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Evaluation of Extension and USDA Price and Production Forecasts

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This study evaluates agricultural forecasting accuracy in an analysis of responses to the Annual Outlook Survey conducted by the American Agricultural Economics Association from 1983 through 1995. Representative extension and composite, production, and price forecasts for several commodities are constructed from the survey data. These forecasts are compared to each other and to U.S. Department of Agriculture (USDA) and futures-based forecasts. Relationships between forecast features and accuracy are examined. Generally, extension forecasts are more accurate than USDA forecasts for livestock series, but not more accurate for crops. Composite forecasts are often more accurate than either extension or USDA forecasts.

Key words: extension forecasting, forecast accuracy, forecasting

Introduction

Forecasting has been an integral part of agricultural economics since the discipline's inception. The U.S. Department of Agriculture (USDA), in particular, has routinely provided both quantity and price forecasts of agricultural commodities for many years. These forecasts are intended to assist agricultural industry participants in making informed production, marketing, processing, and retailing decisions. For over 70 years, applied university agricultural economists, or simply extension, have bridged the gap between the USDA and industry participants by providing regular real-time forecasts of their own—presumably because their forecasts are thought to be more accurate than the USDA's, or because they more closely meet the needs of extension clientele.[1]

Fundamentally important to extension forecasters and forecast users is whether such "extending upon" USDA's direct forecasts is worthwhile, in terms of either accuracy or relevance in comparison to USDA's direct forecasts.[2] Several challenges to extension's

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[1] Extension is used broadly in that routine producer-targeted forecasts are typically provided by extension agricultural economists in the land grant system. It does not imply that only faculty with formal extension appointments make such forecasts. Extension forecasting is distinguished from USDA outlook work to the degree that its forecasts are developed by individual economists, usually at the state university level, rather than by a USDA committee at the national level. Extension forecasting is distinguished from the balance of applied agricultural economics forecasting based on the degree to which (*a*) forecasts are regular and developed in real time, and (*b*) targeted users are producers and business people, as opposed to other researchers.

[2] Because extension and USDA forecasters regularly communicate with each other, a certain amount of "checks and balances" is provided by this dual taxpayer investment in agricultural outlook. However, in times of diminishing resources committed to outlook, it should be especially important to regularly assess the accuracy of one group relative to the other. After all, private forecasters may be able to provide the necessary checks and balances should commitment to one of the taxpayer-assisted forecasting groups be sharply diminished.

role of providing marketing information have appeared in the literature over the last 20 years. Some have questioned whether the land grant university system in general (Armbruster), and extension forecasters in particular (Brorsen and Irwin), provide redundant information that is available from the private sector. Others have used surveys to determine the importance to producers of extension as a market information provider relative to other sources such as radio or magazines (Harris; Batte, Schnitkey, and Jones). Of course, these other market information sources often rely heavily on extension for their information.

These challenges suggest a need for an evaluation of extension forecasting efficiency. If forecast accuracy can be improved while reducing forecast construction costs, the resultant efficiency gains should be of interest to forecasters, forecast users, and those paying for forecast construction (often taxpayers). Because mechanical, model-based forecasts are less expensive than judgmental forecasts (e.g., Armstrong; Fildes; Makridakis; van Vught), determining the relationship between mechanical model usage and forecast accuracy could help improve the benefit/cost ratio of forecasters. In general, an understanding of how forecast and forecaster traits affect forecast accuracy should improve the efficiency of forecast construction. Thus, uncovering those determinants is an important objective of this research.

If extension forecasts are less accurate than USDA's direct forecasts, from a benefit/cost perspective extension forecast providers should focus on disseminating USDA's forecasts rather than constructing their own. Furthermore, if extension forecasts are less accurate and no less expensive than those readily accessible to users, it may not be appropriate for extension to continue investing heavily in forecasting. Therefore, a second objective of this research focuses on comparing the accuracy of extension forecasts with the accuracy of forecasts provided by the USDA and the futures markets.

Each year for nearly two decades, the American Agricultural Economics Association (AAEA) has conducted a forecasting competition. A composite (simple average) for each forecasted series is compiled and distributed to participants each year. By comparing the historical accuracy of the composite forecast series with that of competing forecasts, we also evaluate the usefulness of this AAEA-sponsored event.

Extension Forecasting Accuracy Studies

In 1926, Green, one of the earliest extension forecasters, began testing the accuracy of his own price forecasts after only one year of price forecasting. However, Green realized the inherent reluctance among both forecast users and forecasters to consider underlying forecast accuracy:

> The real job is in getting county agents, extension men in other lines, and scientific workers who have been used to measuring things with calipers, even to look at anything that may be as much as 25 per cent off when it comes to measurements (p. 187).
>
> [W]orkers will naturally be very reluctant about saying anything that may later necessitate the admission of a mistake. Almost unconsciously they work toward an end such that so far as this kind of work is concerned, it can truthfully be said of one of them, 'he never said a foolish thing nor ever did a wise one.' In so strenuously trying to avoid the first fate workers run headlong into the latter (p. 190).

Apparently, Green's concerns were well founded. Over the ensuing years, many studies examined the accuracy of USDA's forecasts, but few investigated extension's accuracy. There were some exceptions. In 1949, Seltzer and Eggert reported that Kansas State College's monthly hog price forecasts (1925–40) were more accurate (64% correct based on an arbitrary scoring technique) than a simple seasonal price forecast (37% correct). Cattle price forecasts were 62.7% accurate compared with 52.7% for the seasonal forecast. Heer similarly scored the 1948–51 monthly grain price forecasts for Iowa State College.

More recently, Gerlow, Irwin, and Liu compared Purdue University expert opinion forecasts with those of a single-equation econometric model, an autoregressive integrated moving average (ARIMA) model, and two composite models. Forecasts of U.S. quarterly hog prices (1976–85) were compared using statistical accuracy measures and an economic measure comprised of simulated trading profits based on the forecasts. Expert opinion ranked about in the middle by statistical measures, but last by the economic criterion. The econometric model, although ranked last by statistical accuracy measures, was the only procedure that generated statistically significant profits by the economic criterion.

