Retail Food Price Forecasting at ERS: The Process, Methodology, and Performance from 1984 to 1997. Frederick L. Joutz, Robert P. Trost, Charles Hallahan, Annette Clauson, and Mark Denbaly. Economic Research Service, U.S. Department of Agriculture. Technical Bulletin No. 1885.

Abstract

Forecasting retail food prices has become increasingly important to the U.S. Department of Agriculture (USDA). This is due to the changing structure of food and agricultural economies and the important signals the forecasts provide to farmers, processors, wholesalers, consumers, and policymakers. The American food system is going through fundamental structural changes. It is unclear how these changes will affect the cyclical variation of food price markups and translate into changes in retail food prices. The only government entity that systematically examines food prices and provides food price forecasts (on an annual basis) is the Economic Research Service, an agency of USDA. This report explains the ERS procedures in forecasting food prices and assesses how changes in the current procedures would improve the quality of the forecasts.

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Preface

ERS periodically evaluates current forecasting procedures for the Consumer Price Index (CPI) for food to determine if alternative procedures should be incorporated. In the 1980's, ERS researchers developed several quarterly econometric models for predicting activity in agriculture, food marketing, and food consumption. The quarterly model described by Westcott and Hull (1985) had four modules: a commodity outlook model, a farm income model, a food price model, and a food consumption model. The equations in this model were estimated using OLS and then fit into a model using three-stage least squares, imposing the aggregation restrictions for the food price components in the CPI. 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. However, components from this earlier quarterly model are currently used to forecast beef, pork, poultry, eggs, and milk retail prices.

Two different five-variable VAR models were tested in 1989 by Elitzak and Blisard for meat and seafood retail prices. These models were compared against one-quarter-ahead USDA forecasts from the third-quarter of 1986 until the second-quarter of 1988. For these eight quarters, the two VAR models performed better than the USDA forecasts.

Hahn (1989) 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 feedback from the retail and farm prices to the wholesale price. As a result of this study, the beef and pork model estimates implied that asymmetry is an important part of meat price transmission. The structural equation estimates for both beef and pork models found that the wholesale level is the leading level, and the estimates implied that meat price transmission processes may be more complex than found in previous studies. Results from this model are currently used along with the earlier quarterly model forecasts to forecast beef and pork retail prices.

In addition to commodity analyst forecasts for beef, pork, poultry, eggs, fresh fruits, and fresh vegetables, ERS has used ARIMA models since 1995 to verify that forecasts made by the commodity analysts are statistically sound and within a 95-percent confidence level. An initial assessment by Denbaly was conducted on seven of the food index components not forecast by commodity analysts. The results from that study concluded that forecasts computed using ARIMA models were more reliable than forecasts computed using the ERS model.

The current study was undertaken to determine if more reliable forecasts of retail food prices could be obtained from methods not currently used by ERS forecasters. The intentions of this study were to evaluate past forecasting performances, identifying areas where improvements could be made, and to document the current forecasting procedures to users of the information. In this study, historical ERS forecasts are evaluated and compared with alternative time series models.

Summary

The only government entity that systematically examines food prices and provides food price forecasts (on an annual basis) is the Economic Research Service (ERS), an agency of USDA. This study explains the current forecasting procedures used by ERS, evaluates past forecasting performance, and creates an up-to-date set of historical forecasts. This study compares the ERS procedures with alternative univariate time series models. This was accomplished by generating out-of-sample forecast errors, computing four accuracy statistics, and performing a statistical test of forecast reliability. The results show that the alternative univariate forecasts had a lower Root Mean Square Error (RMSE) for seven price indexes and the ERS forecasts had a lower RMSE for three indexes. In the other food items, there was no significant difference between the forecast error variances.

The U.S. Department of Agriculture forecasts annual changes in the major categories of the Consumer Price Index (CPI) for food. These forecasts are used in the President's annual budget for designing food and agricultural programs, such as the Food Stamp Program, which cost $19.6 billion in 1997.

Identifiable users of the ERS food price forecasts include USDA's Chief Economist and Secretary's Office, the Federal Reserve Board, the U.S. Congress, other government agencies, the news media, the food retailing and processing industries, private consultants, companies, and universities. Food service purchasing agents from hospitals, universities, State institutions, and military organizations also use the ERS food price forecasts to support their budget requests and expenditures.

Forecasting retail food prices has become increasingly important to USDA due to the changing structure of food and agricultural economies and the important signals the forecasts provide to farmers, processors, wholesalers, consumers, and policymakers. The American food system is going through fundamental structural changes. It is unclear how these changes will affect the cyclical variation of food price markups and translate into changes in retail food prices.

There are three modern approaches to forecasting: (1) judgmental approach, (2) extrapolatory approach, which includes Box Jenkins and smoothing techniques, and (3) explanatory approach, which includes regression techniques. For food, changes in farm to wholesale to retail price spreads, changes in general market conditions (costs for labor, packaging, marketing and advertising), changes in competition among industries, changes in the general inflation rate, and changes in supply, demand, and consumption patterns, suggest that food price forecasts may benefit from a combination of all three forecasting methods.

Retail Food Price Forecasting at ERS

The Process, Methodology, and Performance from 1984 to 1997

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Introduction

The U.S. Department of Agriculture forecasts annual changes in the major categories of the Consumer Price Index (CPI) for food. These forecasts are used in the President's annual budget for designing food and agricultural programs, such as the Food Stamp Program, which cost $19.6 billion in 1997. Other government agencies also use these forecasts. For instance, the Federal Reserve Board considers food price inflation forecasts in its deliberations about monetary policy.

Forecasting retail food prices has become increasingly important to USDA due to the changing structure of food and agricultural economies and the important signals the forecasts provide to farmers, processors, wholesalers, consumers, and policymakers. The American food system is going through fundamental structural changes. It is unclear how these changes will affect the cyclical variation of food price markups and translate into changes in retail food prices.

Along with energy prices, food prices are the most volatile consumer price category the government tracks. The only government entity that systematically examines food prices and provides food price forecasts (on an annual basis) is the Economic Research Service (ERS), an agency of the U.S. Department of Agriculture. ERS has forecast food prices in some form since World War II. The inflationary period of the mid-1970's raised the importance of food forecasting by ERS analysts for USDA. Analysts recognized that price forecasts were increasingly affected by outside influences, and they were required to consider an increasing amount of information. Analysts introduced behavioral econometric models, which account for changing economic conditions, for forecasting some of the major food categories such as beef, pork, poultry, eggs, and dairy products. ERS's Aggregate Indicators in the Quarterly Agriculture Forecasting Model uses three-stage least squares to estimate consumer price indexes for 15 major components of the food-at-home CPI, as well as an equation for food away from home.

This study has several purposes. First, this study will make the current forecasting procedures as transparent as possible to the readers. Second, the study will evaluate past forecasting performance, with an eye toward identifying areas where improvements could be made. Third, this study creates an up-to-date set of the historical forecasts.

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Baseline Projections and Retail Food Price Forecasts

Conditions affecting food price forecasts are both long term and short term. USDA projects long-term food price changes once a year as part of USDA's 10-year Baseline Projections. The projections are a conditional scenario with no shocks and are based on specific assumptions regarding the macroeconomy, the weather, and international developments. These estimates reflect a composite of model results and judgmental analysis with normal weather patterns assumed, and include projections for 17 food categories, including food away from home. The food categories that are projected in the USDA Baseline include: All Food, Food Away from Home, Food at Home, Meats, Beef and Veal, Pork, Other Meats, Poultry, Fish and Seafood, Eggs, Dairy Products, Fruits and Vegetables, Sugar and Sweets, Cereals and Bakery Products, Nonalcoholic Beverages, and Other Foods. These categories are then aggregated to obtain a food-at-home projection. Finally the food-at-home and food-away-from-home forecasts are weighted to obtain an all-food CPI baseline projection. While interagency committees in USDA conduct the baseline projection analysis reflecting a composite of model results and judgmental analysis, ERS has the lead role in preparing the Departmental baseline report.

ERS also forecasts unofficial, internal-use, short-term quarterly food price changes each month. These short-run projections incorporate the most recent USDA baseline assumptions along with current information from several USDA analysts about current market conditions and expectations, weather patterns, commodity prices and supplies, and expected consumer demand for specific food categories.

Food accounts for 15 percent of the all-items CPI and is among the most volatile of the consumer price groups the Federal Government tracks. Retail food price changes are determined by general economic factors and the relative shares of farm and marketing costs. In recent years, food price increases have been small because of the low general inflation rate, the larger share of the food dollar going to away-from-home purchases of food, the continued decline in the farm-value share of the retail price for most food items, and the increasing economies of size in the farm sector.

Figure 1 shows the 1-year-ahead ERS forecasts for the percentage change in the all-food CPI since 1989.[1] In 1989 and 1990, the beginning of an inflationary period, USDA analysts had under-predicted the all-food index inflation change by nearly 2 percentage points each year. Prior to 1995, the methods used by ERS analysts to forecast some of the food categories are unknown and undocumented. However, during each of the next 5 years, the forecast errors were less than 1 percentage point and averaged 0.1 percentage point.

Figure 2 shows the range of public and private food price forecasts for 1996. The ERS forecast of 2.8 percent was the second lowest of the retail food price forecasts. Three agricultural consulting firms, John Schnittker, Sr., Morgan Stanley Dean Witter, and Wharton Econometric Forecasting Associates, had predicted a 3.9-4.0-percent increase. The actual percent change was 3.3 percent. The ERS forecast was off by less than 1 percent; in the previous 3 years the forecast errors had been less than 0.4 percent.

USDA's internal Mid-Session Review baseline projection of 2.3 percent in July of 1996 for the year 1997 was the lowest inflation projection again for the second straight year. (Note: This internal projection is not published; it was chosen for this report since this report evaluates USDA/ERS food price forecasting and methodology.) A baseline projection for food is different from an ERS food forecast because a baseline projection is a conditional longrun scenario about what would be expected to happen under a specific set of assumptions about external conditions. The baseline estimate was the lowest of all the other food price forecasters, except Wharton Economic Forecasting Associates, which predicted the same rate as the baseline.

The 1997 food price forecast that ERS made in November 1996 was for an increase of 2.8 percent over 1996 prices. In January 1997, ERS revised the 1997 food price forecast to 2.7 percent. The actual retail food price inflation rate change for 1997 was 2.6 percent. Figure 3 shows that forecasts ranged from 2.3 to 10 percent. Their range increased from 1.8 percentage points in 1996 to 7.7 percentage points in 1997.

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[1]ERS compiled the forecasts, which were estimated by different private firms.

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 shortrun 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.

Historical Food Price CPI Data

The actual data used for the sample period in the analysis is the second quarter of 1984 through the first quarter of 1997 and include all food, food at home, food away from home, and the 20 subcomponents. Table 1 shows the food items and their relative importance based on weight revisions from the Bureau of Labor Statistics (BLS) in December 1997. The Office of Prices and Living Conditions, Consumer Price Indexes, at BLS provides the CPI historical data series to ERS. Quarterly growth rates are constructed using simple averages for the 3 months in the quarter.

BLS revised the base period for the CPI from 1972 to 1982-84 in January 1987. While this revision affected the levels of the series, it had no impact on the percentage changes in the price levels. BLS provided adjustment factors for transforming the old CPI series into the new CPI series. Table 2 gives the adjustment multiplicative factors. In 1984q1 the actual value for the CPI of All Food was 301.3. This value was adjusted to the 1982-84 base by multiplying it by the factor 0.3411 to obtain a level of 102.77 for that quarter using the new CPI base year. We converted all of the actual data and the forecasts of that data to the 1982-84=100 level before calculating the growth rates.

Figures 5a-5w contain the histograms and the summary statistics of the actual quarterly growth rate for each of the 23 retail food CPI series that were examined. The Jarque-Bera test for normality is rejected for 9 of the 23 price series.[8] In one series, Processed Fruits, we can reject the null of normality at 5 percent, but not at 1 percent. There is a fair amount of variability among the series. The inflation rates for nine series range less than 5 percent.[9] The range is between 5 and 10 percent for another eight series, and the range of the remaining six series is between 10 and 20 percent.

In most cases, these inflation rates exhibit outliers and fat tails.[10] Fresh vegetables experienced the largest spike(s) in prices with a 115-percent increase in the third-quarter of 1994 followed by a 50-percent decline in the next quarter. Otherwise, this series ranged between -20- and 20-percent changes. Egg prices were the second most volatile, ranging from -17 to +20 percent. The range of variation for fresh fruits, third largest, was between -7.5 and 15.5 percent. The poultry and pork series varied about 20 percent each, ranging from approximately -5 to 15 percent. Both exhibit outliers and fat tails. The range of variation for the nonalcoholic beverages series was about 15 percent from -3 to 11 percent; however, removing three outliers leads to a range of just -3 to 3 percent. In some cases, the variability is due to seasonal fluctuations most likely caused by supply effects. The different magnitudes and forms of variability in the food price inflation rates suggest that more than one type of alternative model will be needed for forecasting purposes.

[8] They are All Food, Food at Home, Meats, Poultry and Fish, Poultry, Pork, Dairy Products, Fruits and Vegetables, and Nonalcoholic Beverages.

[9] They are All Food, Food Away from Home, Beef and Veal, Other Meats, Processed Fruits, Fresh Vegetables, Sugar and Sweets, Cereal and Bakery Products, and Other Prepared Foods.

[10] The series are Poultry, Pork, Eggs, Fruits and Vegetables, Fresh Fruits, Fresh Vegetables, Processed Fruits, and Nonalcoholic Beverages. Variation measured as maximum minus minimum.

Retail Food Price Movements Since 1984: An Overview

This section reviews and summarizes food price movements over the sample period. It explains the primary forces driving the markets. The source for this section was monthly unpublished internal ERS documents. Figures 6a-6w can be examined while reading this section; they provide time series plots of the individual food price series annual growth rates.

1984 Update

The CPI for all food increased 3.8 percent in 1984, food at home increased 3.6 percent and food away from home was up 4.2 percent. Meat prices were the major moderating force in the food CPI. Beef production was up and retail prices were down because of continued liquidation of cattle herds in 1984. Pork supplies were slightly lower and prices rose slightly, they were moderated by large beef supplies and declining beef prices. The CPI for fresh fruit was up because of higher orange prices. A smaller California orange crop was due to tree damage sustained in 1983 spring floods. The CPI for fresh vegetables was also up because of a smaller 1983 fall potato crop that increased prices. Shorter vegetable oil supplies in 1984 caused by the previous year's drought contributed to higher fats and oil prices, particularly shortening and margarine. The all items CPI index increased 4.3 percent in 1984.

1985 Update

The CPI for all food increased 2.3 percent in 1985, food at home increased 1.4 percent, and food away from home was up 4.0 percent. Large supplies of meats, eggs, and dairy products all contributed to lower price increases for these categories. Large supplies and lower prices for potatoes contributed to a small increase in the fresh vegetable CPI. The fresh fruit index was up again in 1985 due to the continued shortage of California Valencia oranges. The all items CPI index increased 3.6 percent in 1985.

1986 Update

The CPI for all food increased 3.2 percent in 1986, food at home increased 2.8 percent, and food away from home was up 3.9 percent. Lower support prices for a number of farm commodities led to lower farm prices in 1986. Costs of processing and distributing foods were also lower. Higher consumer demand due to a slightly lower unemployment rate and a modest increase in real disposable personal income had a positive effect on consumer demand for food. Tight supplies of seafood products worldwide and increasing domestic demand caused a significant increase in the CPI for fish and seafood. Large worldwide supplies of vegetable oils put downward pressure on retail prices for margarine, salad oils, and shortening. Pork and poultry prices rose sharply in mid-year due to lower production levels. Pork supplies were the lowest since 1982. Poultry producers operated at capacity to meet consumer demand because of smaller red meat supplies. Demand for poultry and higher retail prices were the result of a declining supply of red meat. Coffee prices were up because of reduced Brazilian supplies. Consumers bought up supplies at grocery stores to avoid higher prices in the early part of the year, and prices rose 40 percent from year earlier levels in January and February. The all items CPI increased 1.9 percent.

1987 Update

The CPI for all food increased 4.2 percent in 1987, food at home increased 4.3 percent, and food away from home was up 4.0 percent. Larger supplies of poultry and pork helped to ease prices for all meats, including beef. Tight supplies of world seafood, which began in 1986, contributed to higher retail prices for fish and seafood for a second year. In spite of larger citrus fruit production, retail fresh fruit prices were higher due to large exports of oranges and grapefruit. Fresh vegetable prices were also higher due to reduced supplies, resulting from cold weather in California and Mexico. Also, the poor weather severely damaged the Mexican winter vegetable crop, which normally supplements domestic supplies of fresh vegetables. Poultry production continued to expand, helping to reduce retail prices and the demand for poultry was stronger because of higher red meat prices. The CPI for all items was up 3.6 percent in 1987.

1988 Update

The CPI for all food increased 4.1 percent in 1988, food at home increased 4.2 percent, and food away from home was up 4.0 percent. The CPI for processed fruits was up because of tight supplies of frozen concentrated orange juice (FCOJ) and canned fruits. Brazil raised its FCOJ prices, pushing world market prices and domestic retail prices up. In addition, carryover stocks of many canned fruits were low. Poultry prices were higher, reflecting demand from the fast food industry. Egg prices were higher because of reduced production caused by high feed costs. The CPI for all items increased 4.1 percent.

1989 Update

The CPI for all food increased 5.8 percent in 1989, food at home increased 6.6 percent, and food away from home was up 4.6 percent. Fresh fruit prices were up because of the withdrawal of Chilean fruit from the U.S. market. The discovery of small traces of cyanide in grapes and the subsequent embargo caused large volumes of fresh fruits to be removed from the retail market. Cold weather in Florida, California, and Mexico disrupted vegetable shipments during the first quarter of 1989 and led to higher prices for fresh vegetables. Tomato prices were high due to a short supply following freeze damage in Florida and an increased demand for tomatoes from the fast food market. Although poultry production continued to increase, retail prices also increased as poultry prices were bid up by fast food firms, which were expanding their menus with new chicken entrees, leaving supplies for grocery stores relatively tight. The CPI for all items increased 4.8 percent.

1990 Update

The CPI for all food increased 5.8 percent in 1990, food at home increased 6.5 percent, and food away from home was up 4.7 percent. Retail prices for pork were up because of a decrease in pork production. Pork production was expected to be higher, but was revised downward and caused tight supplies and higher retail prices. A freeze in Florida and Texas, December 1989, caused severe damage to the grapefruit and orange crops, which was reflected in higher retail prices for fresh market grapefruit. The freeze also lowered fresh market vegetable production, and caused an increase in the CPI for fresh vegetables. The CPI for all items increased 5.4 percent.

1991 Update

The CPI for all food increased 2.9 percent in 1991, food at home increased 2.7 percent, and food away from home was up 3.4 percent. Fresh fruit prices were higher because of a smaller Washington State apple crop and freeze damage to the California orange orchards. Both led to a smaller crop. The CPI for all items increased 4.2 percent.

1992 Update

The CPI for all food increased 1.2 percent in 1992, food at home increased 0.7 percent, and food away from home was up 2.0 percent. Larger supplies of red meat and poultry contributed to lower retail prices for meats. Also, the economy was slowly recovering from the recession, and consumer demand did not rebound quickly. There was rigorous competition with the fast food market and the retail market for the consumer's food dollar. The CPI for all items increased 3.0 percent.

1993 Update

The CPI for all food increased 2.2 percent in 1993, food at home increased 2.4 percent, and food away from home was up 1.8 percent. The CPI for fresh vegetables was up because of shortages of tomatoes during the spring. Price increases for most items were modest as consumers continued to be cautious in food spending, as the recovery from the recession continued but many people faced an uncertain employment outlook. The CPI for all items increased 3.0 percent.

1994 Update

The CPI for all food increased 2.4 percent in 1994, food at home increased 2.9 percent, and food away from home was up 1.7 percent. Sustained large beef, pork, and poultry supplies in the market kept retail prices down. Large supplies of oranges, grapefruit, apples, and pears kept fresh fruit prices lower. An increase in the fresh vegetable CPI was caused by damage by Tropical Storm Gordon that hit Florida and heavy rains that delayed harvesting in California. The nonalcoholic beverage CPI increased because of higher coffee prices. Tight global coffee supplies and two major frosts that hit Brazilian coffee producers contributed to higher retail prices. The CPI for all items increased 2.6 percent.

1995 Update

The CPI for all food increased 2.8 percent in 1995, food at home increased 3.3 percent, and food away from home was up 2.3 percent. Higher retail lettuce prices in April and May, contributed to an increase in the fresh vegetable CPI. Cold, wet, and windy spring weather in the Washington and California fruit areas resulted in poor pollination and fruit set, especially for apples and grapes. This contributed to an increase in the CPI for fresh fruits. Steep declines in the 1995 coffee crop in Brazil, combined with an agreement by the Association of Coffee Producing Countries to restrict exports, kept coffee prices higher for a second year. The CPI for all items increased 2.8 percent.

1996 Update

The CPI for all food increased 3.3 percent in 1996, food at home increased 3.7 percent, and food away from home was up 2.5 percent. High grain prices contributed to price increases for meats, poultry, eggs, dairy products, and cereals and bakery products. Although meat production was higher in 1996, strong domestic and export demand contributed to higher retail prices. The CPI for all items increased 3.0 percent.

1997 Update

The CPI for all food increased 2.6 percent in 1997, food at home increased 2.5 percent, and food away from home was up 2.8 percent. Higher minimum wage rates, which went into effect fall 1996 and fall 1997 contributed to the increase in food away from home. Speculation about a lower 1997/98 coffee crop in Brazil and an uncertain labor situation in Colombia were responsible for higher coffee prices, which is a component of the nonalcoholic beverages index. The CPI for all items increased 2.3 percent.

The Forecast Data

ERS initiated an evaluation of the accuracy of internal ERS consumer food price index forecasts in 1996. Preliminary results are reported in Denbaly and others. The evaluation in this report is a continuation of the 1996 study and contains all the food categories that ERS forecasts.

Below is an example that explains how quarterly forecasts of food CPI inflation rates were constructed from the monthly CPI food price level forecasts. The forecasts are made up to 15 months ahead. Table 3 contains six columns from the ALL FOODS part of the forecast database. The second column contains the historical quarterly averages. The third column gives the 1-month-ahead forecast for the quarter. For example, the forecast for the first quarter of 1990 based on data through March 31st, 1990 was 130.9. The 4-month-ahead forecast for the second quarter of 1990 made on the same day was 130.0. (See column six and the last row.) The forecasters were predicting that prices would drop in the second quarter. The actual rate of inflation between the first and second quarter is

$$\pi_{90q2} = \left(\frac{P_{90q2}}{P_{90q1}} - 1 \right) * 100 = \left(\frac{131.5}{131.1} - 1 \right) * 100 = 0.305\%.$$

The forecasted growth rate for the second quarter made with a lead of 1 month ahead is

$$\pi_{90q2,1} = \left(\frac{P_{90q2,1}}{P_{90q1}} - 1 \right) * 100 = \left(\frac{131.0}{131.1} - 1 \right) * 100 = -0.08\%.$$

The forecasted growth rate for the second quarter with a lead of 4 months ahead is

$$\pi_{90q2,4} = \left(\frac{130.0}{130.9} - 1 \right) * 100 = -0.69\%.$$

Note that for the 4-month-ahead forecast of the second quarter, the denominator is equal to the predicted first-quarter level based on the forecast that was made on the same date. This can be expressed as

$$\pi_{90q2,4} = \left(\frac{P_{90q2,4}}{P_{90q1,1}} - 1 \right) * 100.$$

Thus a 7-month-ahead inflation forecast would be constructed using the 7-month-ahead predicted price level of that quarter relative to the 4-month-ahead predicted price level of the previous quarter.

