Short-Term Forecast of Feeder Cattle Prices

by

Stephen C. Beare, Carl W. O'Connor, and Ray F. Brokken

SHORT-TERM FORECAST OF FEEDER CATTLE PRICES

Stephen C. Beare,
Carl W. O'Connor, and
Ray F. Brokken*

This paper presents the development and estimation of a general short-term (1 to 3 quarters) price forecasting model. The model is considered general in that it may be applied to any class of feeder cattle for which price information is available. In particular, we consider 600-700 pound feeder steers and 500-600 pound feeder heifers at Kansas City. The model evolves from the concept of break-even price calculations for feeder cattle destined for feedlot finishing and slaughter at predominantly choice grade. That is, expected per head returns from cattle feeding, net of non-animal costs, and a target return to management, are imputed as the per head value of a feeder.

*Stephen C. Beare and Carl W. O'Connor are Graduate Research assistant and associate professor of Agricultural and Resource Economics at Oregon State University, respectively. Ray F. Brokken is Agricultural Economist, ERS, USDA and adjunct professor, located at Oregon State University, Corvallis. The authors gratefully acknowledge the help of Steve Buccola, assistant professor of Agricultural and Resource Economics at Oregon State University. His criticisms and suggestions were invaluable in the preparation of this paper. The authors would also like to thank Cathy Turek. Agricultural Experiment Station, Technical Paper No. 6008, Oregon State University, Corvallis, Oregon.

This value, divided by the feeder animal weight, is the estimated break-even feeder price. This is a well used concept in livestock price analysis (e.g., see Brokken, 1975, Buccola, 1980).

Our approach is to first derive a structural model based on the break-even formula, isolating feed prices, slaughter prices, and expected profit as the key explanatory variables. Parameters are then statistically estimated using market observations for these key variables. The initial estimation is made assuming current prices and profit are, where appropriate, expected prices and expected profit. Residuals or errors from this model are then compared with slaughter prices, feed prices, and profits to determine what form of expectations appear to underlie the respective explanatory variables. The model then is reformulated with alternative expressions for expected feed, expected slaughter prices and expected profit, which on the basis of a limited empirical analysis, appear most promising.

The final models are evaluated in terms of statistical significance, comparison of estimated parameter values with prior values, tracking ability, and performance in forecasting a series of historical prices.

Model development

The use of break-even analysis allows the estimation of feeder market prices without information concerning feeder cattle supplies. This approach is of value, because information on feeder cattle supplies for specific markets is often unavailable or difficult to obtain. In addition, break-even analysis provides a good starting point for the development of feeder price forecasting models because it is one tool often used by livestock traders to evaluate market prices. In this analysis, the break-even price includes a return to management which is commonly referred to as "profit," a term adopted here also.

The break-even model may be derived from an identity for expected profit, written as:

$$(1)\quad E(TR) - E(TC) - E(\pi) = 0$$

where:

$E(TR)$ is expected total revenue per head marketed

$E(TC)$ is expected total cost per head marketed

$E(\pi)$ is expected profit per head

In turn, expected revenue is:

$$(2)\quad E(TR) = E(P)(1-\alpha)(W_p+W_g)$$

where:

$E(P)$ is the expected slaughter price per unit weight

α is the shrinkage loss on weight at the end of the feeding period

W_p is the purchase weight per head

W_g is the weight gain per head

Expected total cost is:

$$(3)\quad E(TC) = (1+\delta)(1+r)^{n/365}W_pP_p - E(P_c)CW_g-K$$

where:

δ is the death rate as a proportion of initial number of head purchased

r is the annual rate of interest

n is the number of days on feed

P_p is the feeder purchase price

$E(P_c)$ is the expected ration cost per unit ration weight

C is the feed required per unit weight gain

K is other cost per head

The right hand sides of Equations (2) and (3) may be substituted into Equation (1) and solved for feeder price, P_p. In the following two-step manipulation, factors for deathloss shrinkage and interest costs are dropped for simplification and the feeder price, P_p, is expressed as an expected price $E(P_p)$:

$$\text{(4a)} \quad E(P_p)W_p = E(P)W_p + W_g[E(P)-E(P_c)C] - K - E(\pi)$$

$$\text{(4b)} \quad E(P_p) = E(P) + \frac{W_g}{W_p}[E(P)-E(P_c)C] - \frac{K}{W_p} - \frac{E(\pi)}{W_p}$$

The expected feeder market price is imputed as the expected per head revenue less expected costs and expected profit divided by per head purchase weight. In the initial estimation of the feeder price models, expected slaughter prices and expected feed prices are taken as current market prices.