Lawrence examined Iowa State University's 1968–86 hog price forecasts. He revealed that a persistent downward bias in the forecasts was an underlying attempt to tailor forecast error to match the loss function of the user. Specifically, hog producers were assumed to value lost opportunity differently than real dollars lost. This suggests forecast error variance should be penalized more heavily than bias. However, if downward bias extends to price forecasts of commodities that are inputs for some producers but outputs for others, then tailoring forecasts for user loss functions is potentially troubling. That is, different point forecasts must be developed for alternative groups of risk-averse producers.

Research relating to extension forecasting has rarely appeared in the academic literature, but it has frequently been assessed. Each year since 1978, just prior to the AAEA's annual meeting, an Annual Outlook Survey (AOS) has been conducted of members routinely involved in forecasting. The surveys solicit price and production forecasts for the coming year.[3] At the outlook session of the AAEA annual meeting, the current survey results and accuracy of the preceding year's survey are presented. Generally, accuracy evaluations have not been comprehensive, rigorous, or across time. Cornelius, Ikerd, and Nelson provided a brief evaluation after the first two years of forecasting, noting that soybean price forecasts had been more accurate than corn price forecasts, and hog prices were easier to forecast than cattle prices.

Ferris evaluated AOS accuracy in 1988, using root mean squared and percentage error (RMSE and RMSPE) to compare AOS 1979–88 forecasts with those from the USDA, from a naive no-change model, and from the futures market (adjusted for basis). AOS forecasts were less accurate than futures or naive models for slaughter and feeder steer prices, but more accurate for hog prices (USDA forecasts were not compared). In each case (slaughter steers, feeder steers, and hogs), the average AOS forecast was biased upward, predicting prices that were too high. Apparently, Lawrence's findings

[3] Potential AOS respondents are identified using mailing lists of those who have responded in the past, through personal contacts, and, in some cases, by mailing surveys directly to agricultural economics department chairs, requesting they be passed on to those who may be interested. Respondents represent private, government, and university concerns. Most, however, are agricultural economists from universities—usually those involved in extension outlook work.

of downward bias did not extend to extension hog price forecasting in general during that time. For crop price forecasts, Ferris reported that the average AOS forecast was less accurate (RMSPE) than either USDA or futures for wheat, more accurate than USDA or futures for corn, and equivalent to USDA but less accurate than futures for soybeans. The historical accuracy of AOS forecasts was revisited by Miller and Plain in 1991. No comparisons with other forecasts were offered. However, examination of the forecast errors led the researchers to conclude: "Overall, our livestock forecasting ability exceeds that of crop forecasting. . . . The absolute percent error of all crop production estimates increased [since the previous year] for all crops estimated. The accuracy of crop price forecasts declined for all but soybeans" (p. 1).

No sweeping conclusions regarding extension's forecasting accuracy emerge from past studies. What stands out is the inconsistency in the way extension forecast accuracy has been measured. Metrics ranged from arbitrary accuracy scores to economic profits to several forecast error test statistics. Because the measures are not perfect substitutes for each other, it is difficult to generalize about extension's forecast accuracy over time when alternative measures have been used.

Testing Forecast Accuracy

The choice of forecast accuracy test statistic(s) is relevant, as different test statistics capture different information associated with forecast error. Mathews and Diamantopoulos showed that at least four unique classes of information are available from commonly used accuracy test statistics. They suggested forecast accuracy studies should include a measure from each of the four classes. With A and F denoting actual and forecasted series, respectively, the four classes and a representative test statistic for each are:

- Bias—for example, mean error (ME): $\Sigma(A - F)/n$;
- Ratio-type—for example, mean absolute percentage error (MAPE): $100 * \Sigma|(A - F)/A|/n$;
- Volume-type—for example, root mean squared forecast error (RMSE): $[\Sigma(A - F)^2/n]^{1/2}$; and
- Fit—for example, squared linear correlation coefficient (R^2): $[\Sigma(A - \bar{A})(F - \bar{F})]^2/[\Sigma(A - \bar{A})^2\Sigma(F - \bar{F})^2]$.

Empirically, because individual point forecasts frequently are on opposite sides of the actual value, a composite forecast series is often more accurate than the most accurate of the individual series making up the composite—by each of the four test statistics suggested. In the case of root mean squared error, this is especially well known (Granger). This empirical result should be valuable to forecast users who have access to the composite forecast series. It also means that the most relevant forecast series to compare with that of a competitor may be a composite series. For example, when pitting extension against USDA, it may be more appropriate to compare USDA's accuracy with that of a composite series involving a group of extension forecasters rather than with a single extension forecaster's accuracy. However, if the composite series is unavailable, and when no individual forecaster's forecasts consistently cover a time period of interest, users who want to evaluate a class of forecasters such as extension should be more interested in the accuracy of a representative forecast. A representative forecast is made by randomly drawing one of several individual forecasts each time period.

Percentage errors have appeal where accuracy measures are aggregated across series that vary widely in scale. For computing the accuracy of a representative forecast series, absolute errors are intuitively appealing. For a single time period, the representative forecast accuracy is the mean of the individual absolute errors. Across time, the representative forecast accuracy is the mean of the time periods' mean absolute errors. Of the four accuracy test statistics noted, only MAPE has this broad-based appeal. For these reasons, and to contain the quantity of reported results, this research uses only MAPE (and the single-point counterpart, APE) to measure forecast accuracy.

Forecast Description and Supporting Data

General Overview

This study principally uses the AOS survey collected annually for the AAEA outlook sessions. Only surveys from 1983–95 were available. The survey has been modified in several ways over the 13 years examined. Forecasted series were added, dropped, or redefined to keep reasonably compatible with USDA's forecasted series. Whenever possible, compatible USDA forecast series, naive series, and futures series also were collected or constructed to compare with the AOS forecasts. The AOS survey contains a personal information section; a production and price forecast section for livestock, poultry, and milk; a supply and utilization section for crops; a low and high monthly price forecast section for livestock, poultry, milk, and crops; and a general macroeconomics forecast section. Monthly high/low forecasts and macroeconomics-related responses were not analyzed.