Initial Assessment of ERS Forecasts

This study examines the quarterly forecast record of the food CPI inflation rates made by ERS over the period 1984q2-1997q1. Table 1 lists the food CPI series examined in this report. ERS forecasts for 23 components of the CPI are analyzed at the one-quarter- ahead to four-quarter-ahead horizons. Then, the ERS forecast record was compared against an alternative set of models. A separate univariate model for each series was constructed. These alternative models were fit over the sample 1984q1-1991q4 and then used in a recursive manner to forecast one through four quarters ahead. After the forecasts for 1992q1-1992q4 were made, the models were fit over the sample 1984q1-1992q1 and forecasts were made from 1992q2-1993q1. The process is repeated until there are no longer any observations. The forecast comparison is performed over the sample period 1992q1-through 1997q1. The forecasts from the alternative models can be treated as realtime forecasts since they use the same information that was available to the staff at ERS.

The inflation forecasts in this study are quarterly. ERS and the WAOB make forecasts every month on a quarterly basis. For example, in January a one-quarter-ahead forecast for the first quarter is made using data available through December of the previous year. (This is sometimes referred to as a current-quarter forecast or a 3-month-ahead forecast.) In February and March of the same quarter, forecasts are made using the latest CPI data from January and February, respectively. These are current quarter forecasts, but effectively 2- and 1-month-ahead forecasts, respectively. A two-quarter-ahead or 6-month-ahead forecasts for the first quarter in a given year is made in October of the previous year. It is based on data through September, which includes livestock working data numbers from the beginning of the month, with revisions made if necessary after the CPI indexes are released mid-month. Similarly, the three-quarter-ahead and four-quarter-ahead forecasts for the first quarter of a given year are made in June and March. The quarterly forecasts in the study are based on data at the 3-, 6-, 9-, and 12-month horizons.

Summary statistics for the one-quarter- through four-quarters-ahead ERS forecasts are given in tables 4a-4d for the period 1984q2 through 1997q1. There are 52, 48, 35, and 22 observations for each of the forecast horizons respectively.

Five statistics are reported, the mean error, mean absolute error (MAE), root mean squared error (RMSE), the minimum error, and the maximum error. These statistics are explained in greater detail below. (See the section Comparison with Alternative Models.) The mean errors are statistically insignificant from zero. None of the ratios of the mean error to the RMSE are greater than unity. Typically, forecast evaluations find that the RMSE increases with the horizon. In this case, only four of the forecast error measures go up with the horizon by more than 10 percent: Fish and Seafood, Poultry, Dairy Products, and Nonalcoholic Beverages. The RMSE neither increases or decreases for 12 series while in 7 it appears to fall by more than 10 percent. This result is likely due to the seasonality in the data.

Figures 6a-6w provide plots of the historical series and the one-quarter ahead forecasts from 1984q2 through 1997q1. The left hand axes give the price changes on an annual growth rate basis. The All Food and Food at Home forecasts appear to have under-predicted the actual inflation rates from 1986 to 1991. The Meats, Poultry, and Fish inflation rate is over-predicted for most of the sample. This appears to be primarily the result of predictions from the Meats forecasts, in particular the Beef and Veal and the Other Meats series. The Poultry price inflation rate tends to be over-predicted as well. Despite the nearly 40-percent inflation range for Eggs, the forecasts appear to perform rather well. The Fruits and Vegetables series appear to be seasonal, particularly in the first half of the sample. In 1986 and 1993, the forecasts for Fats and Oils had sharp increases when the actual index change was negative both years. This forecast increase was likely due to smaller world supplies and higher prices for oilseeds, which would signal increases for the Fats and Oils index.

Comparison with Alternative Models

A set of simple univariate quarterly time series models was developed for the 23 CPI price series in growth rates and the results of these models were compared against ERS unpublished, quarterly forecasts. Analysts use alternative models as a forecasting tool. The alternative models were estimated using the same information available to ERS staff when they made their forecasts.

The alternative models are estimated using the period 1984q1-1991q4 to initialize the models. One- to four-quarter-ahead forecasts are constructed starting in 1992q1. Then, actual data from 1992q1 is added to the sample and the model is re-estimated. Based on the updated model, one- to four-quarter-ahead forecasts are constructed once again. The price series for 1992q2 are added to the sample and the process is repeated. This continues until 1996q2 when the forecast horizon is reduced to a length of three quarters. Then, using data up through 1996q3 a two-quarter-ahead forecast is constructed. Finally, using data from the fourth quarter of 1996, a one-quarter-ahead forecast is made. Thus, there are 25, 24, 23, and 22 one-, two-, three-, and four-quarter-ahead forecasts, respectively, to compare with the internal ERS forecasts for the period 1992q1 through 1997q1. One of the weaknesses of comparing the ERS forecasting period 1984q1 through 1991q4 with the alternative models was that the ERS forecasting methods for this time period are unknown. Also, from 1987 through 1990, higher inflation rates ranging from 4.2 to 5.8 percent led to larger index changes for All Food. This would have made forecasting during this period more challenging.

Our method of identification and estimation differs slightly from Box and Jenkins' original suggestions for identifying and estimating time series models. We used the menu-based Time Series Forecasting System in SAS and various other procedures in SAS/ETS (Economic Time Series) to identify an alternative time series model that best fits the observations from the second quarter of 1984 to the fourth quarter of 1991. Observations from first quarter of 1992 to the first quarter of 1997 are used to measure the model's forecast performance. Prior to selecting the alternative model, ETS identifies the appropriate transformation of the data. It first performs a test of the log transformation, and if the log transformation cannot be rejected, the logged data are analyzed. Next, it performs a Dickey-Fuller test of the presence of a unit root in either the level or natural log form of the data. Next, the procedure tests the statistical significance of seasonal dummies within an autoregressive model of large order. If the set of seasonal dummies cannot be rejected, each candidate model contains seasonal dummies. ETS's preliminary tests are consistent with the suggestions of Joutz, Maddala, and Trost. Once the data are transformed, the model selected to compete with ERS' forecast is the one with the smallest root-mean-squared error (RMSE) among the alternative univariate, ARIMA, and seasonal models.[11]

The MA(1) model with seasonal dummies minimized the RMSE for most price growth rate series. Exponential smoothing models had similar fits to the MA(1) with seasonal dummies models; we decided to use the moving average model. If y_t denotes the original time series, the MA(1) model is

$$y_t = \theta \in_{t-1} + \sum_{k=1}^{k=4} d_k S_k + \in_t \tag{3}$$

where $\in_{t-1}$ is last quarter's forecast error, $\in_t$ is the current quarter's forecast error, S_k are quarterly seasonal dummies defined in the usual way, and θ and the d_k are parameters to be estimated.

The AR(P) model with seasonal dummies minimized the RMSE criterion for the remaining price data. This model is given by

$$y_t = \alpha_1 y_{t-1} + ... \alpha_p y_{t-p} + \sum_{k=1}^{k=4} d_k S_k + \in_t \tag{4}$$

where the α=I are parameters to be estimated. Table 5 lists the univariate models selected for each series.

Comparison with Alternative Forecasts

This section compares the accuracy of ERS forecasts with the alternative univariate models. This is accomplished by generating out-of-sample forecast errors, computing four accuracy statistics, and performing a

[11]The particular parameter estimates of the identification stage are not reported. They are available from the authors upon request.

statistical test of forecast reliability. The forecasts evaluated are out-of-sample forecasts in the sense that the periods of the time series forecasted are separated from the periods used to estimate model parameters. In generating and evaluating rolling forecasts,[12] we are simulating a forecaster updating a model in light of new information. This procedure is used for each of the 23 CPI indices that are being forecast.

The rolling forecasts are generated as follows: The parameters from the alternative models are estimated using the initial base period of the second quarter of 1984 through the fourth quarter of 1991. Based on the parameter estimates, predictions are produced for 1992q1 through 1992q4. Next, the observation for 1992q1 is added, and the alternative model parameter estimates are recomputed using the 1984q2 to 1992q1 observations. The revised parameter estimates are used to forecast the 1992q2 through 1993q1 observations. This process is repeated until the 1996q2 observation, when forecasts are limited to three quarters ahead. In each succeeding update, the forecast horizons are reduced by one quarter until the 1996q4 observation is added to the sample, and a single forecast is generated for 1997q1. For our data, the rolling forecast procedure results in 21 one-quarter-ahead forecasts, 20 two-quarter-ahead forecasts, 19 three-quarter-ahead forecasts, and 18 four-quarter-ahead forecasts. Unfortunately, we do not have the same number of ERS forecasts. This is due to the process described in the section above. For each variable, there are 21 one-step-ahead forecasts, 18 two-step-ahead forecasts, 13 three-step-ahead forecasts and 8 one-year-ahead forecasts from ERS for comparison purposes.

The forecast error of a j-quarter forecast made in quarter t is defined by

$$e_{t+j} = y_{t+j} - \hat{y}_{t,t+j} \qquad (5)$$

where y_{t+j} is the actual observation, and $y_{t,t+j}$ is the j-quarter-ahead forecast at time *t*.

Summary measures of forecast performance are computed using the following three statistics: the mean error (ME),

$$ME_j = \frac{1}{n_j} \sum_t (y_{t+j} - \hat{y}_{t,t+j}) \qquad (6)$$

the mean absolute error (MAE),

$$MAE_j = \frac{1}{n_j} \sum_t \left| y_{t+j} - \hat{y}_{t,t+j} \right| \qquad (7)$$

and the root-mean-squared error (RMSE),

$$RMSE_j = \sqrt{\sum_t \frac{(y_{t+j} - \hat{y}_{t,t+j})^2}{n_j}} \qquad (8)$$

for j = 1, 2, 3, and 4 where n_j denotes the number of j-step-ahead forecasts. The mean error is an indicator of bias in the forecast. The mean error measures how close the average value of the forecast is to the average value of the observations. The mean absolute error and the root-mean-squared error measure forecast error dispersion. Both the MAE and the RMSE reflect the potential uncertainty of a forecast. The larger the MAE or the RMSE, the more dispersion there is in a forecast error. The summary measures are reported in tables 6a-6d for the one- through four-quarter-ahead forecasts generated by both ERS and the alternate univariate models.

Across all prices for the ERS and alternate univariate models, the mean forecast errors do not appear to be biased. The t-statistic for the ratio of the mean error to RMSE is never greater than unity. Three series are particularly difficult to predict as might be expected from the initial examination of the data. Eggs, Fresh Fruit, and Fresh Vegetables in particular have the largest MAE and RMSE. The implications from MAE and RMSE statistics are very similar with respect to the relative performance of the two approaches. The alternate univariate models generally produce lower RMSE than the ERS forecasts. It should be noted that for All Food, the aggregate of the individual food subcategories, ERS and the alternative model are comparable. The RMSE for the ERS model ranged from 0.47 to 0.59 percent, while the alternative model RMSE range was 0.41 to 0.45 percent. In the one-quarter-ahead case, the RMSE is lower for 17 of the 23 price series using the alternate models. Other Meats, Poultry, and Fats and Oils show that the alternate models reduce the RMSE to 50 percent of the ERS forecast error.

The alternate models have lower RMSE for 18 of the 23 price series at the two-quarter-ahead forecast horizon. The alternate model RMSE for Fresh Vegetables

[12] See Joutz, Maddala, and Trost for more details of the rolling forecast procedure.

is more than twice the size of the ERS forecast: 26 percent versus 11 percent. This problem gets worse at the three-quarter and four-quarter-ahead forecasts. In the first part of the sample, that part for which the alternate models were estimated and selected, there appears to be a fair amount of seasonal variation in the Fresh Vegetables inflation series. The seasonal pattern appears to diminish as we move further into the 1990's. The alternate model is a MA(1) with seasonal dummy variables.

The alternate model produces forecast RMSE which are lower in 17 and 16 of the price series at the three- and four-quarter-ahead horizons, respectively. The Food Away from Home RMSE for the alternate model is one-half that of the ERS forecast at both horizons.

Another way of evaluating these forecasts is to determine whether they have produced "good" results in the sense that they are unbiased and have incorporated the information contained in past forecasts and forecast errors. The regression approach to forecast evaluation recommended by Mincer and Zarnowitz does this. Consider the following regression of the historical series at time t+h on the conditional forecast for time t+h made at time t and a constant.

$$y_{t+h} = \beta_0 + \beta_1 \hat{y}_{t,t+h} + e_{t+h}$$

We test the null hypothesis that the coefficient on the constant is zero and the slope coefficient is one jointly and the residuals are white noise. This test is referred to as the weak form efficiency test in the forecast evaluation literature.

Tables 7 and 8 present the results for the weak form efficiency tests at the one-quarter-ahead horizon using the ERS forecasts and the Alternate Model forecasts, respectively. There are 21 observations for each regression since the sample period is 1992q1 through 1997q1. The results are not particularly promising for either forecasting approach.

The tables are formatted in a similar manner. Coefficient estimates for the intercept and slope are provided in the second and third columns with t-statistics reported below them. The hypothesis or F-test is given in the fourth column; the p-value is provided below the test statistic. R-squared and the Durbin Watson statistic are found in the fourth and fifth columns.

The weak form efficiency hypothesis test is rejected at the 5-percent level for 17 of the 23 ERS price forecasts. It cannot be rejected at the 1-percent level for three series: Fish and Seafood, Fruits and Vegetables, and Processed Fruit. Six price series forecasts appear to pass the weak form test at 5-percent level of significance. They are Dairy Products, Fresh Vegetables, Processed Fruits and Vegetables, Processed Fruits, Sugars and Sweets, and Nonalcoholic Beverages. The Fresh Vegetables result is curious given the tremendous volatility and forecast errors reported earlier. Nevertheless, the ERS forecasts and forecasters appear to make good predictions of this CPI component in this environment.

The alternate univariate forecasts appear to be inefficient in only 11 of the 23 price forecasts. Four of the rejections of the weak-form test are at 5 percent, the remainder are at 1 percent. Among these is the Fresh Vegetables series. There are 12 price series where the null hypothesis cannot be rejected at the 5-percent level. Among the non-rejections is where the value is 3.94 and the standard error is 1.59.

There are seven price series for which both forecasting approaches cannot reject the null hypothesis of weak form efficiency. They are Fish and Seafood, Dairy Products, Fresh Vegetables, Processed Fruits and Vegetables, Processed Vegetables, Sugars and Sweets, and Nonalcoholic Beverages.

There is a third method for evaluating two sets of forecasts. Granger and Newbold (1977) propose a statistical test designed to compare the one-step-ahead forecast uncertainty of the two competing models. The test presumes that the forecasts are unbiased and the forecast errors from each model are serially uncorrelated. Since the forecast errors associated with j-step-ahead forecasts are generally serially correlated for $j > 1$, Granger and Newbold's test can only be applied to compare the uncertainty of one-step-ahead forecasts.[13]

Since the one-step-ahead forecasts from each model are presumably unbiased, and the RMSE of the forecast errors is a monotonically increasing function of the variance of the forecast errors, the variance of the forecast errors is a measure of forecast uncertainty.

[13]The optimal j-step-ahead forecast errors follow an MA(j-1) process, and hence, for greater than one-step-ahead forecasts, violate the uncorrelated residuals condition necessary for applying the Granger and Newbold test.

The null hypothesis is the variance, σ_1^2, of the one-step-ahead ERS forecast errors, e_1, equals the variance, σ_2^2, of the one-step-ahead Alternate forecast errors, e_2. The test assumes the vector (e_1, e_2) is randomly drawn from a bivariate normal distribution with parameters, σ_1^2 and σ_2^2, and correlation coefficient, ρ.[14] Under the null hypothesis, $\sigma_1^2 = \sigma_2^2$, the correlation between the variables $(e_1 - e_2)$ and $(e_1 + e_2)$ is zero. Consider the regression of $(e_1 - e_2)$ on $(e_1 + e_2)$:

$$(e_1 - e_2)_t = \alpha + \beta * (e_1 + e_2)_t + u_t \qquad (10)$$

The hull hypothesis, β=0 is equivalent to $\sigma_1^2 = \sigma_2^2$, which means the two models' one-step-ahead, unbiased forecasts are equally reliable. The statement β≠0 is equivalent to the statement $\sigma_1^2 \neq \sigma_2^2$, implying that the models' forecasts are not equally reliable. The statement β>0 is equivalent to the statement $\sigma_1^2 > \sigma_2^2$. (Alternate more reliable than ERS.) Finally, the statement β<0 is equivalent to the statement $\sigma_1^2 < \sigma_2^2$. (ERS more reliable than Alternate.)

Table 9 reports results from the Granger and Newbold test for minimum RMSE. The coefficient estimate for the slope term is provided in the second column with the associated p-value below. We use a 10-percent rule to test if one forecast methodology provides a significantly lower RMSE. The Alternate is the lowest for seven price series: Food Away from Home, Poultry, Processed Vegetables, Sugars and Sweets, Cereals and Bakery Products, and Other Prepared Foods. The ERS forecast appears to have a lower RMSE in three cases: Fruits and Vegetables, Fresh Fruits, and Processed Fruits. In the other cases, there is no significant difference between the forecast error variance.

Combining ERS Forecasts and Alternative Models

Forecast comparisons with respect to different loss functions are always interesting and likened to horse races. Typically, there is no clear and consistent winner for a particular variable or over all time periods. It has become a common forecasting practice to combine predictions generated by alternative methods. This can lead to improved forecasts since the hybrid forecast is using a larger information set. We can combine the forecasts in a linear combination and test if the Alternate forecast provides significant information towards a better forecast than using the ERS predictions alone.

$$y_{t+h} = \beta_0 + \beta_1 y^{ERS}_{t+h,t} + \beta_2 y^{Alt}_{t+h,t} + e_{t+h}$$

A restricted version of this model would be to have the slope coefficients, interpreted as weights, sum to unity.

$$y_{t+h} = \beta_0 + (1 - \beta_2) y^{ERS}_{t+h,t} + \beta_2 y^{Alt}_{t+h,t} + e_{t+h}$$

Table 10 presents estimates for both of these models. The F-test for the restriction is in the last column. There are only six rejections out of 23 prices of the null hypothesis that the coefficients sum to unity: All Food, Food Away from Home, Food at Home, Other Meats, and Fruits and Vegetables, and Fresh Fruits. The fifth column contains the restricted coefficient for the Alternate forecast. The coefficient is significant in 17 of 23 cases; 14 of these are significant at 1 percent. This result suggests that the alternate forecasts can provide valuable information to ERS forecasters.

Does the linear forecast combination exercise produce forecasts which would have had significantly lower RMSE than the ERS forecasts? It appears that the competing forecasts can be profitably combined to yield a composite forecast which is superior to each of the individual forecasts.

Table 11 presents the one-quarter-ahead RMSE for the ERS and alternative forecasts with the implied RMSE from the forecast combinations where the weights are not constrained and where they are forced to sum to unity. The last four columns show the improvement in the RMSE on a percentage basis from combining the ERS and alternative forecast in an optimal least squares approach over the individual forecasts. Focus on the fourth and second columns from the right labeled ERS since they show whether or not the forecast information provided by the alternative models helps to improve the ERS forecasts.

The results from table 10 suggest that the ERS and alternate forecasts can be merged into a simple weighted average with the weights (constrained) summing to unity for 17 of the CPI components. These forecast combinations produce lower RMSE than the ERS forecasts by 20 percent or more for 18 and 16 components when the weights are unconstrained and

[14] The assumption the forecast errors are randomly drawn from a bivariate normal assumption rules out the possibility of serially correlated forecast errors.

constrained, respectively. There is significant value in using the alternative models as a means to improve the forecasts. The current ERS forecasting methodology or information set is not improved by the alternative models for Dairy Products, Fruits and Vegetables, Fresh Vegetables, and Processed Fruits. This result is consistent with the earlier evidence.

In practice, the weights assigned to different forecasts should not be considered to be fixed over time. They should be periodically reestimated. The forecast evaluation literature finds that the relative importance of individual forecasts can vary over time.

Limitations of the Alternative Time Series Model Forecasts

Although the best alternative time series model was selected, it is not reliable in forecasting turning points. Time Series Model predictions are based solely on the past behavior of the variable estimated and that variable alone. Some of the movement can be difficult to explain and if the past movement was due to factors that are not explainable such as the weather, changes in consumer tastes, or simply seasonal cycles in consumer spending, the model may not be able to relate to other economic variables. After careful review of each food category from 1992 through 1997, the alternative time series model consistently overestimated many of the food indexes, which indicated serial correlation in several food categories. Since 1992, changes in consumer tastes and preferences for certain foods plus the low general inflation index for the all items CPI, which ranged from 2.3 to 3.0 percent, may have contributed to the alternative time series model overestimation. Although the alternative time series model RMSE was generally lower than the ERS forecasts, the time series model did not capture some of the recent trend changes in several of the food CPI categories.

The time series model overestimated the actual index 5 out of 6 years for All Food, Fruits and Vegetables, and Other Foods; and 4 out of 6 years for Food Away from Home and Food at Home. In addition, the time series model overestimated the actual index 4 out of 6 years for Other Meats, Fish and Seafood, Dairy Products, Processed Fruits and Vegetables, Sugar and Sweets, Cereals and Bakery Products, and Nonalcoholic Beverages. Many of the food categories that were overestimated at least 4 out of 6 years are highly dependent on changes in the All Items inflation index, which has not increased at the rate that the time series model would have expected. When consumer tastes and preferences for selected foods changed and the All Items inflation index remained lower than expected, the time series model did not detect the changes from 1992 through 1997.

Conclusions

The results of this examination into quarterly retail food price forecasting at ERS over the period 1984 through 1997 provide four main conclusions for improvement in the forecasting process and methodology. The conclusions range from those directly based on the statistical results to statements about the understanding of the forecasting process within ERS.

First, the RMSE and MAE tests at the one- to four-quarter ahead horizons yield the same patterns of results. At each horizon, between 16 and 18 of the 23 alternative models have lower test results. This implies that the dispersion of their forecast errors is smaller than for the ERS forecast errors. The results are essentially the same for each CPI series. The ERS forecasts RMSE are lower for four retail price series at all horizons: Dairy Products, Fruits and Vegetables, Fresh Vegetables, and Processed Fruits. The last three of these are the CPI series which appear to be the most difficult to predict (with the exception of Eggs and Nonalcoholic Beverages.) There is little difference between the ERS and alternative model RMSE's across all four horizons for three price series: All Food (which is the single most important index to forecast), Meats (composite), and Nonalcoholic Beverages. Otherwise, the alternative model appears to have lower RMSE for the remaining CPI indexes. In particular, the CPI components Food Away from Home, Other Meats, Poultry, and Fats and Oils suggest that the alternative model can help reduce the RMSE by 50 percent or more at the different horizons.