One might assume expected profit to be at some fixed target level through time. However, a survey of monthly enterprise budgets prepared by the USDA for 600 pound feeder steers shows this to be a poor assumption. Feeder margins from 1977 through 1980 averaged \$-0.96/cwt. with a standard deviation of \$7.76/cwt. The volatility of actual feedlot profits may be due to a number of factors. Errors in producer expectations for slaughter prices and feed prices occur. In addition, there may be a willingness to accept different returns under different conditions. For example, when active feedlots are not filled to capacity, producers may deliberately accept lower returns (that cover short-run variable costs) in order to utilize more of their capacity.

While the interaction of these factors is complex, a relatively simple empirical question may be considered. Will estimates of current and past profits provide a better proxy for expected profit than a constant target profit? Calculated profit in the previous period is used initially as an approximation for $E(\pi)$.

$$\text{(5a)} \quad \pi/W_p = P - P_p + \frac{W_g}{W_p}(P-P_cC) - K_2/W_p$$

For ease of estimation the component K_2 is dropped, and the expression used for expected profit $E(\pi)$ becomes:

$$\text{(5b)} \quad E(\pi) = W_p(P-P_p) + W_g(P-P_cC)$$

where, initially:

P is slaughter price in current quarter

P_p is feeder price lagged 2 quarters

P_c is the average price of corn over the last two quarters

The structural form of the feeder price forecasting model may now be written as:

$$(6)\quad E(P_p) = B_0 + B_1E(P) + B_2\{\frac{W_g}{W_p}[E(P)-E(P_c)C]\} + B_3\,\frac{E(\pi)}{W_p} + \varepsilon$$

where $E(\pi)$ is initially calculated as described in Equation (5b) with its accompanying definitions. The effects of shrinkage, death rates, and interest rates may be shown in terms of a structural interpretation for the estimated parameters:

For example, B_3 may be described as follows:

$$(7)\quad B_3 = \frac{a_e}{(1+\delta)(1+r)^{n/365}}$$

The coefficient B_3 indicates the impact on feeder prices of the expectation for profit. From the development of the model it is clear that B_3 should be negative. B_3 can be further decomposed into the terms adjusting for death rate $(1+\delta)$, interest rate $(1+r)^{n/3565}$ and a_3. Since $E(\pi)$ as shown in Equation (5b), does not include all expenses, the absolute value of a_3 should be less than 1.

The coefficient B_2 shows the effect on the feeder price of returns above feed costs on weight added in the feedlot.

$$(8)\quad B_2 = \frac{1}{(1+\delta)(1+r)^{n/365}}$$

As shown in Equation 2, the final weight can be factored into two components, the purchase weight, W_p, and the weight gain, W_g. The coefficient B_1 indicates the effect on feeder price of a unit change in finished value of the purchase weight. Hence, B_1 would be unity except for effects of shrinkage (α), death loss (δ), and interest (r).

$$(9) \quad B_1 = \frac{(1-\alpha)}{(1+\delta)(1+r)^{n/365}}$$

The constant term B_0 is interpreted as follows:

$$(10) \quad B_0 = \frac{-K}{(1+\delta)(1+r)^{n/365}W_p} + \frac{-B_3K_2}{(1+\delta)(1+r)^{n/365}W_p} = \frac{-K - B_3K_2}{(1+\delta)(1+r)^{n/365}W_p}$$

$$\simeq \frac{-K(1+B_3)}{(1+\delta)(1+r)^{n/365}W_p}$$

where K is taken from Equation (4b), K_2 is taken from Equation (5a), and B_3, a parameter to be estimated, is described and interpreted above.

Establishing approximate prior values for the model coefficients may be helpful in evaluating the estimated form of the model. This is accomplished by selecting values of the coefficient parameters which are consistent with enterprise budgets for feedlot production. Values selected are: death loss (δ) 1½%; two alternative annual interest rates (r), 10% and 15%; production period (n), 180 days; purchase weight (W_p), 6.5 cwt.; and shrinkage factor (α), 4%. To compute B_0, K, all costs not explicitly in the profit model, are estimated at $40 per head and K_2 is estimated to be the same as K at $40 per head. No prior value can be calculated for B_0 without information about B_3. The initial estimated value of B_3 for feeder steers is -0.503 (see Table 2).

