Journal of Agribusiness 22,2 (Fall 2004):119–131

The Value of Public Price Forecasts: Additional Evidence in the Live Hog Market

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USDA and Cooperative Extension Service forecasts of hog prices are directly tested for incremental value vis-à-vis futures-based forecasts in a forecast encompassing framework. At horizons less than six months, the lean hog futures-based forecast is found to be more accurate than both the USDA and Extension Service forecasts, and the difference in forecasting performance is statistically significant. Not only are the agency forecasts less accurate, but neither the USDA nor the Extension Service forecasts add incremental information relative to the futures forecast. The results suggest that extension forecasters may want to refocus forecasting efforts on basis relationships, longer forecast horizons, or commodities without active futures markets.

Key Words: forecast encompassing, hog prices, public forecasts

The purpose of price forecasting and marketing research is to improve resource allocation, and thereby social welfare (Freebairn, 1978; Stein, 1981). However, there is considerable debate related to the effectiveness, and ultimately the value, of publicly generated forecasts such as those provided by the USDA or those developed by university marketing and extension economists. For instance, Brorsen and Irwin (1996) argue there is little evidence that the agricultural economics profession has excelled in the forecasting arena. They propose that extension economists can improve the relevance of their forecasts by moving away from predicting prices. Zulauf and Irwin (1998) echo this advice and specifically suggest that producers focus on controlling costs—not predicting prices—to increase returns. Likewise, Kastens, Jones, and Schroeder (1998) advocate the use of futures-based forecasts for agribusiness firms. Accordingly, Kansas State University's Cooperative Extension Service has moved away from predicting prices and now issues futures-based forecasts in its monthly "Livestock Market Update" (Mintert, 2001).

Despite this criticism, many extension programs still publish price forecasts (e.g., Grimes and Plain, 2003) and advocate marketing strategies that may increase grower returns (Wisner, Blue, and Baldwin, 1998). Indeed, the "marketing and risk analysis

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of agricultural firms," which presumably includes a forecasting component, continues to rate as a high priority among both agricultural economists and agribusiness participants (Ahearn et al., 1998, p. 339). In this vein, the University of Illinois, in combination with Purdue University, produces market and outlook information which "provides producers with objective up-to-date market information, analysis, outlook and other references to assist in making marketing decisions" (Farm Decision Outreach Central, 2003). Likewise, public agencies such as the USDA's World Agricultural Outlook Board provide forecasts developed to assist producers, agribusinesses, and financial institutions in making production, marketing, and lending decisions (USDA/National Agricultural Statistics Service, 2001). Clearly there is some disagreement as to whether or not price forecasting is a useful allocation of public funds, especially for commodities with active futures markets (Brorsen and Irwin, 1996).

Given this active debate, our research seeks to provide additional information regarding the value of publicly available forecasts. Specifically, this study examines the marginal value of USDA and University of Illinois/Purdue University Cooperative Extension Service (CES) forecasts relative to those obtained from the futures market for live hog prices. Unlike previous research (Kastens, Jones, and Schroeder, 1998; Irwin, Gerlow, and Liu, 1994; Kastens, Schroeder, and Plain, 1998), the focus here is not on absolute forecast accuracy per se. While smaller forecast errors are important, predictive accuracy may not be the best measure for evaluating public forecasts. As pointed out by Harvey, Leybourne, and Newbold (1998), a forecast can produce a larger mean squared prediction error, but still provide incremental information to the decision maker. Thus, it is important for the assessment of public forecasts to consider their incremental value, if any, and not rely solely on comparisons of predictive accuracy. A preferred forecast is said to encompass another forecast if it contains all the information in the competing predictor (Harvey, Leybourne, and Newbold, 1998). Therefore, a more appropriate test for the value of a public forecast is whether or not it is encompassed by other forecasts in the public domain. If it is not, then the forecast does provide incremental forecasting value to decision makers.

This research extends the current state of knowledge regarding the value of publicly available forecasts in several ways. First, as suggested by Irwin, Gerlow, and Liu (1994), three sources of price forecasts for live hogs are examined—those produced by the USDA, Extension Service experts, and the futures market (a market-based forecast). Second, longer forecast horizons are used (up to one year) as well as a relatively new cash settled futures contract (lean hogs). Third, and most important, this research incorporates methods that go beyond the examination of forecast accuracy, and utilizes the encompassing technique of Harvey, Leybourne, and Newbold (1998) to explicitly test for incremental forecast value of the three forecasts (USDA, CES, and futures). Finally, careful consideration is given to the ramifications of the results for forecasting in general, and extension forecasters in particular.

