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An Econometric Model of the U.S. Dairy Industry

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The Model

Ten-year projections for the U.S. agricultural sector and international agricultural commodity markets are produced biannually by the Food and Agricultural Policy Research Institute (FAPRI). These projections incorporate macroeconomic and financial forecasts from the WEFA Group (Bala Cynwyd, Pennsylvania) and domestic and trade policy assumptions for major participants in world markets for feed grains, soybeans, wheat, cotton, and rice.

The purpose of the FAPRI ten-year exercise is to evaluate implications of current and projected agricultural policies of the United States and other countries in the context of a likely world macroeconomic and financial environment. Consequences of macroeconomic, financial and agricultural policy for the performance of U.S. agriculture and the international commodity markets are emphasized in the interpretations of the results.

Inputs include macroeconomic conditions, agricultural policy assumptions, and outcomes for world and domestic markets for feed grains, wheat, soybeans, cotton, and rice. For the U.S. livestock sector, prices, production, consumption, and other market outcomes are included for beef, pork, poultry, eggs, and dairy. The system used to develop the FAPRI projections is solved simultaneously for world and U.S. market outcomes and includes provision for feedback between the crops and livestock sectors.

The 36 equation econometric model of the U.S. dairy industry (Figure 1) includes behavioral equations at the farm, wholesale and retail levels. As a result, the impact of technological change on production can be assessed at all levels with price signal feedback an integral part of the process. Individual equations were estimated over the time period 1962-1985 via ordinary least squares regression. The equations are the result of extensive research combining theoretical concerns with the desire for empirical validation. The criteria for ultimate inclusion in the model were the consistency of each parameter estimate's sign with a priori expectations and the size of the standard error relative to the parameter estimate. The solution values are obtained for projections by the simultaneous solution of the system of equations using the Gauss-Seidel iterative technique.

The supply sector of the model consists of five structural equations and one identity. Structural equations are estimated for January 1 dairy cow numbers, average number of cows on farm, feed consumed per cow, 16 percent protein ration cost and milk production per cow. The farm price of milk is the single most important variable influencing the supply of milk.

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Fifteen behavioral equations and 15 identities comprise the demand sector. Per capita consumption (net of donations) is estimated for each of six product categories; fluid milk, butter, cheese, non-fat dry, frozen and evaporated. One area in which the current dairy model differs from previous research efforts is the inclusion of demographic factors in the retail demand equations. The hypothesis is that failure to incorporate appropriate demographic variables may lead to a missing variable problem and inappropriate estimation of economic impacts. The results of the retail demand equations are particularly encouraging in this respect.

Perhaps the most important improvement in the current model relative to earlier dairy models (e.g. Novakovic and Thompson, 1977; Salathe, et al., 1982; Kaiser, et al., 1987), is the retail fluid demand equation. Although fluid is the largest utilization category, accounting for 40% of civilian dairy consumption in 1986, it has been a difficult component to portray econometrically. Negative or insignificant coefficients on the income variable have been the norm when using time series data. This has prompted some researchers to exclude income from their retail fluid demand equation (e.g. Salathe, et al., 1982). Other studies (Salathe, 1980; Blaylock and Smallwood, 1983) have opted for the utilization of cross-section data to estimate income elasticities for fluid milk. These studies found the income elasticity to be small but positive. The current FAPRI equation posits per capita demand for fluid milk as a function of the real price of fluid milk deflated by the consumer price index for non-durables less food, real per capita income, the deflated price of non-alcoholic beverages, and the proportion of the U.S. population under the age of 20. The income elasticity is 0.14.

The retail demand equations for manufactured products follow a logic similar to the fluid equation. Cheese, non-fat dry, and evaporated milk retail demands are estimated as a function of the price of the good, the price of a substitute, real per capita income, and an age of the population variable. Butter and frozen product retail demands include lagged dependent variables rather than demographic variables because of the importance of habit formation for these products.

The farm price of milk is endogenous in the current model and is consistent with the pricing mechanism for federal milk marketing orders. The federal milk marketing order system sets the price of fluid milk equal to the manufacturing grade price plus an administratively determined differential. This differential is exogenous in the model.

Economic Environment

The model used to determine changes in dairy industry production, consumption, price, and stock levels is conditioned by the economic environment expected over the next decade. Consumption of milk and dairy products is influenced by factors affecting consumer well-being. Profitability to dairy farmers is partially determined by costs of production of the operation. Both of these important factors are largely outside the control of the producer.