Table 1. Definition of Variables for Initial Model; Means and Standard Deviations; Quarterly from 1968 to 1979

Description	Variable identification	Source	Value	Mean	Standard deviation
<u>Purchase weight:</u>					
Feeder steer	W_{ps}	See text page 6	600 lbs.	-	
Feeder heifer	W_{ph}	See text page 6	550 lbs.	-	
<u>Weight added:</u>					
Steer	W_{gs}	See text page 6	450 lbs.	-	
Heifer	W_{gh}	See text page 6	425 lbs.	-	
<u>Bushels of corn per hundredweight gain:</u>					
Steer	C_s	See text page 6	11.79	-	
Heifer	C_h	See text page 7	12.86	-	
<u>Finish cattle prices:</u>					
Steer	P_s	900-1100 lb. choice (Omaha)	Variable	$39.06/cwt.	$8.72/cwt.
Heifer	P_h	900-1100 lb. choice (Omaha)	Variable	$37.96/cwt.	$8.41/cwt.
<u>Feeder prices:</u>					
Steer	P_{Fs}	600-700 lb. choice (Kansas City)	Variable	$40.87/cwt.	$11.24/cwt.
Heifer	F_{Fh}	500-600 lb. choice (Kansas City)	Variable	$39.06/cwt.	$10.52/cwt.
<u>Corn price:</u>					
Expected	P^*_c	Current price #2 yellow (Chicago)	Variable	$2.05/bu.	$0.74/bu.
Average price paid	AP_c	$(P_{c_{t-2}} + P_{c_{t-1}})/2$	Variable	$2.01/bu.	$0.74/bu.
<u>Feeder purchase price:</u>					
Steer	P_{ps}	$P_{Fs_{t-2}}$	Variable	$38.73/cwt.	$8.72/cwt.
Heifer	P_{ph}	$P_{Fh_{t-2}}$	Variable	$34.36/cwt.	$8.24/cwt.

Table 1 (Continued)

Description	Variable identification	Source	Value	Mean	Standard deviation
Returns to feeding per hundredweight of feeder purchased:					
Steer	RFS	$\frac{W_{gs}}{W_{ps}}(P_s - C_s \times CP_c)$	Variable	\$10.31/cwt.	\$5.40/cwt.
Heifer	RFH	$\frac{W_{gs}}{W_{ph}}(P_h - C_h \times CP_c)$	Variable	\$8.96/cwt.	\$6.20/cwt.
Expected (current) profit per hundredweight feeder purchased:					
Steer	PRS	$\frac{1}{W_{ps}}[W_{ps}(P_s - P_{ps}) + W_{gs}(P_s - C_s \times AP_c)]$	Variable	\$10.96/cwt.	\$9.48/cwt.
Heifer	PRH	$\frac{1}{W_{ph}}[W_{ph}(P_h - P_{ph}) + W_{gh}(P_h - C_h \times AP_c)]$	Variable	\$12.94/cwt.	\$9.70/cwt.

Table 2. Initial Estimation of Feeder Cattle Price Models

Regression Model:

Feeder Steer Price (600-700 lbs., Choice at Kansas City)

$$P_{Fs} = \underset{(-2.56)^*}{-7.29} + \underset{(12.9)}{1.02}\, P_s + \underset{(8.86)}{1.35}\, RFS - \underset{(-5.31)}{.503}\, PRS$$

$R^2 = .902$ Durbin-Watson = 1.19 F statistic = 120.0

Mean Square Error = 13.3 Standard Error = 3.65

Feeder Heifer Price (500-600 lbs., Choice at Kansas City)

$$P_{Fh} = \underset{(-2.40)}{-6.99} + \underset{(12.2)}{1.03}\, P_h + \underset{(8.60)}{1.18}\, RFH - \underset{(-4.85)}{.486}\, PRH$$

$R^2 = .881$ Durbin-Watson = 1.13 F-statistic = 96.2

Mean Square Error = 14.2 Standard Error = 3.77

* t-statistics are in parentheses.

The approximate prior coefficient values at annual interest rates (r) of 10% and 15% are:

	r = .10	r = .15
B_0	= -2.87	-2.81
B_1	= 0.90	0.88
B_2	= 0.94	0.92
B_3	= $0.940a_3$	$0.920a_3$

All coefficient values corresponding to 15% interest are approximately 98% of these values at 10% interest.

In the initial quantification of the feeder price forecasting models, the assumption is made that all expected values of the variables are equal to their current values. This assumption is subjected to a critical evaluation and the models are reestimated using explicit models of aggregate producer expectations.