AOS surveys were mailed annually in early July to university, private, and government individuals with agricultural forecasting interests. Responses were to be returned by 24 July on average. The total number of surveys examined for the 1983–95 period was 557, involving 201 unique respondents, for an average of 2.77 years that an individual participated. However, only 39 unique respondents provided more than half of the total responses, indicating a persistence of some forecasters—often those involved in extension outlook work. The least number of annual responses (27) was received in 1989, the most (68) in 1985. No analyst responded all 13 years. Only seven individuals responded at least 10 years, and only 41 responded at least five years. Ninety-eight individuals responded only one year. Of the 103 individuals who responded more than one year, 58 delivered nonconsecutive responses. The low number and nonconsecutive individual responses precluded analyzing individual forecaster accuracy, forcing the analysis into representative and composite forecast frameworks.

In the personal information section of the AOS surveys, respondents reported levels of econometric model usage and importance of forecasting in their job responsibilities, and indicated areas in which they have major forecasting responsibilities. Additional personal forecaster information was derived from AAEA directories and by direct follow-up requests. Respondents' years of experience and terminal academic degrees were collected to serve as indications of forecasting experience and professional training. The average number of years experience associated with the 530 responses, where it could

Table 1. Annual Outlook Survey (AOS) Forecaster Personal Information Summary Distributions, 1983–95

Use of Econometric Model:								
Major	Moderate	Minor	None	No Indication				
10.4	21.2	41.3	24.1	3.0				
Level of Forecasting Responsibility:								
Major	Moderate	Minor		No Indication				
38.2	34.5	23.7		3.6				
Areas of Major Forecasting Responsibility:								
Beef	Pork	Broilers	Eggs	Milk[a]	Wheat	Corn	Cotton	Soybeans
32.1	31.8	12.2	6.6	4.9	27.8	29.1	11.7	30.5
Terminal Degree of Forecaster:								
Ph.D.	Masters	Bachelors		No Indication				
77.9	18.3	0.4		3.4				
Forecasting Institution:								
Univ.	Gov't	Private		No Indication				
72.5	7.4	20.1		0.0				

Note: Table values are percentages of 557 total surveys received 1983–95.
[a] Milk forecasts began in 1991; of the 185 surveys for 1991–95, 27 (14.6%) indicated milk expertise.

be obtained, was 17.2 (standard deviation of 11.3 years). Respondents were categorized as university, government, or private. Table 1 summarizes personal information categories. Most respondents are university forecasters with Ph.D.s, who make little use of econometric models, and who are involved primarily with the traditional commodities of beef, pork, wheat, corn, and soybeans.

Two classes of AOS forecasts are further distinguished in this study. To focus attention on extension forecasts, the first class (labeled EXT) involves only forecasts from university respondents who indicated forecasting was a major part of their jobs and that they were responsible for forecasting the specific series examined. EXT forecasts are representative forecasts, meaning EXT accuracy is that expected by following a random EXT forecaster each year. The second class, COMP, is the composite forecast across all AOS respondents (not just EXT). Examining the accuracy of this class is important because the COMP series is actually developed and presented to AOS respondents each year. Thus, COMP represents a series that is readily available to those involved in outlook. Although a composite of EXT forecasts likely would be more accurate than representative EXT forecasts, as defined here, COMP accuracy is not necessarily expected to exceed EXT accuracy a priori (because COMP includes forecasts of more casual forecasters).

Livestock, Poultry, and Milk

The periods forecasted for this section of the AOS survey were the third quarter, the fourth quarter, and the annual value for the survey (current) year, and each quarter and the annual value for the following year. Percentage changes (from the same period in the prior year) were forecasted for commercial beef and pork production, federally inspected broiler production, farm egg production, and farm milk production (commencing with the 1991 survey). Prices were forecasted for the same time periods as those associated with the production forecasts. The prices forecasted were choice slaughter steers ($/cwt, Omaha 1,000–1,100 lbs., 1983–94; Nebraska Direct 1,100–1,300 lbs., 1995), feeder steers ($/cwt, Kansas City 600–700 lbs., 1983–90; Oklahoma City 600–700 lbs., 1991–94; 750–800 lbs., 1995), barrows and gilts ($/cwt, U.S. 7-market, 1983–91; U.S. 6-market, 1992–93; Iowa/Minnesota, 230–250 lbs., 1994–95), broilers (¢/lb., U.S. 12-city, ready-to-cook, 1983–95), eggs (¢/doz., NY grade A large, 1983–95), and milk ($/cwt, M-W series, 3.5% BF, 1991–95).

Actual production and price series underlying the AOS forecasts were obtained from various USDA publications and databases. Compatible USDA forecasts (most recent prior to 24 July) were derived from various USDA outlook publications (for exact publication or database, consult the authors). For some point forecasts, in computing forecast error, a different actual value was used for USDA than for AOS (as when USDA changed to a new commodity definition earlier than AOS). Although this may introduce some error in the analysis, unless new actual series were systematically more or less variable than old actual series, any distortions should not favor one group of forecasters over another. That is, errors were always computed based on the actual series forecasted by the forecaster, even when the actual series was not identical across forecasting groups. Because USDA began forecasting table egg rather than farm production in 1995, it is assumed that AOS respondents also began to forecast changes in table egg production beginning in 1995. USDA began forecasting milk prices in 1994.

The naive production forecast series assumed no change from the same quarter the year before. The naive price forecast series assumed that each quarterly and annual price forecasted was the same as the second quarter price in the survey year. For slaughter steers, feeder steers, and barrows and gilts, a futures-derived compatible forecast was constructed using the Chicago Mercantile Exchange (CME) futures prices for live cattle, feeder cattle, and hogs, respectively, and a rolling five-year average basis (selection of a five-year basis was arbitrary).