Second, the weak form forecast efficiency tests reveal how well the forecasts performed at the one-quarter-ahead horizon. There was an insufficient number of observations to conduct the proper testing at more than one quarter ahead. The alternative model could not be rejected as weakly efficient for 16 of the 23 CPI components (12 at 5 percent and 4 at 1 percent.) The ERS forecasts are weakly efficient for only nine components (six at 5 percent and three at 1 percent.) The forecasts by ERS and the alternative model are weakly efficient for the same seven components: Fish and Seafood, Dairy Products, Fresh Vegetables, Processed Fruits and Vegetables, Processed Vegetables, Sugars and Sweets, and Nonalcoholic Beverages. In a number of cases, there is substantial imprecision in the parameter estimates permitting the forecasts to be relatively accurate. The alternative model forecasts are weakly efficient for the same four series in which the RMSE is better by more than 50 percent over the ERS forecasts.

Third, the Granger and Newbold test is used to test if the differences in RMSE are statistically significant. The alternative forecasts are found to be smaller for seven of the CPI components: Food Away from Home, Poultry, Fats and Oils, Processed Vegetables, Sugars and Sweets, Cereals and Bakery Products, and Other Foods. ERS' forecast RMSE is significantly lower for three of the four CPI components mentioned above with the exception of Dairy Products. This test is consistent with a more formal analysis of the results stated in the first conclusion.

These first three conclusions are based on the approach, "Which forecast model works best?" In practice, forecast evaluations of this kind find that no single forecasting approach works best for all variables or at all horizons. A second approach asks whether the competing forecasts can be profitably combined to yield a composite forecast that is superior to the individual forecasts. Analyzing the individual forecasts and integrating their relative strengths can produce better forecasts and more effective decisions.

The fourth conclusion is based upon forecast combination exercises for the 23 CPI components. The results suggest that the ERS and alternate forecasts can be merged into a simple weighted average, with the weights (constrained) summing to unity for 17 of the CPI components. These forecast combinations produce lower RMSE than the ERS forecasts by 20 percent or more for 18 and 16 components when the weights are unconstrained and constrained, respectively. There is value in using the alternative time series models as a means of improving the forecast errors. However, time series model predictions are based solely on the past behavior of the variable estimated and that variable alone. By combining the ERS and alternative forecasts, the changes in consumer tastes and preferences along with structural changes in selected food industries would be included in the forecasts.

By comparing historical ERS forecasts with alternative forecasting models, this study found that no single forecasting approach works best for all variables or at all horizons. Although the alternative time series model RMSE was generally lower than the ERS forecasts, the time series model did not capture changes in several of the food categories from 1992 through 1997. The alternative time series models that were tested were not perfect, but added information to the analysts' forecasts and ARIMA models that are currently used. In future work, information past the farmgate should be analyzed to determine what can be added to the retail food price forecasting methods.

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Table 1—The Consumer Price Index and the relative importance of food items

Items	Percent of total food	Percent of food at home
All Food	100.0	
Food at Home	62.7	
Food Away from Home	37.3	
Meats, Poultry, and Fish		17.3
Meats		12.2
Beef and Veal		6.2
Pork		3.4
Other Meats		2.5
Poultry		2.7
Fish and Seafood		2.4
Eggs		1.0
Dairy Products		7.4
Fats and Oils		1.6
Fresh Fruits and Vegetables		8.9
Fresh Fruits		4.5
Fresh Vegetables		4.5
Processed Fruits and Vegetables		3.8
Processed Fruits		2.1
Processed Vegetables		1.8
Sugars and Sweets		2.1
Cereals and Bakery Products		9.2
Nonalcoholic Beverages		5.0
Other Prepared Foods		6.5

Source: BLS estimated expenditure shares, December 1997.

Table 2—The Consumer Price Index (CPI) adjustment weights following the rebasing from 1972=100 to 1982-84=100*

All Food	0.3411
Food at Home	.3516
Food Away from Home	.3124
Meats, Poultry, and Fish	.3715
Meats	.3725
Beef and Veal	.3640
Pork	.3988
Other Meats	.3750
Poultry	.4905
Fish and Seafood	.2649
Eggs	.5217
Dairy Products	.3998
Fats and Oils	.3700
Fresh Fruits and Vegetables	.3326
Fresh Fruits	.3214
Fresh Vegetables	.3261
Processed Fruits and Vegetables	.3408
Processed Fruits	.6509
Processed Vegetables	.7069
Sugars and Sweets	.2651
Cereals and Bakery Products	.3404
Nonalcoholic Beverages	.2309
Other Prepared Foods	.3617

*These weights were used to adjust the CPI levels prior to the change in January 1987 to the new levels.
Source: USDA/ERS.

Table 3—Construction of quarterly inflation forecasts from monthly level projections

Quarter	Actual quarterly CPI	One month before end of quarter	Two months before end of quarter	Three months before end of quarter	Four months before end of quarter
1990q1	131.1	130.9	129.8	129.8	127.4
1990q2	131.5	131.0	131.0	130.7	130.0

Source:USDA/ERS.

Table 4a—Summary statistics of one-quarter-ahead ERS forecast errors, 1984 2nd quarter to 1997 1st quarter (52 observations)

	Mean	MAE	RMSE	Min	Max
All Food	0.26	0.55	0.66	-1.09	1.42
Food Away From Home	-.06	.36	.46	-1.23	.76
Food at Home	.51	.85	1.00	-1.22	2.07
Meat, Poultry, and Fish	1.29	1.73	1.94	-2.72	4.13
Meats	1.26	1.89	2.15	-3.99	4.25
Beef and Veal	1.11	1.94	2.25	-3.67	5.17
Pork	1.35	2.44	3.11	-6.12	8.80
Other Meats	1.45	1.82	2.13	-3.82	4.82
Poultry	2.89	3.19	4.03	-4.23	10.80
Fish and Seafood	.57	1.34	1.68	-2.76	4.05
Eggs	2.31	5.54	7.08	-10.81	16.28
Dairy Products	.38	.97	1.25	-2.68	2.52
Fats and Oils	-.34	1.05	1.39	-3.75	3.05
Fruits and Vegetables	.91	2.18	2.84	-3.71	8.41
Fresh Fruits	1.55	3.45	4.74	-6.25	12.89
Fresh Vegetables	3.68	6.85	16.21	-11.18	107.96
Processed Fruits and Vegetables	-.23	1.16	1.45	-3.46	3.62
Processed Fruits	-.49	1.61	1.99	-4.82	4.65
Processed Vegetables	.16	1.18	1.60	-3.27	4.65
Sugar and Sweets	-.09	.57	.79	-3.31	1.61
Cereals and Bakery Products	-.11	.56	.71	-1.98	1.43
Nonalcoholic Beverages	-.42	1.47	2.27	-5.98	8.82
Other Prepared Foods	-.10	.46	.59	-1.50	1.58

Source: USDA/ERS.

Table 4b—Summary statistics of two-quarter-ahead ERS forecast errors, 1984 2nd quarter to 1997 1st quarter (net 48 observations)

	Mean	MAE	RMSE	Min	Max
All Food	0.21	0.60	0.76	-1.32	2.44
Food Away From Home	-.15	.33	.43	-1.35	.76
Food at Home	.44	.91	1.17	-1.91	3.96
Meat, Poultry, and Fish	.55	1.35	1.72	-3.55	4.46
Meats	.44	1.56	2.01	-4.61	4.30
Beef and Veal	.20	1.59	2.02	-6.24	3.30
Pork	.92	2.64	3.71	-8.16	13.01
Other Meats	.46	1.36	1.66	-3.77	3.45
Poultry	1.75	2.56	3.83	-3.62	14.46
Fish and Seafood	.21	1.21	1.51	-2.68	4.14
Eggs	2.14	5.75	7.18	-10.92	16.07
Dairy Products	.91	1.35	2.00	-3.21	7.20
Fats and Oils	-.07	.88	1.17	-2.50	2.96
Fruits and Vegetables	.85	2.37	3.30	-7.54	12.47
Fresh Fruits	1.03	3.89	4.88	-8.10	13.72
Fresh Vegetables	.74	6.39	9.44	-40.09	26.51
Processed Fruits and Vegetables	.00	1.16	1.51	-2.86	4.68
Processed Fruits	-.29	1.60	2.07	-4.92	4.74
Processed Vegetables	.40	1.30	1.87	-2.53	7.77
Sugar and Sweets	-.11	.54	.64	-1.46	1.09
Cereals and Bakery Products	-.02	.55	.71	-2.55	1.15
Nonalcoholic Beverages	-.23	1.10	1.96	-2.54	10.90
Other Prepared Foods	-.04	.47	.61	-1.32	1.41

Source: USDA/ERS.

Table 4c—Summary statistics of three-quarter-ahead ERS forecast errors, 1984 2nd quarter to 1997 1st quarter (net 35 observations)

	Mean	MAE	RMSE	Min	Max
All Food	0.02	0.54	0.64	-1.18	1.22
Food Away From Home	-.18	.37	.47	-1.33	.76
Food at Home	.15	.81	.97	-1.76	1.92
Meat, Poultry, and Fish	.57	1.42	1.83	-3.77	4.26
Meats	.46	1.61	1.96	-4.49	4.02
Beef and Veal	-.10	1.51	1.98	-4.91	3.79
Pork	1.36	2.56	3.31	-5.34	10.30
Other Meats	.59	1.32	1.59	-4.30	2.63
Poultry	1.63	3.24	4.86	-4.16	14.46
Fish and Seafood	.18	1.08	1.36	-2.65	3.15
Eggs	.44	5.15	6.78	-17.38	16.95
Dairy Products	.62	1.10	1.73	-3.62	5.77
Fats and Oils	-.36	1.03	1.31	-2.82	3.31
Fruits and Vegetables	.17	2.18	2.73	-7.07	5.46
Fresh Fruits	-.24	3.83	4.63	-10.45	9.48
Fresh Vegetables	.87	5.94	7.48	-23.52	14.75
Processed Fruits and Vegetables	-.10	1.04	1.27	-2.01	3.40
Processed Fruits	-.35	1.36	1.89	-3.82	5.64
Processed Vegetables	.11	1.20	1.62	-2.54	4.77
Sugar and Sweets	-.29	.61	.81	-2.74	1.16
Cereals and Bakery Products	.03	.62	.76	-1.36	2.17
Nonalcoholic Beverages	-.50	1.47	2.37	-2.54	11.33
Other Prepared Foods	-.13	.45	.55	-1.13	1.13

Source: USDA/ERS.

Table 4d—Summary statistics of four-quarter-ahead ERS forecast errors, 1984 2nd quarter to 1997 1st quarter (net 22 observations)

	Mean	MAE	RMSE	Min	Max
All Food	0.01	0.46	0.62	-1.40	1.17
Food Away From Home	-.25	.38	.46	-.96	.40
Food at Home	.11	.70	.89	-2.06	1.48
Meat, Poultry, and Fish	.52	1.40	1.64	-2.71	3.53
Meats	.27	1.34	1.56	-3.12	2.64
Beef and Veal	-.07	1.31	1.74	-4.91	3.78
Pork	.78	2.29	3.11	-4.16	8.75
Other Meats	.45	1.12	1.32	-2.73	2.48
Poultry	2.31	3.32	4.87	-6.41	13.17
Fish and Seafood	.36	1.37	2.00	-2.66	6.16
Eggs	1.78	3.88	4.92	-8.94	12.88
Dairy Products	.56	1.17	1.54	-1.68	4.34
Fats and Oils	-.84	1.29	1.47	-3.14	2.37
Fruits and Vegetables	.29	2.01	2.43	-5.89	3.77
Fresh Fruits	.75	3.82	4.87	-10.45	9.48
Fresh Vegetables	.68	4.79	6.03	-10.71	11.72
Processed Fruits and Vegetables	-.55	.93	1.15	-2.01	2.12
Processed Fruits	-.25	1.21	1.56	-2.88	4.53
Processed Vegetables	-.42	1.05	1.49	-2.92	4.51
Sugar and Sweets	-.36	.62	.83	-2.74	0.99
Cereals and Bakery Products	-.07	.53	.66	-1.18	1.37
Nonalcoholic Beverages	-.23	1.62	2.74	-2.18	11.33
Other Prepared Foods	-.36	.56	.66	-1.12	1.28

Source: USDA/ERS.

Table 5—Univariate models selected for forecasting purposes (Dyearqi is a single dummy variable)

All Food	MA(1) with Seasonal Dummies and D90q1
Food Away from Home	AR(2) with Seasonal Dummies (no AR(1) term)
Food at Home	AR(1) with Seasonal Dummies (no AR(1) term)
Meats, Poultry, and Fish	MA(1) with Seasonal Dummies
Meats	MA(1) with Seasonal Dummies
Beef and Veal	AR(3) with Seasonal Dummies
Pork	MA(1) with Seasonal Dummies
Other Meats	MA(1) with Seasonal Dummies
Poultry	MA(2) D86q3, D88q3
Fish and Seafood	AR(2) with Seasonal Dummies (no AR(1) term)
Eggs	MA(1) with Seasonal Dummies
Dairy Products	MA(1) with Seasonal Dummies
Fats and Oils	MA(1) with Seasonal Dummies
Fresh Fruits and Vegetables	MA(1) with Seasonal Dummies
Fresh Fruits	MA(1) with Seasonal Dummies
Fresh Vegetables	MA(1) with Seasonal Dummies
Processed Fruits and Vegetables	MA(1) with Seasonal Dummies
Processed Fruits	MA(1) with Seasonal Dummies
Processed Vegetables	MA(1) with Seasonal Dummies
Sugars and Sweets	MA(1) with Seasonal Dummies
Cereals and Bakery Products	AR(1and 3) with Seasonal Dummies
Nonalcoholic Beverages	MA(1) with Seasonal Dummies
Other Prepared Foods	MA(1) with Seasonal Dummies

Source: USDA/ERS.

Table 6a—One-quarter-ahead forecast error statistics for 1992 through 1997[1]

Variables	Mean error		Mean absolute error		RMSE	
	ERS	Alternate	ERS	Alternate	ERS	Alternate
All Food[2]	0.05	-0.13	0.36	0.38	0.49	0.45
Food Away from Home[3]	-.22	-.12	.32	.22	.44	.28
Food at Home[4]	.35	-.05	.68	.51	.87	.63
Meat, Poultry, and Fish[5]	1.37	-.20	1.44	.84	1.57	.98
Meats[5]	1.52	-.24	1.52	.83	1.68	1.02
Beef and Veal[6]	1.16	-.08	1.43	.76	1.63	.91
Pork[5]	1.71	.05	1.84	1.43	2.24	1.90
Other Meats[5]	2.11	-.18	2.11	.74	2.42	.88
Poultry[7]	2.83	1.18	2.89	1.31	3.39	1.61
Fish and Seafood[3]	.39	-.32	1.17	.92	1.37	1.16
Eggs[5]	3.10	.90	5.16	3.52	6.68	4.38
Dairy Products[5]	-.05	-.06	1.02	.98	1.26	1.32
Fats and Oils[5]	-.59	-.17	.81	.40	1.14	.50
Fruits and Vegetables[5]	.63	-.56	1.87	2.03	2.38	2.37
Fresh Fruits[5]	1.35	-1.05	2.87	4.44	3.75	5.20
Fresh Vegetables[5]	5.73	.95	9.02	12.10	24.22	26.87
Processed Fruits and Vegetables[5]	-.15	-.06	1.12	.94	1.40	1.05
Processed Fruits[5]	-.15	.08	1.48	2.00	1.74	3.60
Processed Vegetables[5]	0	-.02	1.19	.99	1.63	1.15
Sugar and Sweets[5]	0	-.15	.54	.43	.68	.52
Cereal and Bakery Products[6]	-.35	-.04	.55	.32	.72	.40
Nonalcoholic Beverages[5]	-.39	.02	2.06	1.70	3.08	3.14
Other Prepared Foods[5]	-.11	-.16	.39	.28	.47	.35

[1]21 forecast errors processed for each alternate model.
[2]Alternate Model, Seasonal Dummies, D90-1, MA (1).
[3]Alternate Model, Seasonal Dummies AR(2) (no AR(1) term).
[4]Alternate Model, Seasonal Dummies, D90-1, AR(1).
[5]Alternate Model, Seasonal Dummies & MA (1).
[6]Alternate Model, Seasonal Dummies, AR (1,3).
[7]Alternate Model, D86-3, D88-3, MA(2).
Source: USDA/ERS.

Table 6b—Two-quarter-ahead forecast error statistics for 1992 through 1997[1]

Variables	Mean error		Mean absolute error		RMSE	
	ERS	Alternate	ERS	Alternate	ERS	Alternate
All Food[2]	0.18	-0.14	0.42	0.37	0.58	0.44
Food Away from Home[3]	-.29	-.11	.41	.21	.52	.27
Food at Home[4]	.45	-.04	.66	.49	.89	.59
Meat, Poultry, and Fish[5]	.75	-.18	.85	.79	1.16	.92
Meats[5]	.75	-.27	1.07	.85	1.41	1.02
Beef and Veal[6]	.39	-.09	1.32	.85	1.54	1.05
Pork[5]	1.40	.19	1.81	1.34	2.37	1.84
Other Meats[5]	.82	-.25	1.01	.61	1.26	.75
Poultry[7]	1.25	1.32	1.72	1.44	2.08	1.72
Fish and Seafood[3]	.28	-.27	1.01	.89	1.24	1.14
Eggs[5]	2.88	1.58	5.49	3.41	6.99	4.36
Dairy Products[5]	.46	0	.99	1.06	1.41	1.44
Fats and Oils[5]	-.41	-.20	.60	.41	.88	.53
Fruits and Vegetables[5]	.68	-.34	1.95	2.08	2.53	2.48
Fresh Fruits[5]	.80	-.85	3.20	4.05	3.70	4.86
Fresh Vegetables[5]	-1.69	1.79	5.69	12.51	10.57	26.28
Processed Fruits and Vegetables[5]	.01	-.23	1.00	.81	1.30	1.03
Processed Fruits[5]	.07	-.40	1.50	1.71	2.08	2.57
Processed Vegetables[5]	-.08	-0.01	1.06	.75	1.37	0.99
Sugar and Sweets[5]	-.17	-.24	.57	.49	.66	.61
Cereal and Bakery Products[6]	-.21	-.09	.64	.36	.85	.47
Nonalcoholic Beverages[5]	.38	.33	1.23	1.63	2.71	2.98
Other Prepared Foods[5]	-.15	-.23	.47	.33	.59	.38

[1]21 forecast errors processed for each alternate model.
[2]Alternate Model, Seasonal Dummies, D90-1, MA (1).
[3]Alternate Model, Seasonal Dummies AR(2) (no AR(1) term).
[4]Alternate Model, Seasonal Dummies, D90-1, AR(1).
[5]Alternate Model, Seasonal Dummies & MA (1).
[6]Alternate Model, Seasonal Dummies, AR (1,3).
[7]Alternate Model, D86-3, D88-3, MA(2).
Source: USDA/ERS.

Table 6c—Three-quarter-ahead forecast error statistics for 1992 through 1997[1]

Variables	Mean error		Mean absolute error		RMSE	
	ERS	Alternate	ERS	Alternate	ERS	Alternate
All Food[2]	0.10	-0.11	0.48	0.36	0.59	0.42
Food Away from Home[3]	-.35	-.16	.47	.22	.60	.26
Food at Home[4]	.36	-.02	.76	.49	.90	.60
Meat, Poultry, and Fish[5]	.92	-.17	1.13	.81	1.48	.93
Meats[5]	.75	-.26	1.36	.88	1.68	1.04
Beef and Veal[6]	.13	-.04	1.40	.89	1.60	1.07
Pork[5]	1.87	.21	2.31	1.39	2.69	1.88
Other Meats[5]	.65	-.22	1.11	.60	1.24	.75
Poultry[7]	2.36	1.03	2.39	1.21	2.87	1.47
Fish and Seafood[3]	.16	-.39	.81	1.01	1.02	1.24
Eggs[5]	.64	1.57	3.85	3.49	4.51	4.45
Dairy Products[5]	.49	.01	1.03	1.10	1.51	1.48
Fats and Oils[5]	-.54	-.17	.61	.39	.81	.52
Fruits and Vegetables[5]	.83	-.23	1.99	2.07	2.15	2.49
Fresh Fruits[5]	1.21	-.57	3.87	3.94	4.41	4.79
Fresh Vegetables[5]	1.46	1.93	4.73	13.12	5.90	26.96
Processed Fruits and Vegetables[5]	-.29	-.20	.83	.82	.99	1.04
Processed Fruits[5]	-.32	-.39	1.41	1.77	2.03	2.63
Processed Vegetables[5]	-.33	.04	.89	.74	1.23	.99
Sugar and Sweets[5]	-.35	-.23	.63	.49	.71	.62
Cereal and Bakery Products[6]	-.13	-.14	.67	.35	.78	.45
Nonalcoholic Beverages[5]	.45	.37	1.88	1.69	3.43	3.06
Other Prepared Foods[5]	-.11	-.21	.46	.32	.56	.37

[1]21 forecast errors processed for each alternate model.
[2]Alternate Model, Seasonal Dummies, D90-1, MA (1).
[3]Alternate Model, Seasonal Dummies AR(2) (no AR(1) term).
[4]Alternate Model, Seasonal Dummies, D90-1, AR(1).
[5]Alternate Model, Seasonal Dummies & MA (1).
[6]Alternate Model, Seasonal Dummies, AR (1,3).
[7]Alternate Model, D86-3, D88-3, MA(2).
Source: USDA/ERS.

