Livestock Basis Forecasts: How Beneficial Is The Inclusion of Current Information?

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ABSTRACT

Successful risk management strategies for agribusiness firms are contingent on the ability to accurately forecast basis. There has been substantial research on the actual use of basis forecasts, yet little research has been conducted on actually forecasting basis. This study evaluates the effect incorporating current basis information into a historical-average-based-forecast has on forecasting accuracy when forecasting live cattle and feeder cattle basis. Furthermore, the optimal weight to place on this current information is evaluated in an out-of-sample framework. Root mean squared errors are generated for both commodities and evaluated to determine the significance of these issues. Results suggest that livestock basis forecasters should consider incorporating a proportion of the difference in current basis and the historical average of the current week when making their projections. The optimal amount of current information to include declines as the time interval between the week the forecast is being made and the week being forecasted increases.

Keywords: livestock prices, hedging, basis forecasts, current information

INTRODUCTION

The difference between the futures market price and the cash market price is known as the "basis" (cash – futures). Successful hedging requires hedgers to be able to accurately predict basis at the outset of a hedge. In other words, at the time a hedge is initiated, hedgers need to accurately predict what basis will be when the cash sale or purchase is made and the futures position is offset. Hedgers are often interested in forecasting basis prior to delivery at locations other than delivery points specified in the futures contract. A typical approach to forecasting basis is to average historic basis levels, across years, for a particular calendar week. This technique ignores any other information that may be known at the time of the forecast, i.e., current market information. To improve forecasting accuracy, it may be important to "adjust" the historical average to reflect the current basis level. For further illustration, consider an example where in addition to knowing the historical average for the week being forecasted, a hedger knows that the current basis is $1.00/cwt. higher than the historical average for this week. Forecast accuracy may potentially be enhanced if forecasts are modified to account for the deviation of the current basis from the historical average at the time of the forecast.

PREVIOUS RESEARCH

Research indicates the importance of basis forecasting (see Kastens, Jones, and Schroeder), yet comparatively little research focuses on livestock basis forecasting. Dhuyvetter and Kastens evaluated various crop basis forecasting techniques and, based upon out-of-sample forecasts, concluded that multi-year averages were as good as or better than forecasts from more complex techniques. Tonsor, Mintert, and Dhuyvetter concluded that the use of 4-year historical averages has performed favorably to using 1-, 2-, 3-, or 5-year historic averages for forecasting live cattle and hog basis and that using 3-year historical averages has performed well for forecasting feeder cattle basis, as compared to 1-, 2-, 4-, or 5-year historic averages.[1]

Jiang and Hayenga suggest that the inclusion of current market information may enhance basis forecasting accuracy. Based upon root mean squared errors, the most accurate soybean basis forecasting method was a "3-year average plus" method. This method incorporates current supply and demand information along with the 3-year historical average to formulate a forecast.

Hauser, Garcia, and Tumblin; Dhuyvetter and Kastens incorporated current price spreads between futures contracts into some of their crop basis forecasting models. Hauser, Garcia, and Tumblin concluded that forecasts using current price spreads between futures contracts performed well for shorter time periods (up to 60 days); but did not evaluate their performance over longer time periods. Dhuyvetter and Kastens also found this method to work relatively well 4 to 12 weeks prior to the forecast period, but beyond a 12 week horizon this method generated poor forecasts. Furthermore, forecasting errors, averaged over the entire time period studied, were highest using this forecasting method.

OBJECTIVE

The objective of this study is to evaluate whether the inclusion of current information increases livestock basis forecasting accuracy. More specifically, basis forecasts for feeder cattle and live cattle will be generated over different time periods incorporating different

[1] Findings varied as the time period of evaluation varied. These comments correspond to the data spanning the entire time period studied for each commodity.

proportions of the deviation of the current basis from the historical average basis of the week the forecasts are being made. These forecasts will then be compared against a pure historical average forecast, where there is no inclusion of the current basis deviation from the historical average. Basis forecasts will be generated out-of-sample for the nearby basis to compare the benefits of including varying amounts of this current information, where "nearby" refers to the contract closest to expiration. In-sample forecasts will also be generated to identify the "optimal" amount of current information to include in forecasts.

This work extends the recent work of Tonsor, Mintert, and Dhuyvetter. Out-of-sample forecasts are used to compare models for forecasting feeder cattle and live cattle basis. Forecasts are generated using models based solely on historical averages as well as models which incorporate varying proportions of current basis information with the historical average.

DATA

Futures settlement price data were obtained from Bridge Financial Data Center. The data series begin on January 1, 1993 for Feeder Cattle and Live Cattle and continue through December 31, 2002. A nearby futures data series was created for each commodity, where "nearby" denotes the contract closest to expiration. Futures contracts were rolled to subsequent contracts following the last day a contract was traded (i.e., every day that a contract represents the nearby contract its price is used in calculating the basis).

Caution must be exerted when calculating basis to insure that the cash and futures prices are for consistent time periods. Therefore, Wednesday's nearby contract settlement futures prices were used to compute feeder cattle basis, given that the cash price series was from the Dodge City, Kansas Wednesday feeder cattle auctions. In contrast, live cattle futures settlement prices for a given week were averaged since the respective cash price series were weekly averages.

