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BUILDING A WORLD TRADE MODEL: SOME LESSONS WE ARE LEARNING

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The Agricultural and Trade Policy Branch (ATP) of the Agriculture and Trade Analysis Division, ERS, has been in the trade-modeling business for many years, working with large dynamic multicommodity models like GOL and the IIASA model, and small single-commodity models. We are currently building another world trade model as a part of a broader ERS study of trade liberalization. During our past and present modeling activities, we have learned some lessons. This morning, I will discuss some of those lessons as well as some present model-related problems.

The Optimal Trade Model

In our trade modeling work, we are constantly reminded of a concept called the "optimal trade model." One could think of this concept as a math ematical function:

$$\text{Trade model} = f\ (S, I, C, D, O)$$

with the arguments in the function being:

S = the problem setting
I = inputs to the modeling process (people and budget)
C = computer technology
D = data (prices, quantities, elasticities, etc.), and
O = other factors (omitted from this discussion).

The modeler wishes to maximize this function (that is, find the optimal trade model), given the current values of the independent variables. I'll discuss how the first four arguments of this function are shaping our current trade-modeling efforts.

The Problem Setting

The setting relates to the nature of the research problem and the nature of the research institution. Both have an impact on what constitutes an optimal trade model. As a part of its current trade liberalization study, ERS needs a world trade model for evaluating changes in various countries' agricultural policies--domestic policies and trade policies. This research problem dictates that the model should include such characteristics as multiple countries, multiple commodities, production, domestic consumption, trade, policies, etc.

Any model of significant size in ERS should be designed to have a useful life well beyond the immediate research needs. An agricultural trade model is no exception. We anticipate recurring trade policy and related issues that could be addressed with a trade model. To help ensure that a model will continue to be used in the institutional setting of ERS two additional model characteristics are desirable: quick turn-around and transferability. Quick turn-around is needed because of the short fuse on many requests for research that come from outside the agency. The model must be easy to modify, quick to solve, and give results that are easy to interpret, or else it will have very limited use in ERS. The model must also be relatively easy to transfer among researchers so that it will not die if one or two key researchers leave the project. The conceptually simpler, well-documented model has a better chance of surviving and being transferred among researchers.

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Inputs to the Modeling Process

The optimal trade model is also influenced by the available research budget and professional staff. A larger modeling effort can be pursued with more inputs. The equivalent of about 3 scientist-years (spread over about eight people) are being invested directly in model construction and use. Many more ERS researchers with country/region expertise are indirectly involved in constructing policy variables and evaluating model parameters.

Computer Technology

The trade model is being designed for the personal computer. The personal computer has provided a major breakthrough for policy modelers in ERS. It enables the analyst to obtain quick turn-around from sophisticated models at low cost. And the software allows excellent interaction between the model and the modeler. These characteristics greatly increase the potential for using formal models for policy analysis.

Data

The quality of the available data and coefficients help determine the nature of a model. The model is no better than the data in it. If the quality of the available data is poor, then there is little justification for building a complicated model. A trade policy model needs data for quantities (supplied, demanded, traded), prices, technical coefficients, elasticities, and policy variables for major traded commodities and countries. The quality of the data on quantities is relatively good, but the quality of the rest is quite poor. This suggests that a trade model should be kept relatively simple.

Given the current status of S, I, C, and D in the ATP Branch, we have defined what we think is an optimal trade model. To be more accurate, a modeling process is being followed that will yield one rather large trade model as well as many smaller trade models. It differs from past trade modeling activities in ERS because (a) we have learned from the past, and (b) there have been significant changes in several of the arguments in the trade model function, especially the introduction of the microcomputer.

I'll discuss two components of our current trade model: the structure of the model and the algorithm used to solve the model. We call the model "TLIB" for trade liberalization and we call the algorithm "SWOPSIM" for Static World Policy Simulation.

Structure of the Tlib Model

TLIB is a static, equilibrium, net trade, synthetic model of world agricultural trade in 1984. The complete model contains 22 commodities and 36 countries. As described below, world models with fewer commodities and countries can be constructed from the complete model.

We assume that the base year (1984) is in intermediate-run (3- to 5-year) static equilibrium. In other words, the model is designed so that the "base solution" reproduces the base year prices and quantities produced, consumed, and traded. Thus, this base solution represents the outcome as a result of agricultural policies that were in place in all countries in 1984. All of the model's price elasticities also represent a 3- to 5-year adjustment period.

One does policy analysis by changing selected policy variables in the base model and obtaining a new solution. The difference between the new and base static equilibrium solutions suggests how the policy change would have affected the world, as it existed in 1984, but after a 3- to 5-year period of adjustment.

TLIB is a synthetic model, meaning that the builders obtained the estimates of parameters from secondary sources rather than by using econometric techniques. The theory of competitive production, consumption, and trade of homogeneous goods is used to specify relationships among the parameters, and to reduce the number of estimates needed.

