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Usefulness of Placement-Weight Data in Forecasting Fed Cattle Marketings and Prices

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ABSTRACT

In 1996, the USDA began reporting cattle-on-feed placements in various weight groups, which should provide information regarding expected slaughter timings and improve fed cattle price forecasts and marketing strategies. Private data were collected to obtain the necessary degrees of freedom to test statistical relationships between placement weight distributions, beef supply, and fed cattle prices. Use of placement weights improved beef supply forecasts only at a one-month horizon; it contributed nothing to price forecast accuracy or returns from selectively hedging.

Key Words: *fed cattle, forecasting, marketing, prices, placements.*

Despite long-term efforts to produce accurate fed cattle price forecasts, economists have found this a daunting task (Kastens, Schroeder, and Plain). However, cattle producers indicate that they rely on price forecasts for making production, market timing, and forward pricing decisions (Schroeder *et al.*). Recently, the USDA began reporting monthly steer and heifer placement on feed numbers by weight in the monthly *Cattle on Feed Report.* These placement-weight data are expected to improve fed cattle marketing projections, since cattle placed on feed at a particular weight will typically be fed a similar and relatively fixed number of days before slaughter. Fed cattle marketings are the most important fed cattle price determinant; therefore, improved ability to project marketings should also improve price forecasting accuracy. The objective of this study is to determine whether monthly fed cattle placement-weight distribution data can be used to improve fed cattle price forecasting and cattle feeder and beef packer marketing decisions.

Bacon, Koontz, and Trapp concluded that monthly steer and heifer placement on feed weight distribution data are useful for forecasting monthly fed cattle marketings. In 1996, the USDA began reporting feeder-cattle placement on feed numbers by various weight categories in the monthly seven-state *Cattle on Feed Report.* Because these USDA data have only been available for a short time, they are not sufficient to derive and test statistical relationships between placement weights and fed cattle marketings. Therefore, this study uses private feeder-cattle placement-weight data collected by Cattle Fax and Professional Cattle Consultants (PCC) to estimate the relationship between placement-weight distributions and marketings and fed cattle price forecasts.

The value of placement-weight data in

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forecasting monthly marketings can be determined by comparing out-of-sample fed cattle marketings forecasts with and without placement-weight data included in the model. Two marketings forecasting models are constructed for one- to six-month horizons; one uses aggregate placement data and the other uses placement-weight data. Out-of-sample marketing forecasts are conducted to compare the relative forecasting ability and for use in two econometric fed cattle monthly price forecasting models.

Econometric model price forecasts are conducted using marketings forecasts from the aggregate placement and placement-weight data models using data in their original form and first differences, resulting in four econometric price forecasts. Monthly out-of-sample point forecasts and 50% and 90% prediction intervals are simulated one- to six-months ahead from January 1994 through June 1997. Performance of the point forecasts are judged by root-mean-squared error (RMSE) and the percent of price directions (direction of price change from the current price) forecasted. Prediction intervals are judged by the percent of actual monthly prices contained within the expected interval. Also, the point forecasts and prediction intervals are used in a selective hedging simulation to determine the relative ability of placement-weight data to generate profit-enhancing selective hedges for cattle feeders and beef packers.

Placement-Weight Data

Without knowing placement weights, cattle placed on feed this month may remain on feed from two to eight months or longer. However, if placement weights are known, better approximations can be made regarding the number of days cattle of each weight are expected to be on feed. Actual closeout data on over 10,000 pens of cattle finished in Kansas reveal a strong relationship between days on feed and feeder cattle placement weight (Albright *et al.*). Days on feed ranged from an average of 119 for cattle weighing 800–899 lbs. placed on feed to 150 days for cattle weighing 600–699 lbs. placed on feed.

Before 1996, historical feeder-cattle placement-weight data were not publicly reported. Therefore, private data were used to estimate past placement-weight data. These private estimates were provided by Professional Cattle Consultants and Cattle Fax. Both consultants survey their clients' monthly cattle placements on feed across various weight groups; these consultants indicated their samples each represent approximately 20–25% of U.S. placements. Cattle Fax provided their clients' percent of monthly placements weighing less than 600, 600–699, 700–799, and over 800 lb from 1985–1996. PCC provided total monthly placements and placements in those same weight groups from 1988 through June 1997 for their clients. When both private data sets were available, the percents of placements in each weight group were averaged; otherwise only the one available was used.

