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Three Decades of Evidence in Hog and Cattle Markets

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Outlook vs. Futures: Three Decades of Evidence in Hog and Cattle Markets

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Practitioner's Abstract

The purpose of this paper is to provide a comprehensive evaluation of the accuracy of outlook forecasts relative to futures prices in hog and cattle markets. Published forecasts from four prominent livestock outlook programs are available for analysis. Most of the series begin in the mid- to late-1970s and end in 2006. Root mean squared error (RMSE) comparisons indicate, with one exception, no meaningful differences in forecast accuracy between outlook forecasts and futures prices. The null hypothesis that futures prices encompass outlook forecasts is rejected in 9 of 11 cases for hogs and 7 of 8 cases for cattle, clearly indicating that outlook forecasts provide incremental information not contained in futures prices. The magnitude of decline in RMSE from combining outlook forecasts and futures prices is non-trivial in almost all cases. The reduction in RMSE for composite forecasts averages -6.3% and -9.0% in hogs and cattle, respectively. Overall, the results of this study provide compelling evidence of the substantial economic value of public outlook programs in cattle and hogs.

Key Words: cattle, encompassing, forecast, futures price, hogs, outlook, RMSE

Introduction

Price forecasting has long been an important part of agricultural economists' work. As one example, the USDA's annual Agricultural Outlook Forum has been held for over 80 years. The importance of price forecasting is not surprising given that agricultural prices are more volatile compared to prices in many other economic sectors (Tomek and Robinson 2003, p.4). Forecast (expected) prices directly affect the profitability of producers, processors, traders, and market participants in general, and therefore, are important determinants of resource allocation decisions and economic welfare.

A number of measures can be used to evaluate the performance of price forecasts issued by public outlook programs (e.g., Sanders and Manfredo 2003). When available for comparison, futures prices are considered the "gold standard" of performance evaluation. This is based on the logic of the efficient market hypothesis. Specifically, futures prices in an efficient market provide forecasts of subsequent spot prices that are at least as accurate as any other forecast (Tomek 1997). In other words, it should not be possible to "beat the market" in terms of forecast accuracy. A number of empirical studies compare the accuracy of outlook forecasts and futures prices (e.g., Just and Rausser 1981; Bessler and Brandt 1992; Irwin, Gerlow, and Liu 1994; Bowman and Husain 2004; Hoffman 2004; Sanders and Manfredo 2004 2005). With few exceptions, these studies find that outlook forecasts are no more accurate, and often less accurate, than comparable futures prices.

Taken at face value, the weight of the existing evidence indicates that outlook forecasts cannot beat futures prices in terms of forecasting accuracy. This raises serious questions about the performance and economic value of public outlook programs. McCloskey (1992, pp. 28-29) provides a colorful rendition of the argument against public programs:

> An economist who claims to know what is going to happen to the price of corn is claiming to know how to make money. Many models printed for free in the journals of agricultural economics imply knowledge of the price of corn. With a little borrowing on the equity of his home or his reputation for sobriety, the agricultural economist can make enormous sums. If an agricultural economist could forecast the price of corn better than the futures markets, he would be rich. Yet he does not put his money where his mouth is. He is not rich. It follows that he is not so smart.

In short, outlook price forecasts are redundant because futures markets provide fully efficient forecasts. The harsh implication for public outlook programs is that resources should be re-allocated towards program areas with positive economic benefits.[1]

There are two important reasons for treating the existing evidence about the performance of outlook forecasts relative to future prices with some degree of caution. First, statistical tests in previous studies generally have low power to reject a null of no difference in accuracy because of small sample sizes. Ashley (2003) shows that at least 100 observations are typically needed in order for a 20% reduction in mean square error (MSE) to be statistically significant at the 5% level. Second, it is possible for futures prices to have a smaller MSE than outlook forecasts but still not entirely "encompass" the information contained in outlook forecasts (Sanders and Manfredo 2005). Encompassing tests establish whether a given forecast is conditionally efficient in the sense that that alternative forecasts do not add incremental information to the forecast. Only two previous studies have applied encompassing tests to outlook and futures forecasts, finding mixed results (Sanders and Manfredo 2004, 2005).

The purpose of this paper is to provide a comprehensive evaluation of the accuracy of outlook forecasts relative to futures prices in hog and cattle markets. Published forecasts from four prominent livestock outlook programs are available for analysis: University of Illinois/Purdue University, Iowa State University, University of Missouri, and the Economic Research Service of the U.S. Department of Agriculture (USDA). One-, two- and up to three-quarter-ahead hog and cattle price forecasts are available for each program over the last three decades. Most of the series begin in the mid- to late-1970s and end in 2006. Two-thirds of the forecast series have 100 or more observations, providing by far the largest sample of outlook forecasts examined in the literature to date. Following the model developed by Hoffman (2005), live/lean hog and live cattle futures forecasts are constructed based on futures prices available on the day before and the day of release for outlook forecasts.

The first part of the analysis provides descriptive statistics on the forecast errors for each series. The second part presents a comparison of the root mean squared error (RMSE) from outlook and futures forecasts. The statistical significance of differences in RMSE is tested using the modified Diebold-Mariano test (Harvey, Leybourne, and Newbold 1997). The third part tests the conditional efficiency of outlook and futures forecasts using the encompassing test of Harvey, Leybourne, and Newbold (1998). Finally, unrestricted composite forecasts based on outlook and futures are computed and performance with respect to futures is analyzed. The combination of rigorous statistical tests and large sample sizes should provide powerful and definitive evidence on the performance of outlook forecasts relative to futures prices in hog and cattle markets.

This research will make a valuable contribution to the ongoing debate about the economic value of public situation and outlook programs (e.g,. Just 1983; Salin et al. 1998). The value of these programs has been debated for several reasons, including the growth of private firms that provide relatively low cost information and market analysis of the type traditionally provided by public programs and evolving priorities within the USDA and Land-Grant Colleges of Agriculture. In addition, the results will provide important new information about the efficiency of live/lean hog and live cattle futures markets.

Outlook Forecasts

Quarterly finished hog and fed cattle price forecasts from four prominent livestock outlook programs are available for analysis: University of Illinois/Purdue University, Iowa State University, University of Missouri, and the Economic Research Service of the USDA. Table 1 describes sample periods, missing observations, timing of release, cash prices, and publication sources for each outlook forecast series. With two exceptions, all of the forecasts are released on a quarterly basis. The first exception is the USDA, which switched from a quarterly to a monthly release schedule in 1992. Consequently, quarterly average price forecasts are updated once a month after 1991 instead of once a quarter. In order to maintain a consistent timing of USDA release schedules across the entire sample, only quarterly forecasts released during the same months pre- and post-1992 are considered. The second exception is Illinois/Purdue in cattle, where quarterly average price forecasts are released on a semi-annual basis.[2] The number of quarters and number of missing observations found in table 1 for Illinois/Purdue in cattle reflect an assumption of only two release quarters per year.