Cash data were organized uniquely for each commodity studied to make the cash data series reflect approximately the same specifications as the futures prices over the entire time period analyzed. For example, from January 1, 1993 to December 31, 1999 the feeder cattle futures contract's average target weight was 700-800 lbs and from January 7, 2000 to December 31, 2002 the par weight range was 700-850 lbs. Thus, the cash data series was created in an attempt to hold the hedge ratios near 1.0 over the time period studied.[2] A breakdown of how each contract's specifications have changed since inception was obtained from the Chicago Mercantile Exchange.

The feeder cattle cash series is composed of data reported by USDA's Agricultural Marketing Service and provided by the Livestock Marketing Information Center (LMIC) for sales at Dodge City, Kansas beginning on January 1, 1993. From January 1, 1993 to December 31, 1999 the Dodge City 700-800 lb. price series was used because the futures contracts' average target weight was 700-800 pounds for this time span. From January 1, 2000 to December 31, 2002 an average of the Dodge City 700-750 lb., 750-800 lb., and the 800-850 lb. prices were used to reflect the future contract's par weight range of 700-850 pounds.

The live cattle cash price series was also obtained from the LMIC. Specifically, the price series used was the *Western Kansas Direct Slaughter Steers* price series. Since April 1,

[2] Additionally, an analysis was conducted using the Dodge City 500-600 cwt. price series to justify the arrangement of cash data series used for the results reported in this paper. As expected (because the hedge ratio was not 1.0) the RMSE and optimal amounts of current information were both significantly higher when using Dodge City 500-600 cash prices as compared to using the cash series we created. These results are not shown here but are available from the authors upon request.

2001, with the initiation of mandatory price reporting, this price series changed to the *Kansas Slaughter Steers* price series. This is a weekly average data series, which required the futures' daily settlement prices to be averaged for each week.

METHODOLOGY

To calculate the actual basis, Week 1 was defined to be the first week of the year including a minimum of three trading days. Thus, if the first trading day in January fell on either a Thursday or Friday, the following week was defined to be week 1. Weeks 2 through 52 were simply the subsequent weeks.

Using this basis data and corresponding historical averages of these basis levels, out-of-sample squared basis prediction errors were generated for both feeder cattle and live cattle basis forecasts based upon the historical average basis for that week as shown by:

$$(1) \quad SE_{\text{iltk}} = (Basis_{\text{it}} - (HistAvg_{\text{ijt}} + ((x) * (Basis_{\text{lt}-\text{k}} - HistAvg_{\text{ljt}-\text{k}})))) \wedge 2$$

where *SE* is the squared basis prediction error, *HistAvg* is the historical average basis (3-year for feeder cattle and 4-year for live cattle), *x* is a variable representing the proportion of the current basis deviation from its historical average included in the forecasts (ranging from 0.0 to 1.0 in increments of 0.1)[3], *i* denotes the year being forecasted, *l* denotes the year the forecast is being made during, *t* denotes the week of the year, and *k* represents the forecast horizon and is the number of weeks between the date of the forecast and the week being forecasted (k = 4, 8, 12, 16, 20, and 24). This process was repeated for every week, forecast

[3] Note that when x = 0 the basis forecast collapses to a simple historical average.

horizon, and value of x between 1993 and 2002 to formulate a table of squared errors. Following the creation of these tables, the *x* variable in Equation (1) was solved for that would minimize the sum of these squared errors over the entire time period, i.e. optimized in-sample. The root mean squared errors (RMSE) are given by:

$$(2) RMSE_{iltk} = ((\sum_{ijtlk}^{IJTLK} (Basis_{it} - (HistAvg_{ijt} + ((x) * (Basis_{lt-k} - HistAvg_{ljt-k})))) \wedge 2) / (\# forecasts)) \wedge .5$$

Basis forecast accuracy with various weights placed on current information, over different time periods, for several different forecasting time horizons was evaluated. The 1993-2002 and 1998-2002 time periods for both commodities were evaluated as they represent the most recent 10- and 5-years of data. Furthermore, the process was repeated for forecasts made 4, 8, 12, 16, 20, and 24 weeks prior to the week being forecasted.

Root mean squared errors (RMSE) were calculated for each commodity according to Equation (2). Paired t-tests were used to determine the statistical significance of difference in the RMSEs of the different models considered and to determine the optimal amount of current information to include in basis forecasts over a variety of time spans.

RESULTS

Feeder Cattle Evaluation

Tables 1 and 2 provide the paired t-tests results of comparing the RMSE of the different proportions of current information incorporated into the forecasts for feeder cattle basis over the 1998-2002 and 1993-2002 time periods, respectively, across the different forecasting horizons (4, 8, 12, 16, 20, and 24 weeks out). These tables also provide the root mean squared errors from each horizon allowing the actual differences in prediction accuracy to be identified.

When forecasting basis four weeks into the future, the optimal percentage of current basis information (i.e., the "x" variable in Equation (2)) to include would have been 32% (Table 1a) during the 1998-2002 time period and 45% (Table 2a) during the 1993-2002 time period. This "optimal" amount was found in-sample by identifying the "x" value of Equation (1) that minimized the sum of squared errors over the period of interest.