Quantification of the model

The following quarterly price series are needed to quantify the model: feeder cattle, slaughter cattle, and feed prices. Two feeder prices are selected: 600-700 pound choice feeder steers and 500-600 pound choice feeder heifers at Kansas City. Choice slaughter steers and choice slaughter heifer prices, both 900-1100 pounds at Omaha, are selected for finished cattle prices. The price of number two yellow corn at Chicago is taken as a proxy for the price of feed. Several additional assumptions are required to quantify the model. First, the purchase weight, W_p, is taken to be the mid-point of the feeder weight class; 650 pounds for feeder steers, and 550 pounds for feeder heifers. Second, finishing weights of 1100 and 975 pounds are selected for steers and heifers, respectively. The weight gained in the feedlot, W_g, is 450 pounds for steers and 425 pounds for heifers.

Feed requirements per hundredweight gain (c) can be computed for a corn diet using an adaptation of the California Net Energy system (Brokken, 1975). The following information is required for this computation: a) the beginning weight assumed equal to W_p; b) the finishing weight, W_p plus W_g; c) the rate of gain, assumed to be 2.6 and 2.3 pounds/day for steers and heifers, respectively; d) the net energy for gain of the diet, 0.67 Mcal/pound for number two yellow dent corn adjusted for 12 percent moisture. For a 650-pound steer fed to 1,100 pounds, 11.79 bushels of corn are required per hundredweight gain. For a 550-pound heifer fed to 975 pounds, 12.86 bushels of corn are required per hundredweight gain.

Profits are estimated using Equation 3 for a two-quarter production period. An animal, ready to slaughter in the current quarter, is assumed to be purchased two quarters previously. Feed costs (monthly corn prices) are averaged over the entire production period. Specific definitions of the model parameters and variables are presented with variable means and standard deviations in Table 1.

The feeder price equations were estimated with ordinary least squares. The results are summarized in Table 2. Both the feeder steer and heifer models yield a good fit with the sample data. The standard error for the initial feeder steer price model (IFSPM) is \$3.65/cwt. with an adjusted R^2 value of 0.90. The standard error for the initial feeder heifer price model (IFHPM) is slightly larger at \$3.77/cwt. while the R^2 value is slightly lower at 0.88.

All explanatory variables are statistically significant. The "t" values for the expected profit variables, -5.31 and -4.85 for the steer and heifer models, respectively, are good evidence for the correlation between current actual and expected profits. All the estimated coefficients are consistent with the prior values with the exception of the coefficients of the returns to feeding variables, RFS and RFH. The hypothesized value for the coefficients of the returns to feeding variable (0.94) is outside the 95% confidence interval for the steer model coefficient and near the lower bound for heifer coefficient. This may be the result of the misspecification of the model parameters (W_p, W_g, C). However, the presence of severe correlation between the error terms suggests a more serious problem exists. The Durbin-Watson statistic values indicate the strong presence of autocorrelation, which is often the result of model misspecification.

One possible source of specification bias in the model is the formulation of producer expectations as their current values. Past prices and recent price trends may be important components of producer expectations which have been omitted from the model. Two approaches to incorporating recent prices into the models of price expectation were considered. The first was to interpolate between current and past prices by using techniques such as moving averages and exponential smoothing. The second was to extrapolate price trends beyond the current price, a method advocated by Nelson and Spreen (1973). A simple extrapolating model, which may be useful, is a moving average of the change in price added to the current price.

To gain some insight into which form of the price expectation models to use, a visual comparison of the model error terms, slaughter prices, feed prices and current profits was made. Strong trends in the error terms occurred during strong trends in either finished cattle prices or current profits, suggesting an extrapolating model. Trends in the error terms tended to follow movements in feed prices after a delay of about two quarters, suggesting an interpolating model for feed price expectations.

The procedure used to evaluate alternative expectation formulas is detailed with trial and error playing a large role. A simple functional form was selected for the extrapolating models. A trend term was added to the current price, where the trend term is a moving average of the change in price or current profit. This formulation of the trend term may project false trends when market prices are moving in an erratic rather than a trending manner. However, the trend term will diminish in magnitude as the market stabilizes and allows the expectation model to anticipate the major price trends which often characterize the beef industry.

Evaluating alternative temporal structures for the trend term is an empirical problem. To reduce the computational burden of multiple regressions and to expand the range of time considered; third order partial correlation analysis was used to evaluate a one-to-five period moving average in the change in price. First, the trend terms for the expected salughter steer price were correlated with feeder steer prices controlling for the variables in the initial model, P_s, RFS and PRS. On the basis of highest correlation, a four-period average was selected (Table 3) and added to the current slaughter price variables P and RFS. The expected profit trends were then correlated with feeder prices, controlling for P*, RFS* and PRS. A two-period average was selected for the expected profit trend (Table 3). The procedure and results for the feeder heifer model are identical. To examine the assumption that an interpolating model for corn expectations is appropriate, the procedure was repeated for corn prices. No significant correlation was observed between the corn price trends and feeder prices, controlling for P*, RFS* and PRS*.

