methodologies. Hertel (1989a,b) surveys many of the CGE models and some of the empirical results. Stoeckel, Vincent, and Cuthbertson (1989) edited a collection of papers describing analysis of a common liberalization scenarios with single-country CGE models of various countries. The most elaborate models were developed for the U.S. and

[24]Helpman (1988) surveys some of the externality models and relates them to recent work in trade theory. De Melo and Robinson (1989b) present a model with externalities linked to exporting which is designed to capture the major features of manufacturing export-led growth in many semi-industrial countries.

Australia.[25] There is much less work with single-country models of developing countries.[26] Burniaux et al. (1989) describe the results from a set of small, single-country CGE models of the OECD countries, tied together in a world model called Walras. Results from other, non-CGE models are surveyed by Baker, Hallberg, and Blandford (1989) and Gardner (1988). The results from a USDA world model are presented in Roningien and Dixit (1989).

Policy interest centered on a few key questions (in descending order of importance). What happens to the agricultural sectors? What happens to the rest of the economy, especially sectors linked to agriculture, either upstream or downstream? What is the net impact on the government budget? What is the impact on aggregate welfare?

The main empirical results are robust across different methodologies. In most countries, and certainly in the U.S., trade liberalization is not a substitute for existing programs supporting agriculture. Even under the most optimistic world-market scenarios, with significant rises in world prices, income gains from higher market prices do not offset income losses due to removal of agricultural programs. From the results of the OECD Walras models, only in New Zealand does the agricultural sector gain under multilateral liberalization.[27]

The welfare effects, while small relative to GNP, are generally positive and represent a significant share of the change in program costs. In the U.S., for example, Robinson, Kilkenny, and Adelman (1989) find that removal of a 20-30 billion dollar agricultural program leads to about a 10 billion dollar increase in real GDP (in 1982 dollars). Part of this gain comes about because of removal of land set-asides, increasing the total supply of a primary factor. Capital and labor move out of agriculture, with gains to the non-agricultural sectors. As a group, grain importing developing countries lose from trade liberalization, while grain exporters gain. Within all developing countries, specific groups of poor people who are net buyers of cereals lose.[28]

In general, intersectoral linkages and general equilibrium effects are significant. For example, in the U.S., about half of the benefits of programs aimed at agriculture accrue to other sectors through forward and backward linkages.[29] In Australia, Higgs (1989) finds that protection granted to the manufacturing sectors has indirectly taxed agriculture, and if all trade policies were removed, agriculture would actually gain. Similarly, Stoeckel (1985) finds that the Common Agricultural Policy (CAP) in the European Community has hurt the industrial sectors and contributed to increased unemployment.

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[25]See, for example Higgs (1986, 1989); Hertel and Tsigas (1988); Hertel, Thompson, and Tsigas (1989); Robinson, Kilkenny, and Adelman (1989); and Kilkenny and Robinson (1989).

[26]See Loo and Tower (1989) and Sadoulet and de Janvry (1989). The archetype models by Sadoulet and de Janvry represent a major advance in CGE modelling of agriculture in developing countries in terms of specification of agricultural technology, sectoral disaggregation, and the incorporation of income distribution effects.

[27]Burniaux et al. (1989), Table 11a.

[28]See Sadoulet and de Janvry (1989).

[29]See Kilkenny and Robinson (1989).

The empirical results from past work have generated a need for new approaches. Given that trade liberalization is not a substitute for existing agricultural programs in virtually all countries, it is necessary to consider proposals for partial liberalization. The current position of the United States is to eliminate all "distorting" agricultural programs, but allow "non-distorting" programs that serve to maintain the incomes of farmers.[30] This change in focus has a number of implications for modelers, and the next generation of work is already underway to analyze more complicated liberalization scenarios. In the next section, I discuss the implications of this new policy focus on model specification.

Modelling Issues

There have been a number of recent surveys of different technical specifications for trade-focused CGE models.[31] In particular, Hertel (1989b) has surveyed the treatment of agriculture in existing CGE models, focusing on issues of aggregation, specification of technology (including the treatment of land), time horizon, the operation of factor markets, and the modelling of agricultural policies.[32] I will not duplicate Hertel's survey, but will instead focus on two modelling issues that arise from the recent change in policy focus: the treatment of agricultural programs and the need for forward-looking analysis.