Methodology

Measures of predictive accuracy, such as mean squared error, are typically used in assessing the value of public forecasts, and have been used in prior research examining forecasts of hog prices. For example, Kastens, Jones, and Schroeder (1998) found that futures-based live hog forecasts have smaller mean absolute percentage errors than naïve methods, such as the five-year average, at forecast horizons up to 11 months. Likewise, Irwin, Gerlow, and Liu (1994) did not find a statistically significant difference in mean squared prediction errors between USDA live hog forecasts and futures-based forecasts at one- and two-quarter horizons. Further, in their examination of forecasts made in the *Annual Outlook Survey* conducted by the American Agricultural Economics Association, Kastens, Schroeder, and Plain (1998), using pair-wise t-tests, concluded extension forecasts are not typically more or less accurate than those based on futures quotes. Other researchers (e.g., Bessler and Brandt, 1992) have also reported that expert predictions are not more accurate than those found in the livestock futures markets. Although these studies are different in terms of research design, they share one common methodology: the pair-wise comparison of prediction errors.

Therefore, as a first step in assessing the value of USDA, CES, and futures forecasts, forecast accuracy is assessed. The primary statistical test used is a modification of Diebold and Mariano's (1995) test for predictive accuracy. Harvey, Leybourne, and Newbold (1997) modified Diebold and Mariano's test to improve its size properties in moderately large samples when comparing forecast accuracy. This test is referred to as the Modified Diebold-Mariano (MDM) test.

Given two time series of h-step-ahead forecast errors (e_{1t}, e_{2t}), for $t = 1, ..., n$, and a specified loss function $g(e)$, the null hypothesis of equal expected forecast performance is $E[g(e_{1t}) - g(e_{2t})] = 0$. For h-step-ahead forecasts, the MDM test is based on the sample mean ($\bar{d}$) of $d_t = g(e_{1t}) - g(e_{2t})$ with appropriate adjustments for $h - 1$ autocorrelation. Specifically,

$$\text{(1)} \qquad MDM = \left[\frac{n + 1 - 2h + n^{-1}h(h-1)}{n}\right]\left[n^{-1}\left(\hat{\gamma}_0 + 2\sum_{k=1}^{h-1}\hat{\gamma}_k\right)\right]^{-1/2}\bar{d},$$

where

$$\hat{\gamma}_k = n^{-1}\sum_{t=k+1}^{n}(d_t - \bar{d})(d_{t-k} - \bar{d})$$

is the estimated kth autocovariance of d_t, and $\bar{d}$ is the sample mean of d_t. The MDM statistic is compared with the critical values from a t-distribution with $n - 1$ degrees of freedom. Harvey, Leybourne, and Newbold's (1997) modifications to the original Diebold-Mariano statistic make it more robust in the presence of nonnormal errors, and the authors deem it the preferred test for differences in forecast accuracy measures. Based on this feature, the MDM test is used to statistically test for differences in forecast accuracy.

However, as discussed earlier, lack of forecast accuracy alone is not a sufficient reason to discard a forecast. A large forecast error is permissible, if the forecast adds incremental value to other predictions. That is to say, the information in the forecast is not encompassed in existing forecasts. Harvey, Leybourne, and Newbold (1998) state that one forecast encompasses another if the inferior forecast's optimal weight in a composite predictor is zero—i.e., it provides no incremental information. With just two competing predictors, forecast encompassing can be tested with the regression-based model:

$$(2) \qquad e_{1t} = \alpha + \lambda(e_{1t} - e_{2t}) + \varepsilon_t,$$

where e_{1t} is the forecast error series of the preferred forecast, and e_{2t} is the forecast error series of a competing forecast. The null hypothesis, $\lambda = 0$, is that the covariance between e_{1t} and $(e_{1t} - e_{2t})$ is zero. Failure to reject the null hypothesis implies a composite forecast cannot be constructed from the two series which results in a smaller expected squared error than that of the preferred forecast; thus, the competing forecast provides no marginal information.