Why static? A static model is simpler than a dynamic model. The additional work of adding dynamics to the model does not appear to be cost effective at this time.

Why build a net trade model rather than a model that incorporates specific trade flows among trading countries, such as an Armington model or transportation model? The main reason is that the net trade model is simpler and requires less data. Besides, the main research interest of the trade liberalization study is not on individual trade flows among countries. We are, however, experimenting with an Armington version.[2]

The TLIB model is conceptually quite simple, yet it provides powerful conclusions. It provides estimates of net changes in production, consumption, prices, and shifts in welfare across sectors and countries for a wide variety of policy changes or other shocks to the base model. These changes, however, have to be interpreted within the context of the model's assumptions about how the world works. More is said in the last section about how one tests the validity of this model in representing the real world.

The Algorithm - SWOPSIM

The algorithm used to build and compute solutions to the TLIB model is called SWOPSIM.[3] Its creator is Vernon Roningen. SWOPSIM uses the latest spreadsheet software and can be handled by the more powerful microcomputers. The spreadsheet approach meets several of our objectives quite well. Its a widely used and flexible technology that simplifies the problem of transferring the model to other users. It allows interaction between the user and the model. And with the right match of model size and computer capability, the spreadsheet provides quick turn-around.

SWOPSIM stores data, builds trade models, solves trade models, and reports results. At present, the data set represents 22 commodities for 36 regions. The "model" discussed here refers to that total data set. From that common data set, however, SWOPSIM can create single-commodity world trade models or multicommodity models. It can create two-region world models or N-region world models with one region always being "the rest of the world." That flexibility allows the model to be tailored to the specific problem being investigated.

Modeling Problems

There are numerous problems associated with building a trade model. I'll mention five major problems that we had to address.

1. Base Period. The TLIB model is assumed to be in an intermediate run equilibrium in the base period. Thus it is important that world agriculture roughly approximate an intermediate run equilibrium during the base period. The base period might be defined as the average of

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[2] Praveen M. Dixit and Vernon Oley Roningen. Modeling Bilateral Trade Flows with the Static World Policy Simulation (SWOPSIM) Modeling Framework. ERS Staff Report No. AGES861124., Econ. Res. Serv., U.S. Dept. Agr., Dec. 1986.

[3] Vernon Oley Roningen. A Static World Policy Simulation (SWOPSIM) Modeling Framework. ERS Staff Report No. AGES860625., Econ. Res. Serv., U.S. Dept. Agr., July 1986.

several years or as one year. An average smooths out year-to-year random variations in prices and quantities. On the other hand, it is easier to define policies for a specific year. We chose to define a 1-year (1984) base period.

2. Time Horizon. Should the model be short run, long run, or something between? Since "trade liberalization" is the research issue, we discarded the short run and assumed that the model represented an equilibrium solution that would result after a 3- to 5-year period of adjustment.

3. Obtaining Price Elasticities. The full TLIB model needs about 3,600 own- and cross-price elasticities. It is impossible to obtain a consistent set of econometrically estimated values for all. In addition, the data do not exist for many countries. As a substitute, results of other studies are used and experts are polled. Further, theory provides opportunities to make simplifying assumptions. For example, first order conditions from a system of competitive supply equations can be used to specify certain cross-price elasticities.

4. How Insert Policy? There are three ways to insert policy into the TLIB model: (a) with price wedges between the world price and domestic producer and consumer prices (for example, producer and consumer subsidy equivalents), (b) by altering domestic supply and demand equations, and (c) with price transmission elasticities. We plan to use all three. We assume that when a country fully liberalizes trade, changes in world prices are fully transmitted to domestic producers and consumers. For these scenarios, price transmission elasticities are set at 1.0.

5. How Test the Model? How does one evaluate a static synthetic model? I know of no objective tests. By definition, the model will reproduce the base period. Alternative solutions are obtained by changing one or more parameters in the model. Those solutions represent outcomes that are not experienced by the real world in the base period. I conclude that an evaluation of the model must be based upon extensive sensitivity analysis and the analyst's judgment on the reasonableness of the results.

We use several sensitivity tests. For example, we estimate the implied elasticity of demand for U.S. exports by shifting the U.S. supply functions. Results show new export prices and new export quantities that can be used, with base solution export prices and quantities, to calculate export demand elasticities. Those export demand elasticities are functions of quantities and elasticities in all other countries. Thus, their interaction can be captured in one summary statistic that has some meaning to the analyst.

The model-building process described in this paper is summed up in one sentence in the text by Pindyck and Rubinfeld, "Model building is very much an art, and part of that art is learning to trade off alternative criteria in different ways.[4]

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[4]Robert S. Pindyck and Daniel L. Rubinfeld. Econometric Models and Economic Forecasts. Second Edition, McGraw-Hill Book Co., New York, 1981, p. 367.