In hogs, the forecast series start in 1974, 1975, or 1979 and end in 2006. One-, two-, and three-quarter-ahead forecasts are available for all programs except the USDA, which is limited to one- and two-quarter ahead forecasts. Note that the number of quarters reported in table 1 reflects the full number of quarters within a given sample period. The number of missing observations must be subtracted from this figure in order to obtain the actual sample size. For instance, four observations are missing from the series of three-quarter-ahead hog price forecasts from Missouri. Subtracting four from the total number of quarters over 1974.II-2006.III (129) yields the correct sample size (125 = 129 - 4). The number of missing observations is quite small in hogs, with the exception of three-quarter-ahead forecasts for Missouri and two-quarter-ahead forecasts for the USDA. In both cases, about 20% of the observations are missing. Even with the missing observations, every forecast series in hogs contains at least 100 observations.

In cattle, the forecast series start in 1974, 1975, or 1987 and end in 1992, 1996, and 2006. Hence, there is more variation in the availability of data for cattle than hogs. One-, two-, and three-quarter-ahead price forecasts are available for Illinois/Purdue. One- and two-quarter ahead forecasts are available for Iowa and the USDA. Only one-quarter-ahead forecasts are available for Missouri.[3] Note that the cattle forecasts from Iowa and Missouri end in 1996 and 1992, respectively, because the forecasts are discontinued in those years.[4] The number of missing observations also is small in cattle, with the exception of two-quarter-ahead forecasts for Iowa, where over 40% of the observations are missing, and two-quarter-ahead forecasts for the USDA, where nearly 20% of the observations are missing. Sample sizes in cattle range much more widely than in hogs. The smallest sample size is 34 (Illinois/Purdue: three-quarters ahead) and the largest is 127 (USDA: one-quarter ahead). Five of the eight cattle price forecast series contain at least 50 observations and two contain over 100 observations.

Data on timing of release is critical in order to correctly match the release date of outlook forecasts to futures forecasts. A mismatch could create an informational advantage for either outlook or futures forecasts. Iowa, Missouri, and USDA outlook publications provide the exact release date. Illinois/Purdue outlook publications only report the month and year of publication. Additional information on timing of release is obtained from Chris Hurt of Purdue University, the current livestock outlook analyst responsible for the forecasts, and Darrel Good of the University of Illinois, the long-time editor of Illinois/Purdue outlook publications. These two individuals indicate that reports containing hog price forecasts generally are released five business days after the release of USDA Hogs and Pigs Reports, while cattle price forecasts are released five business days after the USDA January and July Cattle Reports. These rules are used to specify release dates for Illinois/Purdue outlook forecasts in hogs and cattle.

Some noticeable differences in the timing of release are observed for the different outlook programs. USDA hog price forecasts are, on average, released 43 days before the start of each quarter. In contrast, Illinois/Purdue, Iowa, and Missouri hog price forecasts are issued during the first two business weeks of each calendar quarter, usually following release of the USDA's quarterly Hogs and Pigs Report. Iowa, Missouri, and USDA cattle price forecasts are released on average 59, 57, and 43 days before the start of each quarter, while Illinois/Purdue forecasts are released much later, on average, 25 days after the start of the calendar quarter. These differences in timing of release do not affect outlook and futures forecast comparisons because release dates of outlook forecasts are matched to the dates of futures forecasts (see the next section). However, it is not strictly appropriate to compare forecast performance across outlook programs because the different release dates reflect different information sets. This is true even when the average release dates are the same or similar because release schedules are not constant through time.

Since each outlook program generally releases forecasts on different dates, a flexible definition of forecast horizons is needed to categorize forecasts into one-, two- and three-quarter ahead horizons. With the exception of Illinois/Purdue cattle price forecasts, predictions issued up to the first two business weeks of a given quarter are considered one-quarter-ahead price forecasts. A similar criterion is used to define two- and three-quarter ahead forecasts.

It is important to compare outlook forecasts to the correct cash price. As shown in table 1, the target cash price for each outlook program has not remained constant. The marketing structure of the U.S. livestock industry has evolved over time, and as consequence, the target cash price used by outlook forecasters has changed. In all cases, outlook price forecast errors are computed using the target cash price given in the outlook publication at the time the forecast is made.

Several additional points regarding the outlook forecast data should be noted. First, forecasts often are reported as ranges, typically \$4-5/cwt. Following previous researchers (e.g., Irwin, Gerlow, and Liu 1994; Sanders and Manfredo 2003 2005), point forecasts are generated as the mid-point of the reported forecast price range, which assumes that forecast prices within the reported range follow a symmetric distribution. Second, outlook price forecasts are not reported as ranges or point forecasts in a limited number of cases; instead they are given as qualitative statements like 'upper \$40s' or 'low \$70s.' A consistent set of rules is applied to map these statements into point forecasts (e.g., upper 40s = \$47.50/cwt.) Third, missing outlook forecast observations correspond to gaps in outlook publications rather than gaps in the collection of data. Fourth, missing observations generally are randomly distributed in the outlook forecast series, and thus, are not expected to bias performance comparisons.

Futures Model Forecasts

Live/lean hog and live cattle futures contracts do not expire each calendar month. The contracts also reflect a particular set of delivery markets (whether the contracts specify physical delivery or cash settlement). Consequently, a set of assumptions must be applied to convert the available array of live/lean hog and live cattle futures prices to a quarterly average cash price forecast comparable to outlook program forecasts. Several approaches have been used in previous comparisons of hog and cattle outlook forecasts to futures prices. Just and Rausser (1981) take an average of daily settlement prices from the second week of the mid-month of each calendar quarter. If a contract is not available for the mid-month, the next futures expiration month is applied. For hogs and cattle, the February contract is used for the first quarter, June for the second quarter, and August for the third quarter and December for the fourth quarter. No attempt is made to adjust futures price forecasts by an estimated basis, which could bias forecast comparisons against futures forecasts. Bessler and Brandt (1992) adopt a similar procedure for hogs and cattle whereby the February contract is used to determine the futures price forecast for the first quarter, an average of April and June contracts is used for the second quarter, the August contract is used for the third quarter and an average of the October and December contracts is used the fourth quarter. Again, a basis adjustment is not considered. Irwin, Gerlow, and Liu (1994) follow Bessler and Brandt's procedure with and without a basis adjustment. The estimated basis is a three-year moving average of the quarterly average of the daily difference between nearest-to-maturity futures prices and actual cash prices. A limitation of this basis adjustment procedure is that the computed basis does not exactly match the set of futures prices used to compute quarterly average futures forecasts.