As part of the work to support the GATT negotiations, the OECD organized work to measure the size of existing agricultural programs. After much debate, two ad valorem measures were agreed on: a consumer subsidy equivalent (CSE) and a producer subsidy equivalent (PSE). Data on PSE's and CSE's have been tabulated for a number of countries.[33] The standard approach, with a few exceptions, has been to model the programs as an ad valorem price wedge, analogous to an indirect tax or subsidy.[34] The model is estimated or calibrated for some base year with the wedges in place, then a liberalization scenario is simulated by simply setting all the wedges to zero and resolving the model. One problem with this approach is that the PSE and CSE measures include the cost of all programs to support agriculture. While some of these programs affect incentives, some do not. The modelling issue is to decide which programs affect incentives, and hence can be treated as a incentive wedge, and which programs should be treated as lump-sum transfers, with no effect on production or consumption incentives.[35]

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[30]The current official position of the U.S., apparently, is that this was their position all along.

[31]See the references cited in footnote 2.

[32]De Janvry and Sadoulet (1987) survey the treatment of agriculture in CGE models of developing countries.

[33]See U.S. Department of Agriculture, Economic Research Service (1988).

[34]The exceptions are: (1) CGE models of the U.S. by Kilkenny and Robinson (1988,1989); Robinson, Kilkenny, and Adelman (1989); and Hanson, Robinson, and Tokarick (1989); and (2) a linked set of CGE models of EC countries and the Common Agricultural Policy (CAP) by Harrison, Rutherford, and Wooton (1989). These models incorporate the various programs explicitly, albeit in a fairly stylized way. The U.S. models were developed at the USDA and are implemented with the GAMS software. The core model is described in Robinson, Hanson, and Kilkenny (1989) and the software is described in Brooke, Kendrick, and Meeraus (1988).

[35]The terminology used was "coupled" versus "decoupled" programs. For coupled programs, benefits are related to output, and hence affect production decisions by farmers. Decoupled programs have no affect on production decisions. Rausser and Wright (1987) proposed developing measures of producer incentive equivalents (or PIEs).

Even granting our ability to distinguish programs which affect supply decisions from those which do not, the use of ad valorem equivalents raises problems. Programs to support agriculture around the world are not, in fact, administered as ad valorem wedges. In virtually all countries, agricultural policies involve a complex mix of programs. For example, Kilkenny and Robinson (1988) classify U.S. agricultural policies into five broad categories, with benefits depending on instruments such as fixed target prices and loan rates, land "set aside" requirements (with voluntary participation by farmers), government stock accumulation, import quotas, and export subsidies. Only the last, export subsidies, are set in terms of an ad valorem measure.[36] The question is how accurate will be empirical estimates of the impact of liberalization scenarios when this complex mix of programs is approximated by a few ad valorem wedges? It may be reasonable to use such an approximation when the experiment is to simulate complete liberalization; i.e., eliminating all programs and hence setting all wedges to zero.[37] However, in the current policy environment, we must analyze the impact of partial liberalization scenarios and movement toward non-distorting agricultural support programs. The policy challenge is to design such programs. Policy models must reflect existing institutional arrangements and be capable of incorporating alternative policies, if they are to be useful in supporting the next phase of policy work.[38]

In the first round of work on analyzing the impact of agricultural liberalization, modelers used a comparative static approach. The model is first "benchmarked" on a base year, preferably as recent as possible, and is designed to reflect the policies in place at that time. Most models use 1986, but some start from 1982 or even 1977. Analysis proceeds by changing policy variables and/or exogenous parameters and then comparing the results with the benchmark solution. The models are used as simulation laboratories, allowing controlled experiments to sort out the empirical importance of changes in policies. While this approach yields useful information for policy makers, it also has serious limitations. The impact of the current round of trade negotiations will not start to be felt until the early 1990s, and policy makers need to estimate the impact of their current decisions five to ten years into the future. If they are to support such analysis, policy models also need to be forward looking.