If PCC and Cattle Fax placement-weight distribution data are similar to total placements reported by the USDA for the seven major cattle feeding states[1], these historical private data should be a reasonable proxy for what the USDA data would have been had it reported before 1996. By multiplying the percent of monthly placements in each weight group in the private data set by total placements for the seven major cattle feeding states reported in the *USDA Cattle on Feed Report*, cattle placements in each weight group were estimated.

To test whether the private data is a reasonable proxy for the USDA data, the percent of total placements in each weight group from the USDA data was regressed against a constant and the percent of total placements for the same weight group in the private data. The estimations are shown in Table 1. The hypothesis that the coefficient on the percent of total placements in the private data set was equal to 1 could not be rejected at the 5% significance level for any weight group. This suggests the change in percent of total monthly placements in each weight group for the USDA and the private data move approximately one for one. Additionally, the constant

[1] The seven major cattle feeding states are AZ, CA, CO, IA, KS, NE, and TX.

Table 1. Regressions of Percent of Total Monthly Placements in Each Weight Group in USDA Data on a Constant and the Percent of Total Monthly Placements in the Same Weight Group in the Private Data[a] (Sample Period: December, 1995–May, 1997)

Estimate of a_0	Estimate of a_1
Regression 1: % total placements under 600 lbs. in USDA data = $a_0 + a_1$*% total placements under 600 lbs. in private data	
0.035	1.008
(0.017)[a]	(.097)
Regression 2: % total placements 600–699 lbs. in USDA data = $a_0 + a_1$*% total placements 600–699 lbs. in private data	
−0.012	0.966
(0.032)	(0.108)
Regression 3: % total placements 700–799 lbs. in USDA data = $a_0 + a_1$*% total placements 700–799 lbs. in private data	
0.015	0.848
(0.028)	(0.078)
Regression 4: % total placements over 800 lbs. in USDA data = $a_0 + a_1$*% total placements over 800 lbs. in private data	
0.017	1.040
(0.017)	(0.088)

[a] Standard errors are in parenthesis.

was only significantly different from zero at the 5% significance level for the less-than-600 lb weight group, implying there is statistical bias for this weight category when using the private data to predict the USDA data. This bias is quite small, however, with an estimate of only 0.035%, so it is economically inconsequential. Therefore, the private placement data are generally unbiased estimates of the USDA data and are a reasonable proxy for the USDA data before its existence.

Marketings Forecasts

Bacon, Koontz, and Trapp explained marketings as a function of past placements, monthly dummy variables, and a time trend. A similar model is developed here. The first model uses *aggregate placement* variables four to seven months before the fed cattle marketing month to represent past placements; the second model uses *placement weight* variables three to seven months before marketing. The models were updated monthly starting with data from 1980 through 1993, which was used to forecast marketings for January through May of 1994. The last estimations used data from 1980 through 1997. The models reported in Table 2 are the first estimations using data from 1980 through 1993. Model details and estimation results are shown in Table 2. Marketings used in the estimation were total monthly marketings for the seven major cattle feeding states.

In-sample standard errors using *aggregate placement* and *placement-weight data* are not significantly different at any horizon. The coefficient of determination (R-squared) for the aggregated placement model was 70% and 67% one and six months ahead, and in the placement weight model 82% and 79% one and six months ahead, respectively. The models were re-estimated each month and used to conduct monthly out-of-sample fed cattle marketings forecasts and 50% and 90% prediction intervals one to six months ahead for January 1994 through June 1997. Table 3 shows the out-of-sample root-mean-squared errors (RMSE), percent marketings directions forecasted, and the percent of actual monthly marketings contained within the prediction intervals. The Ashley, Granger, and Schmalensee (AGS) test was used to discern significant differences in RMSE's.