Specifically, monthly futures-based price forecasts were derived using the 20 July closing price for the appropriate deferred futures contracts (for compatibility, this assumes AOS surveys were completed four days prior to the deadline of 24 July). Delivery months were assumed to be comprised of three weeks from the delivery-month contract and one week from the next contract. For example, the futures-derived October slaughter steer price forecast made 20 July 1995 was 3/4 times the October plus 1/4 times the December live cattle futures price on 20 July, plus the average 1990–94 October basis. The historical monthly basis was the difference between the actual monthly cash price and the average daily closing prices of the nearby futures contract(s) for that month. For July in the survey year, the average daily close through the 20th was multiplied by 3/4, and added to 1/4 of the price on the 20th, to obtain the futures part of the futures-derived July price forecast. Quarterly and annual futures-derived price forecasts were calculated from monthly forecasts.

Supply, Utilization, and Market-Year Average Price for Crops

The items forecasted in this section of the AOS survey were current (survey) year U.S. production, U.S. exports, carryout, and market-year average price for the crop marketing year beginning with the survey-year harvest. Crops forecasted were wheat, corn, soybeans (all in mil. bu. and $/bu.), and cotton (upland and ELS, mil. bales and ¢/lb.). The actual production and price series underlying the forecasts were obtained from the USDA's *World Agricultural Supply and Demand Estimates* (*WASDE*) reports issued in November of the year following the survey year. Compatible USDA forecasts were constructed from *WASDE*'s July reports (usually released around 11 July), where projections were made for the marketing year which had just begun in June (wheat), or about to begin in August (cotton) or September (corn and soybeans). Naive forecasts were *WASDE*'s July estimates for the marketing year just ending. Thus, naive forecasts are essentially no-change forecasts. No futures-based crop price forecasts were constructed.

Analytical Procedures

In this study, forecast accuracy was examined in two ways. First, to determine the relationship between forecast accuracy and forecast features, AOS survey forecast error was expressed as a function of several variables of interest in a regression framework. Second, accuracies of EXT forecasts (AOS forecasts of university outlook economists responsible for forecasting those series), COMP forecasts (composite of all AOS forecasts), USDA, naive, and futures-based (where relevant) forecasts were compared pairwise using MAPEs. In both the regression and pairwise accuracy frameworks, price series and production series were examined independently, and by commodity.

For each forecasted livestock, poultry, and milk production and price series, the absolute percentage error (APE) for each AOS point forecast was modeled as:

(1)
$$\begin{aligned} APE_{it} = {} & \beta_0 + \beta_1 GOVT_{it} + \beta_2 PRIV_{it} + \beta_3 EXPER_{it} + \beta_4 MAST_i \\ & + \beta_5 ECONOMET_{it} + \beta_6 MAJFORC_{it} + \beta_7 RESPONS_{it} \\ & + \beta_8 QTR4_t^t + \beta_9 ANNUAL_t^t + \beta_{10} QTR1_t^{t+1} + \beta_{11} QTR2_t^{t+1} \\ & + \beta_{12} QTR3_t^{t+1} + \beta_{13} QTR4_t^{t+1} + \beta_{14} ANNUAL_t^{t+1} + \beta_{83} YR1983_t \\ & + \beta_{84} YR1984_t \ldots \beta_{93} YR1993_t + \beta_{95} YR1995_t + \varepsilon_{it}, \end{aligned}$$

where subscript i refers to forecaster, subscript t refers to the survey year (1983–95), and ε_{it} is a stochastic error term. *GOVT* and *PRIV* are variables equal to 1 if the respondent is from the government or private sector, respectively, and 0 otherwise (default is a university employee). *EXPER* denotes the respondent's years of experience (survey year less year of terminal degree). *MAST* equals 1 if the forecaster has less than a Ph.D., and 0 otherwise (default is Ph.D.). *ECONOMET* equals 1 if the respondent indicated major or moderate use of formal econometric models in forecast construction, and 0 otherwise (default is minor or no use). *MAJFORC* equals 1 if forecasting was a major part of the forecaster's responsibility, and 0 otherwise (default is moderate or minor part). *RESPONS* equals 1 if the forecaster had a major forecasting responsibility in the commodity corresponding to the model, and 0 otherwise. *QTR*1 through *QTR*4 equal 1 if the forecast is for the quarter designated, and 0 otherwise. Similarly, *ANNUAL* denotes an annual forecast. Superscripts denote the year the forecast covers. For example, $QTR3_t^{t+1}$ equals 1 if the forecast made in survey year t is for the third quarter of year $t + 1$ (default is $QTR3_t^t$). YR19xx equals 1 if the survey year is 19xx, and 0 otherwise (default is YR1994).

Similar to the explanatory APE models for livestock, poultry, and milk forecasts, a supply/utilization APE model was constructed for each of the crops forecasted in the AOS surveys (wheat, corn, cotton, and soybeans):

$$(2) \qquad \begin{aligned} APE_{it} = {} & \beta_0 + \beta_1 GOVT_{it} + \beta_2 PRIV_{it} + \beta_3 EXPER_{it} + \beta_4 MAST_i \\ & + \beta_5 ECONOMET_{it} + \beta_6 MAJFORC_{it} + \beta_7 RESPONS_{it} \\ & + \beta_8 EXPORT_t + \beta_9 CARRYOUT_t + \beta_{83} YR1983_t \\ & + \beta_{84} YR1984_t \ldots \beta_{93} YR1993_t + \varepsilon_{it}, \end{aligned}$$

where subscript i refers to forecaster, subscript t refers to survey year (1983–94), and ε_{it} is a stochastic error term. Except for *EXPORT* and *CARRYOUT*, all explanatory variables in (2) are defined following (1). Production, exports, and carryout forecasting percentage errors for a crop were considered in the same model, with intercept shifting dummy variables serving to isolate production (the default) from exports (*EXPORT*) and carryout (*CARRYOUT*). Year dummies were included to capture unaccounted for changes in supply and demand (default is 1994). Market-year average price APE models were constructed for each of the crops as well:

$$(3) \qquad \begin{aligned} APE_{it} = {} & \beta_0 + \beta_1 GOVT_{it} + \beta_2 PRIV_{it} + \beta_3 EXPER_{it} + \beta_4 MAST_i \\ & + \beta_5 ECONOMET_{it} + \beta_6 MAJFORC_{it} + \beta_7 RESPONS_{it} \\ & + \beta_{83} YR1983_t + \beta_{84} YR1984_t \ldots \beta_{93} YR1993_t + \varepsilon_{it}, \end{aligned}$$

where all explanatory variables are as previously defined. Notice that (3) contains no exports and carryout dummy variables because only market-year average price forecasts are considered.