Two U.S. CGE models have been used in forward-looking analyses of alternative agricultural trade policy scenarios. Robinson, Kilkenny, and Adelman (1989) use a ten-sector model to examine alternative scenarios for 1991, and Hanson, Robinson, and Tokarick (1989) use a thirty-sector model to explore alternative scenarios for 1995. In order to make forward projections, these models incorporate projections of all their exogenous variables and time-varying parameters. Their results must then be seen as conditional on these exogenous projections. Important exogenous variables that must be projected include: aggregate labor force; aggregate capital stock; sectoral total factor productivity; world prices of exports and imports and/or shifts in world demand functions for U.S. exports; agricultural policy parameters such

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[36]See Newman, Fulton, and Glaser (1987) for a comparison of agricultural policies in the U.S. and European Community.

[37]Kilkenny and Robinson (1988) compare models using the ad valorem approach and explicit modelling of programs, and show that even when simulating complete liberalization, the ad valorem modelling approach leads to errors in estimating the impact of policy changes.

[38]Whalley and Wigle (1989) and de Gorter and Fisher (1989) present models that endogenize the decision by farmers to participate in programs which require the farmer to "set aside" land from production. While suggestive, these approaches have not yet been implemented within a CGE model.

as target prices, loan rates, and land set-asides; and key macro aggregates such as the balance of trade and the government deficit and/or aggregate investment.

In making forward projections, the models cited above drew on sector-specific and macro "baseline projections" developed by the USDA and on similar exercises done by other groups.[39] The CGE model results turn out to depend critically on the underlying macro scenario. The 1981-85 period in the U.S. was characterized by high real interest rates, increasing federal deficits, growing trade deficits, and significant real appreciation of the exchange rate. U.S. agriculture suffered in these circumstances, with declining shares in export markets and increasing costs of government programs to support agricultural incomes.[40] Most macro analysts project a reversal of these trends over the next 5-10 years, with reductions in the federal deficit, a shift in the trade balance back to surplus, and significant real depreciation of the exchange rate. This macro scenario implies a significant increase in U.S. exports, with exports growing much faster than GNP.

Given the macro scenario, the CGE models are solved to determine the implications for sectoral production, employment, prices, income, exports, and imports. The models are specified so that the balance of trade and government deficits are exogenous variables (close in spirit to the model given in Table 1). Both the CGE and macro baselines project a successful expansion of U.S. exports, including agriculture. Certainly, the incentives for producers to increase exports are already strengthening and should strengthen further over the next few years. A legitimate question is to consider to what extent the assumptions of the macro models, and the CGE models, about the evolution of export markets are valid. How will world markets absorb the increase in U.S. exports? What will happen to the structure of world trade? These are questions best considered within the framework of multi-country models of world trade. However, the U.S. model results indicate that the U.S. will be attempting to increase exports and will actively contest world markets for agricultural goods, regardless of the outcome of the GATT negotiations. This is an important message for trade negotiators.

The CGE results also indicate that the cost of agricultural support programs will decline over time. These results are sensitive to assumptions about agricultural supply responses and the speed of macro adjustment, especially the improvement in the trade balance. If output were to grow faster than projected, or exports expand less rapidly, then domestic prices would be lower and the programs would cost more. Even with these qualifications, the projections indicate that the U.S. may be moving into a period analogous to the 1970s, where real depreciation was accompanied by improved agricultural performance and reductions in the cost of government support programs. If so, then the U.S. negotiating stance in the GATT is stronger. Over the next decade, the U.S. should be under less budgetary strain from agricultural programs than the European Community.

The macro and CGE results indicate a continued strong U.S. interest in furthering the current round of trade negotiations. To reestablish macro balance, the U.S. must expand exports. Expanding exports in a world environment of liberalized trade would be much easier than in an environment of increasing protectionism. Indeed, a collapse of the current GATT negotiations might generate an economic

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[39]The USDA macro model is described in Malley (1989). In addition to USDA baseline projections, detailed sectoral projections are given in FAPRI (1989).

