The Forecasting Process

The Interagency Commodity Estimates Committees (ICEC) are composed of various agricultural commodity experts employed by USDA. The membership include staff from the World Agricultural Outlook Board (WAOB), Economic Research Service (ERS), the Agricultural Marketing Service (AMS), the Foreign Agricultural Service (FAS), the National Agricultural Statistics Service (NASS), and the Farm Service Agency (FSA). The members from different agencies bring their perspective, knowledge, and expertise of their respective commodity markets to the table. The objective is to benefit from this information and lead to a consistent set of numbers used internally in USDA, with some results made official and released to the public. The ICEC meets each month and meetings are not open to the public or USDA staff unless invited.[2]

The Interagency Commodity Estimates Committees for Livestock and Dairy

The current structure of the ICEC for livestock and dairy was set up in 1977, merging the Agricultural Stabilization and Conservation Service (ASCS) interagency committees established in the 1960's with supply estimates for program commodities. Both committees (livestock and dairy) meet and report their forecasts to the WAOB chairperson responsible for reviewing the forecasts. The ICEC meets monthly to assess the current outlook and review available data and information. The members decide if recent information or developments due to weather, the national and industry economic outlook, and international trade imply a need to revise the previous month's forecast.

The ICEC produces quarterly and annual forecasts of the prices and quantities of livestock and dairy commodities. Historically, the livestock and dairy committees have focused on the supply side and quantities of livestock, grain, and dairy in various stages of the production process. However, wholesale and retail pricing forecasts appear to be increasingly important.

The forecasting procedure for the livestock committee begins with an ICEC meeting in May. At this meeting, forecasts for the next six quarters are generated, ending with the fourth quarter of the following year. In June, these quarterly forecasts are re-examined and possibly revised, but the forecast period is not extended beyond the fourth quarter of the following year. This process of meeting each month and revising the previous month's quarterly forecast continues until April of the following year. During that April ICEC meeting, only the forecasts for the second, third, and fourth quarter of the current year are revised. The process then repeats itself in May by generating a six-quarter forecast out to the fourth quarter of the following year. The meeting in May is the most important for livestock and sets the tone for the next 18 months of meetings. This occurs after key annual and quarterly agricultural surveys have been completed.

ERS staff make individual commodity projections and then the committee members discuss the forecasts. If an analyst believes that the previous forecast needs revising, the committee weighs the analysis and evaluates the importance of the change. The ICEC is reluctant to make minor modifications to the forecasts and prefers to minimize (unless warranted) the number of revisions, given the volatility in the commodity markets.

The livestock and dairy ICEC does not formally vote on forecasts. It decides by consensus. The livestock or dairy chairperson provides the data tables that are used in the deliberations of the WAOB meetings. Scenarios are examined using a spreadsheet "model" interactively during the meeting. Minutes of the meetings are not published.

ERS and the ICEC Approach[3]

The ERS methods of forecasting retail food prices for selected categories start at the farmgate. After reviewing farm and wholesale prices, the interagency committee determines the retail prices and CPI index changes.

ERS analysts assist with forecasting retail prices for three main areas: 1) meats, poultry, and eggs; 2) dairy and related products; and 3) fruits and vegetables. The process for CPI projections of meats, poultry, and eggs begins with forecasting the farmgate price of the

[2]This description is based on discussions with committee members and a "mock ICEC meeting" organized for the authors by the WAOB.

[3]The information contained in this section is based on extensive interviews with ERS analysts and a questionnaire sent to analysts responsible for the commodities.

related raw commodities using a set of balance-sheet models that contains inventories, stocks of animals in the biological cycle, exports, imports, consumption, and farm to wholesale to market prices. First, individual commodity analysts come up with forecasts for demand and supply factors (quantities, prices, income, and international trade) based on a combination of statistical analysis, rules of thumb, and conversations with public and private industry experts and colleagues. The analysts discuss their predictions with other USDA commodity analysts in the ICEC setting. Each commodity is either an input, substitute, or complement to other commodities. Based on these discussions, the analysts check to see if their predictions need revising. In the end, the committee members agree on the fundamental factors affecting retail food and food processing firms and agricultural markets, and use consistent assumptions in their predictions. Movements in farmgate commodity prices are then connected to changes in the CPIs through a set of fixed linear relationships (explained below), covering the economic activities in manufacturing, wholesaling, and retailing the final products.

Similarly, changes in the CPI for dairy products are obtained from forecasts of farm-level prices of milk derived from a model accounting for changes in the number of cows, milk per cow, total milk production, expected commercial use, and net removals.

In the case of pork, the first step of the forecasting process is to look at farm-level hog prices and estimate the hog supplies in different parts of the biological cycle. The biological cycle is calculated through a series of spreadsheets that model the cycle. Since the interagency estimates are for 18 months maximum, the number held for breeding sets the parameters for the next year's production. Because the analysts at the livestock interagency meetings must make a forecast judgment based on preliminary data and must be consistent with the projections of all the other interagency committees and analysts, spreadsheets using coefficients from Hahn and other analysts are reviewed before each interagency meeting.