Between 1998-2002, when forecasting basis four weeks out, including 30% of the basis deviation from its historical average in the forecast, would have resulted in a RMSE of $1.54/cwt. (Table 1a). This RMSE is significantly lower than the $1.63/cwt. RMSE associated with not including any current basis information in the forecasts (simply using the historical average for the week being forecasted, in which case the "x" in Equation (2) equals zero).[4] Between 1993 and 2002, basis forecast errors (in terms of RMSE) would have been lowered by approximately $0.18/cwt. (Table 2a) if 40% to 50% of the current basis deviation from its historical average was incorporated into the forecasts.

As the forecasting interval (i.e., the length of time between the forecast and the week being forecasted) increased, the optimal amount of current basis information to include in the forecast generally declined. This is expected because, as the amount of time between when the forecast is made and the week being forecasted increases, more time exists for unexpected events to change the basis, making incorporation of current basis information less beneficial.

[4] Here and throughout the rest of the paper the term "significantly" is used based on p-values less than 0.05 and p-values between 0.05 and 0.15 are referred to as being "marginally significant."

Between 1998 and 2002 the optimal amount of current basis information to include in forecasts made for basis eight weeks ahead was approximately 30% (Table 1a). A forecast incorporating 30% of the current information yielded a RMSE $0.08/cwt. lower than forecasts made excluding current basis information. For the 1993-2002 time period, basis forecasts made for eight weeks into the future were most accurate if approximately 40% (Table 2a) of the current basis information was included in the forecasts. Such forecasts would have resulted in a RMSE approximately $0.13/cwt. lower than forecasts based solely on a 3-year historical average.

When the forecasting horizon was extended to 12 weeks, the optimal weighting of current basis information was 24% for 1998-2002 (Table 1a) and 32% for 1993-2002 (Table 2a). Forecasting accuracy (in terms of RMSE) increased by about $0.05/cwt. (Table 1a) and $0.09/cwt. (Table 2a), respectively, for the two time spans by including the current information into the forecast.

The optimal amount of current basis information to include in forecasts made for 16 weeks into the future ranged from about 15% (Table 1b) to 21% (Table 2b) for the 1998-2002 and 1993-2002 time periods, respectively. Forecast accuracy (RMSE) improved about $0.02/cwt. (Table 1b) and $0.03/cwt. (Table 2b), respectively by following these models, as compared to not including any current information (i.e., x = 0). However, over the 1998-2002 time span, the RMSE associated with incorporating approximately 15% of the current basis information was not significantly different than the RMSE of simply using the three-year historical average. Due to this statistical insignificance, forecasting accuracy over the 1998-2002 time period would not have been improved by incorporating current information in basis forecasts16 weeks into the future This difference over the 1993-2002 time period was however statistically significant and thus forecasting accuracy would have been enhanced by including current information.

When the forecasting horizon was extended to 20 weeks the value of incorporating an amount of the current basis deviation from its historical average was similar to the 16 week forecasting horizon. However, when the forecasting horizon was extended to 24 weeks, the optimal amount of current basis information to include decreased, as did the forecasting accuracy. Over the 1998-2002 time period, the optimal percentage to include when forecasting basis 24 weeks into the future was about 7%, and this resulted in a decline of about $0.01/cwt. in the RMSE (Table 1b) Between 1993 and 2002, the optimal percentage was about 13% and the resulting decline in the RMSE was approximately $0.01/cwt. (Table 2b). The RMSE associated with this model incorporating current information over the 1998-2002 period was not significantly different from the RMSE of merely using a three-year historical average, but the difference over the 1993-2002 time period was marginally significant. This suggest that accuracy in making basis forecasts over the 1998-2002 time period for 24 weeks out would not have been improved by including current information.

Live Cattle Multi-Year Average Evaluation

Tables 3 and 4 provide the paired t-tests results of comparing the RMSE of the different proportions of current information incorporated in the forecasts for live cattle over the 1998-2002 and 1993-2002 time periods, respectively, across the different forecasting horizons.

When forecasting basis four weeks into the future, the optimal percentage of current basis information to include was approximately 45%, over the 1998-2002 (Table 3a) and

1993-2002 (Table 4a) time periods. During the 1998-2002 time period, forecasts including 50% of the basis deviation from its historical average at the time the forecast was being made resulted in a RMSE of the forecast of $1.35/cwt. (Table 3a). This RMSE is significantly lower than the $1.51/cwt. RMSE associated with not including any current basis information in the forecasts (i.e., x = 0). Between 1993 and 2002, basis forecast errors (in terms of RMSE) would have been lowered by approximately $0.17/cwt. (Table 4a) if 50% of the current basis deviation from its historical average was incorporated into the forecasts.

Between 1998 and 2002 the optimal amount of current basis information to include in forecasts made for basis eight weeks ahead was 33% (Table 3a). Such forecasts resulted in a RMSE $0.08/cwt. lower than forecasts made excluding current basis information (Table 3a). For the 1993-2002 time periods, basis forecasts made for eight weeks into the future would have been most accurate if approximately 40% of the current basis information was included in the forecasts (Table 4a). These current-information-adjusted forecasts would have resulted in a RMSE approximately $0.12/cwt. lower than forecasts based solely on a 4-year historical average.