[40]Adelman and Robinson (1988) use a CGE model to analyze the impact of macro shocks in the 1982-86 period on U.S. agriculture.

environment of shrinking world trade akin to that of the 1930s. Hanson, Robinson, and Tokarick (1989) simulate a scenario in which the U.S. lapses into a protectionist environment. The results indicate that the structural adjustments required in the U.S. would be very difficult, even ignoring the likely results of additional macro adjustment problems and increased unemployment.

Forward-looking projections with these models indicate that the approach should be fruitful. However, it imposes new demands on models. In particular, given the importance of the macro scenarios, there is a real need for work to integrate macro phenomena into CGE models. This is an area of active research, especially in developing countries.[41] Much of the existing work along these lines has been motivated by issues of structural adjustment in developing countries in the face of shocks such as the need for debt repayment or large swings in international prices (such as oil prices). There is some recent work in this vein that incorporates asset markets and endogenous macro variables in CGE models that also incorporate income distribution.[42] In view of the past dramatic changes in the world macro environment, and the likelihood of equally dramatic future changes, research to incorporate such changes in policy analysis with multisector models is very important.

Conclusion

The analysis of trade liberalization has generated an active body of work with multisectoral, computable general equilibrium (CGE) models. This work has drawn heavily on earlier work with trade-focused CGE models designed to analyze issues of structural adjustment in developing countries. The core of most single-country, trade-focused CGE models can be seen as an extension of the Salter-Swan "Australian" model of a small, open economy producing both tradables and non-tradables. The addition of assumptions about imperfect substitution and transformability between goods produced for the domestic and world markets represented a considerable advance, certainly in empirical realism. The resulting models, however, are still theoretically very much in the neoclassical paradigm.

While these CGE models have proven useful in policy analysis, they have also demonstrated the need for further work extending the modelling framework. One strand of work has sought to improve the specification of the models in addressing issues related to agriculture and trade liberalization, while remaining within the structure of neoclassical general equilibrium theory. Work in this strand has sought, for example, to improve model specification of agricultural technology, factor markets, and the operation of agricultural programs. A second strand of work with CGE models has sought to incorporate phenomena such as rent seeking, imperfect competition, scale economies, and externalities which extend the paradigm. Future models seeking to analyzing issues relating to agricultural trade liberalization could fruitfully draw on some of this work.

[41]Robinson (1989ab) discusses the theoretical issues and surveys recent models.

[42]This work is in response to recent policy interest in the distributional impact of World Bank and IMF structural adjustment and stabilization packages. See, for example, Bourguignon, Branson, and de Melo (1989). De Janvry, Fargeix, and Sadoulet (1989) present a model of Ecuador in this tradition which has a more detailed specification of income distribution and the agricultural sectors.

The development of CGE models for analyzing agricultural liberalization has been strongly influenced by the policy concerns expressed in the GATT negotiations. As the negotiations move into the next phase, policy models need to reflect the changing concerns. To support the ongoing negotiations, future models will need: to be forward looking, to incorporate the actual implementation of agricultural policies, to provide a framework for considering the impact of different macro scenarios, and to consider the links between agriculture and the rest of the economy.

References

Adelman, Irma and Sherman Robinson (1988). "Macroeconomic Shocks, Foreign Trade, and Structural Adjustment: A General Equilibrium Analysis of the U.S. Economy, 1982-1986. In Colin Carter and Walter Gardiner, eds., Elasticities in International Agricultural Trade. Boulder, Colorado: Westview Press.

Ahmed, S., A. Bhattacharya, W. Grais, and B. Pleskovic (1985). "Macroeconomic Effects of Efficiency Pricing and the Public Sector in Egypt." Staff Working Paper No. 726, World Bank.

Allston, Julian M., Colin A. Carter, Richard Green, and Daniel Pick (1989). "Whither Armington Trade Models." American Journal of Agricultural Economics, forthcoming.

Armington, Paul (1969). "A Theory of Demand for Products Distinguished by Place of Production." IMF Staff Papers, vol. 16, pp. 159-176.

Baker, Derek, Milton Hallberg, and David Blandford (1989). "U.S. Agriculture Under Multilateral and Unilateral Trade Liberalization --What the Models Say." Paper A.E.&R.S. 200, Department of Agricultural Economics and Rural Sociology, The Pennsylvania State University, University Park, PA.