Expected feed prices may be based on the annual pattern of grain production and consumption, and not on feed price trends. The form of the model selected is an average price based on a crop year; and can be expressed as follows:

Quarter of forecast	Equation
4th	$P_{AC}^* = Pc_t$
1st	$P_{AC}^* = (Pc_t + Pc_{t-1})/2$
2nd	$P_{AC}^* = (Pc_t + Pc_{t-1} + Pc_{t-2})/3$
3rd	$P_{AC}^* = (Pc_t + Pc_{t-1} + Pc_{t-2} + Pc_{t-3})/4$

where:

P_{AC}^* = expected price of corn

P_c = price of corn

t = current quarter

Table 3. Summary of the Third Order Partial Correlation Analysis[a]

Dependent variable	Independent variable	Value	Significance level	Control variables
P_{Fs}	T_{s1}	-.060	.357	P_s, RFS, PRS
P_{Fs}	T_{s2}	-.187	.125	P_s, RFS, PRS
P_{Fs}	T_{s3}	.186	.126	P_s, RFS, PRS
P_{Fs}	T_{s4}	.372***	.010	P_s, RFS, PRS
P_{Fs}	T_{s5}	.310	.026	P_s, RFS, PRS
P_{Fs}	$T_{\pi s1}$	-.248	.067	P_s*, RFS*, PRS
P_{Fs}	$T_{\pi s2}$	-.547***	.001	P_s*, RFS*, PRS
P_{Fs}	$T_{\pi s3}$	-.214	.099	P_s*, RFS*, PRS
P_{Fs}	$T_{\pi s4}$	-.174	.149	P_s*, RFS*, PRS
P_{Fs}	$T_{\pi s5}$	-.012	.473	P_s*, RFS*, PRS

[a]<u>Variable identification</u>:

i = the number of periods in moving average,

T_{si} = a moving average of the change in the slaughter steer prices,

$T_{\pi si}$ = a moving average of the change in the steer profit,

$P_s* = P_s + T_{s5}$, expected slaughter steer price,

RFS* = RFS corrected for the expected slaughter steer price,

*** = highest correlation in appropriate set.

The feeder price model may be requantified using the three new expectation parameters, as summarized in Table 4.

Reestimation of the feeder price models

The feeder price models are again estimated with ordinary least squares. The results are summarized in Table 5. Correcting for price expectations improves both the feeder steer and heifer price models. A comparison of the initial and revised model estimates is presented in Table 6. Revision of the expectation models results in a 47 and 52 percent reduction in the variation in prices not explained by the initial steer and heifer prices models, respectively. The standard error for the FSPM* is reduced 26 percent and the FHPM* standard error is reduced 31 percent. The Durbin-Watson statistics for both models fail to reject the null hypothesis of zero autocorrelation at the 95 percent confidence level.

None of the estimated coefficients are significantly different from *a priori* values at the 95% confidence level. The significance of all independent variables is improved. The expected profit variables show the greatest increase in significance with "t" values increasing 57 and 75 percent for the FSPM* and FHPM*, respectively. The overall fit of the revised feeder price models to the sample data appears adequate.

Table 4. Requantification of Feeder Price Model (Quarterly; second quarter, 1968 to first quarter, 1979)

Description	Variable code	Source	Average	Standard deviation
Expected slaughter steer price	P_s*	$P_s + T_{s4}$	$39.7/cwt.	$9.64/cwt.
Expected slaughter heifer price	P_h*	$P_h + T_{h4}$	$38.6/cwt.	$9.29/cwt.
Expected corn price	$P_{hc}*$	See text	$2.01/cwt.	&.731/cwt.
Expected returns to feeding steers	RFS*	$\frac{W_{gs}}{W_{ps}} \cdot (P_s* - 11. X P_{ac}*)$	$11.1/cwt.	$6.52/cwt.
Expected returns to feeding heifers	RFH*	$\frac{W_{gh}}{W_{ph}} \cdot (P_h* - 12. X P_{ac}*)$	$9.87/cwt.	$7.44/cwt.
Expected steer profit	PRS*	$PRS + T_{\pi s2}$	$11.3/cwt.	$12.8/cwt.
Expected heifer profit	PRH*	$PRH + T_{\pi h2}$	$13.3/cwt.	$13.0/cwt.