When the forecasting horizon was extended to 12 weeks, the best weighting of current basis information was approximately 5% (Table 3a) and 16% (Table 4a) over the 1998-2002 and 1993-2002 time periods, respectively. The reduction in RMSE associated with incorporating these “optimal” amounts of current information was minimal; it is also noteworthy that these RMSE are not significantly different from those of the simple four-year historical average forecasts for the 1998-2002 period and that the difference is only marginally significant over the 1993-2002 period. This suggest that forecasting accuracy over the 1998-2002 period would not have been improved if current information were included in forecast for basis 12 weeks into the future.

When the forecasting horizon was extended to 16 weeks, 20 weeks, and finally 24 weeks; incorporating a proportion of the current basis deviation from its historical average failed to significantly increase forecasting accuracy. In fact, the “optimal” amount of information to include was actually 0% for the 20 and 24 week time horizons over both the 1998-2002 (Table 3b) and the 1993-2002 (Table 4b) time periods. Once again, this implies that incorporating current information into forecasts for basis 20 or 24 weeks into the future fails to improve forecasting accuracy.

CONCLUSION

The ability to make accurate livestock basis forecasts is vital to the successful management of risk of agribusiness firms. There has been much research conducted evaluating the use of price and basis forecasts for grains and how accurate they may be, but little research has specifically looked at the procedures of making livestock basis forecasts. This study used root mean squared forecasting errors in both an out-of-sample and in-sample framework to evaluate whether or not the inclusion of current basis information known at the time of the forecast would improve forecasters’ ability to make accurate livestock basis projections. Furthermore, the optimal amount of this “current information” to include in forecasting livestock basis was evaluated. The optimal amount of information to include depends on how far out the forecaster is attempting to project basis. As a general rule, as the time interval between the week the forecast is made and the week being forecasted increases, the reductions in RMSE resulting from the inclusion of current information declines.

Likewise, the optimal amount of this current information to include in the forecast also declines.

The results of this study suggest that livestock basis forecasters should consider supplementing historical averages with additional basis information known at the time of the forecasts (i.e., current information) when forecasting up to about 12 weeks into the future. The value of incorporating contemporaneous information in basis forecasts declined rapidly, however, as the forecasting horizon increased. Forecasts made 16 or more weeks into the future that incorporated current information were not significantly more accurate than basis forecasts made using only historical information. This research has shown that incorporating current basis information over the 1993-2002 and 1998-2002 time periods may have lowered forecasting RMSE by up to $0.17/cwt. for live cattle and up to $0.18/cwt. for feeder cattle when forecasting up to about 12 weeks ahead. Future research should be conducted to evaluate and compare other forms of current information in making livestock basis forecasts.

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Table 1a. Paired T-Tests Matrices for Feeder Cattle Basis Forecasts (1998-2002)*

4 Weeks Out Forecasts

RMSE	1.63	1.58	1.55	1.54	1.55	1.57	1.61	1.66	1.73	1.81	1.91	1.54
"x"	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.32
0.00	------	0.0000	0.0004	0.0049	0.0440	0.2379	0.7445	0.5939	0.1676	0.0279	0.0029	0.0077
0.10		------	0.0049	0.0440	0.2379	0.7445	0.5939	0.1676	0.0279	0.0029	0.0002	0.0632
0.20			------	0.2379	0.7445	0.5939	0.1676	0.0279	0.0029	0.0002	0.0000	0.3080
0.30				------	0.5939	0.1676	0.0279	0.0029	0.0002	0.0000	0.0000	0.8706
0.40					------	0.0279	0.0029	0.0002	0.0000	0.0000	0.0000	0.4870
0.50						------	0.0002	0.0000	0.0000	0.0000	0.0000	0.1241
0.60							------	0.0000	0.0000	0.0000	0.0000	0.0188
0.70								------	0.0000	0.0000	0.0000	0.0018
0.80									------	0.0000	0.0000	0.0001
0.90										------	0.0000	0.0000
1.00											------	0.0000
0.32												------

8 Weeks Out Forecasts

RMSE	1.63	1.58	1.56	1.55	1.56	1.59	1.63	1.69	1.77	1.86	1.95	1.55
"x"	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.30
0.00	------	0.0002	0.0026	0.0232	0.1328	0.4719	0.9460	0.3980	0.1094	0.0201	0.0026	0.0213
0.10		------	0.0232	0.1328	0.4719	0.9460	0.3980	0.1094	0.0201	0.0026	0.0003	0.1244
0.20			------	0.4719	0.9460	0.3980	0.1094	0.0201	0.0026	0.0003	0.0000	0.4513
0.30				------	0.3980	0.1094	0.0201	0.0026	0.0003	0.0000	0.0000	0.9730
0.40					------	0.0201	0.0026	0.0003	0.0000	0.0000	0.0000	0.4168
0.50						------	0.0003	0.0000	0.0000	0.0000	0.0000	0.1166
0.60							------	0.0000	0.0000	0.0000	0.0000	0.0217
0.70								------	0.0000	0.0000	0.0000	0.0029
0.80									------	0.0000	0.0000	0.0003
0.90										------	0.0000	0.0000
1.00											------	0.0000
0.30												------