One to four months ahead the model using placement-weight data had smaller squared forecasting errors, but these differences were only statistically smaller one month ahead. Similarly, the model using placement-weight data improved percent of marketings directions forecasted one to four months ahead. RMSE and percent of marketings directions forecasted only evaluate a forecasting model's point forecast. To evaluate how well the models describe the distribution of marketings the percent of observations which fell into the 50% and 90% prediction intervals were calculated. If a model adequately describes the marketings distribution, the percent of observations which fall into these

Table 2. Estimated Coefficients of Two Types of Placement Variables (Aggregate and Placement Weight Variables) From Regressions of Marketings on Monthly Dummy Variables, Time Trend, and Placement Variables. (Sample Period: 1980–1993)

Marketings Forecasting Model Using Aggregate Placement Variables[a]

One to Three Months Ahead Forecasting Model:

$$\text{Marketings}_t^d = \beta_0 + \underset{(0.046)^c}{0.100\text{Plmt}_{t-4}} + \underset{(0.046)}{0.060\text{Plmt}_{t-5}} - \underset{(0.047)}{0.010\text{Plmt}_{t-6}} + \underset{(0.046)}{0.0930\text{Plmt}_{t-7}} + \alpha t + \sum \gamma_i M_i + \epsilon$$

Four Months Ahead Forecasting Model:

$$\text{Marketings}_t = \beta_0 + \underset{(0.047)}{0.065\text{Plmt}_{t-5}} - \underset{(0.047)}{0.015\text{Plmt}_{t-6}} + \underset{(0.047)}{0.084\text{Plmt}_{t-7}} + \alpha t + \sum \gamma_i M_i + \epsilon$$

Five Months Ahead Forecasting Model:

$$\text{Marketings}_t = \beta_0 - \underset{(0.047)}{0.017\text{Plmt}_{t-6}} + \underset{(0.047)}{0.076\text{Plmt}_{t-7}} + \alpha t + \sum \gamma_i M_i + \epsilon$$

Six Months Ahead Forecasting Model:

$$\text{Marketings}_t = \beta_0 + \underset{(0.047)}{0.077\text{Plmt}_{t-7}} + \alpha t + \sum \gamma_i M_i + \epsilon$$

Marketings Forecasting Model Using Placement Weight Variables[b]

One to Two Months Ahead Forecasting Model:

$$\text{Marketings}_t = \beta_0 + \underset{(0.081)}{0.193\text{Plmt7} - 800_{t-3}} + \underset{(0.070)}{0.228\text{Plmt7} - 800_{t-4}} + \underset{(0.098)}{0.310\text{Plmt} < 600_{t-7}} + \alpha t$$
$$+ \sum \gamma_i M_i + \epsilon$$

Three Month Ahead Forecasting Model:

$$\text{Marketings}_t = \beta_0 + \underset{(0.079)}{0.288\text{Plmt7} - 800_{t-4}} + \underset{(0.010)}{0.299\text{Plmt} < 600_{t-7}} + \alpha t + \sum \gamma_i M_i + \epsilon$$

Four Months Ahead Forecasting Model:

$$\text{Marketings}_t = \beta_0 + \underset{(0.079)}{0.156\text{Plmt7} - 800_{t-5}} + \underset{(0.108)}{0.293\text{Plmt} < 600_{t-7}} + \alpha t + \sum \gamma_i M_i + \epsilon$$

Five to Six Months Ahead Forecasting Model:

$$\text{Marketings}_t = \beta_0 + \underset{(0.112)}{0.265\text{Plmt} < 600_{t-7}} + \alpha t + \sum \gamma_i M_i + \epsilon$$

[a] Plmt_{t-i} denotes total placements i months before the forecast horizon, t denotes a time trend, M_i denotes Month i, all Greek letters are parameters, and ϵ is the error term.
[b] $\text{Plmt} < 600_{t-i}$ and $\text{Plmt7} - 800_{t-i}$ denote total placements under 600 lbs. and between 700 and 800 lbs., respectively, i months before the forecast horizon.
[c] Standard Errors are in parenthesis.
[d] Marketings are fed cattle put up for sale.

two categories should be approximately 50% and 90%. Neither model's prediction intervals were superior and both contained far fewer observations than expected. Use of placement-weight data, therefore, improves marketings forecasts one month ahead, but is not significantly different than aggregate placement data at longer horizons. Percent marketings directions forecasted is higher one to four months ahead and prediction intervals are not relatively better at describing the marketings probability distribution.