Results

Livestock, Poultry, and Milk

Using OLS, equation (1) was estimated independently for each livestock, poultry, and milk production and price series. To focus on the most relevant results, table 2 reports selected parameter estimates for regression models corresponding to beef and pork production forecasts, and slaughter steer, feeder steer, and barrow and gilt price forecasts. (Results for six models are not shown: production and prices for broilers, eggs, and milk.) Yearly dummy variable parameter estimates are not reported (results not tabulated are available from the authors). MAPE (mean absolute percentage error, the mean of the dependent variable) is reported at the bottom of the table, along with the number of observations used in the estimation, and model R^2. Standard errors were computed using White's heteroskedasticity-consistent covariance estimator.

The MAPEs in table 2 show that survey respondents are substantially less accurate in forecasting price than production. Of course, this could be because production tends to be less variable than price. Relative to university forecasters, government respondents

Table 2. Selected Coefficients in Absolute Percentage Error Models for Livestock Production and Price Forecasts, Survey Years 1983–95

	Production APE Models		Price APE Models		
Estimate	Beef	Pork	Slaughter Steers	Feeder Steers	Barrows and Gilts
Intercept	1.89**	3.42**	3.82**	9.10**	6.44**
	(0.20)	(0.30)	(0.47)	(0.90)	(1.11)
GOVT	0.57**	-0.91**	0.33	0.69	0.07
	(0.26)	(0.31)	(0.54)	(0.57)	(0.84)
PRIV	0.27*	0.38*	-0.13	-0.04	-0.16
	(0.15)	(0.21)	(0.34)	(0.46)	(0.59)
EXPER	-0.00	0.02**	0.01	-0.02	0.09**
	(0.00)	(0.01)	(0.12)	(0.01)	(0.02)
MAST	-0.22*	-0.20	0.16	-0.52	1.17**
	(0.12)	(0.17)	(0.28)	(0.36)	(0.51)
ECONOMET	-0.03	0.30*	0.24	0.16	0.01
	(0.11)	(0.16)	(0.27)	(0.31)	(0.43)
MAJFORC	-0.01	-0.64**	-0.38	-0.63**	-0.61
	(0.11)	(0.15)	(0.26)	(0.29)	(0.42)
RESPONS	-0.23**	-0.66**	-0.64**	-0.69*	-0.89*
	(0.11)	(0.18)	(0.27)	(0.39)	(0.50)
$QTR4^t$	0.13	-0.01	0.19	0.39	3.46**
	(0.17)	(0.25)	(0.38)	(0.48)	(0.73)
$ANNUAL^t$	-0.92**	-1.99**	-1.98**	-2.04**	-2.88**
	(0.14)	(0.20)	(0.34)	(0.42)	(0.51)
$QTR1^{t+1}$	0.39**	-0.45*	1.95**	3.43**	4.02**
	(0.19)	(0.25)	(0.38)	(0.61)	(0.69)
$QTR2^{t+1}$	1.52**	0.20	4.98**	3.37**	4.59**
	(0.21)	(0.28)	(0.51)	(0.57)	(0.74)
$QTR3^{t+1}$	0.63**	1.77**	4.94**	5.38**	6.41**
	(0.20)	(0.31)	(0.65)	(0.61)	(0.76)
$QTR4^{t+1}$	0.56**	1.69**	3.19**	5.20**	5.99**
	(0.20)	(0.32)	(0.46)	(0.67)	(0.98)
$ANNUAL^{t+1}$	0.15	-0.35	2.57**	3.65**	2.85**
	(0.17)	(0.23)	(0.40)	(0.53)	(0.64)
No. of Observ.	1,603	1,551	1,593	1,419	1,493
MAPE	2.57	3.62	5.89	7.77	9.52
R^2	0.25	0.27	0.39	0.31	0.25

Notes: Single and double asterisks (*) denote significance at the 0.10 and 0.05 levels, respectively. Standard errors (in parentheses) were computed using White's heteroskedasticity-consistent covariance estimator. Coefficients on year dummy variables are not reported.

are less accurate beef production forecasters but more accurate for pork production; private forecasters are less accurate for both beef and pork production. Experience does not appear to improve forecast accuracy. In fact, for pork production and barrow and gilt prices, each year of additional experience diminishes accuracy by 0.02 and 0.09 APE, respectively. Non-Ph.D.s (*MAST*) are more accurate beef production forecasters but less accurate for barrow and gilt prices. Respondents who depend more on formal econometric models (*ECONOMET*) are less accurate pork production forecasters. However, in the six models not shown, *ECONOMET* was significantly negative in two (broiler production and egg prices) and positive in only one. Overall, there is little evidence suggesting increased use of econometric models enhances or diminishes forecasting accuracy for these series. Results are more clear for *MAJFORC* and *RESPONS*, where all table 2 estimates are negative and typically significant. That is, where forecasting is a major part of a respondent's job, and where the commodity forecasted is the responsibility of that respondent, accuracy is substantially increased. For example, relative to casual forecasters, full-time forecasters responsible for pork production have APEs that are 1.3 lower (*MAJFORC* + *RESPONS*), which is substantial considering that the pork production MAPE across all forecasters is only 3.62.