12 Weeks Out Forecasts

RMSE	1.63	1.59	1.58	1.58	1.60	1.64	1.69	1.76	1.84	1.93	2.04	1.58
"x"	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.24
0.00	------	0.0007	0.0106	0.0945	0.4467	0.8743	0.2872	0.0526	0.0057	0.0004	0.0000	0.0282
0.10		------	0.0945	0.4467	0.8743	0.2872	0.0526	0.0057	0.0004	0.0000	0.0000	0.1945
0.20			------	0.8743	0.2872	0.0526	0.0057	0.0004	0.0000	0.0000	0.0000	0.7037
0.30				------	0.0526	0.0057	0.0004	0.0000	0.0000	0.0000	0.0000	0.5921
0.40					------	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000	0.1525
0.50						------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0222
0.60							------	0.0000	0.0000	0.0000	0.0000	0.0020
0.70								------	0.0000	0.0000	0.0000	0.0001
0.80									------	0.0000	0.0000	0.0000
0.90										------	0.0000	0.0000
1.00											------	0.0000
0.24												------

* P-values associated with null hypothesis there is no difference in RMSE of different forecasting models.

Table 1b. Paired T-Tests Matrices for Feeder Cattle Basis Forecasts (1998-2002)*

16 Weeks Out Forecasts

RMSE	1.63	1.61	1.61	1.63	1.67	1.72	1.79	1.87	1.96	2.06	2.17	1.61
"x"	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.15
0.00	------	0.0724	0.3842	0.9543	0.3341	0.0661	0.0078	0.0006	0.0000	0.0000	0.0000	0.1727
0.10		------	0.9543	0.3341	0.0661	0.0078	0.0006	0.0000	0.0000	0.0000	0.0000	0.6642
0.20			------	0.0661	0.0078	0.0006	0.0000	0.0000	0.0000	0.0000	0.0000	0.6264
0.30				------	0.0006	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1675
0.40					------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0258
0.50						------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0025
0.60							------	0.0000	0.0000	0.0000	0.0000	0.0002
0.70								------	0.0000	0.0000	0.0000	0.0000
0.80									------	0.0000	0.0000	0.0000
0.90										------	0.0000	0.0000
1.00											------	0.0000
0.15												------

20 Weeks Out Forecasts

RMSE	1.63	1.61	1.60	1.62	1.65	1.70	1.77	1.85	1.94	2.04	2.15	1.60
"x"	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.16
0.00	------	0.0453	0.2567	0.7958	0.5442	0.1482	0.0247	0.0027	0.0002	0.0000	0.0000	0.1496
0.10		------	0.7958	0.5442	0.1482	0.0247	0.0027	0.0002	0.0000	0.0000	0.0000	0.5712
0.20			------	0.1482	0.0247	0.0027	0.0002	0.0000	0.0000	0.0000	0.0000	0.7607
0.30				------	0.0027	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.2482
0.40					------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0489
0.50						------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0062
0.60							------	0.0000	0.0000	0.0000	0.0000	0.0006
0.70								------	0.0000	0.0000	0.0000	0.0000
0.80									------	0.0000	0.0000	0.0000
0.90										------	0.0000	0.0000
1.00											------	0.0000
0.16												------

24 Weeks Out Forecasts

RMSE	1.63	1.62	1.64	1.67	1.72	1.78	1.85	1.94	2.04	2.14	2.26	1.62
"x"	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.07
0.00	------	0.6858	0.6163	0.1624	0.0235	0.0020	0.0001	0.0000	0.0000	0.0000	0.0000	0.5130
0.10		------	0.1624	0.0235	0.0020	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.8021
0.20			------	0.0020	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2496
0.30				------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0425
0.40					------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0042
0.50						------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003
0.60							------	0.0000	0.0000	0.0000	0.0000	0.0000
0.70								------	0.0000	0.0000	0.0000	0.0000
0.80									------	0.0000	0.0000	0.0000
0.90										------	0.0000	0.0000
1.00											------	0.0000
0.07												------

* P-values associated with null hypothesis there is no difference in RMSE of different forecasting models.

Table 2a. Paired T-Tests Matrices for Feeder Cattle Basis Forecasts (1993-2002)*

4 Weeks Out Forecasts

RMSE	1.73	1.66	1.61	1.57	1.55	1.55	1.57	1.61	1.66	1.73	1.82	1.55
"x"	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.45
0.00	------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003	0.0137	0.2106	0.9866	0.2244	0.0000
0.10		------	0.0000	0.0000	0.0000	0.0003	0.0137	0.2106	0.9866	0.2244	0.0156	0.0000
0.20			------	0.0000	0.0003	0.0137	0.2106	0.9866	0.2244	0.0156	0.0004	0.0023
0.30				------	0.0137	0.2106	0.9866	0.2244	0.0156	0.0004	0.0000	0.0637
0.40					------	0.9866	0.2244	0.0156	0.0004	0.0000	0.0000	0.5305
0.50						------	0.0156	0.0004	0.0000	0.0000	0.0000	0.5422
0.60							------	0.0000	0.0000	0.0000	0.0000	0.0673
0.70								------	0.0000	0.0000	0.0000	0.0026
0.80									------	0.0000	0.0000	0.0000
0.90										------	0.0000	0.0000
1.00											------	0.0000
0.45												------