Futures-based forecasts for this analysis are constructed following the model developed by Hoffman (2005). Hoffman's model is well-documented, used for over a decade at the USDA, and avoids the mismatching problem inherent in Irwin, Gerlow, and Liu's approach to basis adjustment. Table 2 provides two examples keyed to the release of USDA hog price forecasts on November 18, 2004 and February 15, 2005. In both cases, the construction of one-quarter-ahead price forecasts from lean hog futures is illustrated. Nearest-to-maturity contracts that do not expire in the target calendar month are first matched to each of the forecast months in a quarter. For example, the February 2005 contract is matched to January 2005 and the April 2005 contract is matched to February and March 2005 for the futures forecast computed on November 18, 2004.

Note that settlement futures prices in the examples presented in table 2 actually pertain to the day before release of the USDA outlook forecasts. Next, a simple average of the three futures prices is taken to represent the quarterly average futures price. The quarterly average futures price in these examples also must be converted from lean to live hog units in order to be comparable to outlook forecasts, which are reported in live weight terms.[5] A three-year moving average of historical basis levels is computed in the next step. Historical basis levels are computed on a daily basis using the mapping of futures contracts in the first step and the target cash price specified for the outlook forecast. The final step is to add the three-year average basis to the quarterly average futures price to obtain the futures model forecast.[6] Similar calculations are used to compute futures model forecasts for the second, third and fourth quarters.[7]

Two different futures forecasts are created for each outlook forecast release date. As outline above, the first is based on settlement prices from the day before each outlook forecast is released. The second is based on settlement prices from the day of release for each outlook forecast. Both futures forecasts are computed in order to test the sensitivity of forecast comparisons to the dating of futures forecasts and to allow for the possibility of an outlook announcement effect between the day before and the day of release. Test results are nearly identical for both sets of futures forecasts, and hence, only results based on settlement prices the day before the release of outlook reports are presented in the following sections.

Forecast Errors

Descriptive statistics on outlook and futures forecast errors for hogs and cattle are presented in Tables 3 and 4, respectively. At a given forecast horizon (one-, two-, or three-quarters ahead), forecast errors are computed as follows:

(1) $$e_{1t} = p_t - f_{1t} \quad t = 1,...,n$$

(2) $$e_{2t} = p_t - f_{2t} \quad t = 1,...,n$$

where e_{1t} is the error of the futures model forecast for quarter *t*, e_{2t} is the error of the outlook forecast for quarter *t*, p_t is the actual cash price in quarter *t*, f_{1t} is the futures model forecast for quarter *t*, f_{2t} is the outlook forecast for quarter *t*, and *n* is the number of forecast observations. Mean errors in hogs generally are positive, which indicates that both outlook and futures forecasts tend to be lower than actual prices (Table 3). However, none of the mean errors is "large" in economic terms; the largest bias is associated with the futures model when evaluated against two-quarter-ahead USDA forecasts and it represents just three percent of the average cash price for the sample period. Only three of the mean estimates (all associated with futures forecasts) are statistically significant. It is interesting that the bias increases in almost all cases as the forecast horizon lengthens (negative means become positive and larger or positive means become larger), and, with two exceptions, the absolute value of the bias is larger for futures forecasts compared to outlook forecasts. The evidence is consistent with unanticipated structural change in hog prices (upward) over time and/or a small, "Keynesian" risk premium in live/lean hog futures prices (e.g., Kolb 1992)

Mean errors in cattle generally are negative for outlook forecasts and positive for futures forecasts (Table 3). Similar to the results for hogs, though, mean errors are relatively small. The largest bias, \$1.65/cwt., is associated with futures errors against two-quarter-ahead USDA forecasts and it represents just 2.5% of the average cash price for cattle during the respective sample period. Only three of the mean estimates (all associated with futures forecasts) are statistically significant. The pattern of bias for futures forecasts in cattle is once again consistent with unanticipated structural change in cattle prices (upward) over time and/or a small, "Keynesian" risk premium in live cattle futures prices.

Standard deviations and minimum and maximums indicate a large range in forecast errors for both commodities. For example, one-quarter-ahead hog price forecasts for Illinois/Purdue range from -\$13.45/cwt. to \$18.24/cwt. As predicted by optimal forecasting theory (Diebold 2004, pp. 294-295), variability of forecast errors is non-decreasing across forecast horizons with one exception (two-quarter ahead vs. three quarter ahead cattle price forecasts for Illinois/Purdue). Large differences in variability generally are not evident when comparing outlook and futures forecast errors in both hogs and cattle. This is not surprising in light of the high correlation observed in most cases between outlook and futures forecast errors. Pair-wise correlation coefficients between outlook and futures forecast errors average 0.74 in hogs and 0.83 in cattle.

The Jarque-Bera test indicates that normality is rejected for only one forecast error series in hogs (one-quarter ahead forecasts for Missouri). Results are less consistent in cattle, as normality is rejected in 7 of 16 cases. Evidence of non-normally distributed errors is found in all USDA cattle forecast errors and two-quarter-ahead Illinois/Purdue forecast errors as well as in the respective futures-based forecasts error series. Overall, forecast errors in hogs show almost no evidence of departures from normality, while forecast errors in cattle show moderate evidence of such departures.

Finally, augmented Dickey-Fuller (ADF) tests show that all forecast error series in hogs and cattle are stationary, or I(0). Lag lengths are selected based on the AIC criterion. In addition, test results are insensitive to the inclusion of a constant or time-trend term in the ADF regressions.

