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# MODELING U.S. AND WORLD AGRICULTURE WITH MICRO TSP — PROCESS AND APPLICATION

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Micro TSP software has been available for a number of years with new versions being introduced regularly by David M. Lilien of Quantitative Micro Software. These programs have been particularly useful in least squares analysis with time series data. The capacity of the program increased and model building capabilities were added. With the introduction of Version 5.0 in 1986, the number of variables this program could handle was increased from 150 to 300 (Hall and Lilien). This version requires 384K of RAM, but will use up to 512K if available. Up to 10,000 data points are allowed for 384K and up to 32,000 data points for 512K. Version 5.1 is now available which is similar to 5.0, but with more facility for interaction with Lotus 1-2-3.

A feature of these recent editions of Micro TSP is the ease with which models can be developed and solved. Micro TSP can solve linear or nonlinear systems of equations by the Gauss-Seidel method.

Least squares equations can be estimated and stored and then later retrieved with the EDIT facility. Equations can also be typed in directly in the EDIT mode. A number of operators and functional forms are available to generate the desired relationships.

Graphics can be developed quickly and used as a diagnostic tool as well as for generating visuals. The GRAPH command creates a two variable dot graph [or with GRAPH(C) a dot graph with successive years connected]. The PLOT command generates a chart of one or more variables over time with several options for scaling. The program lacks a good table-writing routine.

## Developing AGMOD

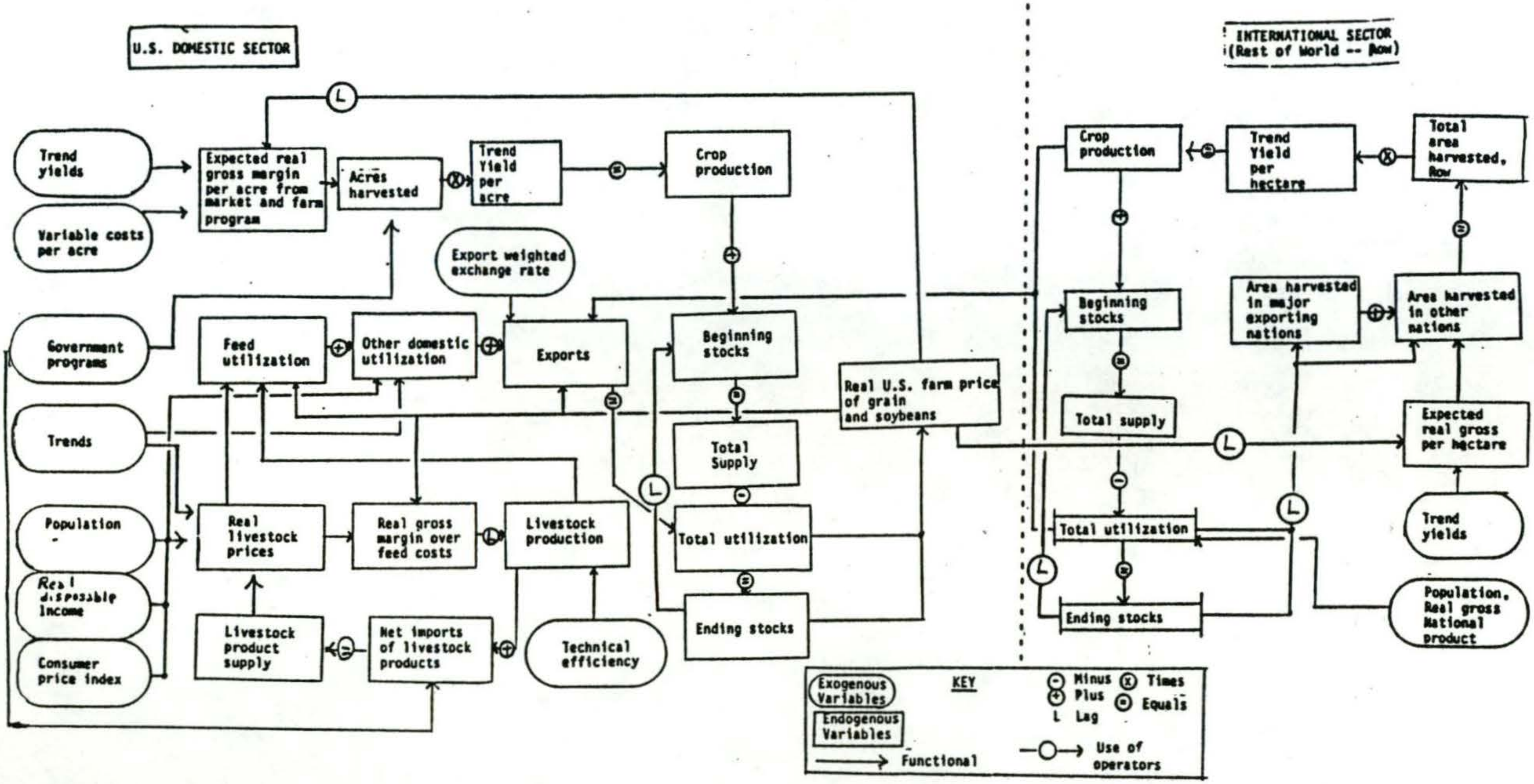
Since the fall of 1986, I have been estimating relationships in U.S. and world agriculture and developing a model based on the relationships using Micro TSP. Early assistance in use of Micro TSP was received from Shayle Shagam, a Graduate Student in Agricultural Economics (Shagam, 1986). The basic model was completed in about three months in what time I was able to divert from on-going commitments. Since completion of the basic model, efforts have been devoted to refinements and testing. While the conceptual framework was fairly well in mind at the outset, all of the behavioral equations were estimated from scratch even though some earlier estimates were available from previous studies. The point is that fairly comprehensive models can be developed by this process in a relatively short time.