Balassa, Bela et al. (1982). Development Strategies in Semi-Industrial Countries. Baltimore: Johns Hopkins University Press.

Bhagwati, Jagdish and T.N. Srinivasan (1980). "Revenue-Seeking: A Generalization of the Theory of Tariffs." Journal of Political Economy, Vol. 88, pp. 1069-1087.

Bourguignon, Francois, William H. Branson, and Jaime de Melo (1989). "Adjustment and Income Distribution: A Counterfactual Analysis." Working Paper No. 2943, National Bureau of Economic Research, April.

Brooke, Anthony, David Kendrick, and Alexander Meeraus (1988). GAMS: A User's Guide. Redwood, Cal.: The Scientific Press.

Burniaux, Jean Marc and Jean Waelbroeck (1989). "Preliminary Results of Two Experimental Models of General Equilibrium with Imperfect Competition." Paper presented at the Fourth IIASA Task Force Meeting on Applied General Equilibrium Modeling, Laxenburg, Austria, August 23-25, 1989.

Burniaux, Jean-Marc, Francois Delorme, Ian Lienert, John P. Martin, and Dominique van der Mensbrugghe (1989). "Economy-Wide Effects of Agricultural Policies in OECD Countries: Final Results." Draft paper, Economics and Statistics Department, OECD, Paris.

Chambers, Robert G. (1989). "Tariff Reform and the Uniform Tariff." Preliminary draft, May.

Clarette, Ramon and John Whalley (1986). "Equilibrium in the Presence of Foreign Exchange Premia." University of Western Ontario, processed.

Condon, Timothy and Jaime de Melo (1986). "Industrial Organization Implications of QR Trade Regimes: Evidence and Welfare Costs." Processed, Country Economics Department, The World Bank.

Condon, Timothy, Sherman Robinson, and Shujiro Urata (1985). "Coping with a Foreign Exchange Crisis: A General Equilibrium Model of Alternative Adjustment Mechanisms." Mathematical Programming Study, No. 23, pp. 75-94. Issue edited by Alan Manne under the title Economic Equilibrium: Model Formulation and Solution.

Cox, D. and R. Harris (1985). "Trade Liberalization and Industrial Organization: Some Estimates for Canada." Journal of Political Economy, vol. 93, no. 1, pp. 115-45.

Dahl, Hendrick, Shantayanan Devarajan, and Sweder van Wijnbergen (1986). "Revenue-Neutral Tariff Reform: Theory and an Application to Cameroon." Discussion Paper No. 1986-25, Country Policy Department, The World Bank, May.

de Gorter, Harry and Eric O'N. Fisher (1989). "The Dynamic Effects of Agricultural Subsidy Programs in the United States." Working Papers in Agricultural Economics, No. 89-9, Department of Agricultural Economics, Cornell University, Ithaca, NY.

de Janvry, Alain and Elisabeth Sadoulet (1987). "Agricultural Price Policy in General Equilibrium Models: Results and Comparisons." American Journal of Agricultural Economics, Vol. 69, No. 2, May, pp. 230-246.

de Janvry, Alain, Andre Fargeix, and Elisabeth Sadoulet (1989). "Economic, Welfare, and Political Consequences of Stabilization Policies: A General Equilibrium Approach." Paper prepared in support of the World Development Report 1990, World Bank, Washington, D.C.

Dervis, Kemal, Jaime de Melo, and Sherman Robinson (1981). "A General Equilibrium Analysis of Foreign Exchange Shortages and Adjustment Mechanisms in a Developing Economy." Economic Journal, vol. 91, December, pp. 891-906.

Dervis, Kemal, Jaime de Melo, and Sherman Robinson (1982). General Equilibrium Models for Development Policy. Cambridge: Cambridge University Press.

Devarajan, Shantayanan. (1989). "Taxation and Natural Resources in Computable General Equilibrium Models of Developing Countries." Journal of Policy Modeling, vol. 10, no. 4.

Devarajan, Shantayanan and Jeffrey D. Lewis (1989). "Structural Adjustment and Economic Reform in Indonesia: Model-Based Policies versus Rules of Thumb." HIID Development Discussion Paper, Harvard University. Forthcoming in D. Perkins and M. Roemer, eds., Reforming Economic Systems.

