STRUCTURAL MODELING WORK IN ERS*

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Objectives of ERS Structural Modelling Work

Structural change in agriculture is the result of many factors from both within and outside the agricultural sector. These include an array of institutional, technological, and macro-economic factors. Although there is a large body of literature discussing the general qualitative impacts of a range of causal factors on farm structure, there has been no attempt to link these factors to projected quantitative changes in farm structure. Structural projections have for the most part been linear extrapolations of historical trends.

The initial objective of the current ERS structural modelling work is to develop a quantitative structural change model that explicitly incorporates the effects of various causal variables on the future configuration of the farm sector. On accomplishing this we will be in a position to conduct quantitative analyses on how changes in these causal variables affect the structure of agriculture.

Modelling Approach

A nonstationary Markov model is being developed as the basic structural change model for the ERS analysis. Initially, the model is being developed to project the future structural change at the U.S. level, but we plan to develop regional models. The initial modelling focus is on projecting changes in the

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sales class distribution. As model development proceeds we plan to include other structural dimensions (acre size, type of farm for example) into the analysis. The initial model will allow projection of the number and distribution of farms by sales class under varying assumptions about commodity prices, input costs, policy, and macroeconomic conditions.

The nonstationary Markov model allows the probability of movement from one state to another to vary over time (in contrast to a stationary Markov model, in which this probability is fixed). Consequently, the transition probability in the nonstationary model varies over time in relation to exogenous factors. In the commonly used stationary model the transition probability is assumed to be independent of exogenous factors. The nonstationary framework requires the estimation of a separate transition probability matrix for each time period.

The procedure being used to estimate the transitional probability is multinomial logit function in which the transitional probabilities are expressed as functions of the exogenous factors. Although other procedures have been used to estimate transition probabilities for nonstationary Markov models, transition probabilities derived using this procedure meet all the restrictive conditions of the Markov process (that all the probabilities must be between 0 and 1 and sum to 1 in each row) and in addition allow each cell in the transitional probability matrix to be derived from a different set of exogenous variables. A separate multinomial logit function can be estimated for each row of the transition probability matrix.

Data Base Development

Ideally, it would be nice to have a long time series linking the U.S. farming transition probabilities to exogenous causal factors. However, such a series is not available. As an alternative, longitudinal micro data from the Census of Agriculture can be used to construct transition probabilities.

A data set consisting of 1.2 million longitudinal records from the 1974 and 1978 Censuses of Agriculture is currently available. A similar file linking the 1978 and 1982 Censuses of Agriculture is being constructed. These longitudinal data can be grouped by geographic region and used as panel data for estimating transition probability functions. Although our preliminary work has used standard census divisions as regions, we are attempting to develop a larger number of more homogeneous regions using a cluster analysis technique. Although problems exist with the census longitudinal micro data (primarily problems of matching individual records from one census to the next), it nevertheless is the most detailed database yet available on changes in individual U.S. farms over time.

Current Status of Project

A preliminary nonstationary Markov model using the 1974-78 census longitudinal data has been developed by Matt Smith to be published as an ERS Staff Report titled A Conditional Approach to Projecting Future Farm Structure. A major purpose of this model is to evaluate the use of regional transition probabilities as a substitute for a larger time series of observed transition probabilities at the U.S. level. In this model, regional transition probability matrices were constructed for Census divisions from the longitudinal data. Logits of the observed regional transition probabilities were regressed on variables representing hypothesized causal factors using ordinary least squares. Causal variables examined were:

- age of operator population--proportion of operators aged 65 and older in each sales class and region.
- off-farm work--proportion of operators working off-farm 200 days or more for each sales class and region.
- change in farm product prices--regionalized by weighting the U.S. indices of prices received by farmers for crop and livestock products by 1974 regional crop and livestock sales.
- changes in farm asset prices--index of change in the total value of farm real estate in the region between 1974 and 1978.
- nonfarm income--index of change in regional nonfarm personal income per capita, 1974-78.

In all, a total of 90 equations were estimated from the regional data. In the regression analysis, the variables for operator age, off-farm work, and nonfarm income were statistically significant for some cells of the matrix, and were used to estimate the U.S. level transition probabilities.

In a test of its prediction performance, the nonstationary Markov model generally performed better than a stationary model estimated directly from the 1974-78 longitudinal data in projecting the sales class distributions of farms for 1982 and 1986.

Although the preliminary model is of limited value for policy or other structural analyses, it demonstrates the usefulness of the Census longitudinal database for structural change analysis, and evaluates a method for incorporating micro data on farm size changes into a Markov model. Further development to define a larger set of more homogeneous regions and to extend the database to more than one time interval are underway. With a larger number of observations of transition probabilities and data covering more than one time interval we will be able to develop more detailed models suited to analyzing the structural impacts of alternative policies and economic environments.