Harvey, Leybourne, and Newbold (1998) propose an extension of the MDM test developed in equation (1) for use in testing forecast encompassing. They state that the null hypothesis of $\lambda = 0$ in equation (2) is a test to determine if the covariance between e_{1t} and $(e_{1t} - e_{2t})$ is zero. This null hypothesis can be tested using the MDM statistic in equation (1) above by defining $d_t = e_{1t}(e_{1t} - e_{2t})$ and $\bar{d}$ as the sample mean of d_t. Based on simulation results, Harvey, Leybourne, and Newbold recommend this approach to test for forecast encompassing due to its good size and power properties. Thus, we utilize this method to discern the incremental value of the competing public forecasts for live hog prices.

Data

The USDA publishes quarterly price forecasts in its *World Agricultural Supply and Demand Estimates* (*WASDE*) reports. These reports are issued between the 8th and 14th of each month and contain a set of quarterly price forecasts for the ensuing four quarters, with the exception of the March report which includes only three-quarter-ahead forecasts. Forecasts are taken from the first report of each quarter (January, March, July, and October) for live hog prices in the first quarter of 1997 (1997.1) through the second quarter of 2003 (2003.2). The result is 26 forecasts that are one, two, and three quarters ahead, and 19 four-quarter-ahead forecasts.

Purdue University, in cooperation with the University of Illinois, publishes quarterly live hog price forecasts in its *Livestock Price Outlook*. These reports are usually issued in the first two weeks of the quarter—shortly before the corresponding *WASDE* reports. Price forecasts for one through four quarters ahead are collected for 1997.1 through 2003.2 to match up with the USDA forecasts.[1]

[1] During this time period, Chris Hurt of Purdue University authored the *Livestock Price Outlook.*

Starting with the February 1997 contract, the delivery settled live hog futures contract listed on the Chicago Mercantile Exchange was replaced by the cash settled lean hog futures contract. Consequently, March of 1996 is the first forecasting date for which the February 1997 lean hog contract is quoted (a four-quarter-ahead forecast). Subsequent forecasts from the lean hog futures contract are collected for quarters 1997.1 through 2003.2 and matched up with the USDA and CES forecasts, resulting in 26 ex ante forecasts.

Following a methodology similar to that of Irwin, Gerlow, and Liu (1994) futures-based forecasts are based on the contracts expiring during the quarter. The first-quarter forecast is derived from the February contract, the second-quarter forecast is the average of the April and June contracts, the third-quarter forecast is the average of the July and August contracts, and the fourth-quarter forecast is an average of the October and December contracts.[2] The forecasting dates are the day prior to the morning release of the January, April, July, and October *WASDE* reports.[3]

The futures-based lean hog forecast is converted to a quarterly average live hog price based on the historical ratio between the cash lean hog index and the quarterly average price used by the CES.[4] As suggested by Kastens, Jones, and Schroeder (1998), the method is kept simple. The ratio for each quarter is estimated using historical data from 1996.1 (the first quarter for which the cash lean hog index is available) up to the forecasting date.[5] The estimated ratio is then applied to the lean hog futures price to arrive at a live hog forecast.

Hog prices often demonstrate seasonal patterns due to natural fluctuations in production. For instance, live hog prices tend to be lowest in the fourth quarter when production is at its highest. Therefore, the analysis focuses on seasonal price differences defined as the log-relative price change from the same quarter of the prior year. In this framework, A_t is defined as the actual price level in quarter t, and F_t is the price forecast for quarter t. The change in actual prices is defined as $AP_t = \ln(A_t/A_{t-4})$, and the forecasted price change is written as $FP_t = \ln(F_t/A_{t-4})$. Thus, changes reflect the percentage change in the quarterly average price from the prior year. This procedure is consistent with the approach used by most industry analysts (Hurt, 2000; Kastens, Schroeder, and Plain, 1998).

[2] A May contract was listed in 2002. However, because it is not available for the full sample, it was not used in compiling the second-quarter forecasts.

[3] Special consideration is given to the forecast dates so that the forecasters have access to the same information set. The futures forecast is pulled from the day prior to the *WASDE* release, and the CES forecasts are generally released a few days prior to the *WASDE* reports. Therefore, no forecast has an advantage from a time perspective.