Table 6d—Four-quarter-ahead forecast error statistics for 1992 through 1997[1]

Variables	Mean error		Mean absolute error		RMSE	
	ERS	Alternate	ERS	Alternate	ERS	Alternate
All Food[2]	0.16	-0.04	0.33	0.34	0.47	0.41
Food Away from Home[3]	-.35	-.15	.45	.21	.54	.26
Food at Home[4]	.29	.01	.59	.48	.74	.60
Meat, Poultry, and Fish[5]	.45	-.11	.87	.78	.93	.90
Meats[5]	.11	-.19	.86	.84	1.01	1.00
Beef and Veal[6]	-.34	-.20	1.20	1.02	1.32	1.11
Pork[5]	.70	.38	1.50	1.32	1.88	1.83
Other Meats[5]	.47	-.14	.83	.55	.97	.68
Poultry[7]	2.08	.94	2.48	1.13	2.90	1.36
Fish and Seafood[3]	.23	-.35	.87	1.01	1.06	1.25
Eggs[5]	-.39	1.65	4.16	3.68	4.95	4.57
Dairy Products[5]	.34	-.03	.90	1.13	1.14	1.51
Fats and Oils[5]	-1.03	-.11	1.09	.34	1.26	.44
Fruits and Vegetables[5]	1.86	-.18	2.49	2.12	2.72	2.54
Fresh Fruits[5]	3.12	-.41	3.98	3.96	4.91	4.85
Fresh Vegetables[5]	3.01	1.99	5.65	13.78	6.98	27.68
Processed Fruits and Vegetables[5]	-.57	-.16	.84	.80	1.08	1.04
Processed Fruits[5]	.21	-.34	1.36	1.79	1.90	2.69
Processed Vegetables[5]	-.58	.07	.98	.75	1.35	1.01
Sugar and Sweets[5]	-.45	-.21	.62	.49	.71	.62
Cereal and Bakery Products[6]	-.24	-.17	.55	.35	.69	.44
Nonalcoholic Beverages[5]	1.24	.39	2.42	1.77	4.20	3.14
Other Prepared Foods[5]	-.18	-.18	.61	.30	.73	.35

[1]21 forecast errors processed for each alternate model.
[2]Alternate Model, Seasonal Dummies, D90-1, MA (1).
[3]Alternate Model, Seasonal Dummies AR(2) (no AR(1) term).
[4]Alternate Model, Seasonal Dummies, D90-1, AR(1).
[5]Alternate Model, Seasonal Dummies & MA (1).
[6]Alternate Model, Seasonal Dummies, AR (1,3).
[7]Alternate Model, D86-3, D88-3, MA(2).
Source: USDA/ERS.

Table 7—Weak form efficiency test for ERS forecasts

CPI price component	b0	b1	F-test	R^2	DW
All Food	0.546	.205	7.64	0.049	1.91
	3.56	.99	.003		
Food Away From Home	.594	-.088	71.037	.344	.91
	6.82	-.824	0		
Food at Home	.656	.238	14.78	.1	2.01
	4.66	1.45	.0001		
Meats, Poultry, and Fish	.931	.457	46.95	.247	1.63
	4.46	2.49	0		
Meats	1.28	.774	45.57	.42	2.27
	4.61	3.68	0		
Beef and Veal	.661	.484	15.29	.21	1.67
	2.11	2.22	.0001		
Pork	1.556	.825	14.47	.53	1.08
	4.32	4.58	0.0002		
Other Meats	.791	.167	103.1	.02	2.05
	2.89	1.19	0		
Poultry	1.347	.225	106.3	.19	1.46
	4.43	2.08	0		
Fish and Seafood	.597	.516	3.6	.23	1.85
	2.1	2.41	.05		
Eggs	1.934	.407	8.31	.18	1.07
	1.63	2.05	.003		
Dairy Products	.269	.584	1.49	.23	.98
	.82	2.41	.25		
Fats and Oils	.327	.1	15.8	.01	2.06
	1.21	.47	.0001		
Fruits and Vegetables	.853	.521	4.92	.33	1.89
	1.89	3.04	.02		
Fresh Fruits	1.19	.159	9.85	.03	2.05
	1.97	.725	.001		
Fresh Vegetables	5.911	1.135	.62	.29	1.64
	1.09	2.77	.55		
Processed Fruits and Vegetables	.478	.213	2.62	.02	1.43
	1.19	.6	.1		
Processed Fruits	-.051	.88	.27	.53	.86
	-.12	4.64	.769		
Processed Vegetables	.618	.095	4.49	.01	2.4
	1.66	.313	.03		
Sugars and Sweets	.315	.435	1.39	0.08	1.36
	1.32	1.28	.27		
Cereals and Bakery Products	.423	.364	19	.3	2.18
	2.34	2.85	.00003		
Nonalcoholic Beverages	.448	.32	2.88	.06	1.94
	.63	1.09	.08		
Other Prepared Foods	.397	.383	9.33	.25	1.79
	2.69	2.51	.002		

Notes: T-statistics are reported below the coefficient estimates. The intercept is b0 and the slope coefficient is b1. The F-test is for the joint hypothesis that b0 = 0 and b1 = 1. The sample period is from 1992q1 to 1997q1; there are 21 observations.
Source: USDA/ERS.

Table 8—Weak form efficiency test for alternative univariate models

CPI price component	b0	b1	F-test	R^2	DW
All Food	0.373	0.373	6.56	0.16	1.95
	2.12	1.92	.006		
Food Away From Home	.549	-.031	21.27	.002	.83
	4.42	-.17	.00001		
Food at Home	.422	.41	4.29	.176	2.26
	2.09	2.01	.029		
Meats, Poultry, and Fish	.53	.044	7.17	.001	1.5
	1.99	.17	.005		
Meats	.243	.3	2.88	.04	1.57
	.79	.89	.08		
Beef and Veal	-.035	.818	.37	.38	1.58
	-.16	3.39	.7		
Pork	.393	.558	3.68	.38	1.25
	1.01	3.43	.04		
Other Meats	.461	.096	4.42	.004	2.11
	1.61	.29	.03		
Poultry	1.032	.429	12.88	.04	1.89
	3.82	.94	.0003		
Fish and Seafood	.103	.625	4.21	.48	2.28
	.37	4.18	.03		
Eggs	.951	.773	.993	.4	1.63
	.99	3.58	.39		
Dairy Products	.295	.545	.61	.08	1.49
	.67	1.31	.55		
Fats and Oils	-.028	.763	2.84	.61	1.34
	-.21	5.46	.08		
Fruits and Vegetables	.562	.155	115.25	.27	1.87
	1.11	2.64	0		
Fresh Fruits	1.59	-.2	29.67	.07	2.05
	2.32	-1.22	.00001		
Fresh Vegetables	-2.12	3.94	.81	.12	2.42
	-.29	1.59	.46		
Processed Fruits and Vegetables	.043	.859	.14	.3	2.52
	.13	2.84	.87		
Processed Fruits	.785	-.25	10.86	.04	1.85
	1.35	-.92	.0007		
Processed Vegetables	-.09	1.108	.036	.27	3.02
	-.24	2.68	.96		
Sugars and Sweets	-.2	1.066	.96	.45	1.92
	-.89	3.91	.4		
Cereals and Bakery Products	-.003	.955	.13	.36	1.66
	-.01	3.28	.88		
Nonalcoholic Beverages	.607	.285	3.35	.05	1.95
	.92	1.03	.06		
Other Prepared Foods	.049	.757	3.35	.37	2.24
	.24	3.36	.06		

Notes: T-statistics are reported below the coefficient estimates. The intercept is b0 and the slope coefficient is b1. The F-test is for the joint hypothesis that b0 = 0 and b1 = 1. The sample period is from 1992q1 to 1997q1; there are 21 observations.
Source: USDA/ERS.

Table 9—Granger and Newbold test

Variable	Coefficient estimate	Minimum RMSE
All Food	0.09	
	.49	
Food Away From Home	.27	Alternate
	.03	
Food at Home	.16	
	.24	
Meats, Poultry, and Fish	-.16	
	.34	
Meats	-.22	
	.12	
Beef and Veal	.2	
	.31	
Pork	-.23	
	.24	
Other Meats	.24	
	.15	
Poultry	.45	Alternate
	.02	
Fish and Seafood	.11	
	.4	
Eggs	.21	
	.11	
Dairy Products	-.03	
	.81	
Fats and Oils	.47	Alternate
	.01	
Fruits and Vegetables	-.6	ERS
	0	
Fresh Fruits	-.24	ERS
	.06	
Fresh Vegetables	-.07	
	.19	
Processed Fruits and Vegetables	.17	
	.12	
Processed Fruits	-.54	ERS
	0	
Processed Vegetables	.21	Alternate
	.06	
Sugars and Sweets	.19	Alternate
	.06	
Cereals and Bakery Products	.35	Alternate
	.04	
Nonalcoholic Beverages	-.02	
	.78	
Other Prepared Foods	.22	Alternate
	.05	

Notes: P-values are reported below the coefficient estimates from the Granger and Newbold regression. The minimum RMSE reports which, if any, RMSE is significantly lower than the other forecast error.
Source: USDA/ERS.

Table 10—Linear forecast combination test

Variable	ERS coefficient	Alternate coefficient	SSR	Alternate coefficient	SSR	F-test
All Food	0.06	0.35	2.48	0.64	3.34	6.22
	.29	1.58		3.12		
Food Away From Home	-.09	.01	.48	.90	1.29	30.50
	-.79	.06		5.13		
Food at Home	.13	.34	5.51	.72	7.28	5.79
	.73	1.50		3.94		
Meats, Poultry, and Fish	.46	.04	8.73	.35	10.12	2.86
	2.43	.15		2.23		
Meats	.76	.21	9.92	.23	9.93	.01
	3.55	.79		1.35		
Beef and Veal	.47	.80	11.65	.64	12.36	1.10
	2.85	3.91		4.88		
Pork	.64	.33	32.37	.34	32.43	.03
	3.50	2.29		2.59		
Other Meats	.16	.07	10.33	.72	13.09	4.80
	1.14	.22		4.90		
Poultry	.22	.36	18.97	.76	19.97	.94
	1.99	.85		7.09		
Fish and Seafood	.11	.57	19.29	.66	22.40	2.91
	.48	2.97		3.45		
Eggs	.14	.68	354.01	.81	365.23	.57
	.72	2.72		4.39		
Dairy Products	.56	.49	26.20	.45	26.22	.02
	2.37	1.31		2.24		
Fats and Oils	-.12	.80	3.91	.97	4.67	3.47
	-.84	5.44		7.49		
Fruits and Vegetables	.40	.05	77.52	-.10	104.63	6.30
	1.37	.52		-1.14		
Fresh Fruits	.20	-.21	131.72	.13	249.99	16.16
	.91	-1.33		.69		
Fresh Vegetables	1.02	1.23	11418.32	-.11	11590.08	.27
	2.13	.47		-.24		
Processed Fruits and Vegetables	.13	.85	22.71	.86	22.72	0
	.41	2.72		3.85		
Processed Fruits	1.08	.35	54.34	.14	58.02	1.22
	4.90	1.60		1.33		
Processed Vegetables	.19	1.15	26.93	.91	27.57	.43
	.74	2.73		4.43		
Sugars and Sweets	.10	1.03	5.06	.96	5.11	.16
	.37	3.48		4.14		
Cereals and Bakery Products	.22	.69	2.90	.79	2.92	.11
	1.59	2.13		5.95		
Nonalcoholic Beverages	.21	.13	151.67	.38	188.75	4.40
	.46	.31		.83		
Other Prepared Foods	.11	.64	1.91	.92	2.05	1.24
	.53	1.96		4.60		

Notes: T-statistic is reported below the coefficient estimate. There are 18 degrees of freedom. The F-test is for the null hypothesis that the weights on the ERS and Alternate forecast can be constrained to unity. The critical value for the test at 5% is 4.41 and 1% is 8.29 with 1 restriction and 18 degrees of freedom.

Source: USDA/ERS.

Table 11—Comparison of linear combination forecast one-quarter-ahead RMSE with ERS and alternative RMSE

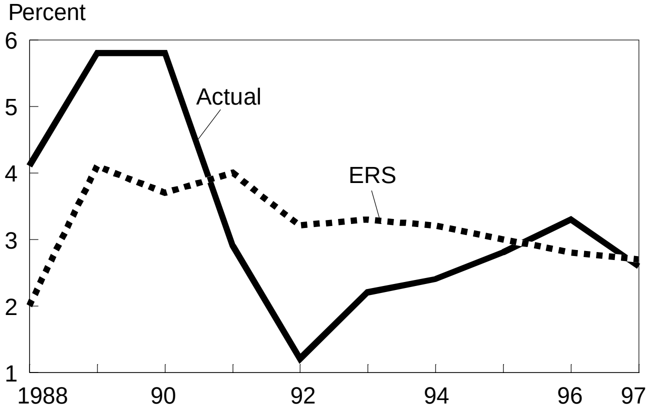
Variable	ERS RMSE	Alternative RMSE	Forecast combination RMSE		Percent improvement in RMSE			
					Unconstrained		Constrained	
			Unconstrained	Constrained	ERS	Alternative	ERS	Alternative
All Food	0.49	0.45	0.37	0.43	24	17	12	4
Food Away From Home	.44	.28	.16	.27	63	42	39	4
Food at Home	.87	.63	.55	.64	36	12	27	-1
Meats, Poultry, and Fish	1.57	.98	.70	.75	56	29	52	23
Meats	1.68	1.02	.74	.74	56	27	56	27
Beef and Veal	1.63	.91	.80	.83	51	12	49	9
Pork	2.24	1.9	1.34	1.34	40	29	40	29
Other Meats	2.42	.88	.76	.85	69	14	65	3
Poultry	3.39	1.61	1.03	1.05	70	36	69	35
Fish and Seafood	1.37	1.16	1.04	1.12	24	11	19	4
Eggs	6.68	4.38	4.43	4.50	34	-1	33	-3
Dairy Products	1.26	1.32	1.21	1.21	4	9	4	9
Fats and Oils	1.14	.5	.47	.51	59	7	55	-2
Fruits and Vegetables	2.38	2.37	2.08	2.41	13	12	-1	-2
Fresh Fruits	3.75	5.2	2.71	3.73	28	48	1	28
Fresh Vegetables	24.22	26.87	25.19	25.38	-4	6	-5	6
Processed Fruits and Vegetables	1.4	1.05	1.12	1.12	20	-7	20	-7
Processed Fruits	1.74	3.6	1.74	1.80	0	52	-3	50
Processed Vegetables	1.63	1.15	1.22	1.24	25	-6	24	-8
Sugars and Sweets	.68	.52	.53	.53	22	-2	22	-2
Cereals and Bakery Products	.72	.4	.40	.40	44	0	44	-1
Nonalcoholic Beverages	3.08	3.14	2.90	3.24	6	8	-5	-3
Other Prepared Foods	.47	.35	.33	.34	31	7	28	4

Source: USDA/ERS.

Figure 1

Annual Forecasts by ERS

All food CPI percentage change

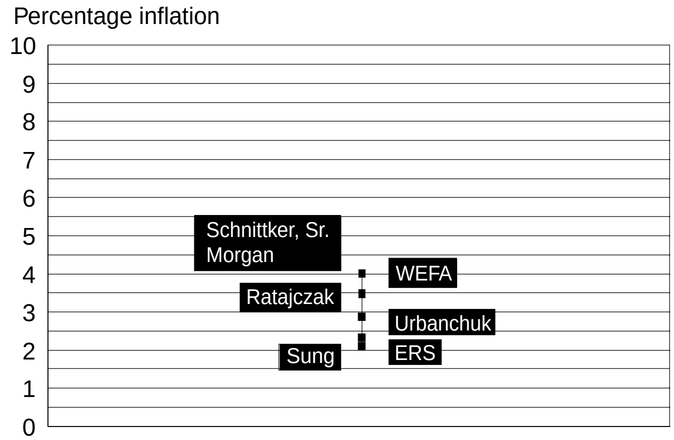


Source: USDA/ERS.

Figure 2

Forecast spread

Food price forecast for 1996

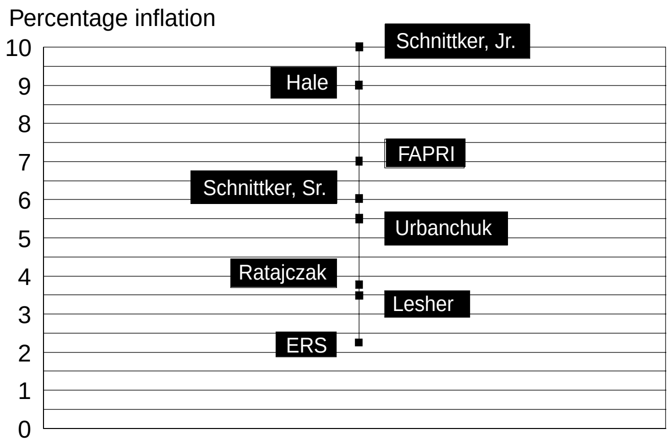


Source: USDA/ERS.

Figure 3

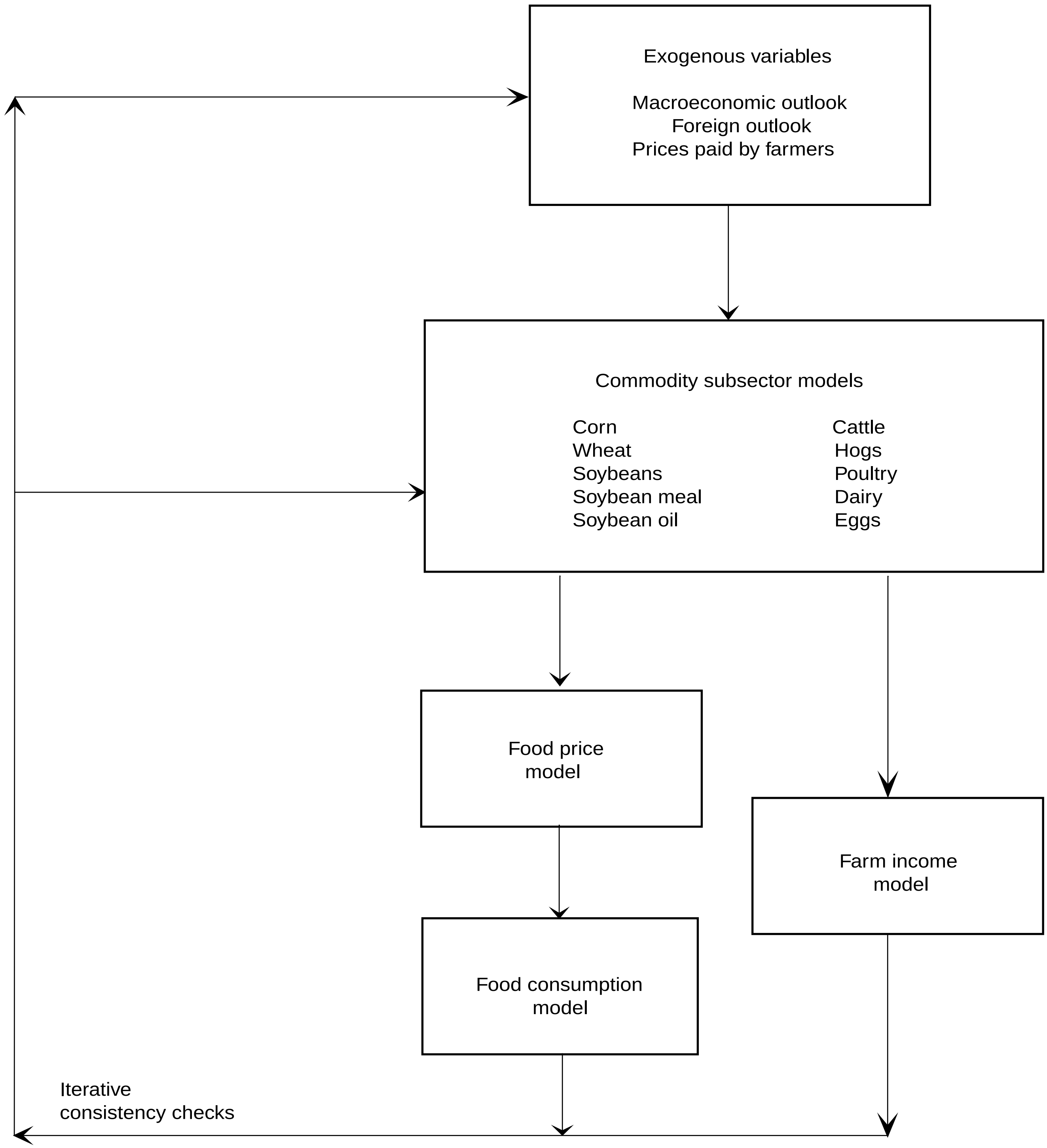
Forecast spread

Food price forecast for 1997



Source: USDA/ERS.

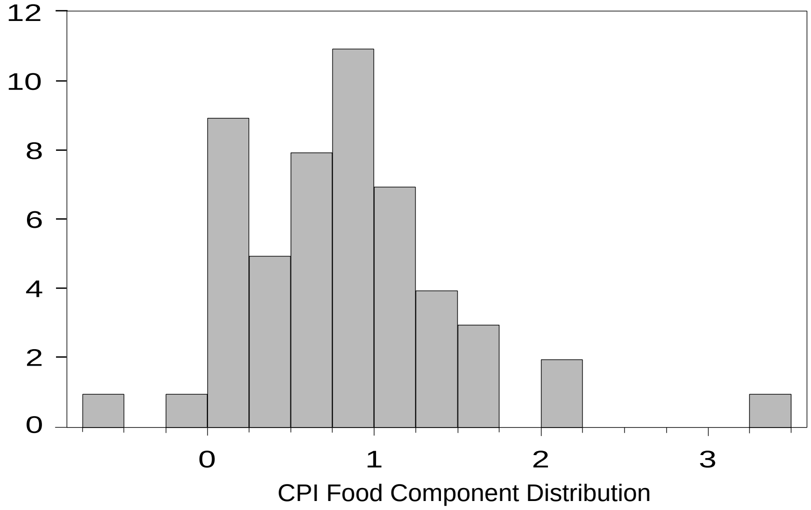
Figure 4
The quarterly agricultural forecasting model



Source: P. C. Westcott, (1986).