Devarajan, Shantayanan and D. Rodrik (1989). "Trade Liberalization in Developing Countries: Do Imperfect Competition and Scale Economies Matter?" American Economic Review, May.

Devarajan, Shantayanan, Jeffrey D. Lewis, and Sherman Robinson (1989). "Policy Lessons from Two-Sector Models." Kennedy School of Government, Harvard University, processed.

Dewatripont, Mathias and Gilles Michel (1987). "On Closure Rules, Homogeneity, and Dynamics in Applied General Equilibrium Models." Journal of Development Economics, Vol. 26, No. 1 (June), pp. 65-76.

Dixit, Avinash (1985). "Tax Policies for Open Economies." Chapter 6 in A. Auerbach and M. Feldstein, eds., Handbook of Public Economics. New York: North-Holland/Elseveir.

Dixon, Peter B. (1978). "Economies of Scale, Commodity Disaggregation and the Costs of Protection." Australian Economic Papers, June, pp. 63-80.

FAPRI (1989). "FAPRI U.S. and World Agricultural Outlook." Staff Report #2-89, Food and Agricultural Policy Research Institute, Iowa State University and University of Missouri-Columbia, April.

Gardner, B. (1988). "Some Recent Studies of Agricultural Trade Liberalization." Invited paper, XX International Conference of the IAAE, Buenos Aires, Argentina, August 24-31.

Grais, Wafik, Jaime de Melo, and Shujiro Urata (1986). "A General Equilibrium Estimation of the Effects of Reductions in Tariffs and Quantitative Restrictions in Turkey in 1978." In Srinivasan and Whalley (1986).

Hanson, Kenneth, Sherman Robinson, and Stephen Tokarick (1989). "United States Adjustment in the 1990's: A CGE Analysis of Alternative Trade Strategies." Working Paper No. 510, Department of Agricultural and Resource Economics, University of California, Berkeley.

Harberger, Arnold (1988). "Reflections on Uniform Taxation." Paper presented at the 44th Congress of the International Institute of Public Finance, Istanbul, August.

Harris, Richard (1985). "Applied General Equilibrium Analyses of Small Open Economies with Scale Economies and Imperfect Competition." American Economic Review, vol. 74, no. 5, pp. 1017-1032.

Harrison, Glenn W., Thomas F. Rutherford, and Ian Wooton (1989). "The Common Agricultural Policy of the European Communities." Unpublished paper, Department of Economics, University of New Mexico, Albuquerque, New Mexico.

Helpman, Elihanan (1988). "Growth, Technological Progress, and Trade." Austrian Economic Papers, Vol. 15, No. 1, pp. 5-25.

Hertel, Thomas W. (1989a). "Quantifying the Effects of Agricultural Trade Liberalization on the LDC's: A Survey of the Models." Paper prepared for the joint World Bank/OECD conference on the impact of agricultural trade liberalization on developing countries, Paris, October 5-6.

Hertel, Thomas W. (1989b). "Applied General Equilibrium Analysis of Agricultural Policies." Paper prepared for the NBER conference on Applied General Equilibrium Analysis, San Diego, California, September 8-9.

Hertel, Thomas W. and M.E. Tsigas (1988). "Factor Market Implications of Trade and Policy Liberalization in U.S. Agriculture." Paper prepared for the IATRC Symposium on "Bringing Agriculture into the GATT," Annapolis, MD, August 19-20.

Hertel, Thomas W., R.L. Thompson, and M.E. Tsigas (1989). "Economywide Effects of Unilateral Trade and Policy Liberalization in U.S. Agriculture." In Stoeckel, Vincent, and Cuthbertson.

Higgs, Peter J. (1989). "The Taxation of Australian Agriculture Through Assistance to Australian Manufacturing." In Stoeckel, Vincent, and Cuthbertson.

Higgs, Peter J. (1986). Adaptation and Survival in Australian Agriculture. Melbourne: Oxford University Press.