RMSE Tests

Following previous studies (e.g., Sanders and Manfredo 2004 2005), the first step of the formal analysis is a comparison of root mean squared errors (RMSE) for outlook and futures forecasts. RMSE for futures and outlook forecasts at a given horizon is computed as follows:

(3) $$RMSE_1 = \left[\frac{1}{n} \sum_{t=1}^{n} \left(p_t - f_{1t} \right)^2 \right]^{1/2}$$

(4) $$RMSE_2 = \left[\frac{1}{n} \sum_{t=1}^{n} \left(p_t - f_{2t} \right)^2 \right]^{1/2}.$$

Statistical significance of differences in RMSE between futures and outlook forecasts is assessed using the modified Diebold-Mariano (MDM) test proposed by Harvey, Leybourne, and Newbold (1997). The MDM statistic tests the null hypothesis of equality of forecast performance based on a specified loss function, $E[g(e_{1t})-g(e_{2t})]=0$. Assuming a quadratic loss function, the test is based on the difference in squared errors for futures and outlook forecasts at a given horizon:

(5) $$d_t = g(e_{1t}) - g(e_{2t}) = e_{1t}^2 - e_{2t}^2.$$

The MDM test is then specified as follows:

(6) $$MDM = \left[\frac{n+1-2h+n^{-1}h(h-1)}{n}\right]^{1/2}\left[n^{-1}\left(\gamma_0 + 2\sum_{k=1}^{h-1}\gamma_k\right)\right]^{-1/2}$$

where $h = 1,2,3$ is the forecast horizon (e.g., 1 = one-quarter ahead forecast), $\gamma_0 = n^{-1}\sum_{t=1}^{n}\left(d_t - \bar{d}\right)^2$ is the variance of d_t, $\bar{d}$ is the sample mean of d_t, and $\gamma_k = n^{-1}\sum_{t=k+1}^{n}(d_t-\bar{d})(d_{t-k}-\bar{d})$ is the k^{th} auto-covariance of d_t, $(k=1,\ldots,h-1)$. Auto-covariance terms are included to account for the overlap in two- and three-quarter ahead forecasts. The MDM test statistic follows a *t*-distribution with *n-1* degrees of freedom. As discussed in the previous section, normality is rejected in some forecast error series, particularly for cattle. Since the *t*-test is known to be conservative (in the sense of controlling the probability of Type I error) and reliable in the absence of normality (e.g., Greene 2003, p. 106), this is not likely to be a serious statistical problem.

RMSE values for hog and cattle forecast series are presented in table 5. The most striking result is the small difference between outlook and futures RMSE, with the notable exception of Illinois/Purdue hog price forecasts. Without Illinois/Purdue, differences in hogs range from -\$0.13/cwt. to \$0.46/cwt. and average \$0.14/cwt. in favor of futures. The average difference represents only 2.4% of the average RMSE value. In cattle, differences range from -\$0.64/cwt. to \$0.21/cwt., with an average difference of -\$0.19/cwt. in favor of outlook forecasts. The average difference in this case represents 3.4% of the average RMSE value. In directional terms, outlook forecasts beat futures prices 3 out of 11 times in hogs and 5 out of 8 times in cattle. However, RMSE differences are statistically significant only for Illinois/Purdue hog price forecasts, which have substantially poorer performance compared to futures. The difference in RMSE for Illinois/Purdue in hogs averages about \$1.60/cwt. in favor of futures across all three forecast horizons. In terms of individual outlook programs, Iowa and Missouri perform better relative to futures than Illinois/Purdue and the USDA for both hogs and cattle.

The RMSE comparisons indicate no meaningful differences in forecast accuracy between outlook forecasts and futures prices, with the exception of Illinois/Purdue in hogs. This finding is consistent across commodities and forecast horizons. The results are also consistent with previous studies of outlook forecasts and futures prices in livestock markets (e.g., Irwin, Gerlow, and Liu 1994; Sanders and Manfredo 2004).

Encompassing Tests

Taken at face value, the RMSE results presented in the previous section indicate that outlook forecasts do not provide significant marginal value relative to futures prices. This raises potentially serious questions about the performance and economic value of public outlook programs. However, as first pointed out by Granger and Newbold (1973), it is possible for a forecast to have a larger MSE than another forecast but still provide useful information. Granger and Newbold define a forecast as conditionally efficient if alternative forecasts do not add incremental information to the forecast. Sanders and Manfredo (2005) argue that conditional efficiency, or encompassing, represents a more stringent and powerful criterion for evaluating the performance of outlook and futures prices.

Harvey, Leybourne, and Newbold (1998) develop a test of forecast encompassing based on the principle that one forecast encompasses another if the optimal weight of the inferior forecast in a composite forecast is zero. This can be formalized in the following regression equation:

$$(7) \qquad e_{1t} = \lambda(e_{1t} - e_{2t}) + \xi_t \qquad t = 1, ..., n$$

where e_{1t} is the error of the preferred forecast (futures) and e_{2t} is the error of the alternative forecast (outlook). The null hypothesis for the encompassing test is $\lambda = 0$, which implies zero covariance between e_{1t} and $e_{1t} - e_{2t}$. Rejection of the null hypothesis indicates that a composite forecast can be constructed based on the two forecast series that has a smaller MSE than the preferred forecast. In other words, the outlook forecast provides marginal information not contained in futures prices.

Harvey, Leybourne, and Newbold (1998) recommend testing the null hypothesis that $\lambda = 0$ in equation (7) using a version of the MDM test. This is accomplished by re-defining d_t in equation (4) to equal $e_{1t}(e_{1t} - e_{2t})$ and then computing the MDM test statistic shown in equation (5). While it is possible to test the null hypothesis using regression estimates, simulation results in Harvey, Leybourne, and Newbold (1998) show that the MDM test has the best combination of size and power, particularly when forecast error distributions are non-normal and heavy-tailed. Following the recommendation of Harvey, Leybourne, and Newbold, the MDM test is used to test the null hypothesis that futures forecasts encompass outlook forecasts.

Encompassing test results for hogs and cattle, shown in table 6, contrast sharply with earlier RMSE results. The null hypothesis that futures forecasts encompass outlook forecasts $(\lambda = 0)$ is rejected in 9 of 11 cases for hogs and 7 of 8 cases for cattle. The only cases where the null hypothesis is not rejected are one- and two-quarter ahead hog price forecasts and two-quarter ahead cattle price forecasts for Illinois/Purdue. Test results for three-quarter ahead hog price forecasts for Illinois/Purdue are especially interesting. Rejection of the null hypothesis in this case demonstrates that even a truly poor performing forecast in terms of RMSE can contain useful information relative to futures. Overall, the evidence shows that a combination of futures and outlook forecasts has a lower RMSE than futures alone, and therefore, outlook forecasts provide incremental value relative to futures prices.

Composite Forecasts and RMSE Reduction

While the encompassing test results are encouraging with respect to the value of outlook forecasts, the tests leave unanswered the key question of economic significance. Two issues must be analyzed to determine economic significance. The first is the magnitude of the reduction in RMSE from combining outlook and futures forecasts. The second is the economic value of the reduction in RMSE to a representative producer.

