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OVERVIEW OF EXISTING AGRICULTURAL TRADE MODELS AND MODELING EFFORTS

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As agricultural trade has increased in importance for American agriculture over the past two decades, efforts to understand that trade in an organized and comprehensive way via formal trade modeling have increased. Much of the detailed theoretical and empirical work on agricultural trade modeling has taken place in the universities. Any potential modeler must first consult the growing set of journal articles and Ph.D. dissertations that have built and exercised agricultural trade models. An auxiliary movement has been the creation and use of agricultural trade models in public and private institutions for policy analyses, projections, forecasts, and as a means of gaining a better understanding of the economic forces and policy regimes that determine agricultural trade.

The International Agricultural Trade Research Consortium (IATRC) proposed the devotion of a session to the comparison and exercise of some of these "institutional" agricultural trade models. Models finally included in the exercise were two from the U.S. Department of Agriculture (USDA), two from land-grant universities, and one from an international institution. However, some institutional trade modeling activities, notable because of the resources devoted to them, were still in the development and review stage and were not yet available for such an exercise.

The participating models represent a wide spectrum of approaches to trade modeling ranging from small single-commodity world trade models to a very large multicommodity, multiregion, dynamic world agricultural trade model. The technology and knowledge required to carry out trade modeling move forward rapidly, and those interested should follow subsequent developments in the models covered in this report as well some of those mentioned above when they are completed.

The theme task of the Vancouver IARTC meeting was to present and compare several trade modeling efforts by giving the model a common task or problem and then comparing the analytical results. Models participating in this exercise included two from USDA, models from Michigan State and Iowa State Universities, and a model from the International Institute for Applied Systems Analysis (IIASA) in Vienna, Austria. Each model was asked to present (a) a base scenario, (b) the impact of a 5-percent shortfall in U.S. crop production, and (c) as best as it could, the impact of a trade liberalization scenario. The results of this exercise constitute the first part of this report. Individual model summaries and results of the exercise are presented for each model followed by a comparison of the results across models.

The models presented in this report reflect divergent viewpoints on the art and science of agricultural trade modeling. The discussion of "viewpoints" can be simplified by presenting, in an extreme form, some choices any modeler must make. An economic "model" is a simplification of reality used to help us understand how the "real world" works. The design and operation of a model presents the model builder with a complex set of choices for the formulation of his version of reality.

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Large Versus Small Models

In this report, the USDA single-commodity world spatial equilibrium model is at the "small" end of the modeling spectrum, while the multicommodity multiregion IIASA world model composed of thousands of lines of computer code is at the large end. The positive properties of small models tend to center on the ease and cost of construction, interpretation, and use, while the negative properties concentrate on their "partial" equilibrium nature—large models are pursued because of their comprehensiveness and general equilibrium properties.

Documented Versus Undocumented Models

Academic research standards applied to trade modeling require that sufficient documentation is available so model results can be analyzed and, if necessary, reproduced by others. This allows improvement and refinement by researchers without having to repeat the mistakes of others. Documentation can be an expensive and time-consuming operation for larger models, however, and in the extreme, some would argue that models are essentially personal tools used by

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Notable among models omitted from the exercise were an effort underway in the Organization for Economic Cooperation and Development (OECD) in Paris, France, a model developed by Don Mitchell at the World Bank in Washington, DC, an international agricultural trade model developed by Tyers and Anderson for the World Bank for its 1986 development report, a world food model developed at the United Nations Food and Agriculture Organization (FAO) in Rome, and a static world policy simulation (SWOPSIM) model framework developed in the Economic Research Service (ERS) at U.S. Department of Agriculture.

For the above models, some references are available. Mitchell's model is briefly discussed in A World Grains and Soybeans Model, Donald O. Mitchell, Division Working Paper No. 1985-7, Commodity Studies and Projections Division, Economic Analysis and Projections Department, Economic and Research Staff, World Bank, Washington, DC, December 1985.

Documentation of a precursor to the World Bank modeling effort by Tyers and Anderson is found in Agricultural Protection and Market Insulation: Analysis of International Impacts by Stochastic Simulation by Rodney Tyers, Pacific Economic Papers No. 111, Australia-Japan Research Centre, Research School of Pacific Studies, Australian National University, Canberra, Australia, May 1984.