[4] Note, there is a slight difference between reference markets used by the CES and USDA. The CES uses the six-market average barrow and gilt price. The USDA uses the Iowa/S. Minnesota No. 1–3, from 1997.3–1999.1; Iowa/S. Minnesota live equivalent, 51–52% lean from 1999.2–1999.4; and the National Base live equivalent, 51–52% lean from 2001.1–2003.2. Despite the differences in the underlying market, the correlation between seasonal differences in the price series is 0.994. So, although we assume the forecasts are for the CES series, this choice is unlikely to materially impact the results.

[5] The quarterly ratio is calculated using the underlying cash lean hog index during the months with futures expirations. Furthermore, the historical underlying price index is pulled from the tenth business day of each month—the day the futures cash settle to the index. This methodology most accurately replicates the conversion of the lean hog futures quotes to a forecast of the quarterly average live hog price.

Results

Forecasting results are first examined using traditional measures of predictive accuracy: root mean squared error, mean absolute error, and Theil's U. Then, the MDM test in equation (1) is used to determine if there is a statistically significant difference in predictive accuracy among the alternative forecasts. Finally, the incremental value of the forecasts is assessed using the MDM test for forecast encompassing.

Predictive Accuracy

The traditional forecast accuracy measures of root mean squared error (RMSE), mean absolute error (MAE), and Theil's U are reported for each forecast and each forecast horizon in table 1. Based on the RMSE measure (panel A), the futures-based forecasts have the smallest prediction error at all forecast horizons. For example, at one quarter ahead, the futures forecasts produce an RMSE of 10.40%, while the USDA and CES record an RMSE of 13.60% and 14.24%, respectively. Interestingly, the USDA records a smaller RMSE than the CES forecast at all but the four-quarter horizon. The results for the MAE (panel B) are comparable to those using the RMSE—i.e., the futures-based forecasts are the most accurate at all horizons. However, the CES forecasts produce a smaller MAE than the USDA at the one- as well as the four-quarter horizons.

Theil's U normalizes forecast errors by the volatility of the underlying series, with a lower bound of zero for perfect forecasts and a value of one for naïve "no change" forecasts (Leuthold, 1975). As expected, all of the forecasts provide performance superior to a "no change" naïve alternative (table 1, panel C). For horizons one through three quarters ahead, the futures forecasts provide the best performance, followed in order by the USDA and CES forecasts. However, at the four-quarter horizon, the USDA has the lowest Theil's U, followed by the futures and then the CES forecasts. Overall, the casual comparisons of these forecast accuracy measures suggest that the futures-based forecasts are generally the most accurate. However, it is important to test if these differences in forecast accuracy are indeed statistically significant.

The statistical difference in forecast accuracy is tested with the MDM test in equation (1) using a mean squared error (MSE) loss function, $d_t = e_{1t}^2 - e_{2t}^2$. The results are presented in table 2. For one-quarter-ahead forecasts (panel A), the futures-based forecast's MSE is statistically smaller than that of both the USDA and CES forecasts at the 10% level. In contrast, there is not a statistically significant difference between the USDA and CES forecasts in terms of forecast accuracy (p-value = 0.7981). The two-quarter-ahead results (panel B) are similar to those for the one-quarter-ahead forecasts, with a statistically significant difference in forecast accuracy of the futures forecasts relative to the USDA and CES forecasts (10% level). Moreover, the null hypothesis of equal mean squared errors cannot be rejected between the USDA and CES forecasts at the two-quarter-ahead horizon.

Table 1. Forecast Accuracy Measures of Futures-Based, USDA, and Cooperative Extension Service (CES) Forecasts for Live Hog Prices (1997.1–2003.2)

PANEL A. Root Mean Squared Error (RMSE)			
Forecast Horizon	Futures	USDA	CES
One Quarter	10.40	13.60	14.24
Two Quarters	16.85	19.72	21.20
Three Quarters	20.65	21.75	22.21
Four Quarters	22.19	25.35	23.76
PANEL B. Mean Absolute Error (MAE)			
Forecast Horizon	Futures	USDA	CES
One Quarter	7.10	10.18	9.63
Two Quarters	12.49	14.27	15.43
Three Quarters	14.43	15.76	15.80
Four Quarters	15.75	19.11	17.95
PANEL C. Theil's U			
Forecast Horizon	Futures	USDA	CES
One Quarter	0.338	0.441	0.463
Two Quarters	0.548	0.642	0.690
Three Quarters	0.672	0.708	0.722
Four Quarters	0.722	0.705	0.773

Sources: The source for the futures-based forecasts is the Chicago Mercantile Exchange. For the USDA forecasts, the source is the *World Agricultural Supply and Demand Estimates* (*WASDE*). The Cooperative Extension Service forecasts are from the *Livestock Price Outlook* published by Purdue University and the University of Illinois.