Relative to quarter 3 forecasts (the default), quarter 4 forecasts ($QTR4^t$) are typically less accurate, and $QTR1^{t+1}$ estimates tend to be larger than $QTR4^t$ estimates, implying diminished forecast accuracy as forecast horizon expands.[4] All $ANNUAL^t$ estimates in table 2 are statistically negative, implying current-year annual series are forecasted more accurately than current-year third quarter series. This is likely because (*a*) half the year is passed at the time forecasts are made, and (*b*) annual series have less intrinsic variability than do quarterly series.

MAPEs of EXT and COMP livestock forecast series are listed in table 3.[5] Where relevant, MAPEs from competing USDA and futures-based forecasts are included for comparison (naive accuracy is not reported). EXT forecasters forecasting at least one time period (respondents routinely provided forecasts for only certain quarters within a survey) for beef production number 75. Corresponding numbers for other production categories are pork 75, broilers 50, eggs 34, and milk 27. Corresponding numbers forecasting prices of slaughter steers are 74, feeder steers 66, barrows and gilts 73, broilers 38, eggs 29, and milk 24. Because surveys covered 13 years, only a small number of EXT forecasts were actually involved in constructing an individual year's representative EXT forecast (e.g., for beef production, the average number is 75/13 = 5.77).

With the exception of the simple sectional averages reported in table 3, each MAPE is supported by a maximum of 13 forecasts (one for each year). Some MAPEs are supported by fewer than 13 observations. For example, the $QTR1^{t+1}$ beef production comparison between EXT and COMP was supported by only 12 forecasts because in one year no EXT forecasters forecasted $QTR1^{t+1}$ beef production. Because of the small sample size (maximum of 13), only a few of the pairwise comparisons in table 3 are statistically different at the 0.10 level. Consequently, results in table 3 should be viewed with caution, and inferences about relative accuracy across forecasting groups should focus more on counts across several commodities rather than on differences in averages for individual commodities.

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[4] Caution must be observed when interpreting results from parameter estimates that are not significant. Nonetheless, across models, a preponderance of positive (negative) estimates lends some statistical support that true underlying effects are positive (negative). For example, considering table 2 results for $QTR4^t$ to be outcomes of independent binomial experiments, where values can be either > 0 or ≤ 0 at a probability of 0.5 each, the probability of observing no more than one negative estimate out of a total of five is 0.1875. This implies that the statement is made with a level of confidence of 0.8125. Across all 11 models (six not reported), 10 of 11 $QTR4^t$ estimates are positive, implying that "fourth quarter accuracy exceeds third quarter accuracy" can be stated at a confidence of nearly 1.

[5] To prevent the potential distortion from differing numbers of survey responses across years, an EXT MAPE is developed by first computing the MAPE across all EXT forecasts for a single survey year, and then averaging the yearly MAPEs. Intuitively, the reported 13-observation MAPE depicts the accuracy associated with following a representative forecaster for each of the 13 years.

Table 3. MAPEs for Competing Forecasts of Selected Livestock Series, Survey Years 1983–95

	PRODUCTION FORECAST SERIES						PRICE FORECAST SERIES										
	Beef			Pork			Slaughter Steers				Feeder Steers			Barrows and Gilts			
Forecast Period	EXT	USDA	COMP	EXT	USDA	COMP	EXT	USDA	COMP	Futures	EXT	COMP	Futures	EXT	USDA	COMP	Futures
QTR3^t	1.92	3.46		2.62	2.65		3.31	4.68						5.73	8.12		
QTR4^t	2.05*	3.69		2.86	2.49		4.19	4.47						9.29	11.54		
ANNUAL^t	1.19	1.83		1.32	1.26		1.80	2.33						3.27*	5.21		
Average	1.72	2.99		2.27	2.13		3.10	3.83						6.10	8.29		
QTR3^t							3.31			6.11	4.31		4.00	5.73			4.42
QTR4^t							3.90*			7.04	4.56		4.64	9.01			7.68
ANNUAL^t							1.80			2.88	2.52		2.01	3.27			2.55
QTR1^{t+1}							5.55			7.79	7.65		8.52	10.53			7.15*
QTR2^{t+1}							8.97			10.27	8.68		8.43	9.80*			13.05
Average							4.71			6.82	5.54		5.52	7.67			6.97
QTR3^t	1.92		1.85	2.62*		3.10	3.31		3.31		4.31	4.56		5.73		6.05	
QTR4^t	2.10		1.88	2.96		3.08	3.90		3.48		4.56	4.89		9.01		9.73	
ANNUAL^t	1.19		1.00	1.32		1.52	1.80		1.77		2.52	2.79		3.27		3.43	
QTR1^{t+1}	2.60		2.38	3.14		2.18*	5.55		5.20		7.65	7.61		10.53		10.12	
QTR2^{t+1}	3.63		3.53	3.35		3.42	8.97		7.73*		8.68	8.45		9.80		10.48	
ANNUAL^{t+1}	2.27		1.90	3.20		2.59	6.55		5.91		8.77	8.92		8.58		8.23	
Average	2.28		2.09	2.77		2.65	5.01		4.57		6.08	6.20		7.82		8.01	
QTR3^t		3.46	1.85		2.65	3.10		4.68	3.31						8.12	6.05	
QTR4^t		3.69	1.83*		2.49	2.75		4.47	3.68						11.54	9.84	
ANNUAL^t		1.83	1.00*		1.26	1.52		2.33	1.77						5.21	3.43*	
Average		2.99	1.56		2.13	2.46		3.83	2.92						8.29	6.44	
QTR3^t									3.31	6.11		4.56	4.00			6.05	4.42
QTR4^t									3.48*	7.04		4.89	4.64			9.73	7.68
ANNUAL^t									1.77	2.88		2.79	2.01			3.43	2.55
QTR1^{t+1}									5.20	7.79		7.61	8.52			10.12	7.15
QTR2^{t+1}									7.73	10.27		8.45	8.43			10.48	13.05
Average									4.30	6.82		5.66	5.52			7.96	6.97

Notes: MAPEs statistically smaller than competitor's denoted by an asterisk (significant at the 0.10 level, paired t-test). Averages are simple sectional columnar averages and are not statistically compared.