Table 3. Out-of-Sample Marketings Forecasting Results (Sample Period: January 1994–July 1997)

	Forecast Horizon in Months					
	1	2	3	4	5	6
RMSE[a]	150[b]/140[c]	163/130	188/148	180/163	184/189	193/204
% Marketings Directions Forecasted	55%/60%	54%/66%	60%/70%	62%/70%	68%/66%	65%/59%
% Monthly Marketings Contained in 50% CI[d]	26%/21%	10%/19%	17%/7%	18%/18%	23%/15%	5%/11%
% Monthly Marketings Contained in 90% CI	51%/49%	33%/52%	34%/44%	28%/33%	36%/31%	37%/37%

[a] RMSE is # of head in thousands, differences in RMSE were only statistically significant one month ahead
[b] Using aggregate placement data
[c] Using placement-weight data
[d] CI denotes confidence interval

Fed Cattle Price Forecasts

The primary use of placement-weight data is to improve forecast accuracy of fed cattle prices. Regardless of whether it improves fed cattle marketings forecasts, it may or may not improve price forecasts. Two econometric models were developed to test this. The first model (ECON1) explained price as a function of the quantity of beef supplied[2], a food marketing cost index, and a dummy variable for the second quarter. The second model (ECON2) used only the change in the quantity of beef supplied to explain the change in fed cattle prices. Beef supply includes marketings; cow, bull, stag, and calf slaughter; imports; and inventories—all in dressed weights.

To forecast prices, the values of the explanatory variables were forecasted. An ARIMA model was employed to forecast the food marketing cost index and beef production components other than marketings. Forecasts were conducted using marketing forecasts from the placement-weight data model and aggregate placement data model. The fed cattle price used was the monthly weighted-average of weekly Western Kansas steer direct trade quotes in dollars per hundredweight. The price forecasting model details and estimations are shown in Table 4. Further details of model specification and how forecasts were conducted are located in the Appendix.

Monthly point forecasts and 50% and 90% prediction intervals one to six months ahead were conducted for January 1994 through June 1997. Forecasting results for each model and horizon are shown in Table 5. The econometric model forecast error differed little when using the two marketing forecasts. Placement-weight data yielded a smaller forecast RMSE only at two to three months ahead in ECON1 and two to four months ahead in ECON2. AGS tests concluded that forecast RMSE's using placement-weight data were only significantly lower at a four-month horizon in ECON2. Neither type of placement data consistently improved the percent of price directions forecasted, and confidence intervals using both data types were virtually identical.

[2] Other determinants of price such as pork and poultry production, consumer income, and population were not included because they either had unexpected signs or were insignificant.

Table 4. Monthly Econometric Fed Cattle Price Forecasting Models (Sample Period: 1980–1993)

ECON1

$\text{Price}_t = \alpha_0 + \alpha_1$[(marketings·dressed weight_{t-k-1}) + (bull and stag slaughter·dressed weight) + (cow slaughter·dressed weight) + (calf slaughter·dressed weight) + (imports in dressed $\text{weights})_{t-1}$ + (lbs. of beef in cold storage/.797)$]_t$ + α_3(Food Marketing Cost $\text{Index})_t$ + α_4(Second Quarter Dummy Variable) + $\rho e_{t-1} + e_t$

	Forecast Horizon					
	1	2	3	4	5	6
	Estimated Coefficients With Standard Errors in Parenthesis					
Beef	$-0.75E^{-05}$	$-0.70E^{-05}$	$-0.69E^{-05}$	$-0.68E^{-05}$	-0.66^{-05}	$-0.66E^{-05}$
Supply	$(0.28E^{-05})$	$(0.28E^{-05})$	$(0.28E^{-05})$	$(0.28E^{-05})$	$(0.28E^{-05})$	$(0.28E^{\cdot 05})$
Food	−1.04	−1.07	−1.08	−1.20	−1.20	−1.09
Marketing Cost Index	(0.24)	(0.25)	(0.25)	(0.23)	(0.23)	(0.23)
Second	2.33	2.38	2.40	2.70	2.65	2.67
Quarter	(0.68)	(0.69)	(0.70)	(0.70)	(0.71)	(0.69)
Constant	197.80	198.91	199.98	209.55	209.37	199.48
	(20.44)	(20.47)	(20.49)	(19.58)	(19.21)	(19.69)
RHO	0.89	0.89	0.89	.88	.88	.88
	(0.03)	(.04)	(0.03)	(.04)	(.04)	(.04)
R^2	0.93	0.93	0.93	0.92	0.92	0.91
Standard Error	3.38	3.40	3.42	3.37	3.40	3.34