8 Weeks Out Forecasts

RMSE	1.73	1.67	1.63	1.61	1.60	1.61	1.65	1.69	1.76	1.84	1.93	1.60
"x"	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.38
0.00	------	0.0000	0.0000	0.0000	0.0000	0.0012	0.0426	0.4354	0.6391	0.0907	0.0042	0.0000
0.10		------	0.0000	0.0000	0.0012	0.0426	0.4354	0.6391	0.0907	0.0042	0.0001	0.0005
0.20			------	0.0012	0.0426	0.4354	0.6391	0.0907	0.0042	0.0001	0.0000	0.0238
0.30				------	0.4354	0.6391	0.0907	0.0042	0.0001	0.0000	0.0000	0.3097
0.40					------	0.0907	0.0042	0.0001	0.0000	0.0000	0.0000	0.8143
0.50						------	0.0001	0.0000	0.0000	0.0000	0.0000	0.1430
0.60							------	0.0000	0.0000	0.0000	0.0000	0.0081
0.70								------	0.0000	0.0000	0.0000	0.0002
0.80									------	0.0000	0.0000	0.0000
0.90										------	0.0000	0.0000
1.00											------	0.0000
0.38												------

12 Weeks Out Forecasts

RMSE	1.73	1.69	1.66	1.64	1.65	1.67	1.71	1.77	1.84	1.93	2.03	1.64
"x"	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.32
0.00	------	0.0000	0.0000	0.0000	0.0028	0.0817	0.6339	0.4375	0.0466	0.0017	0.0000	0.0001
0.10		------	0.0000	0.0028	0.0817	0.6339	0.4375	0.0466	0.0017	0.0000	0.0000	0.0058
0.20			------	0.0817	0.6339	0.4375	0.0466	0.0017	0.0000	0.0000	0.0000	0.1330
0.30				------	0.4375	0.0466	0.0017	0.0000	0.0000	0.0000	0.0000	0.8120
0.40					------	0.0017	0.0000	0.0000	0.0000	0.0000	0.0000	0.3128
0.50						------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0269
0.60							------	0.0000	0.0000	0.0000	0.0000	0.0008
0.70								------	0.0000	0.0000	0.0000	0.0000
0.80									------	0.0000	0.0000	0.0000
0.90										------	0.0000	0.0000
1.00											------	0.0000
0.32												------

* P-values associated with null hypothesis there is no difference in RMSE of different forecasting models.

Table 2b. Paired T-Tests Matrices for Feeder Cattle Basis Forecasts (1993-2002)*

16 Weeks Out Forecasts

RMSE	1.73	1.71	1.70	1.70	1.73	1.77	1.83	1.90	1.99	2.08	2.19	1.70
"x"	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.21
0.00	------	0.0001	0.0088	0.1627	0.8682	0.2963	0.0270	0.0009	0.0000	0.0000	0.0000	0.0112
0.10		------	0.1627	0.8682	0.2963	0.0270	0.0009	0.0000	0.0000	0.0000	0.0000	0.1894
0.20			------	0.2963	0.0270	0.0009	0.0000	0.0000	0.0000	0.0000	0.0000	0.9339
0.30				------	0.0009	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2605
0.40					------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0221
0.50						------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0007
0.60							------	0.0000	0.0000	0.0000	0.0000	0.0000
0.70								------	0.0000	0.0000	0.0000	0.0000
0.80									------	0.0000	0.0000	0.0000
0.90										------	0.0000	0.0000
1.00											------	0.0000
0.21												------

20 Weeks Out Forecasts

RMSE	1.73	1.71	1.70	1.71	1.73	1.78	1.83	1.91	1.99	2.09	2.20	1.70
"x"	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.20
0.00	------	0.0004	0.0150	0.2099	0.9563	0.2540	0.0209	0.0006	0.0000	0.0000	0.0000	0.0162
0.10		------	0.2099	0.9563	0.2540	0.0209	0.0006	0.0000	0.0000	0.0000	0.0000	0.2200
0.20			------	0.2540	0.0209	0.0006	0.0000	0.0000	0.0000	0.0000	0.0000	0.9781
0.30				------	0.0006	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2429
0.40					------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0195
0.50						------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0006
0.60							------	0.0000	0.0000	0.0000	0.0000	0.0000
0.70								------	0.0000	0.0000	0.0000	0.0000
0.80									------	0.0000	0.0000	0.0000
0.90										------	0.0000	0.0000
1.00											------	0.0000
0.20												------

24 Weeks Out Forecasts

RMSE	1.73	1.72	1.72	1.75	1.79	1.84	1.91	1.99	2.09	2.19	2.30	1.72
"x"	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.13
0.00	------	0.0750	0.5441	0.5730	0.0876	0.0050	0.0001	0.0000	0.0000	0.0000	0.0000	0.1394
0.10		------	0.5730	0.0876	0.0050	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.7619
0.20			------	0.0050	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3883
0.30				------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0458
0.40					------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0021
0.50						------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.60							------	0.0000	0.0000	0.0000	0.0000	0.0000
0.70								------	0.0000	0.0000	0.0000	0.0000
0.80									------	0.0000	0.0000	0.0000
0.90										------	0.0000	0.0000
1.00											------	0.0000
0.13												------

* P-values associated with null hypothesis there is no difference in RMSE of different forecasting models.