The supply factors considered include the size and age distribution of the herds, feed costs, and expected prices for hogs. NASS provides important hog inventory data in March, June, September, and December. If there are significant differences, due either to revisions in the past numbers of the hog population or to differences between the actual quantities and the predicted quantities, the analyst will consider modifying previous forecasts. Simple statistical relationships and rules of thumb link farm prices, wholesale prices, and the retail price changes through farm-wholesale and wholesale-retail margins.[4]

The first margin, between farm and wholesale level prices, reflects demand and supply pressures at the processor/wholesale level. The second margin reflects economic forces going from the processor/wholesaler to retail level. Both margins are allowed to change based on market information that the analysts have regarding the interaction among the three prices. These adjustments are performed using expert judgments. On the retail demand side, when relative prices of substitutes like poultry and beef, seasonal demand factors, or per capita income growth are expected to change, the wholesale-retail margin is modified using established rules of thumb. For example, retail per capita demand for pork is sensitive to real disposable income growth whenever it is expected to increase or decrease by more than 2 percent. Similarly, the wholesale-retail price markups tend to vary according to seasonal factors, the competing prices of beef and poultry, inflation, and marketing specials. Another rule of thumb is that retailers have an ideal markup and allow the price to vary within a "comfort zone."[5] These rules of thumb can best be described by the following simple function:

$$Retail\ Price = Markup * Wholesale\ Price$$

$$Markup = f(Price\ of\ Substitutes, Specials, Season, Input\ Costs)$$

The forecasting process for the CPIs of fruits and vegetables is based on simple statistical modeling, rules of thumb, and expert judgment. The approximate weights are 50 percent, 40 percent, and 10 percent, respectively. The econometric modeling effort focuses on the trend and seasonal components of price indices. Rules of thumb and expert judgment are typically used to incorporate the cyclical variation. Currently, there are three CPIs for this category: fresh fruits, fresh vegetables, and processed fruits and veg-

[4]The CPIs are forecast by calculating the percent change in forecast wholesale prices and applying the relationships to retail prices.

[5]Thus, there appears to be a longrun price spread homogeneity. This suggests one could econometrically model the short-run and longrun price dynamics.

etables.[6] (In December 1997, BLS combined processed fruits and processed vegetables into a single category.)

The process is based on a three-step procedure. The first step forecasts the trend for each produce item from linear regressions of the CPIs, using the historical produce prices. The forecast trends are adjusted using expert knowledge about farm production, inventories, and per capita retail consumption. In addition, the forecast trends are adjusted using historical information. In the second step, the seasonal factors are standardized and constructed from historical 12-month moving averages over the previous 15 years. The resulting monthly individual product indexes are averaged to obtain the quarterly forecasts. In the final step, aggregate fruit and vegetable price indexes are calculated using BLS's historical weights for each individual produce item.

The remaining seven categories (Food Away from Home, Fish and Seafood, Fats and Oils, Sugar and Sweets, Cereals and Bakery Products, Nonalcoholic Beverages, and Other Foods) account for 69 percent of the CPI for all food. For these categories, ERS forecasts are based on retail price fluctuations and expected inflation changes.[7]

Denbaly and others discuss the methodology used and evaluate the forecasts over a 10-year period. Their study was based on the assumption that current ERS forecasting methods were also used from 1984 through 1994. Forecast methodologies can vary from simple univariate time series techniques to elaborate agricultural supply and consumer demand models.

The current forecast procedure is based on the assumption that the annual proportionate change in a series follows a random walk. "Annual proportionate" refers to the ratio of the level of the CPI component in a given month divided by its level for the same month in the previous year.

Let y_t represent a CPI component observed in month t. The annual proportionate change in month t is simply $p_t = y_t / y_{t-12}$. Let '^' denote the predicted or forecasted value up to 12 months into the future. The historical forecasts are based on the following formula:

$$\left(\frac{\hat{y}_{t+j}}{y_{t+j-12}}\right) \equiv \hat{p}_{t+j} = \left(\frac{y_t}{y_{t-12}}\right) \equiv p_t \qquad (1)$$

for j = 1,...,12. Equation 1 describes the pattern of the proportionate change *(p)* in the price series over the 12-month forecast horizon. Equation 1 assumes the proportionate change in the series remains fixed at the level measured 1 month prior to the forecast period. In other words, the proportionate change of the price series is assumed to follow a random walk over the forecast horizon. Rearranging equation 1 gives

$$\hat{y}_{t+j} = \hat{p}_{t+j}\, y_{t+j-12} = p_t\, y_{t+j-12}$$

$$= \left(\frac{y_t}{y_{t-12}}\right) y_{t+j-12} \qquad (2)$$

for j = 1,2,..., 12. Equation 2 states that a given month's price forecast over the 12-month horizon is the last annual proportionate change observed multiplied by the level of the index a year before the month to be forecast. ERS uses equation 2 to generate forecasts of CPI components for food.