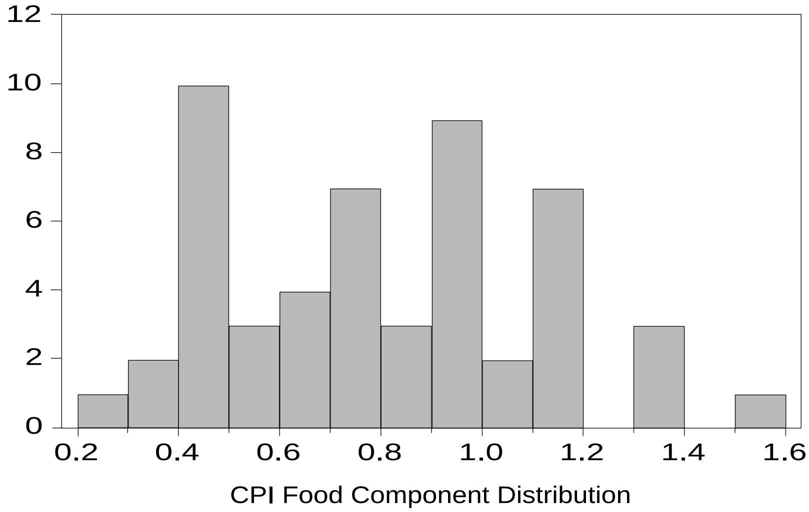
Histograms for Food CPI Components

Figure 5a
All Food



Series: ALLFOOD	
Sample 1984:2 1997:1	
Observations 52	
Mean	0.817712
Median	0.785000
Maximum	3.310000
Minimum	-0.511000
Std. Dev.	0.648377
Skewness	1.122397
Kurtosis	5.894831
Jarque-Bera	29.07481
Probability	0.000000

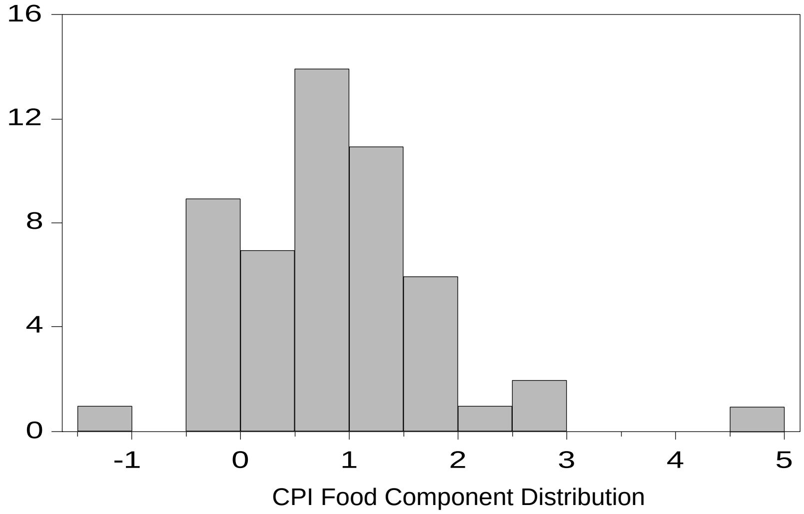
Figure 5b
Food Away From Home



Series: FOODAWAY	
Sample 1984:2 1997:1	
Observations 52	
Mean	0.804077
Median	0.786500
Maximum	1.527000
Minimum	0.277000
Std. Dev.	0.310028
Skewness	0.288042
Kurtosis	2.206911
Jarque-Bera	2.081873
Probability	0.353124

Figure 5c

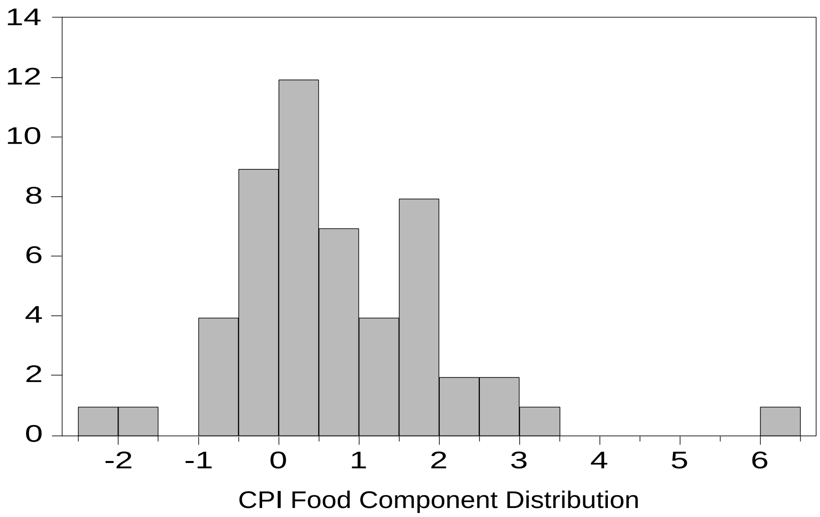
Food At Home



Series: FOODHOME	
Sample 1984:2 1997:1	
Observations 52	
Mean	0.834500
Median	0.772000
Maximum	4.607000
Minimum	-1.313000
Std. Dev.	0.972866
Skewness	1.023017
Kurtosis	5.946235
Jarque-Bera	27.87753
Probability	0.000001

Figure 5d

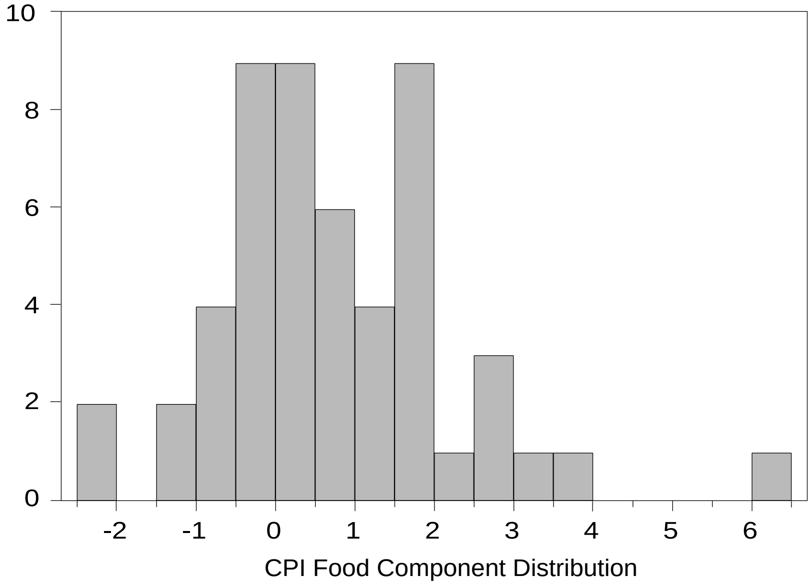
Meat, Poultry & Fish



Series: MPF	
Sample 1984:2 1997:1	
Observations 52	
Mean	0.755308
Median	0.451500
Maximum	6.377000
Minimum	-2.040000
Std. Dev.	1.368059
Skewness	1.322907
Kurtosis	6.975564
Jarque-Bera	49.41180
Probability	0.000000

Figure 5e

Meats

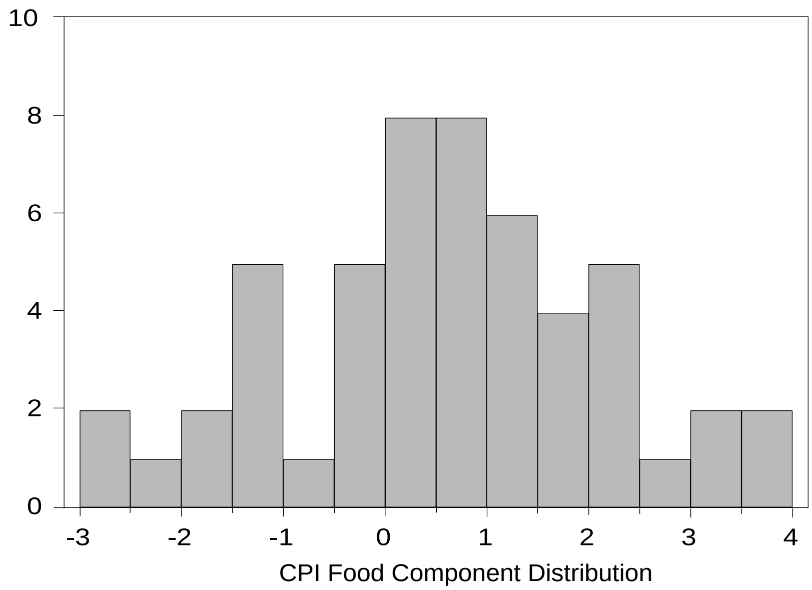


Series: MEATS
Sample 1984:2 1997:1
Observations 52

Mean	0.713212
Median	0.409000
Maximum	6.010000
Minimum	-2.257000
Std. Dev.	1.474338
Skewness	0.911154
Kurtosis	4.879733
Jarque-Bera	14.85077
Probability	0.000596

Figure 5f

Beef & Veal

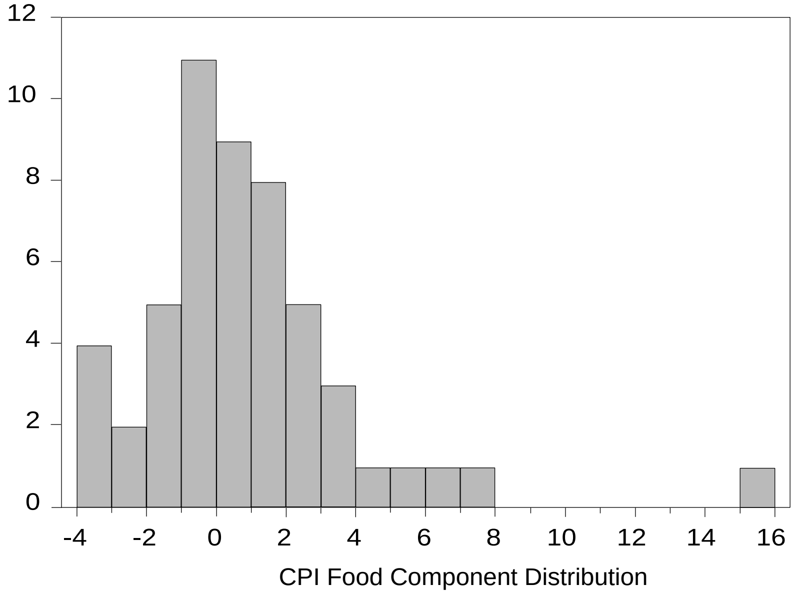


Series: BEEFVEAL
Sample 1984:2 1997:1
Observations 52

Mean	0.586212
Median	0.567500
Maximum	3.881000
Minimum	-2.856000
Std. Dev.	1.548838
Skewness	-0.144344
Kurtosis	2.697004
Jarque-Bera	0.379486
Probability	0.827172

Figure 5g

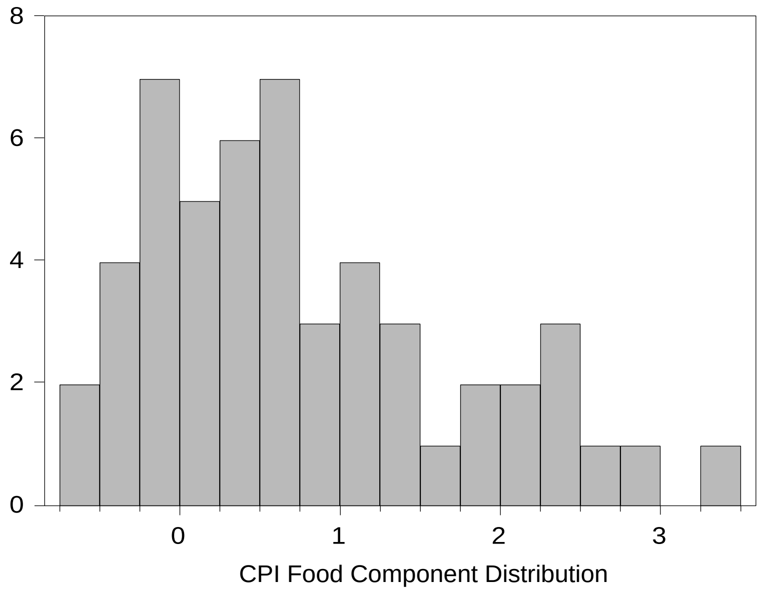
Pork



Series: PORK	
Sample 1984:2 1997:1	
Observations 52	
Mean	0.933173
Median	0.253500
Maximum	15.02200
Minimum	-3.834000
Std. Dev.	3.187910
Skewness	1.836979
Kurtosis	8.885498
Jarque-Bera	104.2969
Probability	0.000000

Figure 5h

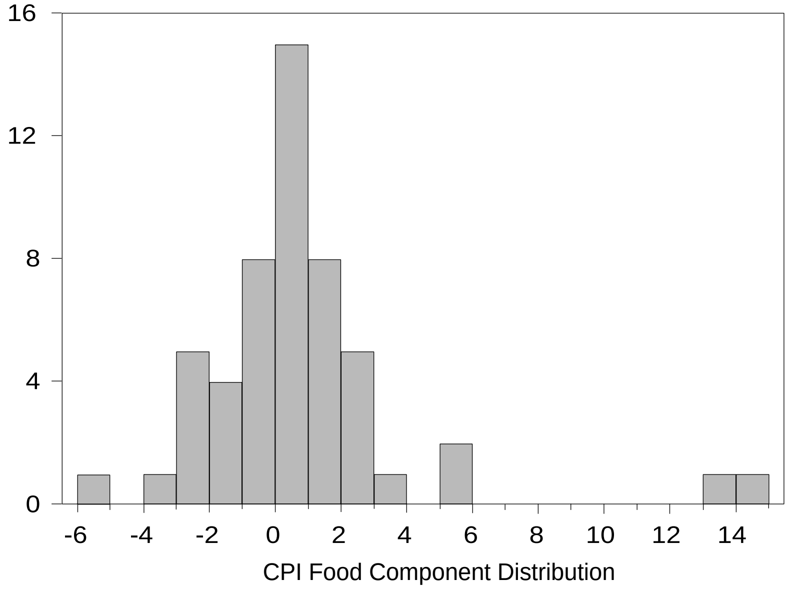
Other Meats



Series: OTHMEATS	
Sample 1984:2 1997:1	
Observations 52	
Mean	0.771365
Median	0.546000
Maximum	3.380000
Minimum	-0.558000
Std. Dev.	0.965431
Skewness	0.776366
Kurtosis	2.792073
Jarque-Bera	5.317449
Probability	0.070038

Figure 5i

Poultry

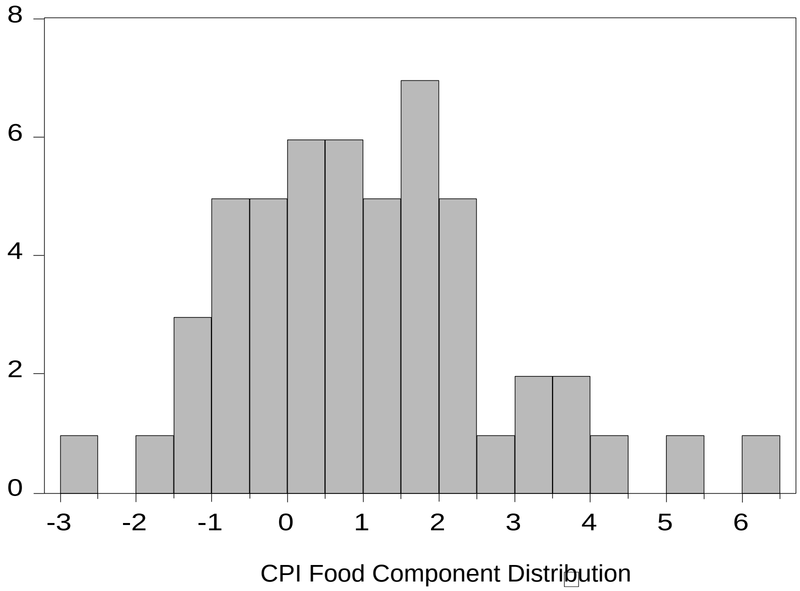


Series: POULTRY
Sample 1984:2 1997:1
Observations 52

Mean	0.762058
Median	0.518500
Maximum	14.46000
Minimum	-5.511000
Std. Dev.	3.301617
Skewness	2.307493
Kurtosis	10.56023
Jarque-Bera	169.9862
Probability	0.000000

Figure 5j

Fish & Seafood

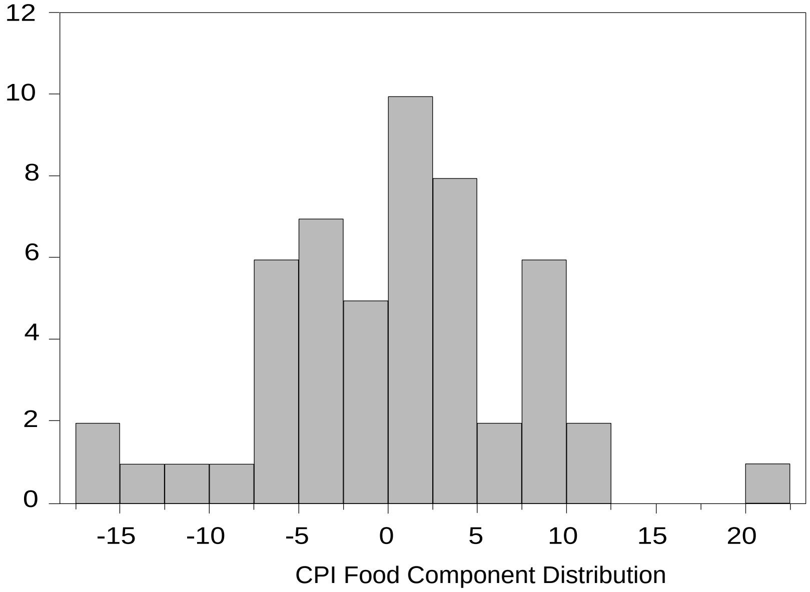


Series: FISH
Sample 1984:2 1997:1
Observations 52

Mean	1.085731
Median	0.987500
Maximum	6.358000
Minimum	-2.882000
Std. Dev.	1.790293
Skewness	0.551761
Kurtosis	3.515666
Jarque-Bera	3.214623
Probability	0.200426

Figure 5k

Eggs

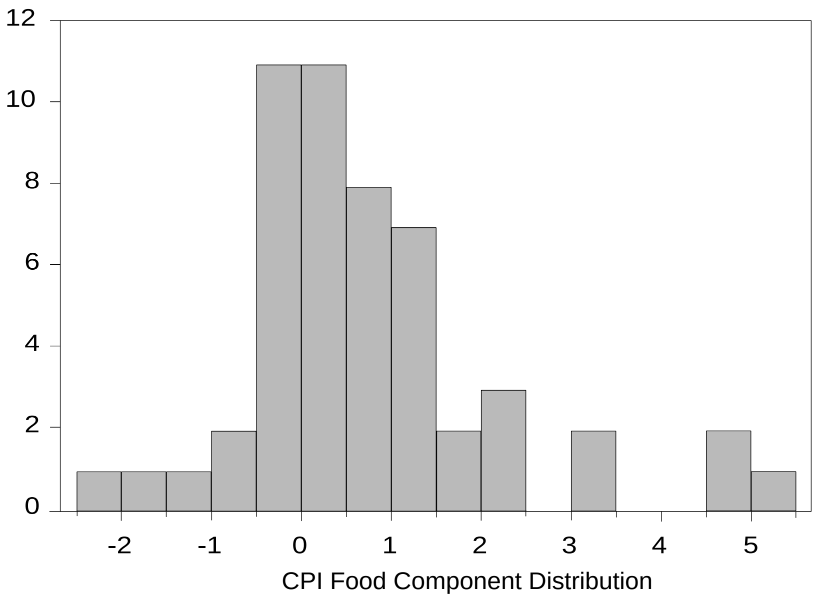


Series: EGGS
Sample 1984:2 1997:1
Observations 52

Mean	0.415519
Median	0.965000
Maximum	20.71900
Minimum	-17.37700
Std. Dev.	7.266350
Skewness	-0.045068
Kurtosis	3.445400
Jarque-Bera	0.447428
Probability	0.799544

Figure 5l

Dairy Products

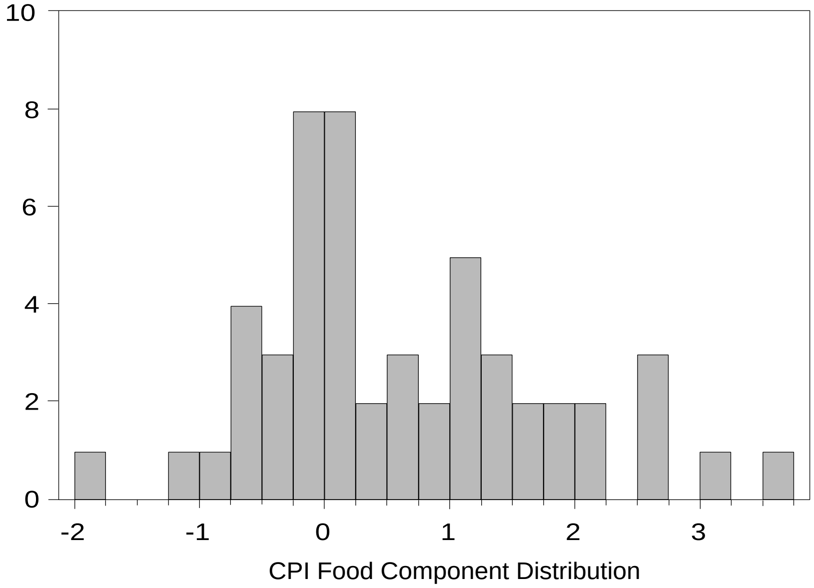


Series: DAIRY
Sample 1984:2 1997:1
Observations 52

Mean	0.744615
Median	0.461000
Maximum	5.066000
Minimum	-2.113000
Std. Dev.	1.452841
Skewness	1.157293
Kurtosis	4.722606
Jarque-Bera	18.03680
Probability	0.000121

Figure 5m

Fats & Oils

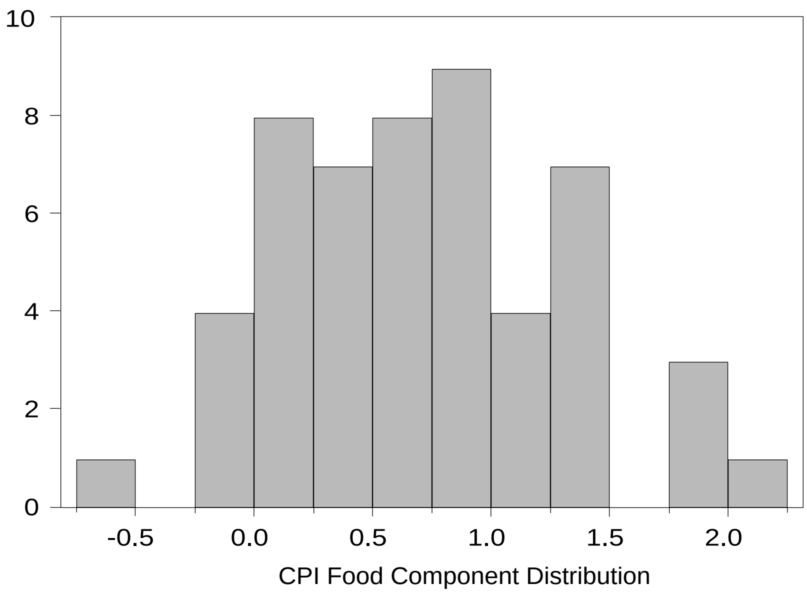


Series: FATSOILS
Sample 1984:2 1997:1
Observations 52

Mean	0.618154
Median	0.258500
Maximum	3.667000
Minimum	-1.821000
Std. Dev.	1.165507
Skewness	0.549430
Kurtosis	2.887033
Jarque-Bera	2.643888
Probability	0.266617