Table 3a. Paired T-Tests Matrices for Live Cattle Basis Forecasts (1998-2002)*

4 Weeks Out Forecasts

RMSE	1.51	1.45	1.40	1.37	1.35	1.35	1.36	1.40	1.44	1.51	1.58	1.35
"x"	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.45
0.00	------	0.0000	0.0000	0.0000	0.0000	0.0002	0.0042	0.0540	0.3269	0.9602	0.3997	0.0000
0.10		------	0.0000	0.0000	0.0002	0.0042	0.0540	0.3269	0.9602	0.3997	0.0931	0.0010
0.20			------	0.0002	0.0042	0.0540	0.3269	0.9602	0.3997	0.0931	0.0143	0.0176
0.30				------	0.0540	0.3269	0.9602	0.3997	0.0931	0.0143	0.0016	0.1535
0.40					------	0.9602	0.3997	0.0931	0.0143	0.0016	0.0002	0.6269
0.50						------	0.0931	0.0143	0.0016	0.0002	0.0000	0.6698
0.60							------	0.0016	0.0002	0.0000	0.0000	0.1967
0.70								------	0.0000	0.0000	0.0000	0.0362
0.80									------	0.0000	0.0000	0.0047
0.90										------	0.0000	0.0005
1.00											------	0.0000
0.45												------

8 Weeks Out Forecasts

RMSE	1.51	1.47	1.44	1.43	1.43	1.45	1.49	1.53	1.59	1.66	1.74	1.43
"x"	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.33
0.00	------	0.0000	0.0005	0.0066	0.0513	0.2410	0.6882	0.7257	0.2834	0.0792	0.0167	0.0119
0.10		------	0.0066	0.0513	0.2410	0.6882	0.7257	0.2834	0.0792	0.0167	0.0029	0.0812
0.20			------	0.2410	0.6882	0.7257	0.2834	0.0792	0.0167	0.0029	0.0004	0.3334
0.30				------	0.7257	0.2834	0.0792	0.0167	0.0029	0.0004	0.0001	0.8416
0.40					------	0.0792	0.0167	0.0029	0.0004	0.0001	0.0000	0.5856
0.50						------	0.0029	0.0004	0.0001	0.0000	0.0000	0.2086
0.60							------	0.0001	0.0000	0.0000	0.0000	0.0538
0.70								------	0.0000	0.0000	0.0000	0.0107
0.80									------	0.0000	0.0000	0.0017
0.90										------	0.0000	0.0003
1.00											------	0.0000
0.33												------

12 Weeks Out Forecasts

RMSE	1.51	1.51	1.52	1.55	1.59	1.65	1.71	1.79	1.87	1.97	2.06	1.51
"x"	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.05
0.00	------	0.9679	0.4160	0.1036	0.0169	0.0020	0.0002	0.0000	0.0000	0.0000	0.0000	0.6482
0.10		------	0.1036	0.0169	0.0020	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.6816
0.20			------	0.0020	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2130
0.30				------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0420
0.40					------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0057
0.50						------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0006
0.60							------	0.0000	0.0000	0.0000	0.0000	0.0001
0.70								------	0.0000	0.0000	0.0000	0.0000
0.80									------	0.0000	0.0000	0.0000
0.90										------	0.0000	0.0000
1.00											------	0.0000
0.05												------

* P-values associated with null hypothesis there is no difference in RMSE of different forecasting models.

Table 3b. Paired T-Tests Matrices for Live Cattle Basis Forecasts (1998-2002)*

16 Weeks Out Forecasts

RMSE	1.51	1.53	1.57	1.62	1.69	1.76	1.84	1.93	2.03	2.13	2.24	1.51
"x"	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.00
0.00	------	0.0026	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	------
0.10		------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0026
0.20			------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002
0.30				------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.40					------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.50						------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.60							------	0.0000	0.0000	0.0000	0.0000	0.0000
0.70								------	0.0000	0.0000	0.0000	0.0000
0.80									------	0.0000	0.0000	0.0000
0.90										------	0.0000	0.0000
1.00											------	0.0000
0.00												------

20 Weeks Out Forecasts

RMSE	1.51	1.53	1.57	1.62	1.68	1.75	1.83	1.92	2.02	2.12	2.23	1.51
"x"	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.00
0.00	------	0.0020	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	------
0.10		------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0020
0.20			------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
0.30				------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.40					------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.50						------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.60							------	0.0000	0.0000	0.0000	0.0000	0.0000
0.70								------	0.0000	0.0000	0.0000	0.0000
0.80									------	0.0000	0.0000	0.0000
0.90										------	0.0000	0.0000
1.00											------	0.0000
0.00												------

24 Weeks Out Forecasts

RMSE	1.51	1.53	1.57	1.63	1.69	1.76	1.85	1.94	2.03	2.14	2.24	1.51
"x"	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.00
0.00	------	0.0009	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	------
0.10		------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0009
0.20			------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.30				------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.40					------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.50						------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.60							------	0.0000	0.0000	0.0000	0.0000	0.0000
0.70								------	0.0000	0.0000	0.0000	0.0000
0.80									------	0.0000	0.0000	0.0000
0.90										------	0.0000	0.0000
1.00											------	0.0000
0.00												------

* P-values associated with null hypothesis there is no difference in RMSE of different forecasting models.