One advantage of this technique is its simplicity. The j-step-ahead forecast of y is the product of the most recently observed annual proportionate change *(p_t)* and *y_{t+j-12}*. The same month from the previous year is j. The one-step-ahead prediction of the March 1996 price index for example is the product of the proportionate change observed from the February 1995 to February 1996 index, times the March 1995 level of the series. The two-step-ahead prediction (that is, the April 1996 index) is the product of the same proportionate change and the April 1995 level. An equivalent expression is $\hat{y}_{t+j} = (y_{t+j-12} - y_{t-12}) / y_t$. The j-step-ahead forecast this year is equal to the j-step observed change from the previous year. It is a routine practice in forecasting to use equation 2 to generate sets of predictions for many different time series. When analysts believe that the forecasting rule in equation 2 will be erroneous, because of special market circumstances, they adjust the forecast.

In addition, ERS began using univariate ARIMA and other simple time series models in 1995 as a forecasting tool. Sims recommends using simple ARIMA and

[6]The individual commodities in the three components are fresh fruits (apples, bananas, oranges, other), fresh vegetables (potatoes, lettuce, tomatoes, other), and processed fruits and vegetables (juices, canned, frozen, dried, and other).

[7]Prior to 1995, the methods used to forecast these remaining seven components of the food CPI were not documented.

VAR models to compare with the predictions of structural and expert judgment models. A separate model is estimated for each category of the CPI for food and the model and is updated each period. These models provide ERS with forecasts containing historical trends and seasonal fluctuations, to compare with the forecasts that are obtained using the procedures described above.

For highly processed food products included in the Fats and Oils, Sugar and Sweets, Cereals and Bakery Products, Nonalcoholic Beverages, and Other Foods categories, individual economic forces that affect retail prices are not specifically accounted for. This economic value, when added to raw commodities to produce the final food products, demands an average 80 cents out of every dollar spent on food. The contribution of manufacturing, processing, wholesaling, and retailing activities as well as the direct impact of changes in consumer preferences are accounted for by changes in the all-items CPI and rules of thumb based on expert judgments.

Empirical Model Forecasts at ERS

In the 1980's, ERS researchers developed several quarterly econometric models for predicting activity in the agriculture, food marketing, and food consumption areas. The quarterly model described by Westcott and Hull begins with exogenous variables related to the macroeconomic outlook, foreign outlook, and prices paid by farmers. The model had four modules. The assumptions and projections about these series feed into a commodity outlook module containing supplies, demand, inventories, and prices of livestock and crops. This module provides information to the next three modules. The first is a farm income model, the second is a food price model, and the third is a food consumption model. Figure 4 depicts the original quarterly agricultural forecasting model.

Westcott developed a quarterly markup model for retail food prices. Twenty-one equations are estimated in a dynamic time series framework. The general specification for the models take the following form:

$$RP_t = A_0 + B(L)RPs_{t-1} + C(L)FLP_t + D(L)FMC_t + E_t$$

where RP is retail prices, RPs are retail prices of substitute and complementary goods, FLP is farm-level prices, and FMC is food marketing costs. The dynamic properties suggest that the multiplier effects occur fairly rapidly, most within two quarters. The less processing required for a good, the faster the passthrough of changes in any of these prices. The equations are estimated using Ordinary Least Squares (OLS) and then fit into a model using Three Stage Least Squares, imposing the aggregation restrictions for the components of the food price components in the CPI.

Elitzak and Blisard tested two different five-variable VAR models for meat and seafood retail prices. They used the same markup pricing approach as Westcott. These models were compared against one-quarter-ahead USDA forecasts from the third quarter of 1986 until the second quarter of 1988. Theil's U2 statistics were used to make the comparisons. For these eight quarters, the two VAR models appear to perform much better than the USDA forecasts.

Hahn tested three alternative models for price transmission in the beef and pork industries. The first model required that current price effects be symmetric; the second model required that lagged price effects be symmetric; and the third model measured the importance of asymmetric feedbacks from the retail and farm prices to the wholesale price. In the results, the beef and pork model estimates implied that asymmetry is an important part of meat price transmission, and in many cases the effects of asymmetry are large and statistically significant. The structural equation estimates for both beef and pork models implied that the wholesale level is the leading level. The pork model's estimates showed asymmetric feedback from the farm and retail levels to the wholesale level; while the beef results do not show asymmetric feedback. The models' estimates imply that meat price transmission processes may be more complex than models used in previous studies.

ERS used these price forecasting models in the 1980's and early 1990's when it maintained a quarterly agricultural model. This model is no longer in use, because of resource constraints and because of a change in the forecast focus from quarterly projections to annual. It is not clear to what extent, if any, the statistical relationships from the earlier quarterly models are used in the current WAOB spreadsheet models and forecasts. Quarterly food price forecasts are building blocks to the official Department annual forecasts, but they are only internal-ERS forecasts.