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A Quarterly Econometric Model for Short-Term Forecasting of the U.S. Dairy Industry

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Roberto Mosheim

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What Is the Issue?

This report documents the ongoing forecasting activities by USDA's Economic Research Service (ERS) that combine judgment-based forecasting with rigorous econometric estimations and data construction that can provide better forecasts than a mostly judgment-based system alone. The formal modeling process gives the forecasting activity at ERS transparency and full documentation on the specification, estimation, and validation procedures employed. Specifically, the econometric models generate the monthly dairy sector forecasts that contribute to the USDA *World Agricultural Supply and Demand Estimates* (WASDE) report. In addition, the model's estimates potentially can be used to examine the structure of the sector and the influence of policy-relevant variables. The merit of various econometric and time series models, however, is more about their ability to forecast effectively than for their potential contribution to policy analysis.

What Did the Study Find?

Various estimation methods successfully forecast different endogenous variables, a situation that might change as the sector evolves or as additional data become available and the applied econometric model improves. The ERS model generated projections that outperformed the consensus forecast by USDA's Interagency Commodity Estimates Committee (ICEC) in roughly half of the instances in terms of accuracy and predicting turning points in the data of interest.

The results demonstrate how different methods are preferable, depending on the variable. To produce forecasts in the dairy sector, we cannot rely on a single estimating method. Moreover, the findings suggest that composite forecasting or forecast blending will play a significant role in this process. Careful econometric specification and data development will ensure a successful transition from the mostly judgment-based forecasting system previously used at ERS.

The ERS forecasting model relied on specific characteristics not seen in previous studies of this kind. Specifically, it:

- Uses a variety of methods to estimate endogenous variables;
- Employs both time series and structural models; and
- Uses quarterly data and ex-post forecasting (seldom seen in this type of research).

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The estimations highlight certain characteristics of the U.S. dairy industry:

- Milk production per cow is seasonal and increases over time.

- Herd size movements are cyclical and tied to fluctuations in the all-milk price.

- As the margin (all-milk price minus feed cost) decreases (increases), herd sizes decrease (increase) after a number of periods.

- Price movement in the all-milk price is correlated to the price of cheese and butter more than whey and nonfat dry milk (NDM).

- The dairy sector is highly interlinked (reflected in block recursive structure where variables at one stage serve as determinants for the next).

How Was the Study Conducted?

The model is divided into 4 blocks comprised of 15 behavioral equations and 1 block comprised of 5 identities. Most of the behavioral equations are specified in logarithmic form that permits interpretation of estimated coefficients as elasticities. Each equation within a block forecasts a variable required by ICEC. The blocks are linked in a block-recursive fashion such that the first one generates estimates of variables that are then employed as predetermined variables in the second, third, and fourth. The resulting structure produces consistent forecasts across different sections of the dairy sector.

Economic theory typically defines the structural equations in models, although that practice is not as useful in the case of time series models where all variables within each block influence each other. The ERS model is based on quarterly data, beginning with the first quarter when all necessary variables are available (fourth-quarter 1998 or Q4/1998). Possible limitations, with respect to degrees of freedom for estimation, were the main reasons that the system of equations were divided into blocks and also explains why some modeling choices, such as the econometric specification of dairy product prices by means of inverse (price dependent) product supply equations, were made.

Prior to estimating, the various blocks were identified by rank condition to ensure that unique values of the structural parameters could be derived from the reduced form of the system. Estimations of the model were conducted by various simultaneous equations and time series methods that generate different values for the endogenous variables. These results were validated by withholding four quarters of known data and estimating the model, generating an ex-post forecast. The ex-post forecasts were compared with the known values of the withheld data to determine how well the models performed based on data available at the end of first-quarter 2009 (Q1/2009). These projections were also compared with those agreed upon by USDA in early April 2009 for the four successive quarters ending in first-quarter 2010 (Q1/2010).