ERS's SWOPSIM static model is documented in A Static World Policy Simulation (SWOPSIM) Modeling Framework, Vernon Roningen, ERS Staff Report No. AGES860625, International Economics Division, Economic Research Service, U.S. Department of Agriculture, Washington, DC, July 1986. Also, see Modeling Bilateral Trade Flows with the Static World Policy Simulation (SWOPSIM) Modeling Framework, Praveen Dixit and Vernon Roningen, ERS Staff Report No. AGES861124, International Economics Division, Economic Research Service, U.S. Department of Agriculture, Washington, DC, December 1986.

FAO's world food model is documented in The FAO World Food Model - Model Specification, an unpublished report, United Nations Food and Agriculture Organization, Rome, Italy, May 1986.

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analysts and, therefore, no more documentation is required than is needed by the model builder. This latter viewpoint suggests that models are essentially nontransferable and that the knowledge and reputation of the analyst-model builder is proof enough of the validity of a model. It should be added that documentation costs of time and effort depend heavily on the computer program or system in which any model is built. The models discussed in this report all have some documentation available; however, some are more completely documented than others.

Formal Versus Nonformal Model Integration

Some models are totally integrated in the sense that all parts are solved simultaneously. Other models may be solved in separate parts, and the parts are made consistent on an overall basis by an informal iterative process. The USDA Grain, Oilseeds, and Livestock (GOL) model is an example of a simultaneous system, while the Iowa State commodity models in this exercise are an example of separate commodity models that are solved independently but in a repetitive process until a satisfactorily consistent set of answers across models is obtained by the user. This latter technique is often used when model components are very large to avoid the mechanics of solving large linked models.

Static Versus Dynamic Models

Dynamic models capture the time path of variables in response to an exogenous disturbance. Static models compare alternative equilibrium states ignoring the time paths followed to reach those states. The USDA Generalized Transportation Problem (GTP) model represents a static model used to examine the mid- to long-term impact of policy changes, while the Michigan State model is an example of a model with a dynamic character. Forecasting models require dynamics, and the degree of structural detail included determine their suitability for the analysis of policy alternatives. Static models avoid the complexity needed to capture and solve a dynamic path of adjustment but at the expense of an inability to handle dynamic questions.

Models in a Computer Program Versus a Modeling Package

Models can be built as a computer program (for example, the IIASA model programmed in FORTRAN), or they can be installed in higher level modeling packages [for example, USDA's GOL which operates in the Time-shared Reactive On-Line Laboratory (TROLL) computer modeling software package]. A model programmed in a computer programming language gives the builder access to all the features of that language and complete control over all aspects of model operation. A model built in a higher level modeling package can take advantage of all the built-in modeling tools and documentation procedures associated with most modeling packages; any limitations of such a package, however, are also imposed on the model.

In all these choices, there are tradeoffs that any model builder and user must make. Some of the tradeoffs are a matter of personal tastes and skills of the people involved; others may be a function of the purpose of any modeling effort. One thing is certain, however: modeling technology is changing rapidly in terms of computer hardware and software and data availability. It is much easier now to build a world model of any type because more and better data are available and because there are better and faster mainframe and microcomputers and software available to ease the task of the model builder.

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The goal of the IATRC exercise was to illustrate and compare existing agricultural trade models by posing them common problems. Asking a model the world impact of a 5-percent U.S. crop shortfall was an attempt to test the responsiveness of the world model to supply shifts and should allow a rough calculation of the implied U.S. export demand elasticity embedded in the model structure. Of course, the stock behavior and levels incorporated in the model could mitigate any price response for such a small shift in the U.S. supply curve. This simple problem is tractable, however, for most operational models, and therefore, the results should be more comparable across models than for a more complicated exercise.

The second problem posed was one of full trade liberalization. This is a considerably more complicated problem that depends heavily on the coverage and structure of any model. Given the current interest in agricultural trade negotiations, this is a real world problem desperately needing illumination and, therefore, appropriate for this exercise. Indeed, many, if not most, of the models included in this exercise were designed to include trade liberalization as a policy simulation exercise to be undertaken.