In table 3, there are 12 EXT/USDA competitions ($QTR3^t$, $QTR4^t$, and $ANNUAL^t$ for each of beef production, pork production, slaughter steer prices, and barrow and gilt prices). EXT values were smaller than USDA values in 10 of the competitions. If the competitions can be treated as independent binomial experiments with equal probability of EXT or COMP winning, the probability of finding EXT < USDA in at least 10 of 12 competitions is only around 0.02. This suggests that extension forecasters may be more accurate than USDA across the series examined. That is encouraging for extension forecasters, especially considering that the USDA is privy to substantial nonpublic information and that its forecasters specialize in particular commodities. However, although not shown, when broiler production and broiler price series are included in the analysis (eggs and milk lacked sufficient observations), EXT < USDA in only 10 of 18 total competitions. This should not be surprising given that extension is not typically known for its forecasting of broiler series.

In table 3, EXT won eight of 15 EXT/futures competitions, suggesting EXT is not typically more or less accurate than futures. It does appear that EXT may be more accurate than futures in slaughter steer price forecasting and less accurate in barrow and gilt price forecasting. Futures-derived forecasts could provide inexpensive substitutes for extension forecasts.

In EXT/COMP comparisons in table 3, COMP won 24 of 30 competitions. This is surprising since COMP includes forecasts from more casual forecasters, and the series involved are those often covered by extension outlook. This finding suggests that the composite forecast coming from the AOS may have considerable value relative to following a random extension forecaster. Forecast users who are not sure which extension forecaster is most accurate may be better off requesting the AOS composite forecast. Casual forecasters may garner substantial gains in accuracy by making the COMP forecasts their own. Further, COMP < USDA in nine of 12 competitions, and COMP < futures in seven of 15, suggesting that the composite forecast fares reasonably well against the USDA and is not particularly poor relative to forecasts derived from futures.

Supply, Utilization, and Market-Year Average Price for Crops

The OLS-estimated results for the supply/utilization APE models depicted by (2), and the market-year average price APE models depicted by (3) are reported in table 4. To focus on the most relevant results, only wheat, corn, and soybean models are reported, and year dummy variable coefficients are not tabulated. The MAPEs indicate that the market-year price forecasts for a crop are more accurate than the supply/utilization forecasts for the same crop. This could be because exports and carryout are especially difficult to forecast (in an absolute percentage error framework). *CARRYOUT* is associated with larger APEs than *EXPORT*, and both are forecasted substantially less accurately than production (the default).

In table 4, although only two are significant, eight of the 12 estimates in the *GOVT* and *PRIV* rows are negative, indicating that government and private AOS forecasters appear to have an edge over university forecasters in crop supply/utilization and price forecasting. As with the livestock results reported in table 2, experience does not appear to enhance forecasting accuracy for these crop series. With five of six estimates positive,

Table 4. Selected Coefficients in Absolute Percentage Error Models for Supply/Utilization and Market-Year Average Price Forecasts, Survey Years 1983–94

	Supply/Utilization APE Models			Market-Year Average Price APE Models		
Estimate	Wheat	Corn	Soybeans	Wheat	Corn	Soybeans
Intercept	4.73*	1.70	2.74	11.33**	4.41**	2.97**
	(2.61)	(4.69)	(2.66)	(1.44)	(1.19)	(1.00)
GOVT	-2.20	-2.08	1.06	-1.53	-1.04	0.87
	(2.05)	(5.05)	(1.84)	(1.19)	(1.68)	(1.08)
PRIV	-2.46*	0.13	-0.40	0.54	-1.43	-1.75**
	(1.43)	(3.27)	(1.65)	(0.93)	(0.90)	(0.85)
EXPER	0.05	0.09	0.06	0.02	-0.00	-0.00
	(0.05)	(0.09)	(0.06)	(0.06)	(0.04)	(0.03)
MAST	3.56**	-0.07	0.81	0.88	3.00**	0.82
	(1.70)	(3.03)	(1.45)	(0.88)	(1.14)	(1.09)
ECONOMET	-0.18	1.27	-2.50*	-2.12**	-0.73	0.54
	(1.08)	(3.07)	(1.45)	(0.82)	(0.74)	(0.80)
MAJFORC	-1.69	-2.10	0.37	0.70	-0.54	-0.37
	(1.12)	(2.97)	(1.37)	(0.71)	(0.79)	(0.73)
RESPONS	0.21	0.30	1.57	-0.97	-0.35	-0.04
	(1.12)	(2.59)	(1.46)	(0.80)	(0.72)	(0.74)
EXPORT	9.84**	7.82**	8.48**	—	—	—
	(0.95)	(2.01)	(0.92)			
CARRYOUT	14.98**	35.04**	23.19**	—	—	—
	(1.16)	(2.65)	(1.65)			
No. of Observ.	536	586	581	196	218	206
MAPE	11.74	24.95	18.03	6.71	10.52	9.69
R^2	0.41	0.52	0.49	0.55	0.58	0.63

Notes: Single and double asterisks (*) denote significance at the 0.10 and 0.05 levels, respectively. Standard errors (in parentheses) were computed using White's heteroskedasticity-consistent covariance estimator. Coefficients on year dummy variables are not reported.

and two significantly so, non-Ph.D.s (*MAST*) generally forecast less accurately than do Ph.D.s. With four of six *ECONOMET* estimates negative (five of seven if cotton models are included), and two significantly so, the case for econometric modeling improving forecast accuracy appears slightly stronger for the crop series than it did for the livestock series reported in table 2. However, it is not a strong case, and across crop and livestock series (tables 2 and 4), little can be established regarding the influence of econometric modeling on forecast accuracy. In contrast to the livestock series, negative *MAJFORC* and *RESPONS* estimates did not dominate in the crop series, which is an unexpected result. That is, those whose jobs are dominated by forecasting and who have responsibilities for specific commodities are not particularly more accurate forecasters than those who are more casual forecasters.