One approach to addressing the first issue is to estimate equation (7) via OLS regression, apply the λ estimates to form composite forecasts, and then compare the RMSE of the resulting composite forecasts to the RMSE of futures alone. Granger and Ramanathan (1984) argue that composite forecasts formed in this way are not likely to be optimal. It may be possible to reduce RMSE further by relaxing the constraints that weights on outlook and futures must sum to one and the constant must be equal to zero. Addition of a constant allows for the possibility that one or both of the forecasts may be biased. Consequently, Granger and Ramanathan (1984) recommend estimating composite weights based on an unrestricted linear regression with a constant term:

$$(8) \qquad p_t = \beta_0 + \beta_1 f_{1t} + \beta_2 f_{2t} + \zeta_t \qquad t = 1, ..., n$$

where β_1 and β_2 are the composite weights on futures and outlook forecasts, respectively. Regressions of this form are estimated for each pair of outlook and futures forecast series in hogs and cattle and the estimated weights are used to form composite forecasts for each available sample observation. The RMSE of estimated composite forecasts is then computed and compared to the RMSE of futures forecasts alone.

Results of the composite forecast analysis for hogs and cattle are presented in tables 7 and 8, respectively. Note that statistical significance is not indicated in the tables because the estimated composite weights and resulting reductions in RMSE relative to futures are the main interest.[8] Confirming the benefit of estimating the unrestricted form of the composite regression, the sum of the estimated composite weights is less than one in all but one case and constant terms are fairly large in several cases. Estimated composite weights for outlook forecasts are surprisingly large relative to futures. In hogs, the average weight given to outlook across all programs and horizons is 0.29 compared to 0.49 for futures. In cattle, the average weight given to outlook across all programs and horizons is 0.58, which exceeds the average weight, 0.36, attributed to futures. Estimated weights by outlook program follow the pattern of relative RMSE performance discussed earlier. The average weight in hogs is 0.10 for Illinois/Purdue, 0.39 for Iowa, 0.40 for Missouri, and 0.25 for the USDA. The average weight in cattle is 0.59 for Illinois/Purdue, 0.56 for Iowa, 0.86 for Missouri, and 0.45 for the USDA.[9]

The magnitude of the decline in RMSE that results from combining outlook forecasts and futures prices is non-trivial in almost all cases. Reduction in RMSE for composite forecasts in hogs ranges from a low of -0.8% to a high of -9.0% and averages -6.3%. By program, reductions in hogs average -1.9% for Illinois/Purdue, -7.7% for Iowa, -6.5% for Missouri, and -6.4% for the USDA. Reduction in RMSE for composite forecasts in cattle range more widely, from a low of -1.9% to a high of -17.0%. The average is -9.0%. By program, reductions in cattle average -8.6% for Illinois/Purdue, -12.8% for Iowa, -6.2% for Missouri, and -7.1% for the USDA.

The remaining question is whether the RMSE reductions are "small" or "large" in an economic context. Adam, Garcia, and Hauser (1996) provide a useful framework for examining this question from the perspective of a hog producer. These researchers estimate the value of improved mean (and variance) price forecasts for a representative hog producer using an expected utility and simulation framework. The results of their study indicate that a one-percent improvement in mean price forecast accuracy increases the certainty equivalent return of a risk-averse hog producer by \$0.47/cwt., or about \$1.15 per head (\$0.47/cwt. x 2.45cwt./head).[10] Using this figure, the -6.3% average RMSE reduction in hogs translates into \$7.25 of certainty equivalent return for each hog produced, or \$70,250 for a representative hog operation producing 10,000 head per year (Lawrence and Grimes 2007). While these computations should only be considered rough approximations, they nonetheless indicate that the economic value of the RMSE reductions is not small, and may be large, for many hog producers. Given that the average percentage reduction in RMSE is even larger in cattle, it seems reasonable to reach a similar conclusion for cattle producers.

Summary and Conclusions

The purpose of this paper is to provide a comprehensive evaluation of the accuracy of outlook forecasts relative to futures prices in hog and cattle markets. Published forecasts from four prominent livestock outlook programs are available for analysis: University of Illinois/Purdue University, Iowa State University, University of Missouri, and the Economic Research Service of the U.S. Department of Agriculture (USDA). One-, two- and up to three-quarter-ahead hog and cattle price forecasts are available for each program over the last three decades. Most of the series begin in the mid- to late-1970s and end in 2006. Two-thirds of the forecast series have 100 or more observations, providing by far the largest sample of outlook forecasts examined in the literature to date. Live/lean hog and live cattle futures forecasts are constructed based on futures prices available on the day before and the day of release for outlook forecasts.

Root mean squared error (RMSE) comparisons indicate no meaningful differences in forecast accuracy between outlook forecasts and futures prices, with the exception of Illinois/Purdue in hogs. In directional terms, outlook forecasts beat futures prices 3 out of 11 times in hogs and 5 out of 8 times in cattle. However, RMSE differences are statistically significant only for Illinois/Purdue hog price forecasts, which have substantially poorer performance compared to futures. Encompassing test results contrast sharply with RMSE test results. The null hypothesis that futures forecasts encompass outlook forecasts is rejected in 9 of 11 cases for hogs and 7 of 8 cases for cattle. Overall, the evidence shows that a combination of futures and outlook forecasts has a lower RMSE than futures alone, and therefore, outlook forecasts provide incremental information not contained in futures prices.

Optimal composite forecasts based on outlook and futures are estimated to determine the economic significance of the incremental information in outlook forecasts. The magnitude of the decline in RMSE that results from combining outlook forecasts and futures prices is non-trivial in almost all cases. Overall, the reduction in RMSE for composite forecasts averages -6.3% and -9.0% in hogs and cattle, respectively. A model developed by Adam, Garcia, and Hauser (1996) indicates the -6.3% average RMSE reduction in hogs translates into $7.25 of certainty equivalent return for each hog produced, or $70,250 for a representative hog operation producing 10,000 head per year. This provides concrete evidence that the economic value of the RMSE reductions is not small, and may be large, for many hog producers. Given that the average percentage reduction in RMSE is even larger for cattle, it seems reasonable to reach a similar conclusion for cattle producers.

In sum, the results provide compelling evidence of the positive economic value of public outlook programs in hogs and cattle. Previous studies of livestock outlook forecasts and futures generally reach the opposite conclusion. For example, Sanders and Manfredo (2004, p.129) conclude that, "…a simple futures-based forecast may be the best alternative for agribusiness decision makers." The difference in conclusions is most likely due to the use of small samples of outlook forecasts and/or the omission of encompassing-type tests in previous studies. Additional research is needed to determine whether the findings of this study generalize to other agricultural markets, especially major grain markets such as corn, soybeans, and wheat.