Real gross national product is projected (WEFA Group) to grow annually at the rate of 2 to 3 percent over the next decade. Civilian unemployment is expected to remain in the 5 to 6.5 percent range over this time period. A modest recession is projected for 1990. The federal budget deficit will decline slowly but remain above $100 billion per year through 1994.

On the production side, corn prices will rise over time as stocks are brought into a more reasonable ratio relative to production. The drought of 1988 has speeded this process. Soybean meal may rise sharply in

the year ahead but decline thereafter to more normal levels as supply response to both North and South Americas to world prices. Barley and oats prices are expected to remain high relative to corn due largely to the tighter stock levels in these two feedgrains. All these factors suggest that the feed cost of producing will rise substantially in the years ahead, particularly relative to the falling prices of the past three years.

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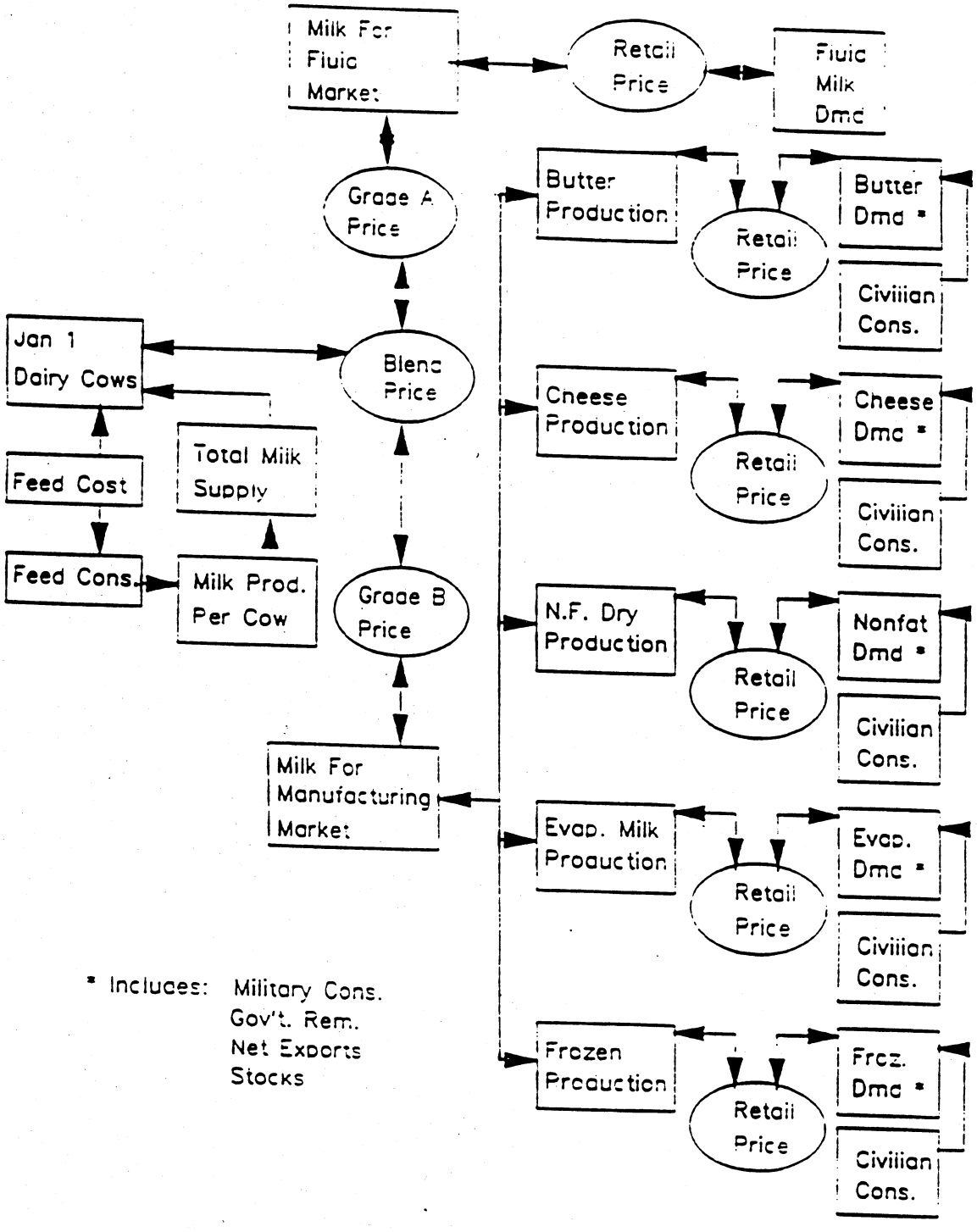

Figure 1. Dairy Model Product Flows