ECON2

$\Delta\text{Price}_t = \alpha_0 + \alpha_1\Delta$[(marketings·dressed weight_{t-k-1}) + (bull and stag slaughter·dressed weight) + (cow slaughter·dressed weight) + (calf slaughter·dressed weight) + (imports in dressed $\text{weights})_{t-1}$ + (lbs. of beef in cold storage/.797)$]_t$ + $\rho e_{t-1} + e_t$

	Forecast Horizon					
	1	2	3	4	5	6
	Estimated Coefficients With Standard Errors in Parenthesis					
ΔBeef	$-0.516E^{-05}$	$-0.493E^{-05}$	$-0.467E^{-05}$	$-0.510E^{-05}$	$-0.467E^{-05}$	$-0.479E^{-05}$
Supply	$(0.23E^{-05})$	$(0.23E^{-05})$	$(0.22E^{-05})$	$(0.22E^{-05})$	$(0.22E^{-05})$	$(0.22E^{-05})$
Intercept	−0.35	−0.29	−0.30	−0.30	−0.36	−0.40
	(0.37)	(0.39)	(0.38)	(0.38)	(0.37)	(0.38)
RHO	.29	0.31	.31	0.30	0.30	0.31
	(.07)	(.07)	(0.07)	(0.07)	(0.08)	(0.08)
R^2	0.12	0.13	0.12	0.12	0.12	0.13
Standard Error	3.40	3.36	3.37	3.37	3.35	3.35

Table 5. Out-Of-Sample Root-Mean-Squared Error (RMSE), Percent Price Directions Forecasted, and Percent of Actual Monthly Western Kansas Fed Cattle Prices Contained in 50% and 90% Prediction Intervals (January 1994–July 1997)

	Forecast Horizon in Months					
Forecast Method	1	2	3	4	5	6
Econometric Model	4.62[a]	7.03	7.37	7.47	6.81	6.86
(ECON1) With	48.84%[b]	47.62%	48.78%	45.00%	51.28%	55.26%
Aggregate Placement	46.51%[c]	26.19%	26.83%	25.00%	28.21%	36.84%
Data	97.67%[d]	69.05%	68.29%	70.00%	76.92%	78.95%
Econometric Model	2.46	4.39	5.49	6.14	6.52	6.63
(ECON2) With	58.14%	50.00%	48.78%	47.50%	61.54%	55.26%
Aggregate Placement	65.12%	30.95%	21.95%	27.50%	23.08%	21.05%
Data	97.67%	78.57%	70.73%	57.50%	56.41%	50.00%
Econometric Model	4.77	6.97	7.29	7.47	6.84	6.88
(ECON1) With	53.49%	52.38%	48.78%	45.00%	51.28%	55.26%
Placement-weight	48.84%	21.43%	26.83%	25.00%	28.21%	36.84%
data	95.35%	64.29%	68.29%	70.00%	76.92%	81.58%
Econometric Model	2.48	4.25	5.42	6.12	6.53	6.64
(ECON2) With	60.47%	47.62%	46.34%	50.00%	58.97%	52.63%
Placement-weight	67.44%	30.95%	24.39%	30.00%	23.08%	21.05%
data	97.67%	80.95%	70.73%	57.50%	56.41%	52.63%

[a] RMSE
[b] Percent of price directions forecasted
[c] Percent of actual monthly prices contained in 50% confidence intervals
[d] Percent of actual monthly prices contained in 90% confidence intervals

Selective Hedging Assessment

Solely determining whether placement-weight data improves fed cattle price forecast accuracy does not measure its value. Smaller errors, per se, have no value; the ability of cattle feeders and packers to improve their economic position from using them is a measure of value. Thus, whether using placement-weight data generates profit-enhancing selective hedges was evaluated. If selective hedges, using price forecasts which incorporate placement-weight data as timing signals, generate relatively higher profits from futures market transactions, placement-weight data will be deemed valuable as a marketing tool for cattle feeders and packers.

Separate selective hedging simulations were conducted for representative packers (long hedgers) and feeders (short hedgers). Using the monthly forecasts at all horizons, if the forecasted price at month t is lower (higher) than the average of the last five days' futures settlement price for the contract expiring at or the month after t, minus (plus) transaction costs, the representative short (long) hedger sells (buys) a futures contract. The only transaction costs considered are brokerage fees of $75 per contract round-turn. Simulations are conducted using forecasted prediction intervals instead of the forecasted price as timing signals as well. The representative traders were assumed to offset their contracts the month corresponding to the forecast horizon; the offsetting price was the average settlement price for days 10–15 of that month. The numbers of short and long hedges signaled and total profits made from the futures transactions are shown in Table 6 for each model.