Kilkenny, Maureen and Sherman Robinson (1988). "Modeling the Removal of Production Incentive Distortions in the U.S. Agricultural Sector." Invited paper, XX International Conference of Agricultural Economists, Buenos Aires, Argentina, August 24-31.

Kilkenny, Maureen and Sherman Robinson (1989). "Economywide Implications of Agricultural Liberalization in the United States." USDA/ERS Staff Report, forthcoming.

Kis, Peter, Sherman Robinson, and Laura D. Tyson (1989). "Computable General Equilibrium Models for Socialist Economies." In L. Bergman, D.W. Jorgenson, and E. Zalai, eds., General Equilibrium Modeling and Economic Policy Analysis. New York: Basil Blackwell.

Krueger, Anne O. (1974). "The Political Economy of the Rent-Seeking Society." American Economic Review, vol. 643, no. 3, pp. 291-303.

Krueger, Anne O. (1985). "The Experience and Lessons of Asia's Super Exporters." In V. Corbo, A. Krueger, and F. Ossa, eds., Export-Oriented Development Strategies: The Success of Five Newly Industrializing Countries. Boulder, Colorado: Westview Press.

Krugman, P.R. (1989). "Industrial Organization and International Trade." In R. Schmalensee and R. Willig, eds., Handbook of Industrial Organization. Amsterdam: North-Holland, forthcoming.

Lewis, Jeffrey D. and Shujiro Urata (1984). "Anatomy of a Balance of Payments Crisis: Application of a Computable General Equilibrium Model to Turkey, 1978-1980." Economic Modelling, Vol. 1, No. 3 (July), pp. 281-303.

Loo, Thomas and Edward Tower (1989). "Agricultural Protectionism and the Less Developed Countries: The Relationship between Agricultural Prices, Debt Servicing Capacities, and the Need for Development Aid." In Stoeckel, Vincent, and Cuthbertson.

Lucas, Robert E., Jr. 1988. "On the Mechanics of Economic Development." Journal of Monetary Economics, Vol. 22, pp. 3-42.

Magee, Steven P. (1978). "Three Simple Tests of the Stolper-Samuelson Theorem," in P. Oppenheimer, ed., Issues in International Economics. Oriel Press.

Malley, James R. (1989). "Analysing Alternative Economic Policies with a Small Multi-Country Macroeconomic Model." Journal of Mathematical and Computer Programming, forthcoming.

Melo, Jaime de (1988). "Computable General Equilibrium Models for Trade Policy Analysis in Developing Countries: A Survey." Journal of Policy Modeling, vol. 10, no. 4, pp. 469-503.

Melo, Jaime de and Sherman Robinson (1985). "Product Differentiation and Trade Dependence of the Domestic Price System in Computable General Equilibrium Trade Models." In Theo Peeters, Peter Praet, and Paul Reding, eds., International Trade and Exchange Rates in the Late Eighties. Amsterdam: North-Holland.

Melo, Jaime de and Sherman Robinson (1989a). "Product Differentiation and the Treatment of Foreign Trade in Computable General Equilibrium Models of Small Economies. Journal of International Economics, Vol. 27, pp. 47-67.

Melo, Jaime de and Sherman Robinson (1989b). "Productivity and Externalities: Models of Export-Led Growth." Trade Policy Division, Country Economics Department, The World Bank, processed.

Melo, Jaime de and David Tarr (1989). "A General Equilibrium Analysis of U.S. Foreign Trade Policy." World Bank, April, processed.

Mitra, Pradeep (1986). "Revenue Raising Tariffs: Theory and an Application to India." Country Economics Department, The World Bank, processed.

Neary, J.P. and K. Roberts (1980). "The Theory of Household Behavior Under Rationing." European Economic Review, Vol 13, pp. 25-42.

Newman, Mark, Tom Fulton, and Lewrene Glaser (1987). "A Comparison of Agriculture in the United States and the European Community." Foreign Agricultural Economic Report Number 233, U.S. Department of Agriculture, Economic Research Service, Washington, D.C.

Pyatt, Graham and Jeffery I. Round, eds. (1985). Social Accounting Matrices: A Basis for Planning. Washington, D.C.: The World Bank.