Table 5. Reestimation of Feeder Market Equations with Revised Expectation Models (Quarterly; second quarter, 1968 to the first quarter, 1979)

Regression Models:

Feeder steer price (FSPM*):

$$P_{Fs} = -1.10 + .881 \times P_s{}^* + .992 \times RFS^* - .359 \times PRS^*$$

(-.49)* (16.02) (11.35) (-8.33)

R^2 = .948 Durbin-Watson = 1.72 F statistic = 234.0

Mean Square Error = 7.14 Standard Error = 2.67

Sample size = 43 quarters Residual degrees of freedom = 39

Feeder heifer price (FHPH*):

$$P_{Fh} = -1.22 + .865 \times P_h{}^* + .906 \times RFH^* - .362 \times PRH^*$$

(-.66) (16.08) (12.21) (-8.30)

R^2 = .941 Durbin-Watson = 1.79 F statistic = 207.7

Mean Square Error = 7.03 Standard Error = 2.65

Sample size = 43 quarters Residual degrees of freedom = 39

---

*t statistics are shown in parentheses.

Table 6. Comparison of the Initial (Table 2) and Expectation (Table 5) Feeder Price Models

Regression Models: VALUE/MODEL	Feeder Steer Price			Feeder Heifer Price		
	Initial model	Expectation model	Change	Initial model	Expectation model	Change
R^2	.902	.948	+5.1%	.881	.941	+7.0%
Durbin-Watson	1.19	1.72	*	1.13	1.79	*
F statistic	120	234	+95%	96.2	207	115%
Mean Square Error	13.29	7.14	-46%	14.2	7.93	-50%
Standard Error	3.65	2.67	-26%	3.77	2.65	-30%
Coefficients: COEFFICIENT MODEL	Expected Value			t statistic		
β_{01}	-7.2	-1.10	+85%	-2.56	-.589	-77%
P_s	1.02	.881	-14%	12.9	16.02	+24%
RFS	1.35	.992	-26%	8.86	11.35	+28%
PRS	-.503	0.359	+29%	-5.31	-8.33	+57%
β_{02}	-6.99	-1.22	+83%	-1.30	-.660	-72%
P_h	1.03	.865	-16%	12.2	16.1	+32%
RFH	1.18	.906	-23%	8.60	12.2	+42%
PRH	-.456	-.362	+21%	-4.85	-8.30	+71%

*Change from rejectance region to acceptance region of null hypothesis of zero autocorrelation [n = 43, k = 3(d_L = 1.36, d_u = 1.55)] at 95 percent confidence level.

Tracking ability

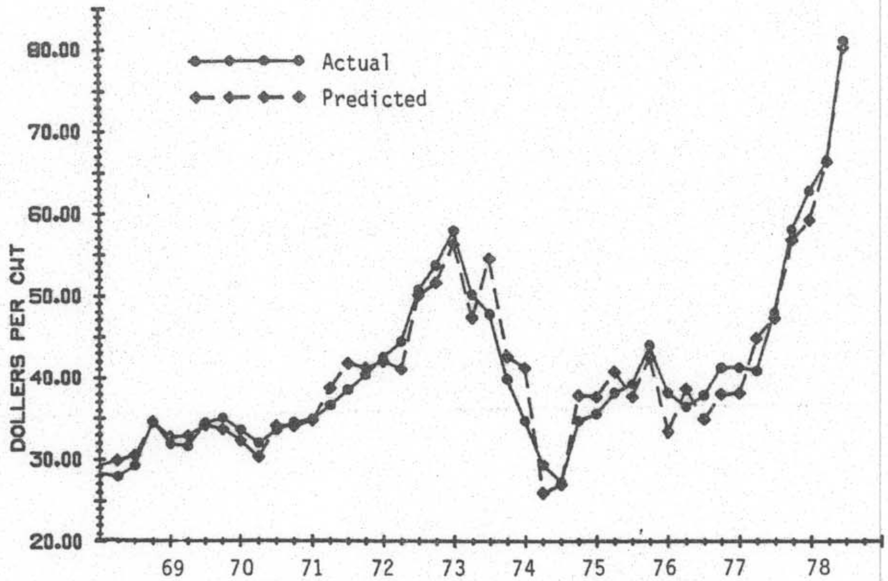
An examination of the models ability to track the feeder market over the past several years can give a good indication of the models' ability to describe feeder market dynamics. In the tracking run, actual cash prices for slaughter cattle and corn are used to generate predicted feeder cattle prices. The predicted prices are then compared to the actual feeder prices. Actual and predicted feeder steer and heifer prices are presented in Figures 1 and 2, respectively.