The results of this study also raise interesting questions about the efficiency of live/lean hog and live cattle futures markets. In the terminology of Sanders and Manfredo (2005), the encompassing test results reject the necessary condition for market efficiency in live/lean hog and live cattle futures. The rejections are especially noteworthy for two reasons. First, true *ex ante* outlook forecasts are compared to futures prices which eliminates data mining as an explanation for the rejections. Second, results generally are consistent across commodities, outlook programs, and forecast horizons. Further research is required to determine whether the sufficient condition for market efficiency also should be rejected. This would involve testing whether net risk-adjusted trading profits can be earned based on the outlook forecasts.

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Endnotes

[1] This argument ignores educational benefits that may be associated the public outlook programs. Brorsen and Irwin (1996) argue that outlook programs can generate net economic benefits in efficient markets by educating participants about the structure and parameters of the underlying economic model and prospective economic conditions.

[2] Some Illinois/Purdue cattle price forecasts are also released on a quarterly timetable over 1979.II – 1986.IV. However, the forecasts are issued only sporadically and therefore are excluded from the sample for this study.

[3] "Current-quarter" cattle price forecasts for Missouri also are available over 1974.III – 1992.I. Since a relatively large fraction of these forecasts reflect actual prices for the quarter, they are not considered in the analysis.

[4] Since 1993, cattle price forecasts from Missouri have been issued once a year on November 1st. These are not evaluated in the present study because of the difference in release schedule compared to the forecasts released before 1992.

[5] An estimated ratio of 0.73673 is applied to lean-hog futures prices. This factor is obtained by dividing the average weight of lean hogs (180.5) by the average weight of live hogs (245) (e.g., Sutton and Albrecht 1996). The adjustment is necessary because the Chicago Mercantile Exchange shifted from the delivery terms from a live weight to carcass weight basis beginning with the February 1997 contract.

[6] Historical mean basis performs as well or better than more complex methods in previous research on futures price forecasts (Kastens, Jones, and Schroeder 1998). In addition, Tonsor, Dhuyvetter, and Mintert (2004) show that a 3-year moving average basis projection is nearly optimal when forecasting live cattle basis.

[7] For both hogs and cattle, second quarter futures forecasts are based on June and August contracts, third quarter forecasts are based on August and October contracts and fourth quarter forecasts are based on December and February (following calendar year) contracts. Settlement prices for live/lean hog and live cattle futures contracts are obtained from the Chicago Mercantile Exchange (CME).

[8] Intercept estimates for hogs are insignificant at one-quarter-ahead but statistically significant at longer horizons. The significance of the weights given to outlook programs is mixed. Iowa and Missouri weights are significant at all forecast horizons in hogs, while USDA weights are significant only at the one-quarter-ahead horizon. Illinois/Purdue weights are statistically insignificant at all horizons in hogs. Most of weights given to futures in hogs are significant with a few exceptions at longer horizons. Results for cattle show that most of the constant estimates are insignificant. Estimated weights for outlook and futures in cattle are significant for USDA equations at both horizons, as well as Illinois/Purdue and Iowa at one-quarter-ahead. Significance results and other regression output for these equations are available from the authors upon request.

[9] It is also interesting to observe that, on average, estimated weights vary only slightly across horizons for outlook programs, but not for futures. In hogs, the average weight for futures declines from 0.64 for one-quarter ahead forecasts to 0.33 for three-quarter ahead forecasts. In cattle, the average weight for futures declines from 0.50 for one-quarter ahead forecasts to 0.43 for two-quarter ahead forecasts.

[10] The return is achieved by hedging in either the live hog futures or options market.

Table 1. Outlook program forecast data

Commodity/ Outlook Program	Forecast Sample Period	# of Quarters	# Missing Observations 1-qtr.	2-qtr.	3-qtr.	Average Timing of Release	Forecast Cash Price Series	Source Publication
Hogs								
Illinois/Purdue	1979.II-2006.III	109	3 (2.8)	4 (3.7)	5 (4.6)	10 days after start of each calendar quarter	1979.II-1985.II: Barrows & Gilts (7mkts) 1985.III-1994.I: Barrows & Gilts (Omaha) 1994.II-2006.III: Barrows & Gilts (6mkts)	*Livestock Price Outlook*
Iowa	1975.I-2006.II	124	1 (0.8)	1 (0.8)	15 (12)	2 days after start of each calendar quarter	1975.I-2006.II: Barrows & Gilts (Iowa-S.MN.)	*Iowa Farm Outlook*
Missouri	1974.II-2006.III	129	4 (3.1)	4 (3.1)	26 (20.3)	2 days after start of each calendar quarter	1974.II-1991.IV: Barrows & Gilts (7mkts) 1992.I-1994.II: Barrows& Gilts (6mkts) 1994.III-2006.III: Barrows & Gilts (Terminal mkt)	*Livestock Outlook Letter* *Quarterly Hog Outlook-AgEBB*
USDA	1974.I-2006.II	129	3 (2.3)	25 (19.3)	NA (NA)	43 days before start of each calendar quarter	1974.I-1991.IV: Barrows & Gilts (7mkts) 1992.I-1992.II: Barrows & Gilts (6mkts) 1992.III-1999.III: Barrows& Gilts (Iowa-S.MN.) 1999.IV-2006.II: Barrows& Gilts (Nat. Base)	*Livestock Situation & Outlook* *LDPO*
Cattle								
Illinois/Purdue	1987.III-2006.I	39	3 (7.7)	3 (7.7)	5 (12.8)	25 days after start of each calendar quarter	1987.III-1995.II: Choice Steers (Omaha) 1995.III-2006.I: Choice Steers (Nebraska)	*Livestock Price Outlook*
Iowa	1975.I-1996.I	85	1 (1.2)	37 (43.5)	NA (NA)	59 days before start of each calendar quarter	1975.I-1996.I: Choice Steers (Iowa-S.MN)	*Iowa Farm Outlook*
Missouri	1974.III-1992.I	71	4 (5.6)	NA (NA)	NA (NA)	57 days before start of each calendar quarter	1974.III-1992.I: Choice Steer (Omaha)	*Livestock Outlook Letter* *Quarterly Cattle Outlook-AgEBB*
USDA	1974.I-2006.III	131	4 (3.1)	24 (18.5)	NA (NA)	43 days before start of each calendar quarter	1974.I-1991.I: Choice Steers (Omaha) 1991.II-2006.III: Choice Steers (Nebraska)	*Livestock Situation & Outlook* *LDPO*

Note: Figures in parentheses are the percentage of missing observations. NA denotes not applicable. AgEBB: Agricultural Electronic Bulletin Board. LDPO: Livestock, Dairy, and Poultry Outlook