MAPEs for the crop forecasting competitions are reported in table 5 (naive accuracy is not reported). Survey numbers corresponding to EXT forecasters of at least one of the crop categories (production, exports, carryout, or market-year average price) are wheat 75, corn 79, soybeans 80, and cotton 25. As with the livestock series, only a small

Table 5. MAPEs for Competing Forecasts of Selected Supply/Utilization and Market-YearAverage Price Series, Survey Years 1983–94

	FORECAST SERIES											
	Production			Exports			Carryout			Market-Year Average Price		
Crop	EXT	USDA	COMP	EXT	USDA	COMP	EXT	USDA	COMP	EXT	USDA	COMP
Wheat	3.37	3.38		11.84	10.09		17.48	16.73		6.05	5.89	
Corn	8.96*	10.76		17.29	15.98*		39.25	43.00		9.72	10.70	
Soybeans	6.31	7.10		14.81	14.83		23.78	28.90		9.02	7.67	
Average	6.22	7.08		14.65	13.63		26.83	29.55		8.26	8.08	
Wheat	3.37		3.25	11.84		10.33*	17.48		16.05	6.05		5.59
Corn	8.96		9.92	17.29		17.11	39.25		39.95	9.72		9.52
Soybeans	6.31		6.41	14.81		13.74*	23.78		25.65	9.02		7.80
Average	6.22		6.53	14.65		13.73	26.83		27.21	8.26		7.64
Wheat		3.38	3.25		10.09	10.33		16.73	16.05		5.89	5.59
Corn		10.76	9.92		15.98	17.11		43.00	39.95		10.70	9.52
Soybeans		7.10	6.41		14.83	13.74		28.90	25.65*		7.67	7.80
Average		7.08	6.53		13.63	13.73		29.55	27.21		8.08	7.64

Notes: MAPEs statistically smaller than competitor's denoted by an asterisk (significant at the 0.10 level, paired *t*-test). Averages are simple sectional columnar averages and are not statistically compared. Last market year with full information is 1994.

number of EXT forecasts were actually involved in constructing an individual year's representative EXT forecast. Here, the maximum number of forecasts supporting a MAPE value in table 5 is 12. Consequently, few pairwise competitions are associated with statistically significant differences.

Whereas EXT was shown to be somewhat more accurate than USDA for livestock forecasts (table 3), in crops (table 5) EXT won seven of 12 competitions with USDA, or eight of 15 if cotton is included (USDA does not make cotton price forecasts). So, extension's superiority to USDA cannot be asserted for crops—meaning that extension adds little value, in terms of accuracy, to USDA forecasts. However, extension is not generally worse than USDA either. In EXT/COMP comparisons, COMP won eight of 12 competitions (10 of 16 if cotton is included). As in the livestock competitions, this suggests that the AOS composite series may have considerable value relative to following a random extension forecaster. Also similar to the livestock competitions, COMP won nine of 12 (12 of 15, including cotton) COMP/USDA competitions, indicating that the composite AOS forecast fares quite well relative to USDA.

Conclusions and Implications

Extension economists have invested considerable resources in forecasting prices. Brorsen and Irwin argue that "extension should move away from predicting prices" (p. 73). They contend that market advisory consultants are better equipped to provide market information and price projections to producers in the timely manner needed. Results presented here provide additional dimensions to this discussion: first by examining determinants of forecast accuracy, second by comparing the accuracy of representative extension forecasters with that of the USDA and futures, and third by examining the accuracy of composite forecasts constructed from those provided by respondents to AAEA's Annual Outlook Survey. A broad cross-section of livestock and crop production and price series was examined in this study, which serves to enhance generalizations derived.

Through models of forecast accuracy, the following generalizations emerged. First, experience does not appear to improve forecast accuracy. Second, government and private forecasters are neither more nor less accurate than university forecasters for livestock series, but appear to have some comparative advantage over university forecasters in forecasting crop series. Third, at the best, Ph.D. forecasters are only marginally more accurate than those without Ph.D.s. Fourth, there is little evidence that increased use of formal econometric models enhances forecast accuracy. Fifth, those who consider forecasting to be a major part of their job descriptions, and who are responsible for specific commodities, are typically more accurate forecasters of livestock series than are more casual forecasters, but not particularly more accurate in forecasting crop series.

Extension economists who perceive demand for their forecasting services are generally just as well off using USDA's crop forecasts. That is, forecasts of supply/utilization and market-year average prices of crops, developed by representative university-based forecasters who spend substantial time forecasting specific commodities, are not typically more accurate than USDA forecasts of the same crop series. However, the same is not true for livestock forecasts. In that arena, extension appears to have an edge over USDA in terms of accuracy, and should not merely adopt USDA's forecasts as their own. In livestock, extension price forecasts are not generally more accurate than futures-derived forecasts. However, there is a tendency for extension to forecast more accurately than futures for slaughter steer prices, and futures to be more accurate for barrow and gilt prices.

Previous research has established that combining forecasts from several sources generally improves forecast accuracy. Here, a composite (average) forecast developed from those provided by individual respondents to AAEA's Annual Outlook Survey is typically more accurate than a comparable representative extension forecast, even though the composite includes forecasts of both full-time forecasters and more casual forecasters (those who may view the AAEA competition as only a friendly competition in which they participate for its entertainment value). Also, the composite forecasts are often more accurate than USDA forecasts. Because the composite forecasts are provided to survey respondents each year, they provide readily available series that could be adopted by both extension and industry practitioners.

In general, where extension cannot commit sufficient resources to developing a forecasting program, several options are available. First, especially for crops, USDA forecasts can provide reasonable substitutes for direct extension-developed forecasts. For livestock, however, the insufficiently funded extension forecaster would be better advised to consult with an extension forecaster who may have more commitment to forecasting as a job and to specific commodities. Also, using futures-based livestock forecasts, especially for feeder cattle and barrow and gilt prices, would be a suitable option for the insufficiently funded extension forecaster. Finally, the value of AAEA's Annual Outlook Survey could be increased if greater effort were focused on disseminating its composite forecasts. Where applicable, those forecasts are inexpensive and typically more accurate than either extension or USDA.

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