Notes: The number of forecast error observations for the one-, two-, and three-quarters-ahead forecasts is 26, and 19 for the four-quarter-ahead forecasts. The units of measure for RMSE and MAE are percentages. For example, the RMSE for USDA one-quarter-ahead forecasts (panel A) is 13.60%.

The distinction in forecasting ability, however, generally dissipates at longer horizons. For three-quarter-ahead forecasts (table 2, panel C), only the futures and the CES forecast accuracy is significantly different at the 10% level. There is not a statistically significant difference between the futures and the USDA or the USDA and the CES forecasts. The distinction further blurs at four quarters ahead (panel D), where the null hypothesis of equal forecast accuracy is not rejected between any of the forecasts.

The forecast accuracy comparisons generally show that the futures-based forecast is more accurate than the USDA and CES forecasts, with statistically significant differences in forecast accuracy at the shorter horizons. Yet, this finding is not sufficient to dismiss the USDA and CES forecasts as having no value. More importantly, in order to truly discard these forecasts, they must not be adding any incremental information to the futures forecast. Similarly, given that there is not a statistically significant difference between the squared errors at the four-quarter horizon, this may lead to the conclusion that the forecasts are equally good (or bad)

Table 2. Modified Diebold-Mariano Test for Difference in Mean Squared Errors Between Live Hog Price Forecasts (1997.1–2003.2)

PANEL A. One-Quarter Horizon

	USDA	CES
Futures	0.0640	0.0704
USDA		0.7981

PANEL B. Two-Quarter Horizon

	USDA	CES
Futures	0.0669	0.0728
USDA		0.5659

PANEL C. Three-Quarter Horizon

	USDA	CES
Futures	0.5598	0.0727
USDA		0.8264

PANEL D. Four-Quarter Horizon

	USDA	CES
Futures	0.4463	0.4086
USDA		0.7014

Note: Numbers are *p*-values for null hypothesis of equal mean squared errors.

at this horizon. However, as we show in the following section, such an assumption ignores the marginal information included in the forecasts.

Incremental Value

A forecast may have a larger error variance than another forecast, but if it adds incremental information, then it is still a valuable forecast. The incremental value of the forecasts is tested using the MDM test in equation (1) applied to forecast encompassing [equation (2)], as suggested by Harvey, Leybourne, and Newbold (1998), with $d_t = e_{1t}(e_{1t} - e_{2t})$. Following Mills and Pepper (1999), forecast encompassing is tested between each forecast series in a pair-wise fashion. The null hypothesis is that the preferred forecast encompasses the information contained in the competing forecast. A rejection of the null suggests the competing forecast, in fact, adds incremental information or marginal forecasting value.

The encompassing results are presented in table 3. The top number is the *p*-value for the null hypothesis that the forecast in the row header (preferred forecast) encompasses the forecast in the column header (competing forecast), and the numbers in brackets represent the reverse order. For example, in panel A, the null that the one-quarter-ahead futures-based forecasts encompass the USDA forecasts cannot be rejected at the 10% level (*p*-value = 0.1545). However, the null hypothesis that the one-quarter-ahead USDA forecast contains all the information in the futures-based forecast is rejected at the 1% level (*p*-value = 0.0057). Therefore, we can conclude the USDA forecast adds no incremental value to the futures forecast at the one-quarter horizon. Moreover, the USDA forecast does not contain all the information impounded in the futures forecast. Similarly, the CES forecasts add no marginal information to the futures forecast at the one-quarter horizon (table 3, panel A). Like the USDA forecast, the CES forecast does not encompass the information in the lean hog futures. Furthermore, at this horizon, the MDM test cannot distinguish between the informational content in the USDA and CES forecasts—i.e., the test cannot

Table 3. Modified Diebold-Mariano Test for Forecast Encompassing (1997.1– 2003.2)

PANEL A. One-Quarter Horizon

	USDA	CES
Futures	0.1545 [0.0057]	0.1827 [0.0066]
USDA		0.1751 [0.1305]