Figure 5n

Sugar & Sweets

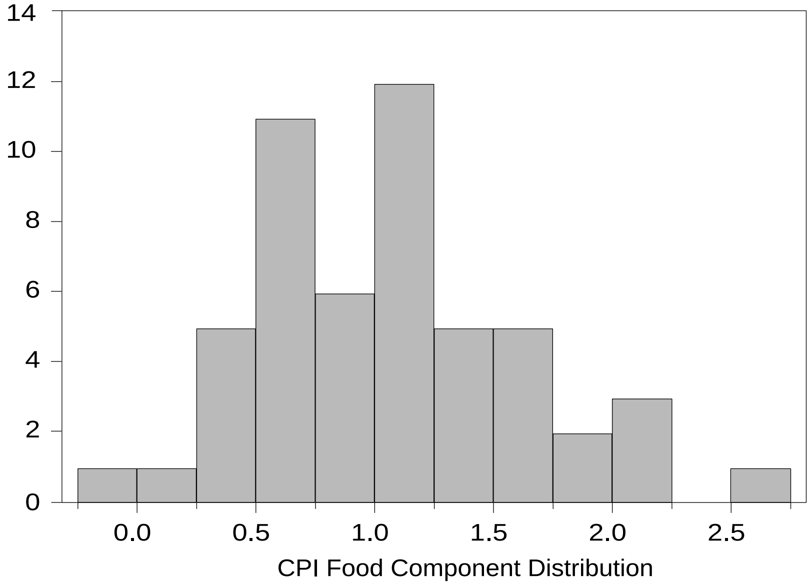


Series: SUGAR
Sample 1984:2 1997:1
Observations 52

Mean	0.718442
Median	0.693500
Maximum	2.235000
Minimum	-0.673000
Std. Dev.	0.616294
Skewness	0.232404
Kurtosis	2.748751
Jarque-Bera	0.604874
Probability	0.739015

Figure 5o

Cereals & Bakery Products

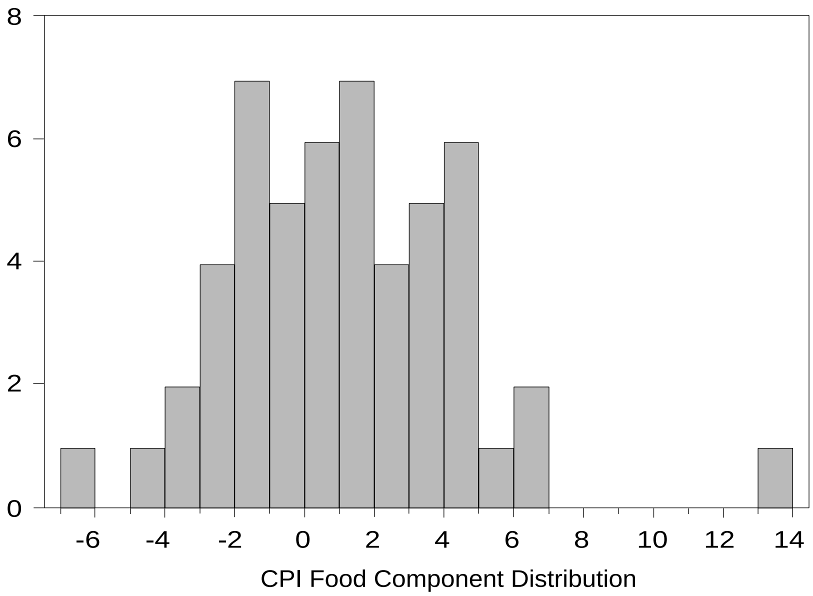


Series: CEREALS
Sample 1984:2 1997:1
Observations 52

Mean	1.057308
Median	1.098000
Maximum	2.743000
Minimum	-0.182000
Std. Dev.	0.577360
Skewness	0.544040
Kurtosis	3.324785
Jarque-Bera	2.793705
Probability	0.247374

Figure 5p

Fruits & Vegetables

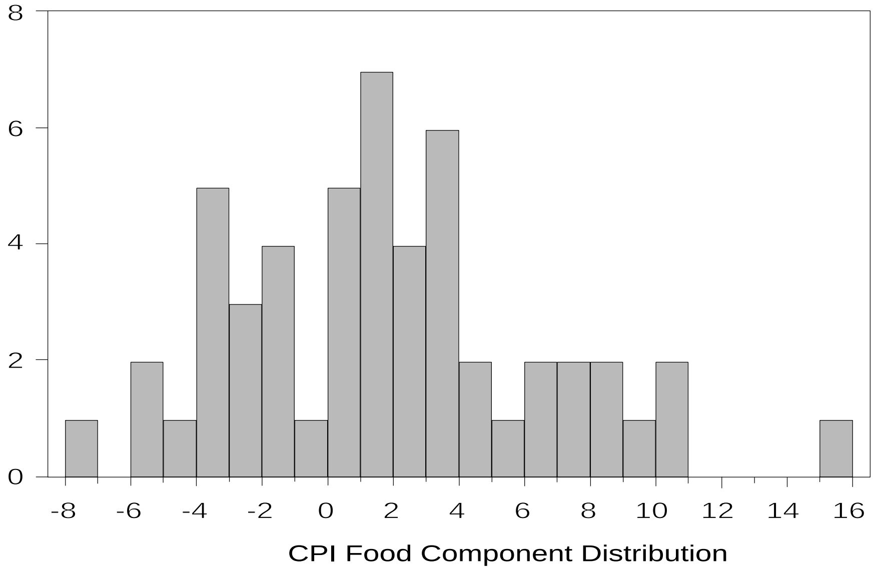


Series: FRUITVEG
Sample 1984:2 1997:1
Observations 52

Mean	1.164673
Median	1.072000
Maximum	13.12000
Minimum	-6.878000
Std. Dev.	3.381909
Skewness	0.634926
Kurtosis	4.719961
Jarque-Bera	9.903376
Probability	0.007071

Figure 5q

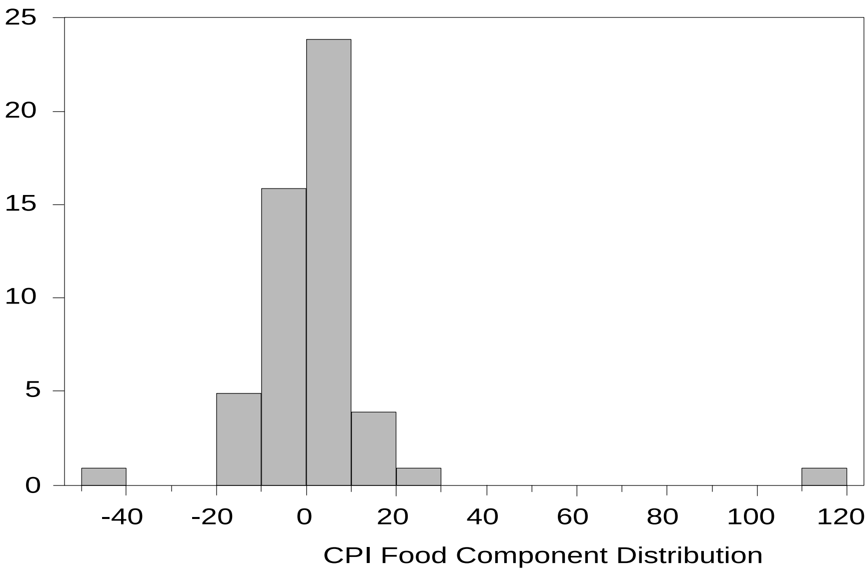
Fresh Fruits



Series: FRESHFRU	
Sample 1984:2 1997:1	
Observations 52	
Mean	1.865115
Median	1.534500
Maximum	15.50500
Minimum	-7.537000
Std. Dev.	4.723324
Skewness	0.484739
Kurtosis	3.121821
Jarque-Bera	2.068577
Probability	0.355479

Figure 5r

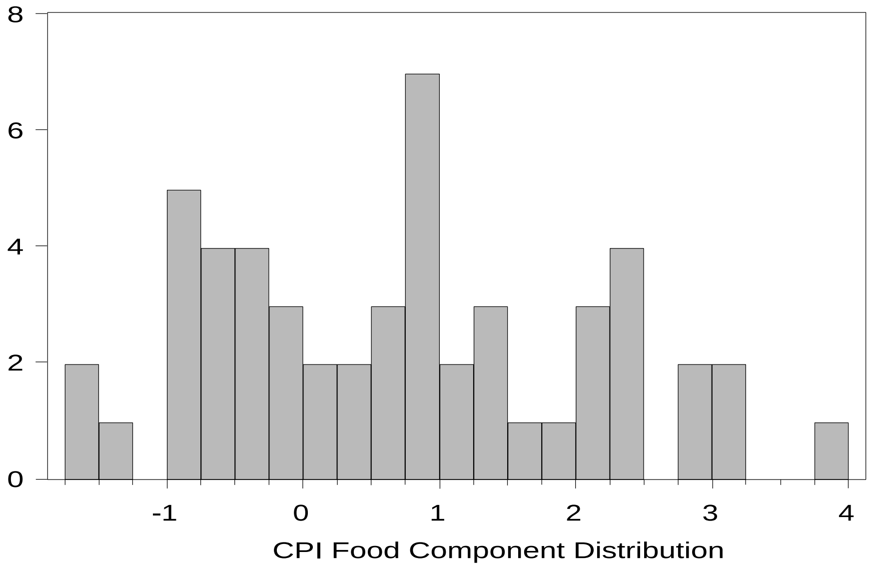
Fresh Vegetables



Series: FRESHVEG	
Sample 1984:2 1997:1	
Observations 52	
Mean	2.325423
Median	1.614000
Maximum	115.3760
Minimum	-48.50200
Std. Dev.	19.28054
Skewness	3.604279
Kurtosis	24.75116
Jarque-Bera	1137.666
Probability	0.000000

Figure 5s

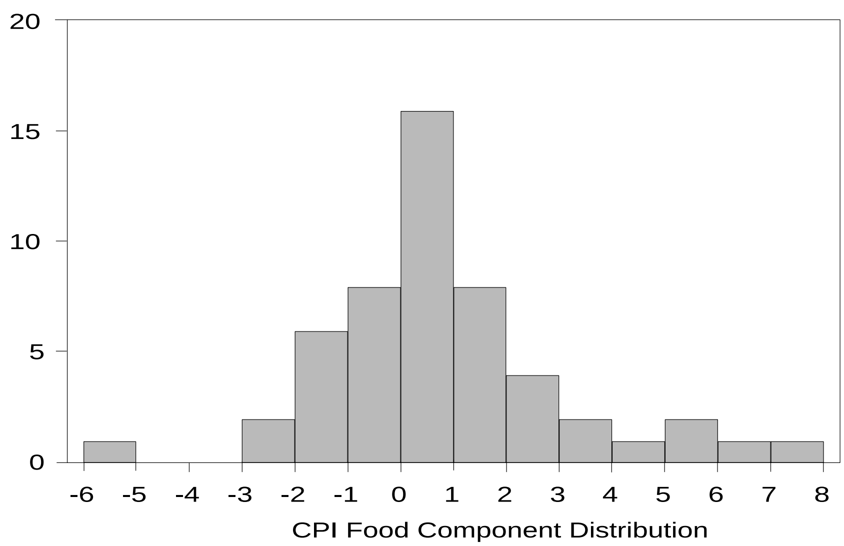
Processed Fruits & Vegetables



Series: PRFRUITV	
Sample 1984:2 1997:1	
Observations 52	
Mean	0.730096
Median	0.780000
Maximum	3.960000
Minimum	-1.638000
Std. Dev.	1.367375
Skewness	0.308207
Kurtosis	2.269416
Jarque-Bera	1.979723
Probability	0.371628

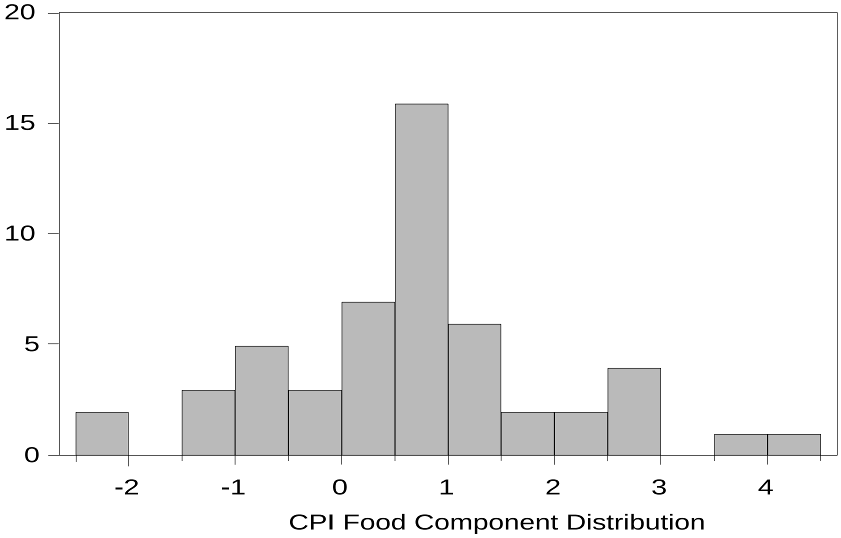
Figure 5t

Processed Fruits



Series: PRFRUITS	
Sample 1984:2 1997:1	
Observations 52	
Mean	0.763865
Median	0.604500
Maximum	7.445000
Minimum	-5.256000
Std. Dev.	2.267095
Skewness	0.584032
Kurtosis	4.230070
Jarque-Bera	6.234466
Probability	0.044280

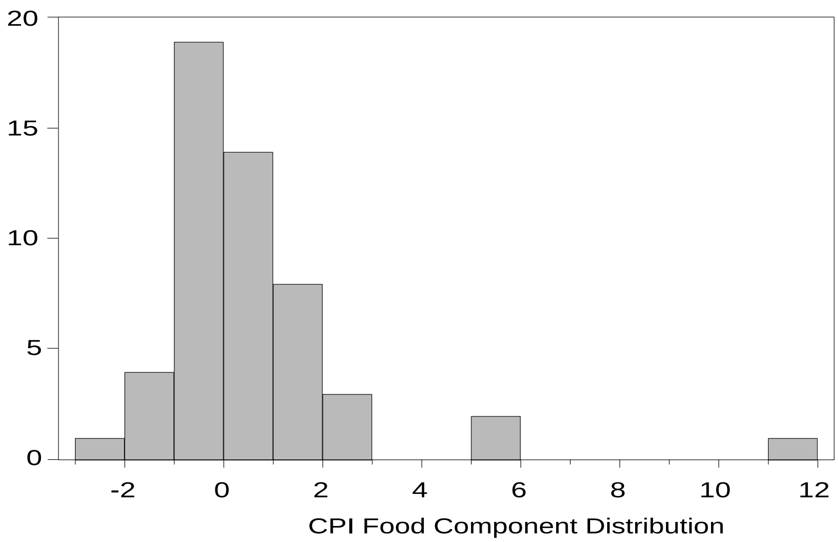
Figure 5u
Processed Vegetables



Series: PRVEGS
Sample 1984:2 1997:1
Observations 52

Mean	0.715212
Median	0.663500
Maximum	4.495000
Minimum	-2.206000
Std. Dev.	1.342913
Skewness	0.393190
Kurtosis	3.638291
Jarque-Bera	2.222588
Probability	0.329133

Figure 5v
Nonalcoholic Beverages

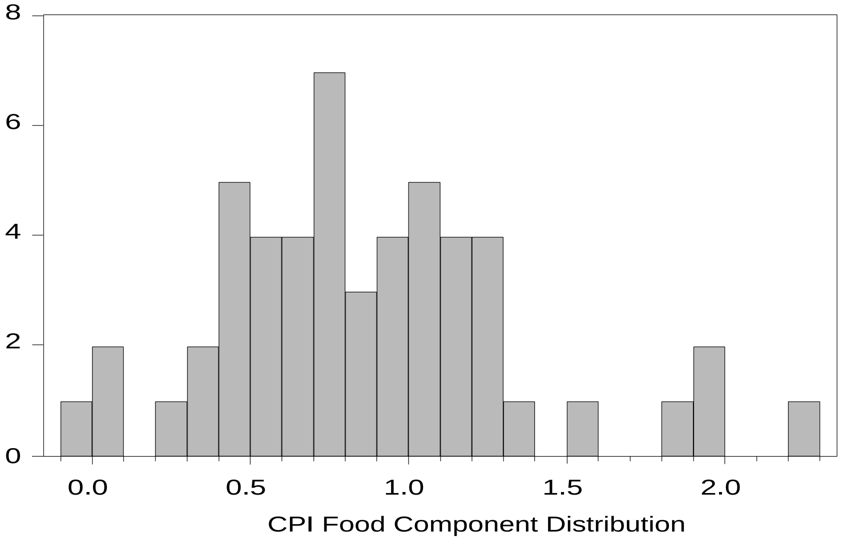


Series: NONALC
Sample 1984:2 1997:1
Observations 52

Mean	0.545596
Median	0.090000
Maximum	11.33200
Minimum	-2.750000
Std. Dev.	2.131902
Skewness	2.930832
Kurtosis	14.54617
Jarque-Bera	363.2919
Probability	0.000000

Figure 5w

Other Prepared Foods



Series: OTHPREP
Sample 1984:2 1997:1
Observations 52

Mean	0.878135
Median	0.797500
Maximum	2.246000
Minimum	-0.067000
Std. Dev.	0.480678
Skewness	0.654350
Kurtosis	3.707567
Jarque-Bera	4.795588
Probability	0.090918