Table 4a. Paired T-Tests Matrices for Live Cattle Basis Forecasts (1993-2002)*

4 Weeks Out Forecasts

RMSE	1.47	1.41	1.36	1.32	1.30	1.30	1.31	1.34	1.39	1.45	1.52	1.30
"x"	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.47
0.00	------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0012	0.0614	0.6127	0.4208	0.0000
0.10		------	0.0000	0.0000	0.0000	0.0000	0.0012	0.0614	0.6127	0.4208	0.0425	0.0000
0.20			------	0.0000	0.0000	0.0012	0.0614	0.6127	0.4208	0.0425	0.0017	0.0002
0.30				------	0.0012	0.0614	0.6127	0.4208	0.0425	0.0017	0.0000	0.0216
0.40					------	0.6127	0.4208	0.0425	0.0017	0.0000	0.0000	0.3546
0.50						------	0.0425	0.0017	0.0000	0.0000	0.0000	0.6845
0.60							------	0.0000	0.0000	0.0000	0.0000	0.0969
0.70								------	0.0000	0.0000	0.0000	0.0050
0.80									------	0.0000	0.0000	0.0001
0.90										------	0.0000	0.0000
1.00											------	0.0000
0.47												------

8 Weeks Out Forecasts

RMSE	1.47	1.42	1.38	1.36	1.35	1.36	1.38	1.42	1.47	1.53	1.61	1.35
"x"	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.40
0.00	------	0.0000	0.0000	0.0000	0.0000	0.0008	0.0241	0.2555	0.9902	0.2751	0.0316	0.0000
0.10		------	0.0000	0.0000	0.0008	0.0241	0.2555	0.9902	0.2751	0.0316	0.0017	0.0008
0.20			------	0.0008	0.0241	0.2555	0.9902	0.2751	0.0316	0.0017	0.0000	0.0244
0.30				------	0.2555	0.9902	0.2751	0.0316	0.0017	0.0000	0.0000	0.2580
0.40					------	0.2751	0.0316	0.0017	0.0000	0.0000	0.0000	0.9951
0.50						------	0.0017	0.0000	0.0000	0.0000	0.0000	0.2725
0.60							------	0.0000	0.0000	0.0000	0.0000	0.0312
0.70								------	0.0000	0.0000	0.0000	0.0016
0.80									------	0.0000	0.0000	0.0000
0.90										------	0.0000	0.0000
1.00											------	0.0000
0.40												------

12 Weeks Out Forecasts

RMSE	1.47	1.46	1.46	1.47	1.50	1.54	1.59	1.65	1.73	1.81	1.90	1.45
"x"	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.16
0.00	------	0.0087	0.1577	0.8451	0.3197	0.0333	0.0015	0.0000	0.0000	0.0000	0.0000	0.0545
0.10		------	0.8451	0.3197	0.0333	0.0015	0.0000	0.0000	0.0000	0.0000	0.0000	0.4813
0.20			------	0.0333	0.0015	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.6160
0.30				------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0965
0.40					------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0059
0.50						------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002
0.60							------	0.0000	0.0000	0.0000	0.0000	0.0000
0.70								------	0.0000	0.0000	0.0000	0.0000
0.80									------	0.0000	0.0000	0.0000
0.90										------	0.0000	0.0000
1.00											------	0.0000
0.16												------

* P-values associated with null hypothesis there is no difference in RMSE of different forecasting models.

Table 4b. Paired T-Tests Matrices for Live Cattle Basis Forecasts (1993-2002)*

16 Weeks Out Forecasts

RMSE	1.47	1.47	1.49	1.52	1.56	1.62	1.69	1.76	1.85	1.94	2.03	1.47
"x"	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.03
0.00	------	0.7182	0.1303	0.0088	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.6866
0.10		------	0.0088	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4461
0.20			------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0572
0.30				------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0028
0.40					------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
0.50						------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.60							------	0.0000	0.0000	0.0000	0.0000	0.0000
0.70								------	0.0000	0.0000	0.0000	0.0000
0.80									------	0.0000	0.0000	0.0000
0.90										------	0.0000	0.0000
1.00											------	0.0000
0.03												------

20 Weeks Out Forecasts

RMSE	1.47	1.48	1.50	1.54	1.59	1.65	1.72	1.80	1.89	1.98	2.08	1.47
"x"	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.00
0.00	------	0.1381	0.0092	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	------
0.10		------	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1381
0.20			------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0092
0.30				------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003
0.40					------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.50						------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.60							------	0.0000	0.0000	0.0000	0.0000	0.0000
0.70								------	0.0000	0.0000	0.0000	0.0000
0.80									------	0.0000	0.0000	0.0000
0.90										------	0.0000	0.0000
1.00											------	0.0000
0.00												------

24 Weeks Out Forecasts

RMSE	1.47	1.48	1.51	1.54	1.59	1.65	1.72	1.80	1.89	1.99	2.09	1.47
"x"	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.00
0.00	------	0.0936	0.0042	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	------
0.10		------	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0936
0.20			------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0042
0.30				------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
0.40					------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.50						------	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.60							------	0.0000	0.0000	0.0000	0.0000	0.0000
0.70								------	0.0000	0.0000	0.0000	0.0000
0.80									------	0.0000	0.0000	0.0000
0.90										------	0.0000	0.0000
1.00											------	0.0000
0.00												------

* P-values associated with null hypothesis there is no difference in RMSE of different forecasting models.