The model, called "AGMOD" has currently 207 equations, of which 80 are behavioral and 127 are transformations. The model includes 181 endogenous, 48 exogenous variables and a number of "dummy variables." About 275 of the maximum 300 variables have been used in the core model. Most of the statistical relationships were based on annual data for 1960 to 1986. The commodity coverage includes cattle, hogs, broilers, turkeys, eggs, milk, feed grain, wheat, soybeans, soybean meal and soybean oil.

The basic structure of the model is presented in Figure 1. It is primarily recursive, but involves a simultaneous equation solution focusing on the real U.S. farm price of grain and soybeans. The supply equations feature gross margins over variable costs on crops and gross margins over feed costs on livestock. Gross margin type variables provide indicators of profits from enterprises over time. Because gross margins tend to display consistency over time or change in a consistent manner, they provide a means for diagnostic checking of the forecast. Major departures from past levels or trends are cause for re-evaluation.

FIGURE 1

AGMOD



The general format of AGMOD is similar to the MSU Agriculture Model, but with much less detail, especially in the international sector.[1/] The international sector is basically the "rest of the world" except that supply relationships on coarse grain and wheat are separately derived for the major exporting nations. Also, the availability of soybeans and soybean meal from Argentina and Brazil was estimated from a sub model.

With an upper limit of 300 variables in Micro TSP, one must be very selective in order to develop a reasonably comprehensive model. Consequently, the model has been kept fairly simple. The development strategy was to produce a working version; that is a version which could consistently be solved and generate reasonable forecasts. As time permitted, the components of the model were then refined and tested. This approach was effective because problems were encountered in obtaining solutions in early forms of AGMOD, a problem that plagued the MSU Agriculture Model. Having a fairly simple version aided in finding ways to handle this problem.

The speed of solution of the model aided greatly in model development and diagnostic checking. AGMOD normally solves in 2-3 minutes on an IBM-AT or Zenith 248-82. The graphics options were also employed frequently for identifying problems.

For each statistical equation which was entered into the model, several alternative equations were estimated--in some cases as many as 5-10 alternative formulations. The equation with the strongest logical and statistical properties was then selected for inclusion. Another test was to observe the estimate of the dependent variable in the model solution for the historical period and the forecast for the projection period. The estimated values were compared to the actual over the historical period as one test. The other test was to check how "reasonable" were the forecasts into the future.