To interpret the simulation results, simulated profits from the futures transactions were regressed against dummy variables representing the forecasting method used, point estimate and 50% and 90% prediction interval market timing signals, selective short and long

Table 6. Simulated Futures Market Transaction Profits From Selectively Short and Long Hedging Over All Horizons Using Various Price Forecasting Techniques as Market Timing Signals (Sample Period: January 1994–July 1997)

	Market Timing Signal					
	Point Forecast		50% Prediction Interval		90% Prediction Interval	
Forecast Method	Short Hedges	Long Hedges	Short Hedges	Long Hedges	Short Hedges	Long Hedges
			per cwt			
Econometric Model (ECON1)	$49.47	$19.92	($0.14)	$64.72	$0.00	$38.71
With Aggregate Placement Data	26[a]	213	1	140	0	14
Econometric Model (ECON2)	($63.09)	($56.75)	($39.94)	($40.20)	($2.33)	($14.92)
With Aggregate Placement Data	135	99	72	57	2	13
Econometric Model (ECON1)	$39.69	$15.58	($0.14)	$90.93	$0.00	$43.80
With Placement-weight data	20	217	1	141	0	18
Econometric Model (ECON2)	($48.87)	($47.79)	($37.24)	($42.82)	($2.33)	($12.16)
With Placement-weight data	134	104	70	58	2	15

[a] Number of hedges.

hedges, and forecast horizon. The regression parameter estimates, shown in Table 7, have many important implications. Horizon has no significant impact on futures profits. Using 90% prediction intervals as market timing signals improves returns, and neither selective short or long hedgers have an advantage in generating positive returns.

Coefficients for each model show the model's relative performances in generating returns from selectively hedging. Econometric model ECON1 (using both aggregate place-

Table 7. Regression of Profits from Selectively Hedging on Horizon, Dummy Variables for 50% and 90% Prediction Interval Timing Signals, Dummy Variable for Selective Short Hedge, and Dummy Variables for Forecasting Model Used[ab]

Regression Coefficients With P-Values in Parenthesis			
Horizon	−0.04394 (0.446)	Econometric Model With Level USDA Data (ECON1)	−0.7043 (0.016)
50% Confidence Interval	0.18483 (0.370)	Econometric Model With Difference Public Data (ECON2)	0.4210 (0.020)
90% Confidence Interval	1.3526 (0.003)	Econometric Model With Level Private Data (ECON1)	−0.6827 (0.020)
Selective Long Hedge	−0.22608 (0.331)	Econometric Model With Differenced Private Data (ECON2)	0.3923 (0.219)
R-Square = 0.0241	*Standard Error = 3.79*	*Degrees of Freedom = 1,573*	

[a] The intercept was dropped to include all dummy variables in the regression

[b] The hypothesis that the coefficients on ECON1 with USDA data and ECON1 with private data were the same, and the hypothesis that the coefficients on ECON2 with USDA data and ECON2 with private data were the same could not be rejected at the 5% significance level.

ment and placement-weight data) was superior in generating positive returns relative to ECON2. However in both ECON1 and ECON2, returns were not significantly different when using aggregate placement data or placement-weight data, implying placement-weight data does not improve profits from selectively hedging.

Conclusion

Using placement-weight data, instead of aggregate placement data, in the marketings forecasting models in this study did little to improve marketing forecasts, and contributed nothing to price forecasts or profitability of selective hedges. This suggests that when USDA placement-weight data become sufficient to incorporate into statistical models, they should be used in a different framework than this study. Perhaps the larger sample size of the USDA placement-weight estimates—relative to the private data used in this study—or a better econometric fed cattle price model will improve their usefulness.

Placement-weight data are useful in short-run supply forecasts. As such, these data may be useful in helping feedlots and beef packers better manage inventories. The placement-weight data may also be useful for futures market price discovery.