Both the steer and heifer price models are able to track an extremely volatile period of feeder prices. Both models follow the phase and magnitude of a full cycle of prices, turning both major corners in the third quarter of 1973 and the first quarter of 1975. The mean squared error for the steer price tracking is $7.14, with a standard error of $2.67/cwt. The mean squared error for the heifer price tracking is $7.03/cwt., with a standard error of $2.65/cwt. The steer and heifer price models appear conceptually and functionally able to model price behavior in the feeder market.

Model validation

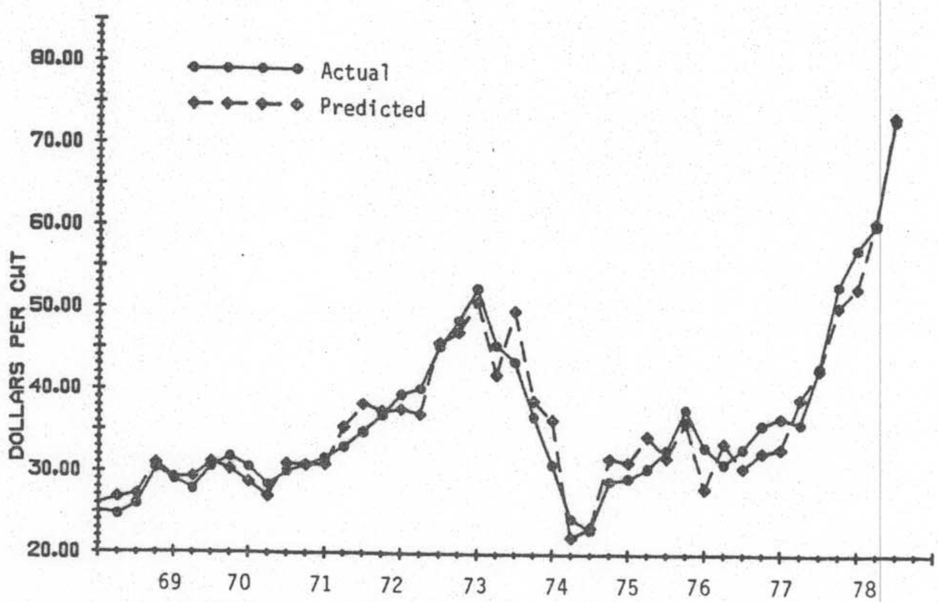
Model validation may be the most problematic aspect of econometric forecasting. Emphasis is often placed upon a model's ability to forecast a historical series of prices, which have been excluded from the sample used to estimate the model. Such an approach is used in this paper, where one-quarter and two-quarter forecasts are generated from the second quarter 1979 through the second quarter 1982, using the

FIG 1: ACTUAL AND PREDICTED FEEDER STEER PRICES



TIME IN QUARTERS: 1968:3 THROUGH 1979:1

FIG 2: ACTUAL AND PREDICTED FEEDER HEIFER PRICES



TIME IN QUARTERS: 1968:3 THROUGH 1979:1

feeder steer price models.

Two different sources of exogeneous information are utilized to generate two series of historical forecasts. Slaughter steer and corn prices from the periods to be forecast are used as one source of exogeneous data. For the second series, current cash prices in the forecasting period are projected as one and two quarter naive forecasts of the exogeneous variables. Actual slaughter steer and corn prices are perfect information, allowing a direct comparison of forecast period and estimation period errors. Increased error levels in the forecast period may indicate the presence of heteroscedastic or collinear disturbances in the explanatory variables. Price levels for feeder cattle, slaughter cattle, and corn during the historical forecast period (79:2-81:2) are much higher than in the estimation period (Table 7), providing a rather severe test in this regard. The use of naive forecasts for the exogeneous variables gives some indication of the sensitivity of a model to exogeneous forecast errors. Furthermore, given both perfect and naive exogeneous forecasts, it is possible to isolate turning point errors attributable to either the profit or expectation components of the models. This information is valuable because the profit and expectation terms are components of the model which differ from traditional breakeven analysis.