Table 2. Examples of futures model computations for one-quarter-ahead hog forecasts, 2005.I and 2005.II

	Forecast quarter: 2005.I USDA outlook release date: 11/18/2004				Forecast quarter: 2005.II USDA outlook release date: 2/15/2005				
	Jan'05	**Feb'05**	**Mar'05**	**Apr'05**	**Apr'05**	**May'05**	**Jun'05**	**Jul'05**	**Aug'05**
Futures prices									
1) Settlement price by contract observed on day previous to USDA outlook report release		72.87		70.07			77.07		70.00
2) Monthly average price based on futures contract prices	72.87	70.07	70.07		77.07	70.00	70.00		
3) Quarterly futures price (average)		71.00				72.36			
4) Lean-live adjustment [(3)*1/1.35]		52.60				53.60			
Basis (cash-futures)									
5) 1st or 2nd quarter basis observed in 2002		-2.98				-2.96			
6) 1st or 2nd quarter basis observed in 2003		-3.35				-4.57			
7) 1st or 2nd quarter basis observed in 2004		-0.08				-0.33			
8) 3-year moving average basis		-2.14				-2.62			
9) Quarterly futures-based forecast [(4)+(8)]		**50.46**				**50.98**			
10) Actual quarterly cash price		51.92				52.09			

Note: All figures are reported as $/cwt.

Table 3. Descriptive statistics for outlook and futures forecast errors in hogs

Forecast Comparison	Horizon	Mean	Standard Deviation	Minimum	Maximum	Correlation	Normality	Stationarity
Illinois/Purdue vs.	1-qtr.-ahead	-0.22	5.69	-13.45	18.24	0.64	Yes	Yes
Futures		-0.11	4.02	-10.18	11.21		Yes	Yes
	2-qtr.-ahead	-0.21	7.67	-20.72	19.23	0.43	Yes	Yes
		0.43	6.22	-15.10	19.99		Yes	Yes
	3-qtr.-ahead	-0.08	8.68	-22.31	18.54	0.67	Yes	Yes
		0.79	6.84	-19.67	17.50		Yes	Yes
Iowa vs.	1-qtr.-ahead	0.29	4.53	-9.71	10.08	0.68	Yes	Yes
Futures		0.37	4.27	-8.90	13.92		Yes	Yes
	2-qtr.-ahead	0.38	6.40	-19.02	17.38	0.85	Yes	Yes
		1.02 *	6.46	-14.83	16.71		Yes	Yes
	3-qtr.-ahead	0.71	7.27	-20.02	17.44	0.87	Yes	Yes
		1.18 *	7.26	-18.95	16.67		Yes	Yes
Missouri vs.	1-qtr.-ahead	-0.02	4.11	-13.73	8.73	0.70	No	Yes
Futures		-0.05	3.97	-8.96	11.99		Yes	Yes
	2-qtr.-ahead	0.31	6.53	-17.01	16.63	0.84	Yes	Yes
		0.87	6.33	-15.79	16.19		Yes	Yes
	3-qtr.-ahead	0.60	7.15	-16.01	17.22	0.85	Yes	Yes
		1.12	7.15	-18.04	16.07		Yes	Yes
USDA vs.	1-qtr.-ahead	0.31	6.08	-15.00	16.82	0.77	Yes	Yes
Futures		0.77	5.64	-13.84	17.15		Yes	Yes
	2-qtr.-ahead	0.46	7.49	-15.00	17.75	0.80	Yes	Yes
		1.42 **	6.89	-16.23	15.27		Yes	Yes

Notes: Mean, standard deviation, minimum, and maximum are reported as $/cwt. The first row in each pair of rows shows results for the indicated outlook program at a given forecast horizon and the second row shows results for the comparable futures forecast. Asterisk (*), double asterisk (**), and triple asterisk (***) denote significance at 10%, 5%, and 1%, respectively. Normality tests are based on the Jarque-Bera test. Stationarity tests are based on the Augmented Dickey-Fuller unit root test. Sample periods are: Illinois/Purdue - 1979.II-2006.III; Iowa - 1975.I-2006.II; Missouri - 1974.II-2006.III; and USDA - 1974.I-2006.II

Table 4. Descriptive statistics for outlook and futures forecast errors in cattle

Forecast Comparison	Horizon	Mean	Standard Deviation	Minimum	Maximum	Correlation	Normality	Stationarity
Illinois/Purdue vs.	1-qtr.-ahead	-0.51	3.10	-5.54	7.55	0.52	Yes	Yes
Futures		0.13	3.08	-4.50	9.97		No	Yes
	2-qtr.-ahead	0.32	6.70	-12.80	22.73	0.90	No	Yes
		0.86	6.46	-9.62	26.02		No	Yes
	3-qtr.-ahead	-0.50	5.68	-10.77	10.97	0.93	Yes	Yes
		1.45	6.02	-12.12	16.34		Yes	Yes
Iowa vs.	1-qtr.-ahead	-0.56	5.46	-14.33	13.07	0.88	Yes	Yes
Futures		1.15 *	5.64	-14.44	13.18		Yes	Yes
	2-qtr.-ahead	0.13	6.05	-12.33	16.91	0.91	Yes	Yes
		1.74 *	6.47	-14.38	17.25		Yes	Yes
Missouri vs.	1-qtr.-ahead	-0.93	5.37	-14.34	13.06	0.85	Yes	Yes
Futures		0.94	5.41	-11.79	11.18		Yes	Yes
USDA vs.	1-qtr.-ahead	-0.61	5.84	-13.84	22.38	0.81	No	Yes
Futures		0.73	5.62	-10.47	23.52		No	Yes
	2-qtr.-ahead	-0.79	6.28	-13.71	22.38	0.80	No	Yes
		1.65 ****	6.48	-11.93	28.77		No	Yes

Notes: Mean, standard deviation, minimum, and maximum are reported as $/cwt. The first row in each pair of rows shows results for the indicated outlook program at a given forecast horizon and the second row shows results for the comparable futures forecast. Asterisk (*), double asterisk (**), and triple asterisk (***) denote significance at 10%, 5%, and 1%, respectively. Normality tests are based on the Jarque-Bera test. Stationarity tests are based on the Augmented Dickey-Fuller unit root test. Sample periods are: Illinois/Purdue - 1987.III-2006.I; Iowa - 1975.I-1996.I; Missouri - 1974.III-1992.I; and USDA - 1974.I-2006.III

Table 5. Root mean squared errors (RMSE) of outlook and futures model forecasts in hogs and cattle