PANEL B. Two-Quarter Horizon

	USDA	CES
Futures	0.2457 [0.0180]	0.1754 [0.0075]
USDA		0.3973 [0.2363]

PANEL C. Three-Quarter Horizon

	USDA	CES
Futures	0.3416 [0.1469]	0.3885 [0.0022]
USDA		0.3047 [0.1974]

PANEL D. Four-Quarter Horizon

	USDA	CES
Futures	0.4725 [0.1486]	0.3130 [0.0740]
USDA		0.1978 [0.1844]

Notes: The top numbers are *p*-values for the null hypothesis that the forecast in the row header (preferred forecast) encompasses the forecast in the column header (competing forecast). The numbers in brackets are *p*-values for the null hypothesis that the forecast in the column header (preferred forecast) encompasses the forecast in the row header (competing forecast).

reject that each one encompasses the other. Very similar results are found at the two-quarter horizon (panel B), where the USDA and CES forecasts do not add incremental information to the futures-based forecast. Also, the USDA and CES forecasts encompass the information contained in each other.

At the three- and four-quarter horizons, the USDA forecasts appear to be more on par with the futures-based forecast, whereas the CES forecasts still lack some of the informational content of the futures forecasts. For instance, at the three-quarter horizon (table 3, panel C), we fail to reject the null hypothesis that the futures forecast encompasses the USDA forecast, and vice versa. Yet, the CES forecast still does not contain all the information incorporated in the futures-based forecast (p-value = 0.0022). As with the other horizons, the test fails to distinguish between the USDA and CES three-quarter-ahead forecasts. In panel D, the results are again similar. Specifically, the null hypothesis that the CES forecast encompasses the futures-based forecast is rejected (p-value = 0.0740). It is important to note this result differs from the conclusion implied in the forecast accuracy comparisons (table 2, panel D). That is, although the MDM test for differences in MSE failed to reject the null of equal mean squared forecast errors, the MDM test for forecast encompassing rejects that the CES forecast contains all the information in the futures-based forecast. This finding suggests the futures-based forecast is a more complete forecast—in an informational sense—than the CES forecast at the four-quarter horizon. The MDM test for forecast encompassing fails to reject the null between the other four-quarter-ahead forecasts. Therefore, at this forecast horizon, there is no distinguishable difference in relative informational content.

Collectively, the empirical results strongly suggest the USDA and CES forecasts provide no incremental value to the forecasts derived from the lean hog futures market. The futures-based forecasts are characterized by a smaller RMSE at all horizons, and they have statistically smaller squared errors than both the USDA and CES forecasts at one- and two-quarter horizons. Similarly, at horizons less than three quarters, the USDA and CES forecasts do not contain all of the information in the futures-based forecasts. Furthermore, at no horizon do either the USDA or CES forecasts add value to the futures-based forecast. Therefore, we cannot reject that the futures forecast encompasses the USDA and CES forecasts at all horizons. At horizons greater than six months, it is more difficult to distinguish between the forecast accuracy. However, the CES forecasts do not appear to contain as much information vis-à-vis the futures market as the USDA forecasts. These results have important implications for forecasters and forecast users.

Summary and Discussion

This study has evaluated the accuracy and relative information content of three public live hog forecasts. Quarterly live hog forecasts made by the USDA and the CES are compared to those derived from the lean hog futures market. In contrast to prior research in this area, the forecast horizons examined here range from one to four quarters ahead. However, the biggest difference between the methods used in this study versus the techniques of previous studies is the focus on the marginal information value of the different forecasts. Specifically, we employ the forecast encompassing technique recommended by Harvey, Leybourne, and Newbold (1998) to test if agency forecasts provide any information beyond that impounded in the futures-based forecast.

The results clearly demonstrate that the futures-based forecast provides the most accurate and comprehensive forecasts at one- and two-quarter horizons. At longer horizons of three and four quarters ahead, the distinction between the competing forecasts blurs. In particular, at longer horizons, there is no statistically significant difference in futures market forecast accuracy and the accuracy of the USDA forecasts. Additionally, we cannot reject the null hypothesis that the USDA forecast contains all of the information in the futures-based forecast. In contrast, the CES forecasts are statistically less accurate than the futures-based forecast at three, but not four, quarters ahead. Furthermore, the CES forecast fails to encompass all the information in the futures forecast at all horizons. Head-to-head, there was not a statistically significant difference between the USDA and the CES forecasts in terms of accuracy or encompassing.