Food CPI Components and ERS One-Quarter-Ahead Forecasts

Figure 6a

All Food

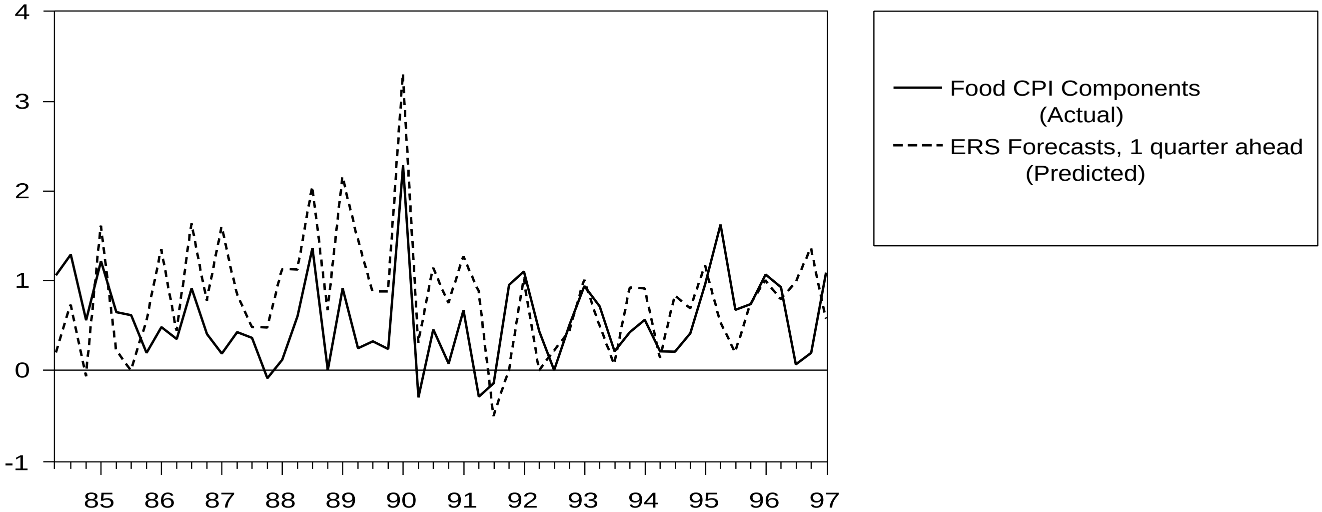


Figure 6b

Food Away from Home

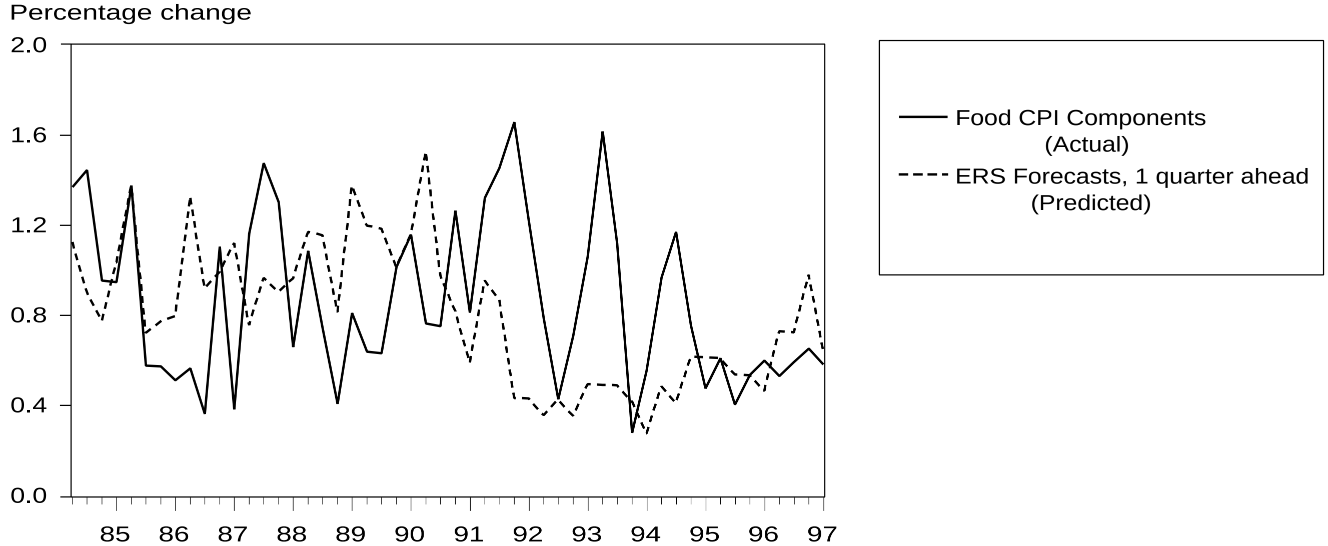


Figure 6c
Food at Home
Percentage change

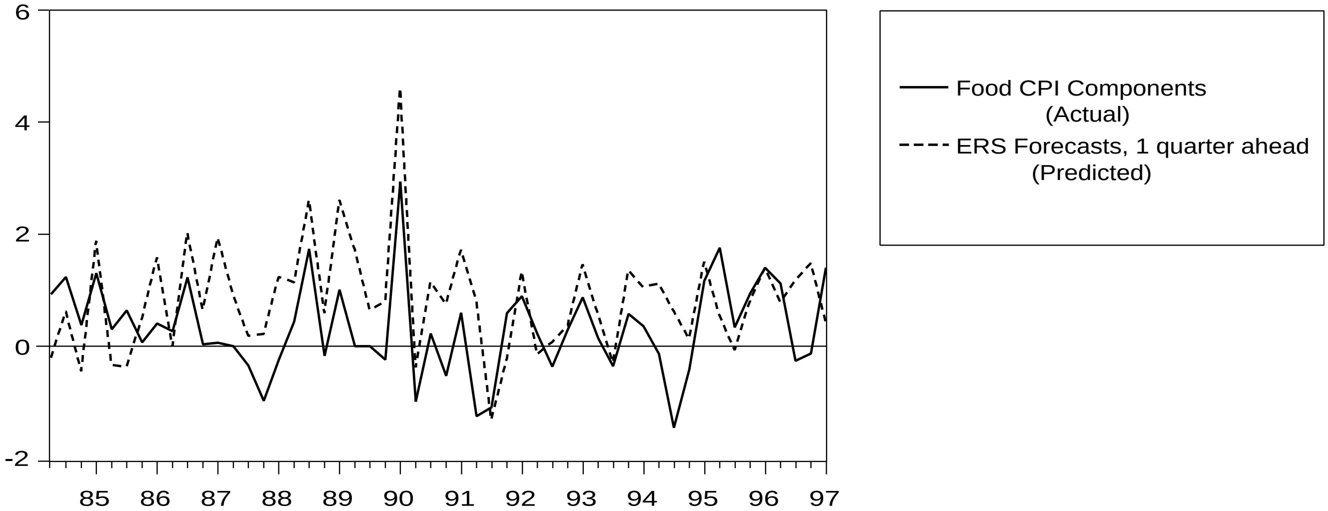


Figure 6d
Meats
Percentage change

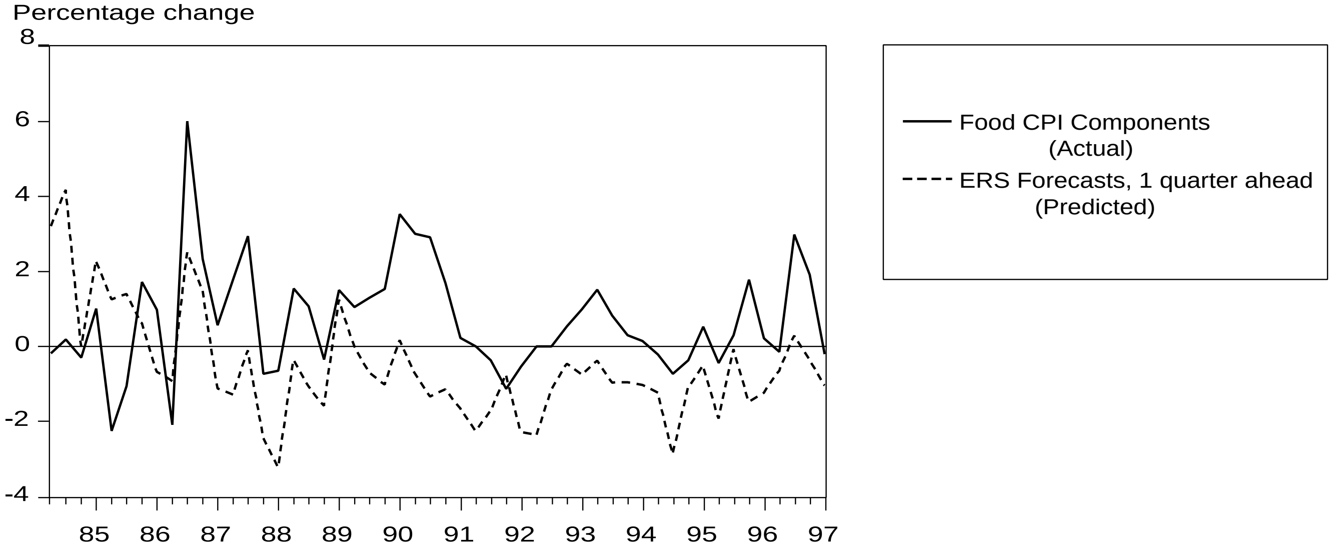


Figure 6e

Meat, Poultry, and Fish

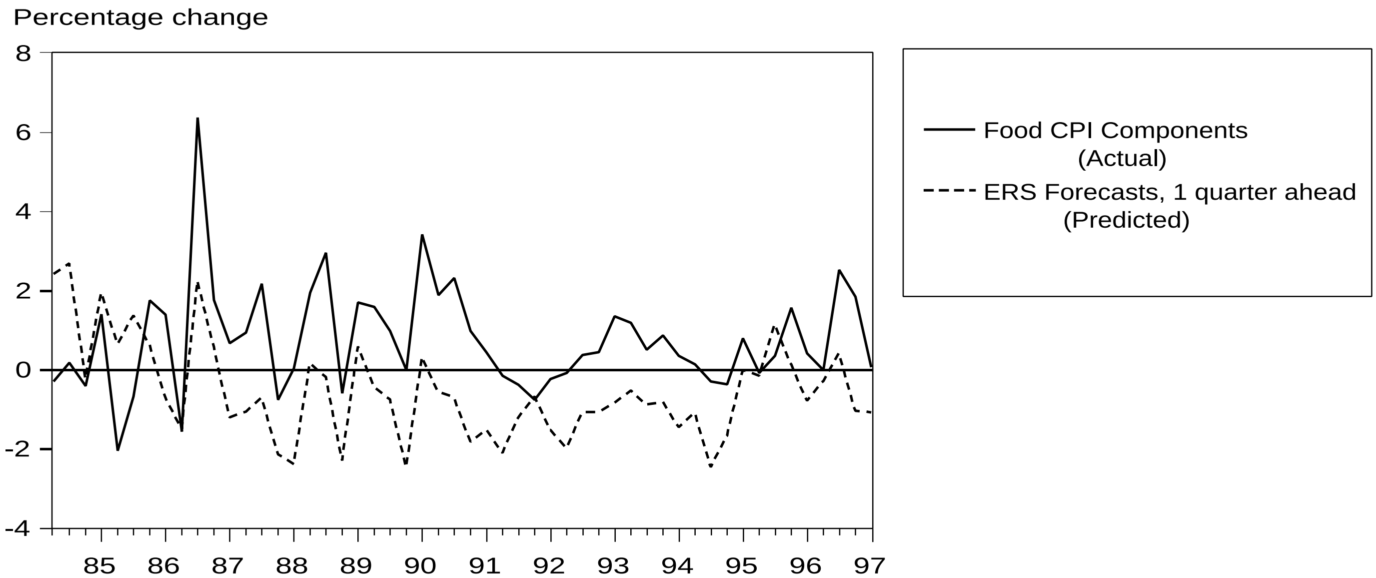


Figure 6f

Beef and veal

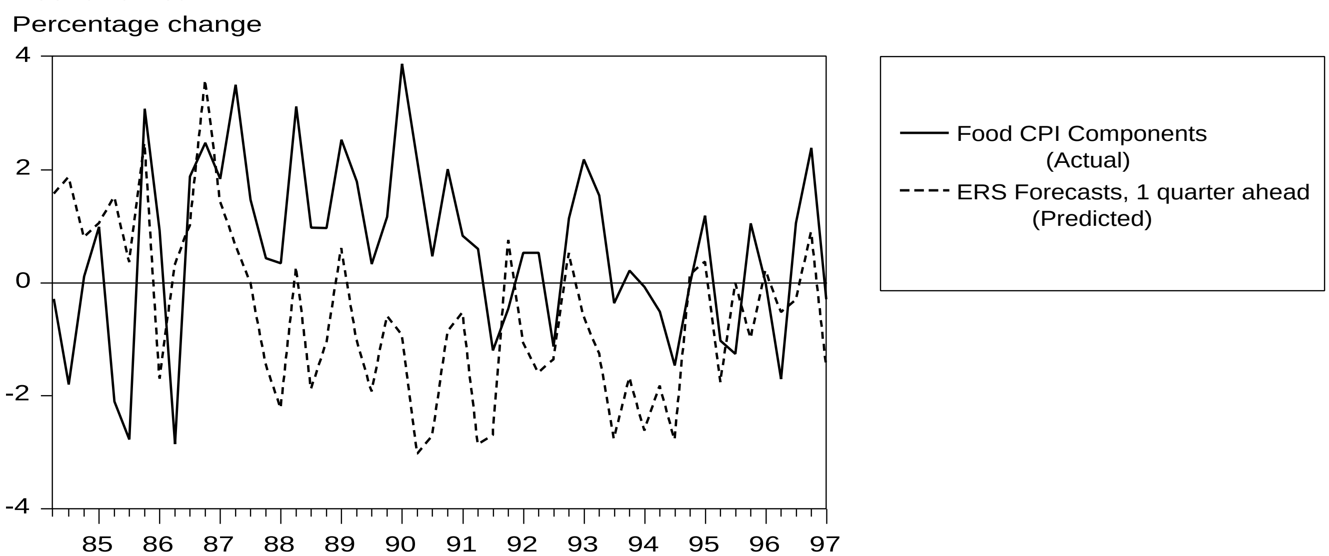


Figure 6g
Pork

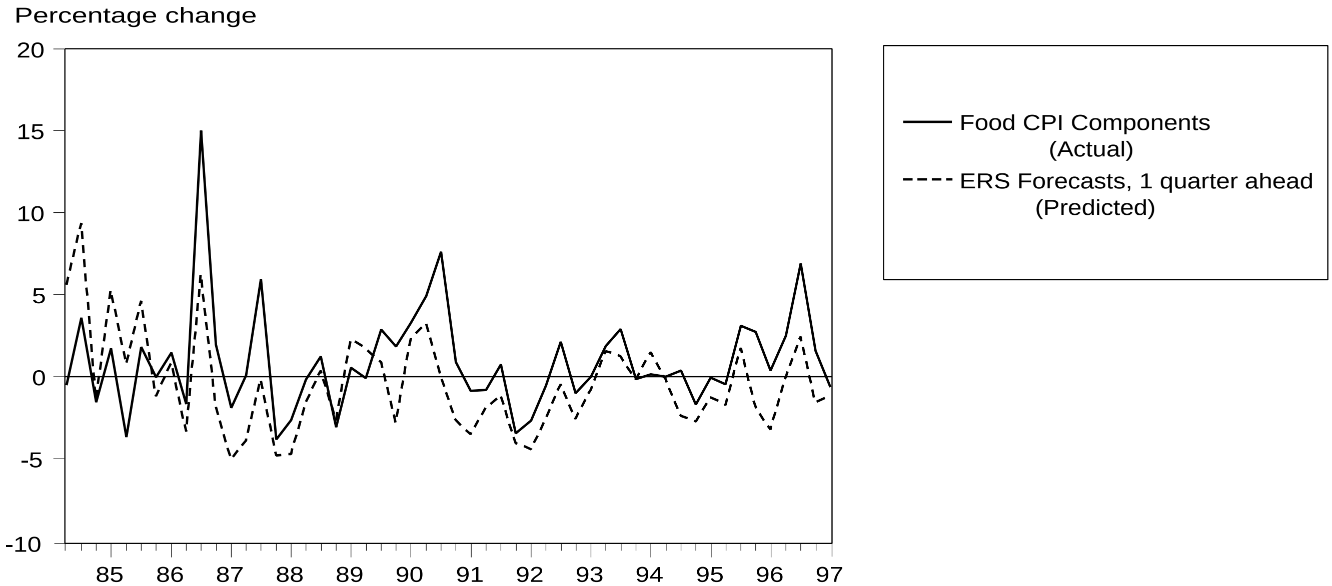


Figure 6h
Other Meats

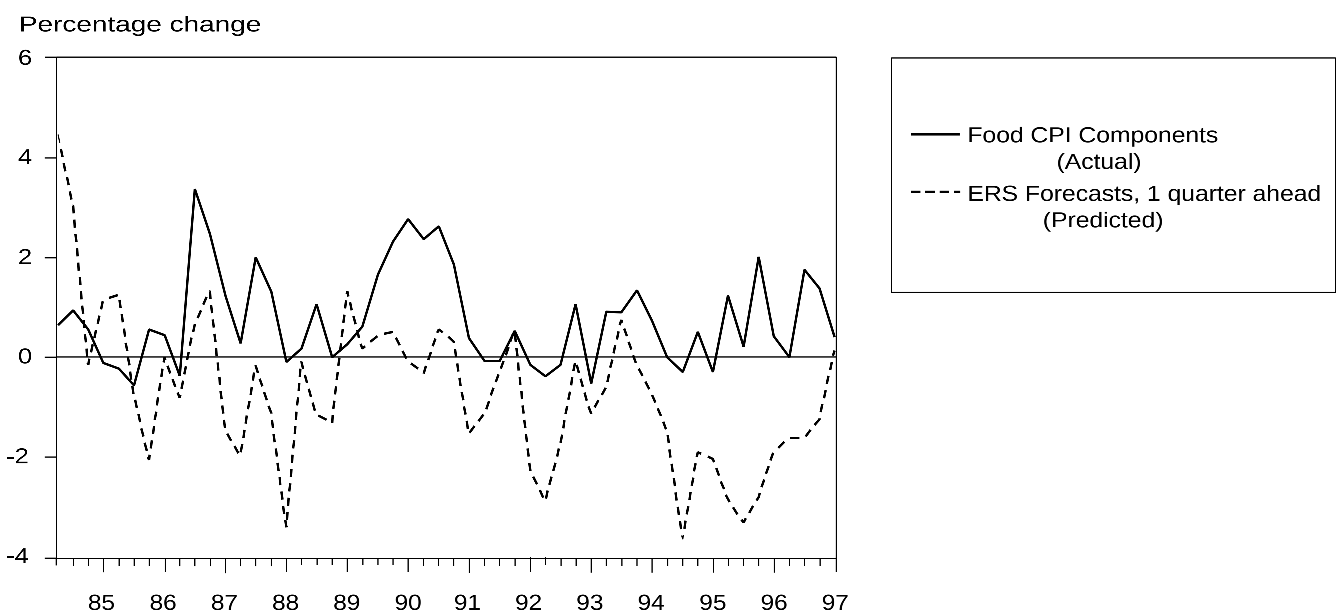


Figure 6i
Poultry

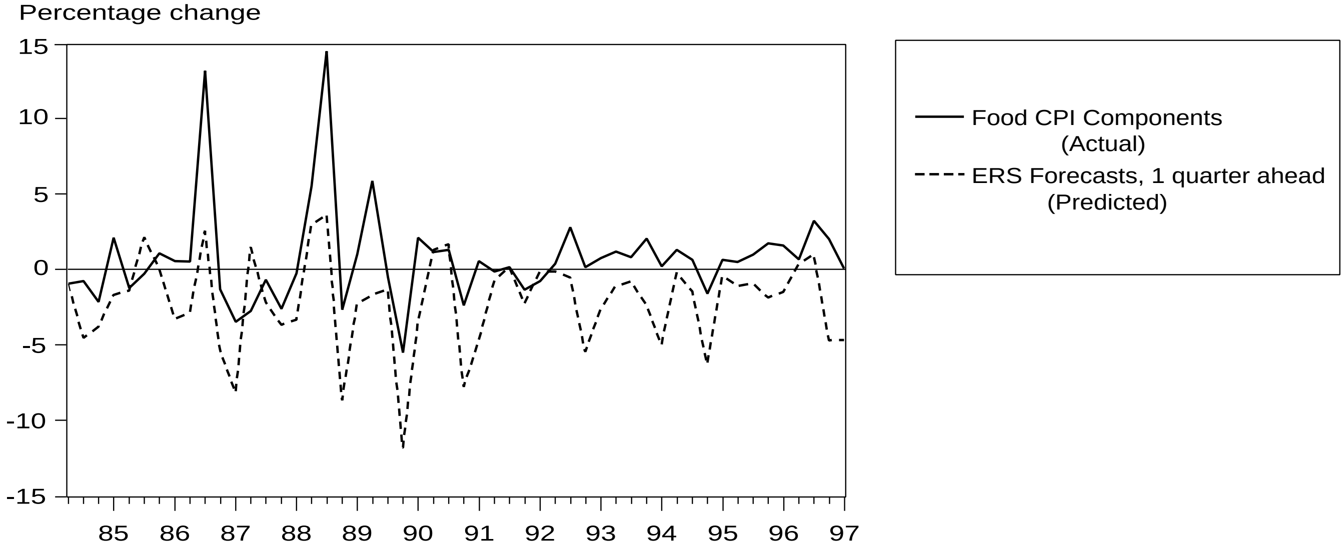


Figure 6j
Fish and Seafood

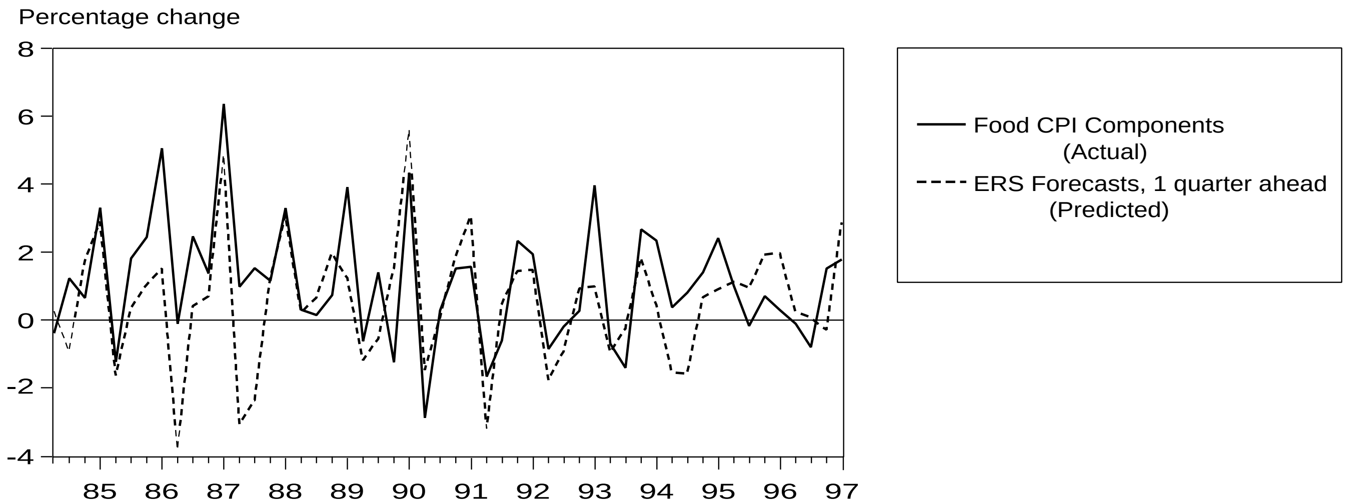


Figure 6k

Eggs

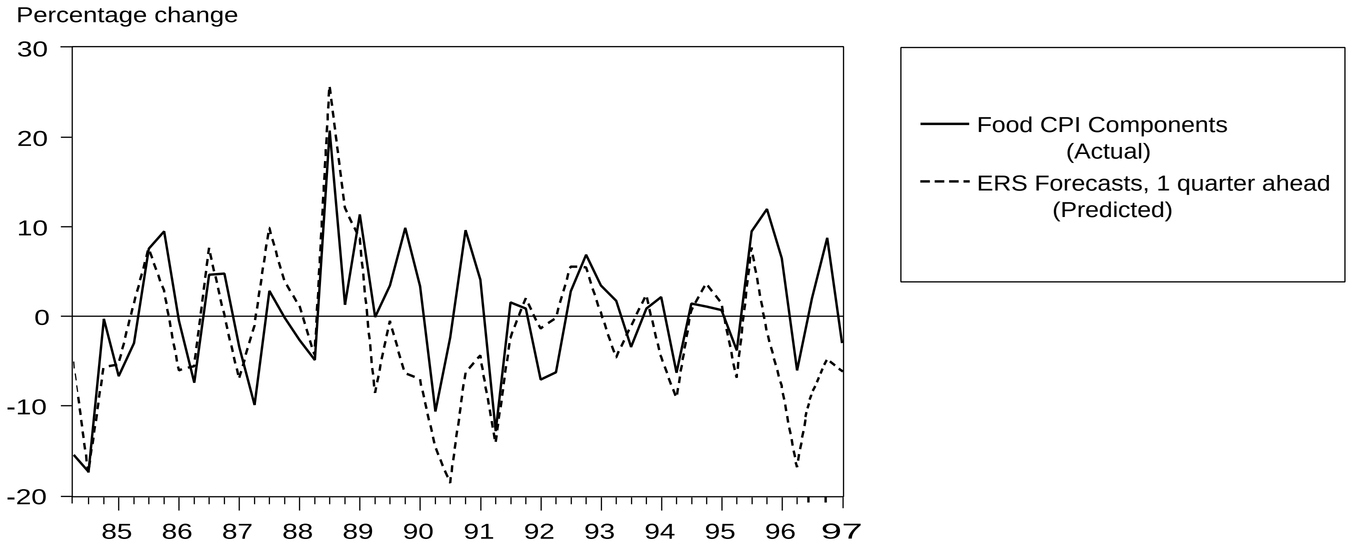


Figure 6l

Dairy Products

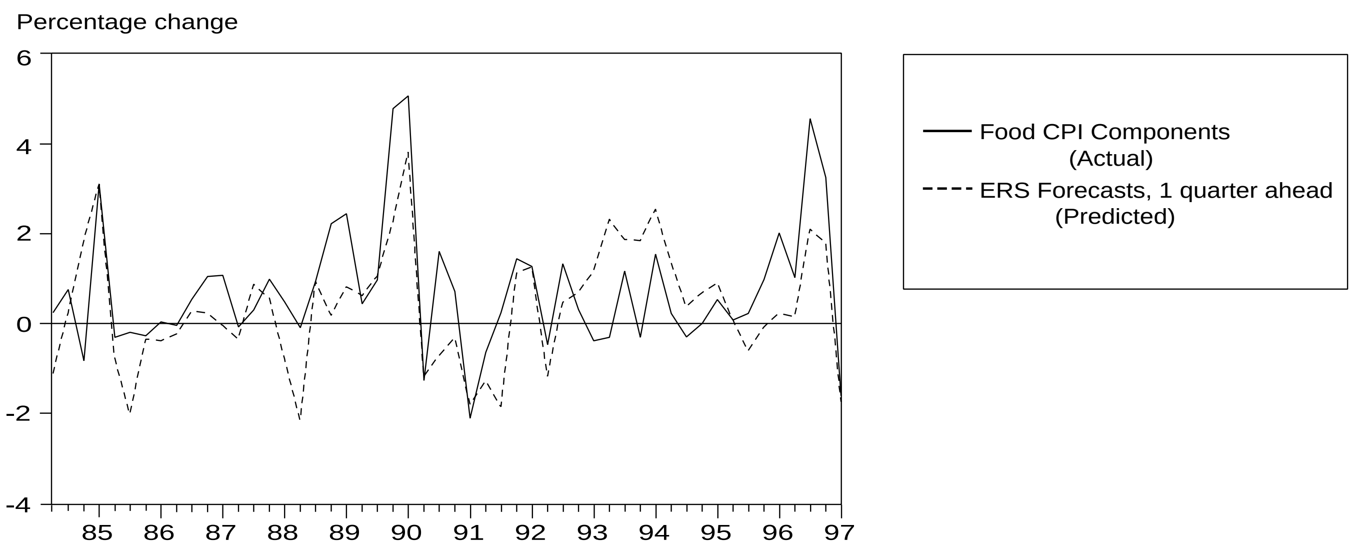