Appendix: Forecasting Model Specifications

Econometric Model One:

Estimation:

$$\text{Price}_t = \alpha_0 + \alpha_1(\text{Second Quarter Dummy}) + \alpha_2(\text{Beef Supply}_t) + \alpha_3(\text{Food Marketing Cost Index}_t) + \rho(\text{error}_{t-1}) + e_t$$

Point Forecast:

$$E[\text{Price}_{t|t-k}] = \alpha_0 + \alpha_1(\text{Second Quarter Dummy}) + \alpha_2(E\{\text{Cattle Slaughter}_{t|t-k}\}) + \alpha_3(E\{\text{Food Marketing Cost Index}_{t|t-k}\}) + \rho(\text{error}_{t-k})^k$$

Prediction Interval:

$$E[\text{Price}_{t|t-k}] \pm t_c \cdot \left(\left(\left(\sum e_t^2\right)/(n-4)\right)(1 + X_0(X'X)^{-1}X_0')\right)^{1/2}$$

Econometric Model Two:

Estimation:

$$\Delta\text{Price}_t = \alpha_0 + \alpha_1(\Delta\text{Beef Supply}_t) + \rho(\text{error}_{t-1}) + e_t$$

Point Forecast:

$$E[\text{Price}_{t|t-k}] = \text{Price}_{t-k} + \alpha_0 + \alpha_1(E\{\Delta\text{Cattle Slaughter}_{t|t-k}\}) + \rho(\text{error}_{t-k})^k$$

Prediction Interval:

$$\text{Price}_{t-k} + E[\text{Price}_{t|t-k}] \pm t_c \cdot \left(\left(\left(\sum e_t^2\right)/(n-2)\right)(1 + X_0(X'X)^{-1}X_0')\right)^{1/2}$$

where $k = 1 \ldots 6$, E is the expectations operator, X denotes the explanatory variable matrix, X_0 is the vector of explanatory variables used to conduct the forecast, and t_c is the appropriate critical value. When calculating the lower (upper) bound for the prediction interval, the upper (lower) bound of a cattle slaughter and food marketing cost index prediction interval was used in the X_0 vector. Forecasts from both models were conducted using marketing forecasts from the aggregate placement model and placement weight model.

Where:

$$\text{Beef Supply}_t = \text{marketings}_t \cdot \text{dressed weight}_{t-k-1} + \text{bull and stag slaughter}_t \cdot \text{dressed weight}_t + \text{cow slaughter} \cdot \text{dressed weight}_t + \text{calf slaughter}_t \cdot \text{dressed weight}_t + \text{imports in dressed weights}_{t-1} + \text{lbs. of beef in cold storage}/.797_t$$

Expected beef supply = forecasted fed cattle beef supply + forecasted non-fed cattle beef supply

Non-fed cattle slaughter forecasting model = ARIMA(2, 1, 1)(0, 1, 1)$_{11}$.

Forecasted fed cattle slaughter was calculated from Generalized Least Squares Regressions allowing for an AR(1) process in both aggregate placement and placement weight models.

Aggregate Placement Model:

Horizon

1–3	$Marketings_t = f(month, time, error_{t-1}, Plmt_{t-4}, Plmt_{t-5}, Plmt_{t-6}, Plmt_{t-7})$
4	$Marketings_t = f(month, time, error_{t-1}, Plmt_{t-5}, Plmt_{t-6}, Plmt_{t-7})$
5	$Marketings_t = f(month, time, error_{t-1}, Plmt_{t-6}, Plmt_{t-7})$
6	$Marketings_t = f(month, time, error_{t-1}, Plmt_{t-7})$

Placement Weight Model:

Horizon

1–2	$Marketings_t = f(month, time, error_{t-1}, Plmt7\text{-}800_{t-3}, Plmt7\text{-}800_{t-4}, Plmt<600_{t-7})$
3	$Marketings_t = f(month, time, error_{t-1}, Plmt7\text{-}800_{t-4}, Plmt<600_{t-7})$
4	$Marketings_t = f(month, time, error_{t-1}, Plmt7\text{-}800_{t-5}, Plmt<600_{t-7})$
5–6	$Marketings_t = f(month, time, error_{t-1}, Plmt<600_{t-7})$

$f(\cdot)$ is a linear function of all the variables in parentheses, $Plmt_{t-4}$ denotes placements four months before the forecast horizon and $Plmt7\text{-}800_{t-4}$ denotes placements weighing 700–800 lbs four months before the forecast horizon. Time is a linear, monthly time trend.

$$\text{Food Marketing Cost Index Forecasting Model} = ARIMA(2, 1, 1)(0, 1, 1)_{11}$$

Further details can be found in Norwood.

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