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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.

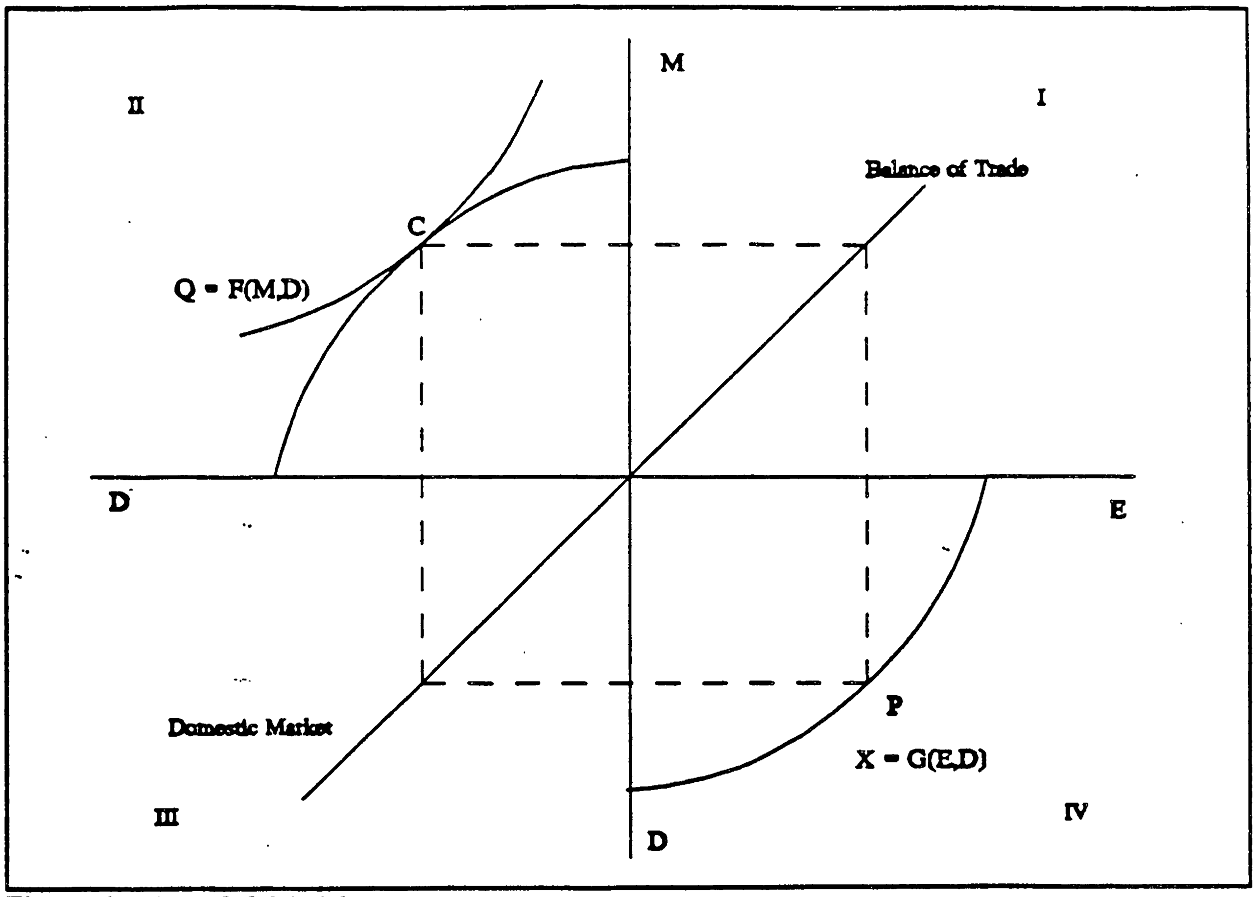

Figure 1: The 1-2-3 Model

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.