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[1/]The MSU Agriculture Model was developed on a mainframe computer in the mid 1970s to mid 1980s. It includes a comprehensive international sector in addition to the domestic component. Gauss-Seidel is also the solution process (MSU Agriculture Model).

As the model grew in size, a decision was made to forego the ability to compare the estimates from the model with the actual. This required two codes for each variable--actual and estimated. In order to enlarge the model, each variable was given only one code name which represented actual values over the historical period and forecast values in the future.

The size of the model is an asset in terms of updating. The U.S. Department of Agriculture, which is the source of most of the data, revises their estimates for the current year frequently, often monthly. Even recent years' numbers are subject to fairly regular change. Updating requires 1-2 hours of time each month.

For the first year into the forecast period, which is 1987 in the current formulation of the model, decisions have to be made as to whether to use the model forecasts or new government or trade estimates. As the year proceeds, the government or trade estimates begin to be given more weight than the model forecasts. By the application of "add" factors in the EDIT mode, the model forecasts can be adjusted to match the emerging actual figure.

## Use for AGMOD

To date, the main use of AGMOD has been for generating long-range projections. The model is geared to forecast to the year 2000. This information has been used for planning and budgeting purposes. The projections have also been used as background information on outlook presentations.

AGMOD is also capable of policy analysis. The current version employs the program parameters of the Food Security Act of 1985 and accounts for the implementation of the Conservation Reserve. Assumptions are made about how these policy tools would be employed as carryover stocks change over time. Alternative policies could be tested.

An additional application of AGMOD which is yet to be explored is to make the model stochastic and gain information on market risk. Micro TSP has random number generators; one of which returns a uniformly distributed random number in the range of 0 to 1; the other returns a normally distributed random number with variance equal to 1.

A possible application of the normally distributed random number generators would simulate the departure of crop yields from trends. That factor could be added to the yield equations and with repeated runs of the model the sensitivity of major variables to yield fluctuations could be discerned. The problem of cross-correlation between corn, soybean and wheat yields in the U.S. and abroad would have to be addressed.

The applications of the random number generators might be extended to simulating errors of the forecasts of the component equations in the model, although this might become a difficult step to take computationally.

If a smaller version of AGMOD could be developed which would allow the comparison of the model forecasts with actual values over the forecast period, errors in the forecasts could be used in risk analysis. Also, this information could be used in the development of games for teaching forward pricing (Ferris, 1986).

The simplicity and rapid feedback from the model solution might be capitalized upon in educational programs. The uses could explore alternative assumptions with audiences and clientele and tailor the analysis to the group or individual views.

## Satellite Models

While the AGMOD is limited in size, an array of satellite models could be developed to interface with the core model. These models depend on the output of the core model, but do not reciprocate. That is, the satellite models have little or no impact on the core model. A number of satellite models are slated for development.

1. U.S. models on vegetables, potatoes, dry beans, sugar and fruit.
2. U.S. farm income and expenses.
3. Retail food prices and consumer expenditures on food.
4. Farm price of land.
5. Demand for capital inputs in agriculture.
6. Model of Michigan agriculture; commodities, farm income.

The solved values for AGMOD for the forecast period could be stored and then retrieved into the satellite models. These models would, in turn, be solved using the AGMOD output as exogenous variables.

**Further Developmnent and Testing**

AGMOD currently incorporates 275 of the maximum 300 variables available in Micro TSP. With minor modifications, the number could be reduced to about 250 variables. This would provide some flexibility in developing special versions tailored to address specific problems. For example, the international sector could be enlarged to include more regional analysis such as was developed for the MSU Agriculture Model (Shagam, 1987). Alternatively, more detailed subsector models could be incorporated in the domestic component drawing from such research as the livestock market analysis by Merlinda Ingco (Ingco, 1987). However, the capacity is not available to do both so that each would serve somewhat different purposes. For many problems, this may not be a major handicap.

AGMOD remains in a formative stage in that it has not been critiqued by commodity outlook specialists or those familiar with the general agriculture picture. More subjective input is needed at this point. A testing ground will be provided in a symposium on "Large-Scale Models and Economic Policy Analysis" scheduled as a pre-AAEA conference for August 1988. Several models in the public sector will focus on a set of policy decisions and the results will be presented at the symposium.

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