Forecast Comparison	Hogs			Cattle		
	1-qtr.-ahead	2-qtr.-ahead	3-qtr.-ahead	1-qtr.-ahead	2-qtr.-ahead	3-qtr.-ahead
Illinois/Purdue vs.	5.67	7.64	8.64	3.10	6.61	5.62
Futures	4.00	6.20	6.85	3.04	6.42	6.11
Difference	1.67 ***	1.44 ***	1.79 ***	0.06	0.19	-0.49
Iowa vs.	4.52	6.39	7.27	5.43	5.99	NA
Futures	4.27	6.52	7.32	5.69	6.63	NA
Difference	0.25	-0.13	-0.05	-0.26	-0.64	NA
Missouri vs.	4.10	6.51	7.14	5.21	NA	NA
Futures	3.95	6.36	7.20	5.45	NA	NA
Difference	0.15	0.15	-0.06	-0.24	NA	NA
USDA vs.	6.06	7.46	NA	5.85	6.30	NA
Futures	5.67	7.01	NA	5.64	6.65	NA
Difference	0.39	0.46	NA	0.21	-0.36	NA

Note: All figures are reported as $/cwt. NA denotes not applicable. The first row in each pair of rows shows the RMSE for the indicated outlook program and the second row shows the RMSE for the comparable futures forecast. Asterisk (*), double asterisk (**), and triple asterisk (***) denote significance at 10%, 5%, and 1%, respectively, based on the modified Diebold-Mariano (MDM) test. Sample periods for hogs are: Illinois/Purdue - 1979.II-2006.III; Iowa - 1975.I-2006.II; Missouri - 1974.II-2006.III; and USDA - 1974.I-2006.II. Sample periods for cattle are: Illinois/Purdue - 1987.III-2006.I; Iowa - 1975.I-1996.I; Missouri - 1974.III-1992.I; and USDA - 1974.I-2006.III.

Table 6. Modified Diebold-Mariano (MDM) tests of forecast encompassing between futures and outlook forecasts in hogs and cattle

Forecast	Hogs			Cattle		
Comparison	**1-qtr.-ahead**	**2-qtr.-ahead**	**3-qtr.-ahead**	**1-qtr.-ahead**	**2-qtr.-ahead**	**3-qtr.-ahead**
Futures vs. Illinois/Purdue	0.80	0.89	1.66 *	2.31 **	0.88	2.02 *
	(0.424)	(0.377)	(0.100)	(0.027)	(0.385)	(0.051)
Futures vs. Iowa	3.71 ***	2.75 ***	2.620 ***	3.740 ***	2.53 **	NA
	(0.000)	(0.007)	(0.010)	(0.000)	(0.015)	
Futures vs. Missouri	3.78 ***	2.86 ***	2.61 **	2.90 ***	NA	NA
	(0.000)	(0.005)	(0.011)	(0.005)		
Futures vs. USDA	2.88 ***	1.71 *	NA	3.220 ***	2.93 ***	NA
	(0.005)	(0.091)		(0.002)	(0.004)	

Note: Figures in parenthesis are *p-values* . NA denotes not applicable. Asterisk (*), double asterisk (**), and triple asterisk (***) denote significance at 10%, 5%, and 1%, respectively. The null hypothesis is that the preferred forecast (futures) encompasses the alternative forecast (outlook). Sample periods for hogs are: Illinois/Purdue - 1979.II-2006.III; Iowa - 1975.I-2006.II; Missouri - 1974.II-2006.III; and USDA - 1974.I-2006.II. Sample periods for cattle are: Illinois/Purdue - 1987.III-2006.I; Iowa - 1975.I-1996.I; Missouri - 1974.III-1992.I; and USDA - 1974.I-2006.III

Table 7. Composite forecast comparisons for hogs

Outlook Program	Horizon	Composite Forecast Weights: Constant	Composite Forecast Weights: Outlook	Composite Forecast Weights: Futures	Futures RMSE	Composite RMSE	RMSE Reduction
Illinois/Purdue	1-qtr.-ahead	2.40	0.05	0.90	4.00	3.97	-0.8%
	2-qtr.-ahead	10.24	0.11	0.67	6.21	6.01	-3.1%
	3-qtr.-ahead	15.28	0.14	0.54	6.85	6.49	-5.2%
Iowa	1-qtr.-ahead	3.12	0.37	0.57	4.27	3.98	-6.6%
	2-qtr.-ahead	12.31	0.41	0.33	6.52	5.95	-8.7%
	3-qtr.-ahead	17.68	0.39	0.23	7.32	6.66	-9.0%
Missouri	1-qtr.-ahead	0.74	0.43	0.55	3.95	3.70	-6.4%
	2-qtr.-ahead	10.83	0.33	0.44	6.36	5.95	-6.5%
	3-qtr.-ahead	14.65	0.44	0.24	7.20	6.59	-8.4%
USDA	1-qtr.-ahead	9.18	0.29	0.52	5.67	5.30	-6.4%
	2-qtr.-ahead	16.34	0.22	0.44	7.01	6.45	-7.9%

Note: RMSE denotes root mean squared error, which is reported as $/cwt. Sample periods are: Illinois/Purdue - 1979.II-2006.III; Iowa - 1975.I-2006.II; Missouri - 1974.II-2006.III; and USDA - 1974.I-2006.II.

Table 8. Composite forecast comparisons for cattle

Outlook Program	Horizon	Composite Forecast Weights: Constant	Composite Forecast Weights: Outlook	Composite Forecast Weights: Futures	Futures RMSE	Composite RMSE	RMSE Reduction
Illinois/Purdue	1-qtr.-ahead	-8.28	0.64	0.47	3.04	2.58	-15.3%
	2-qtr.-ahead	2.43	0.28	0.70	6.42	6.30	-1.9%
	3-qtr.-ahead	4.54	0.86	0.07	6.11	5.58	-8.7%
Iowa	1-qtr.-ahead	6.18	0.48	0.43	5.69	5.20	-8.6%
	2-qtr.-ahead	13.92	0.63	0.15	6.63	5.50	-17.0%
Missouri	1-qtr.-ahead	5.43	0.86	0.06	5.45	5.11	-6.2%
USDA	1-qtr.-ahead	1.58	0.37	0.61	5.64	5.41	-4.2%
	2-qtr.-ahead	3.61	0.53	0.43	6.65	5.99	-10.0%

Note: RMSE denotes root mean squared error, which is reported as $/cwt. Sample periods are: Illinois/Purdue - 1987.III-2006.I; Iowa - 1975.I-1996.I; Missouri - 1974.III-1992.I; and USDA - 1974.I-2006.III