Time-Series Methods for Forecasting and Modeling Uncertainty in the Food Price Outlook

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What Is the Issue?

The USDA, Economic Research Service's (ERS) Food Price Outlook (FPO) provides monthly forecasts on a wide range of food prices along the food supply chain. Historically, these food price forecasts have been reported as 1-percent ranges of annual percent changes for the Consumer Price Index, which reflects retail food prices. Forecasts of percent annual changes for the Producer Price Index, which reflects farm- or wholesale-level food prices, have been reported in 3-percentage-point ranges. These ranges reflect the results of econometric models, expert opinion, and uncertainty about the future of food prices.

Between 2005 and 2020, annual increases in food prices above 3 percent and changes in the food supply chain (from events like natural disasters, the Great Recession, the Global Food Crisis of 2011, and the coronavirus COVID-19 pandemic) have suggested the potential value of evaluating the possibility of improving the models used to forecast food prices. These changes also exemplified the inherent uncertainty in forecasts and highlighted the necessity of a statistically rigorous means of addressing that uncertainty.

Public and private users of the FPO forecasts benefit from more accurate forecasts and more rigorous representations of uncertainty around forecasts. Additional forecasts provide more detailed information that can inform expectations about future food prices.

What Did the Study Find?

This study found substantial gains in forecasting accuracy from implementing time-series econometric techniques, as measured by root-mean-squared error values. Moreover, the new statistical methods (hereafter referred to as "time-series approach") led to several qualitative benefits and improvements to the efficiency of developing the FPO forecasts. In addition to enhancing standardization, transparency, and reproducibility, the study results indicate the time-series approach may advance the representation of uncertainty about forecasts in three ways:

- The forecasting approach used between 2011 and 2021 ("legacy approach") produced forecast ranges that included the actual percent changes in food prices relatively infrequently a year before the actual percent change was realized. Only 16.3 percent of forecast ranges (developed a year in advance) included the actual

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ERS is a primary source of economic research and analysis from the U.S. Department of Agriculture, providing timely information on economic and policy issues related to agriculture, food, the environment, and rural America.

percent change in food prices across the food price categories. The time-series approach generated prediction intervals that contained the actual percent change in prices significantly more often at a 95 percent confidence level (85.5 percent of all forecasted categories) and a 90 percent confidence level (79.1 percent of all forecasted categories).

- Prediction intervals allow for uncertainty about food price changes to resolve, as more data become available. Prediction intervals are wider when forecasts are initially made, then continuously narrow as information becomes available throughout the year. These ranges also account for differences in the variation of each price index, explained by the forecasting model.

- Standardization of model selection allows additional data to be used in estimation or evaluated as a separate series. Apple prices and limited-service prices (a subcategory of food away from home) are evaluated as examples of how these methods may be applied to a new series as data availability and the food price environment change.

The prediction intervals more frequently contain the actual percent change in food prices and provide a more realistic representation of uncertainty about forecasts that adjust to changes in the food price environment.

How Was the Study Conducted?

This report primarily uses price indexes published by the U.S. Bureau of Labor Statistics (BLS) and food price forecast ranges generated by the USDA's Economic Research Service. Proprietary data from Urner Berry is used for a case study about seafood prices not currently covered by BLS. ERS economists use time-series econometrics which facilitate a model selection approach and allow for the generation of prediction intervals based on the data, parameter estimates, and fit of the model to the data.

The results of this forecasting approach are compared to previous Food Price Outlook forecasts. Root-mean-squared estimates are used to compare the accuracy across approaches. The approaches are then compared based on how frequently the forecast range/interval included the actual percentage change in food prices. Additionally, the average delays until a category's forecast range/interval includes the actual percentage change for the remainder of the year are calculated and compared.