Figure 6m
Fats & Oils

Percentage change

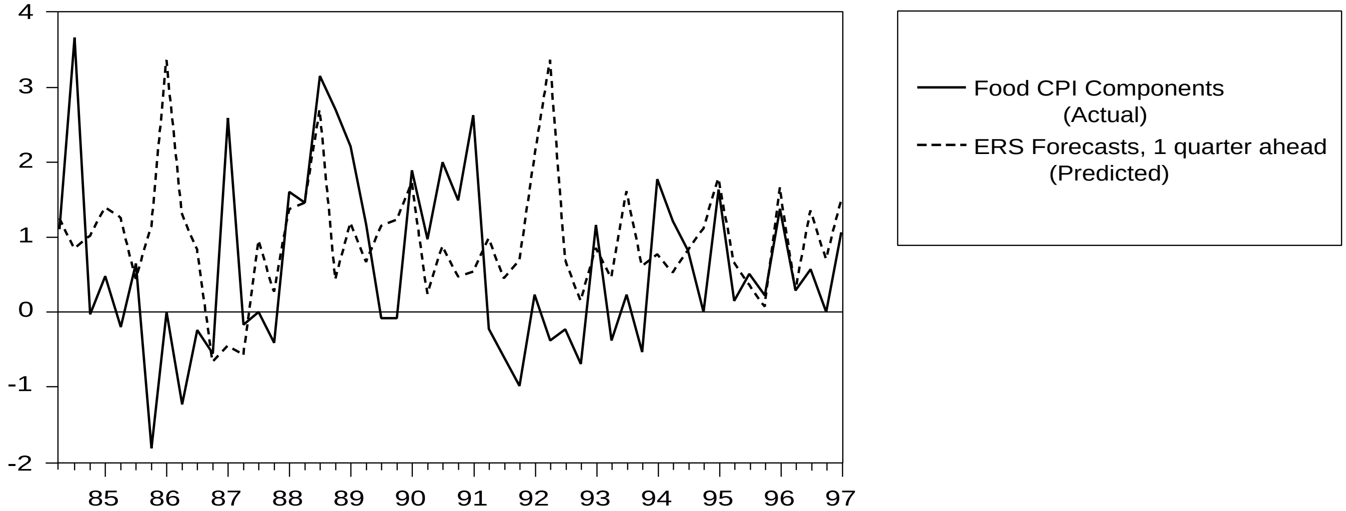


Figure 6n
Sugar & Sweets

Percentage change

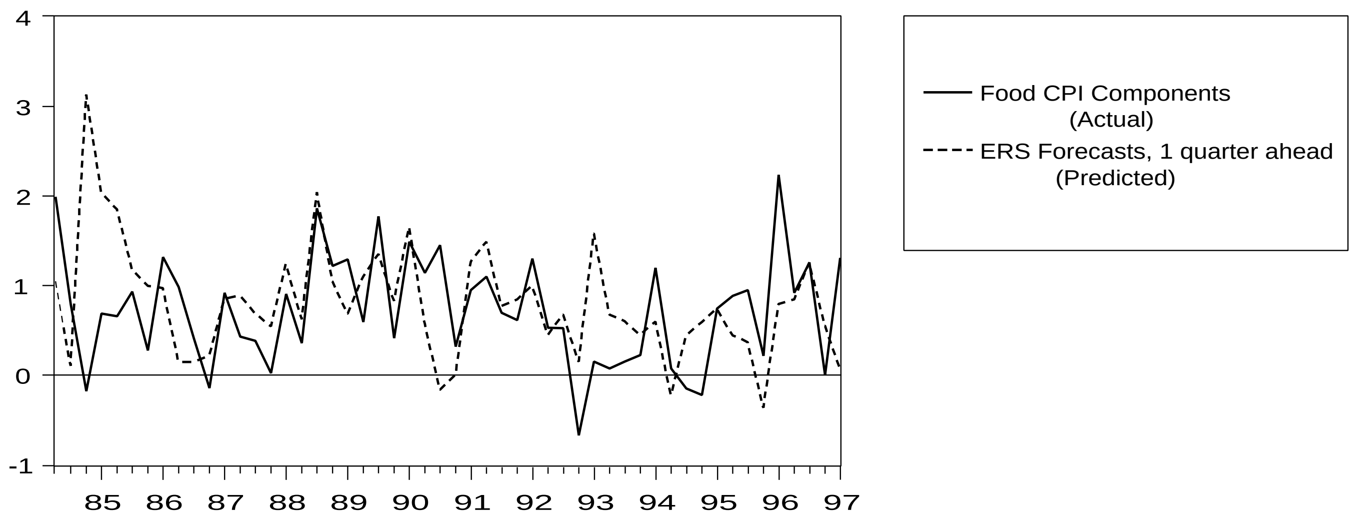


Figure 6o
Cereals & Bakery Products

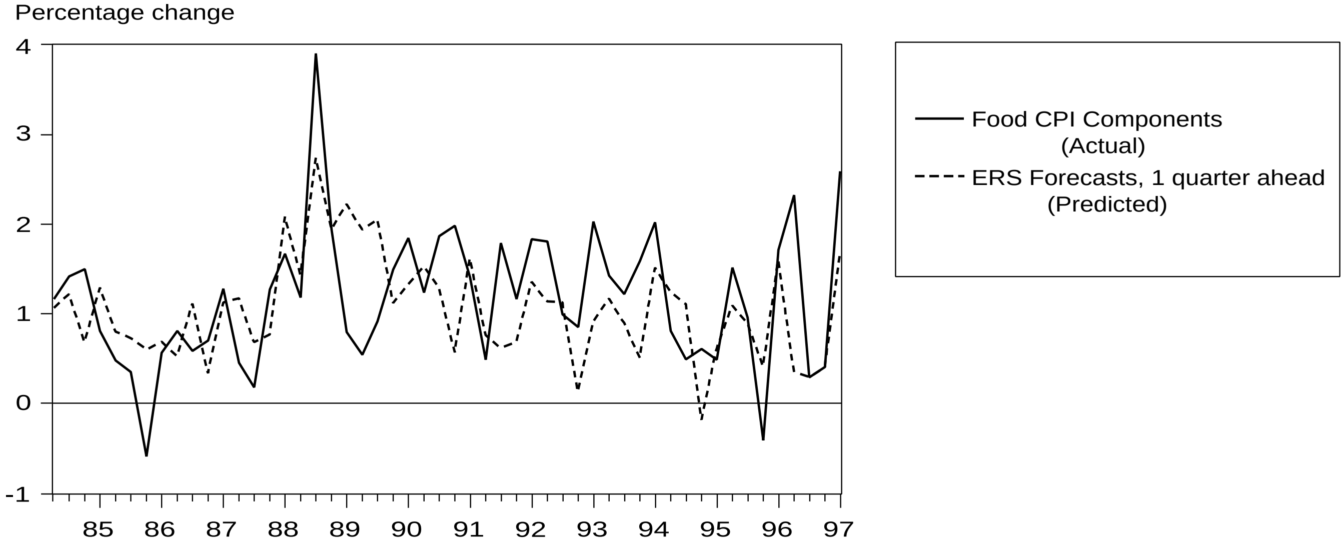


Figure 6p
Fruits and Vegetables

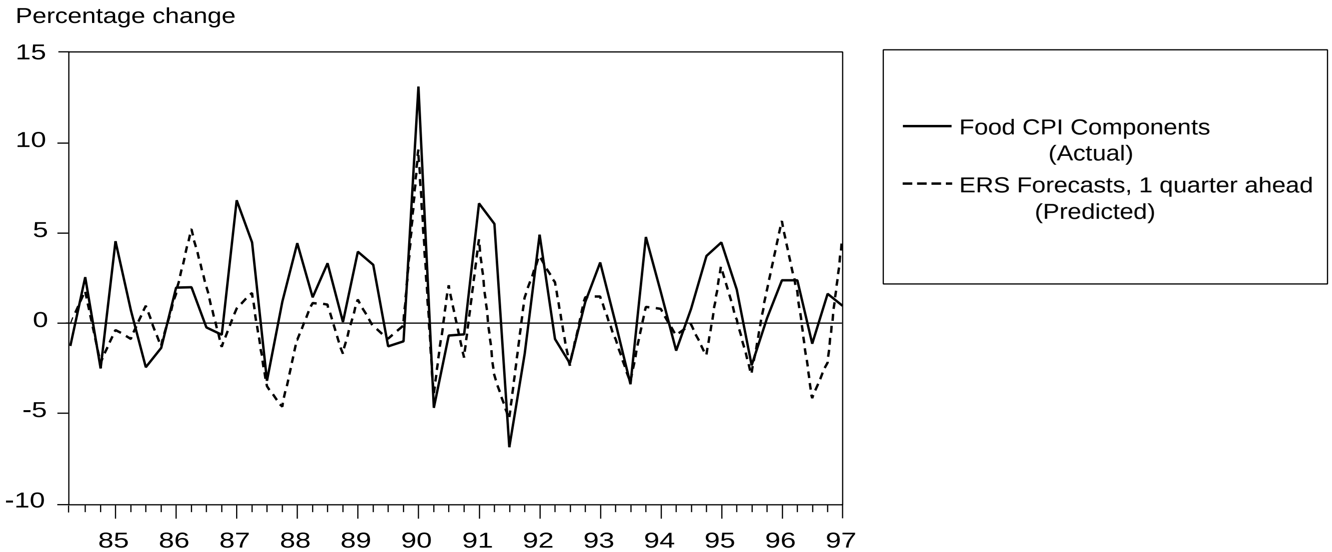


Figure 6q

Fresh Fruits

Percentage change

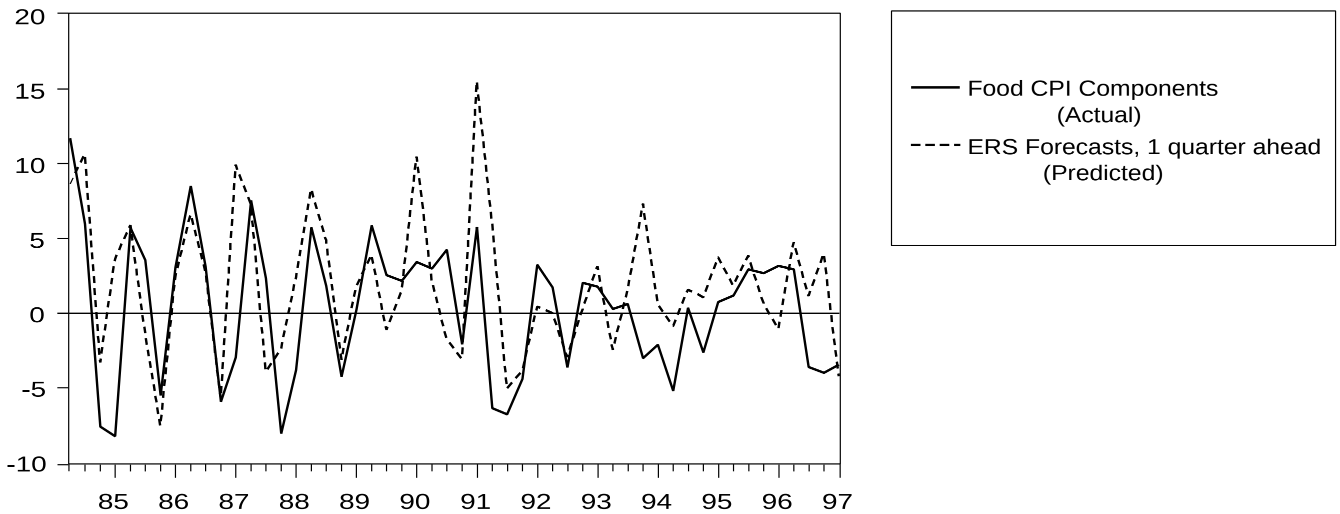


Figure 6r

Fresh Vegetables

Percentage change

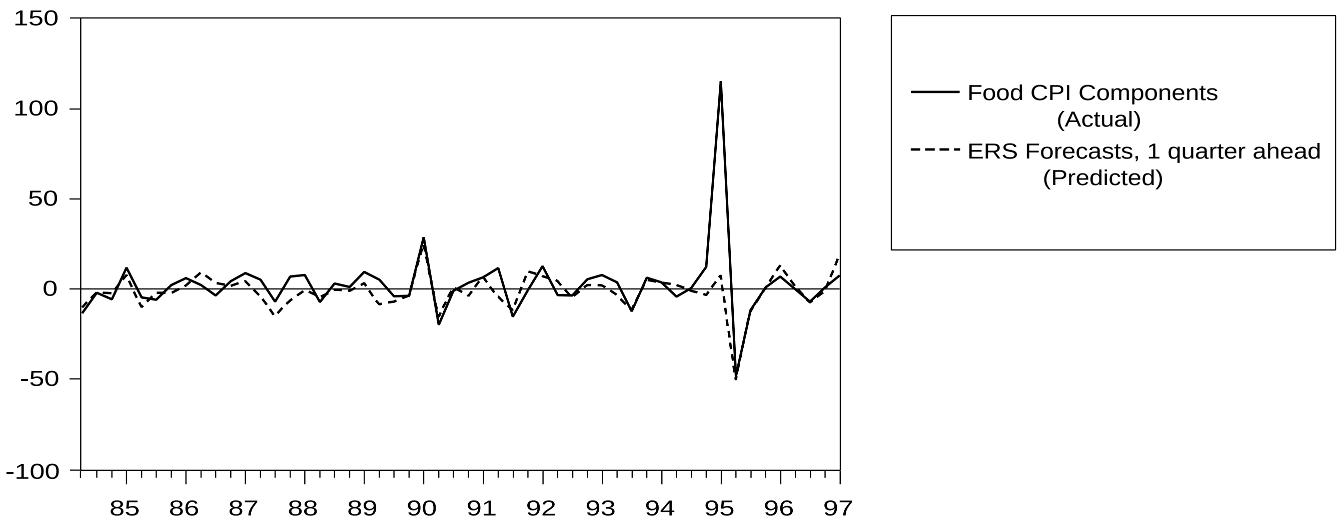


Figure 6s

Processed fruits and Vegetables

Percentage change

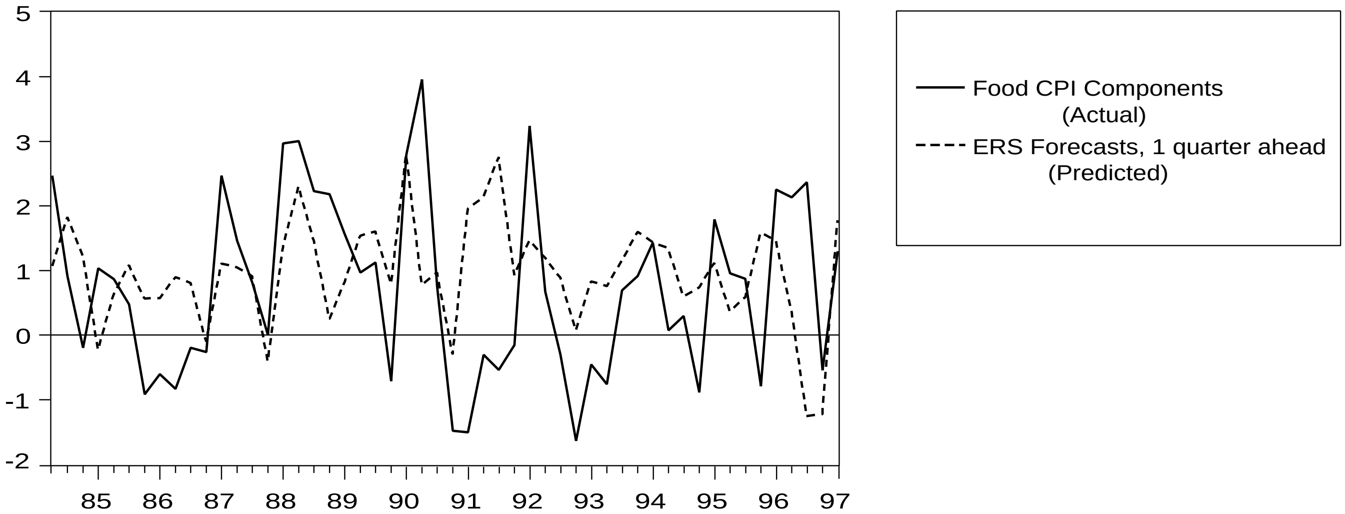


Figure 6t

Processed Fruits

Percentage change

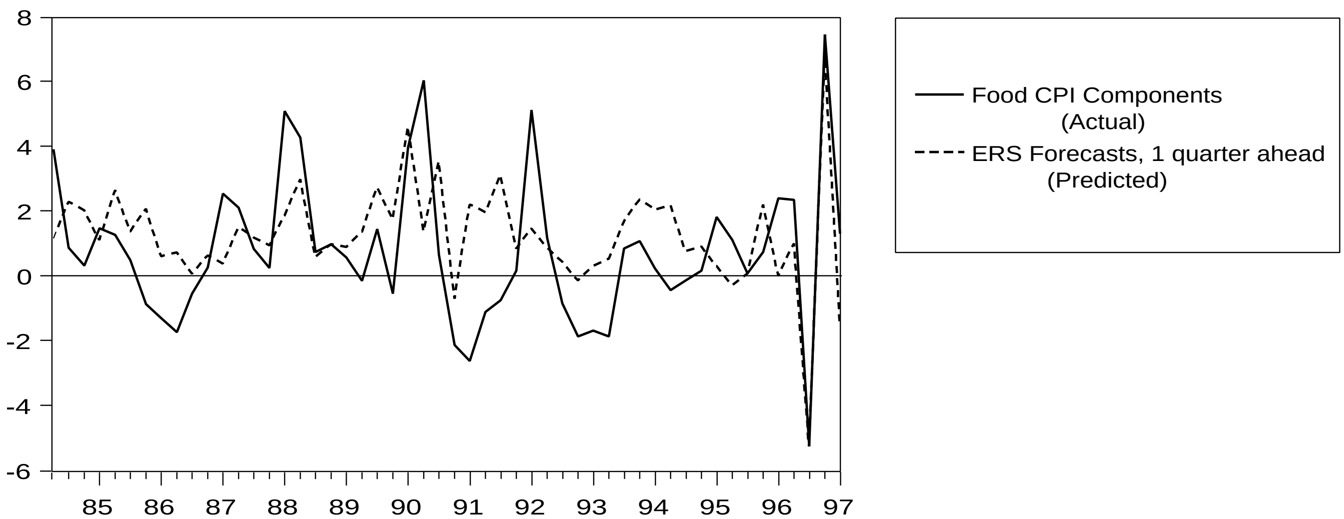


Figure 6u

Processed Vegetables

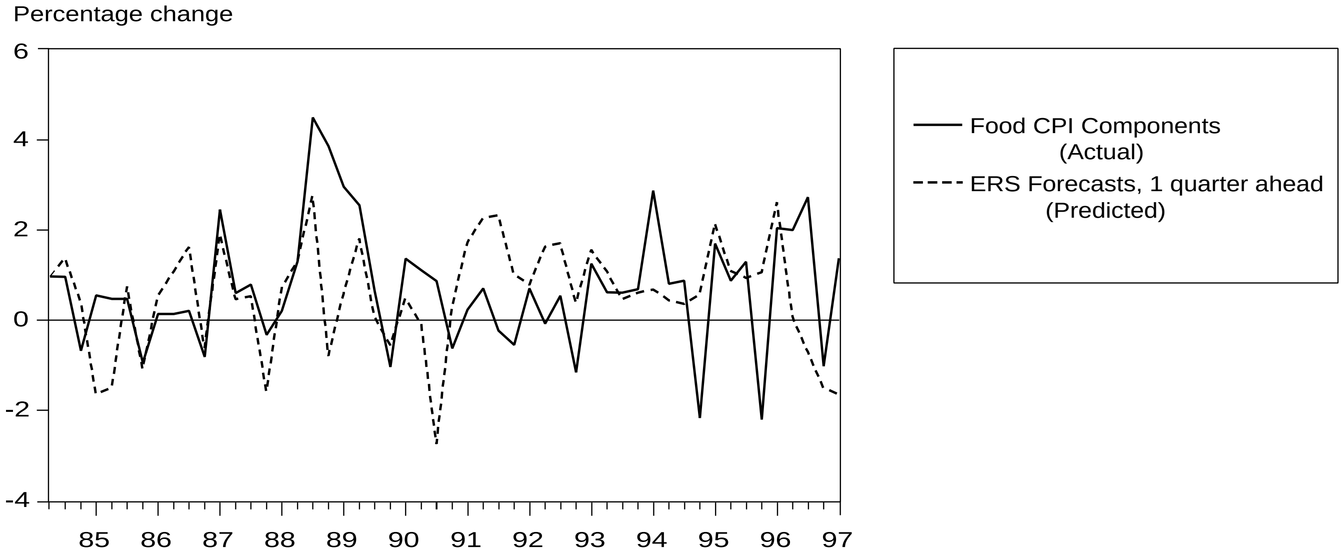


Figure 6v

Nonalcholic Beverages

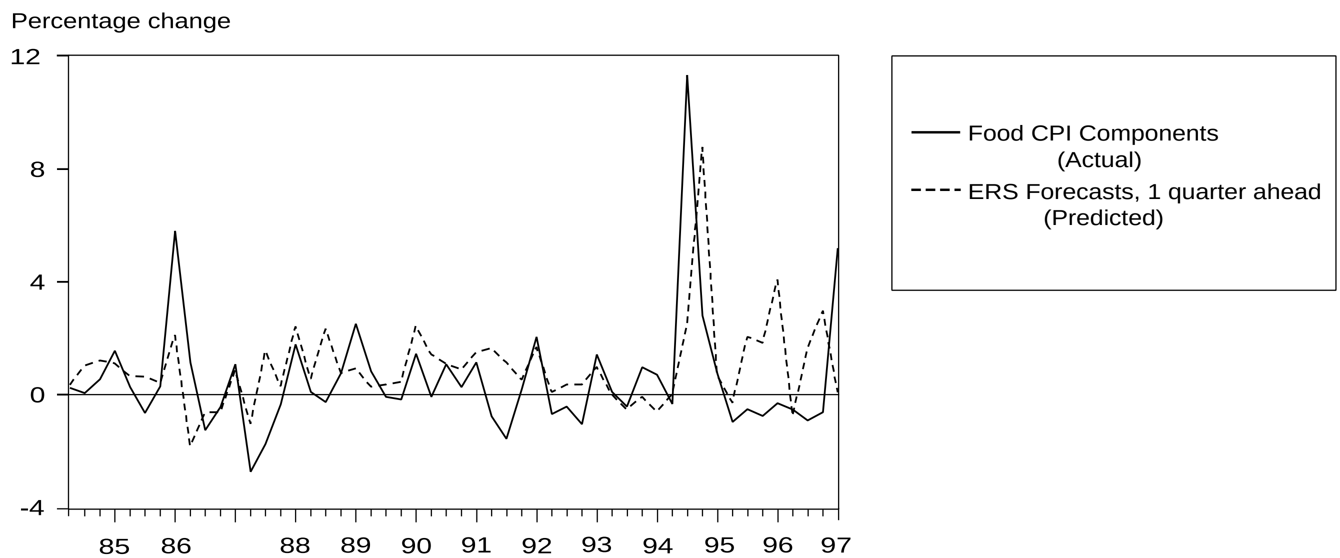


Figure 6w

Other Prepared Foods