As suggested by these findings, forecasting ability, across all horizons, follows the ranking: futures, USDA, and CES. Most importantly, there is no evidence that the USDA or CES forecasts contain information not already aggregated into the futures price at any forecast horizon. Certainly at horizons shorter than three quarters, the futures-based forecast is statistically the most accurate and contains information not present in either the USDA or CES forecasts. At horizons greater than two quarters, the results indicate that the USDA and futures forecasts are comparable in accuracy and relative information content. However, the CES forecasts do not encompass all the information contained in the futures-based forecasts. In direct comparisons, the tests are unable to statistically distinguish between the USDA and CES forecasts in terms of accuracy or information. Yet, the USDA forecasts consistently outperform the CES forecasts relative to the futures-based forecasts. In short, there is no evidence that public forecasts made by the USDA or CES provide any marginal value relative to a futures-based forecast at horizons up to one year. In light of these findings, should public agencies such as the USDA and university extension services continue to provide price forecasts? If so, where should they focus their forecasting attention?

The evidence presented here confirms the results of Kastens, Jones, and Schroeder (1998) that a simple futures-based forecast may be the best alternative for agribusiness decision makers. However, it is not clear that USDA and extension economists should necessarily move away from predicting prices (Brorsen and Irwin, 1996). Although published forecasts themselves may not provide incremental forecasting information that would be useful in developing a composite forecast, the process by which these forecasts are derived and the accompanying market commentary may be quite useful to private forecasters. Private forecasters often read the market analysis provided by the USDA and extension experts, where the focus is not on the forecasts per se, but rather on the thought process and ideas behind the forecasts (personal interviews). The expertise and outlook provided in these commentaries may be impounded into private forecasts, thereby improving their quality in a nonsystematic way. Similarly, futures market participants may use information provided by these experts through media interviews and personal discussions to assist in their trading decisions. Hence, it is naturally the case that information provided by the USDA and extension experts would be reflected in the futures price.

Moreover, it is also important to remember a key mandate of the Extension Service: *education*. Indeed, useful extension programs can be developed around price forecasting and outlook activities. The true value of an extension program is its ability to help farmers and other constituents think about the fundamental supply and demand factors generating prices, not merely what prices are likely to be in the future.

Based on these arguments, there is a continuing role for public price forecasts. However, as suggested by Brorsen and Irwin (1996), as well as Tomek (1997), additional research and forecasting efforts may need to be focused toward certain areas. For instance, additional emphasis should be placed on forecasting basis relationships for those commodities with existing futures markets. Kastens, Jones, and Schroeder (1998, p. 306) recommend that forecasters would "do well to provide historical localized basis values … and simply add current deferred futures." However, as pointed out by Tomek (1997), they might do even better by modeling and forecasting basis levels. Liu et al. (1994), as well as Garcia and Sanders (1996), show that livestock basis contains a predictable component. Thus, if extension forecasters are going to rely on futures-based forecasts, then providing accurate basis forecasts certainly remains an area of useful research (Tomek, 1997).

Furthermore, producers and other agribusinesses may benefit from price forecasting for commodities without futures markets or other publicly available forecasts. Certainly, there are many important commodities for which futures markets do not (or no longer) exist, such as potatoes, durum wheat, boneless beef, poultry products, fruits, and vegetables. In these areas, where there are no futures market forecasts, market participants may benefit from well-devised public forecasts. This may be a particularly useful strategy for input markets (such as fertilizers) where the forecasts can help producers manage their costs (Brorsen and Irwin, 1996). Moreover, in those instances where there are futures markets—such as hogs—public forecasters should carefully explain their views and methods so they will provide the maximum value to private forecasters and other market participants.

Finally, the evidence suggests that futures-based forecasts are relatively weak at longer horizons (as are all forecasts). Hence, developing better forecasting models and procedures for longer horizons may prove useful. Indeed, if the public forecasting process is to add value, then the opportunities appear to be at horizons greater than six months. Overall, whether a public agency or a public market such as the futures market provides forecasts, the goal is to improve accuracy, which in turn improves resource allocation and increases social welfare (Freebairn, 1978; Stein, 1981).

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