Rausser, Gordon and Brian Wright (1987). "Alternative Strategies for Trade Policy Reform." Working paper prepared for the Benjamin E. Lippincot Symposium on Policy Co-ordination in World Agriculture, April 22-24, University of Minnesota.

Robinson, Sherman (1989a). "Computable General Equilibrium Models of Developing Countries: Stretching the Neoclassical Paradigm." Working Paper No. 513, Department of Agricultural and Resource Economics, University of California, Berkeley.

Robinson, Sherman (1989b). "Multisectoral Models." In H.B. Chenery and T.N. Srinivasan, eds., Handbook of Development Economics. Amsterdam: North-Holland.

Robinson, Sherman and Laura D. Tyson (1985). "Foreign Trade, Resource Allocation, and Structural Adjustment in Yugoslavia: 1976-1980." Journal of Comparative Economics, Vol. 9, pp. 46-70.

Robinson, Sherman, Kenneth Hanson, and Maureen Kilkenny (1989). "The Structure and Properties of the USDA/ERS Computable General Equilibrium (CGE) Model of the United States." Forthcoming Staff Report, Economic Research Service, U.S. Department of Agriculture.

Robinson, Sherman, Maureen Kilkenny, and Irma Adelman (1989). "The Effect of Trade Liberalization in Agriculture on the U.S. Economy: Projections to 1991." In Stoeckel, Vincent, and Cuthbertson.

Roland-Holst, David, and Stephen P. Tokarick (1989). "General Equilibrium Modeling for Trade Policy: An Overview." Research Division, Office of Economics, U.S. International Trade Commission, Washington, D.C. (November).

Romer, P. (1986). "Increasing Returns and Long-Run Growth." Journal of Political Economy, Vol. 94, pp. 1002-10037.

Romer, P. (1988). "Endogenous Technological Change." Processed, Economics Department, University of Chicago.

Roningien, V.O. and P.M. Dixit (1989). "Economic Implications of Agricultural Policy Reform in Industrial Market Economies." USDA Staff Report No. AGES 89-36, Washington, D.C.

Sadoulet, Elisabeth and Alain de Janvry (1989). "Growth and Welfare Effects of a GATT Agreement in Agriculture on the Low Income Countries: An Integrated Multimarket-General Equilibrium Analysis." Paper presented at a joint OECD/World Bank conference on "Agricultural Trade Liberalization: Implications for Developing Countries," Paris, October 5-6.

Salter, W. (1959). "Internal and External Balance: The Role of Price and Expenditure Effects," Economic Record, vol 35, pp. 226-238.

Shoven, John, and John Whalley (1984), "Applied General Equilibrium Models of Taxation and International Trade: An Introduction and Survey," Journal of Economic Literature, Vol. 22, September, pp 1007-1051.

Srinivasan, T.N. and John Whalley, eds. (1986). General Equilibrium Trade Policy Modeling. Cambridge, Mass.: MIT Press.

Stoeckel, Andrew B. (1985). Intersectoral Effects of the CAP: Growth, Trade, and Unemployment. Canberra: Australian Government Publishing Service.

Stoeckel, Andrew B., David Vincent, and Sandy Cuthbertson, eds. (1989). Macroeconomic Consequences of Farm Support Policies. Durham: Duke University Press.

Swan, T. (1960). "Economic Control in a Dependent Economy," Economic Record, vol. 36, pp. 51-66.

Taylor, Lance (1975). "Theoretical Foundations and Technical Implications." In C.R. Blitzer, P.B. Clark, and L. Taylor, eds., Economy-Wide Models and Development Planning. London: Oxford University Press.

U.S. Department of Agriculture, Economic Research Service (1988). "Estimates of Producer and Consumer Subsidy Equivalents: Government Intervention in Agriculture, 1982-86." USDA/ERS, Staff Report No. AGES880127, Washington, D.C.

Whalley, John (1989). "General Equilibrium Trade Modelling Over the Last Five Years." Paper presented at the NBER Applied General Equilibrium Conference, San Diego, CA, September 8-9.

Whalley, John and R. Wigle (1989). "Endogenous Participation in Agricultural Support Programs and Ad Valorem Equivalent Modeling." Unpublished manuscript, CSIER, University of Western Ontario.