Summary statistics for the perfect information forecasts are presented in Table 8. The one-quarter and two-quarter forecasts are identical. The root mean squared errors (RMSE) associated with the historical forecast period, are $4.94/cwt. for the revised expectation

Table 7. Estimation and Forecast Period Summary Statistics for Feeder Steer, Slaughter Steer and Corn Prices

Variable	Estimation Period (1968:2 to 1979:1) Mean (S.D.[a])	High (Low)	Forecast Period (1979:2 to 1981:2) Mean (S.D.[a])	High (Low)
Feeder steer $/cwt.	40.87 (11.24)	80.93 (25.96)	76.63 (6.76)	86.83 (66.00)
Slaughter steer $/cwt.	39.06 (8.72)	65.42 (24.18)	66.88 (3.20)	72.51 (61.99)
Corn $/bu.	2.05 (0.74)	3.65 (1.16)	3.03 (6.40)	3.51 (2.60)

[a]Standard deviation.

Table 8. Summary Statistics for the FSPM* and IFSPM Historical Forecasts with Perfect Information

Summary statistic	One and Two-quarter FSPM* forecast	One and Two-quarter IFSPM forecast
Mean Error	1.67	7.21
Mean Absolute Error (% MAE)	4.35 (5.7%)	7.40 (9.7%)
Root Mean Squared Error (% RMSE)	4.94 (6.4%)	9.06 (11.8%)

model (FSPM*) and $9.06/cwt. for the initial model (IFSPM). This is an 85 percent increase in error between the FSPM* estimation period (68:1-79:1) and the historical forecast period (79:2-81:2). However, the proportional or percentage RMSE is 6.5 percent for the FSPM* estimation period and 6.4 percent for the forecast period. This is an encouraging result, suggesting that problems with heteroscedastic or collinear explanatory variables are not severe.

The percent RMSE for the initial model is 8.9% for the estimation period and 11.8% in the forecast period, a 33 percent increase in proportional error (a 148 percent absolute increase in RMSE). In addition, the average errors (biase) for the FSPM* and IFSPM models are $1.67/cwt. and $7.21/cwt., respectively. The relatively large increase in proportional error and the extreme bias of the initial model forecasts is further evidence of the importance of expectations in the determination of feeder prices.

Summary statistics for the naive exogenous forecasts are presented in Table 9. To a limited degree, these measures given an indication of the stability of the exogeneous slaughter and corn markets and, inversely, the quality of the exogeneous forecasts. In general, price movements in the slaughter market averaged $4.07/cwt. per quarter. The direction of price movements in the slaughter market was very erratic. The direction of change alternated in over 50 percent of the sample and no trend extended beyond two quarters. Corn prices were relatively stable within each crop year. However, prices in the 79-80

Table 9. Summary Statistics for the Naive One and Two-quarter Exogeneous Forecasts

Summary statistic	Naive Slaughter Price Forecast $/cwt.		Naive Corn Price Forecast $/bu.	
	One-quarter	Two-quarter	One-quarter	Two-quarter
Mean Error	-0.13	-0.94	-0.13	-0.27
Mean Absolute Error (% MAE)	4.07 (6.1%)	4.65 (7.0%)	0.19 (6.3%)	0.34 (11.2%)
Root Mean Squared Error (% RMSE)	4.71 (7.0%)	7.07 (10.6%)	0.26 (8.6%)	0.44 (14.5%)

crop year averaged $2.72/bu. and $3.45 bu. in 1980-81. With the exception of the transition period between crop years, the naive corn forecasts should not be a major source of forecast error.

Summary statistics for the one-quarter and two-quarter feeder steer price forecasts, generated from naive exogeneous information, are presented in Table 10. Model forecasts may be compared directly with one and two-quarter naive feeder price forecasts. The ratio of the model and naive forecast mean squared errors is Thiel's inequality coefficient. The naive exogeneous and feeder forecasts yield an inequality coefficient value of one. The inequality coefficients for the FSPM* are 1.13 and 0.90 for one-quarter and two-quarter forecasts, respectively. The inequality coefficients for the perfect information forecasts are 1.03 and 0.31 for one- and two-quarters, respectively. Over a one-quarter forecast horizon, the general error level of the model is roughly equal to the variation in feeder prices, with both

Table 10. Summary Statistics for FSPM*, IFSPM and Naive Historical Feeder Steer Price Forecasts Using Naive Exogeneous Information

Summary statistic	One-quarter Forecasts			Two-quarter Forecasts		
	FSMP*	IFSPM	Naive feeder[a]	FSPM*	IFSPM	Naive feeder[b]
Mean Error	1.84	8.48	1.58	1.64	8.86	1.13
Mean Absolute Error (% MAE)	4.15 (5.4%)	9.56 (12.4%)	4.01 (5.2%)	6.42 (8.4%)	12.36 (16.1%)	6.84 (8.9%)
Root Mean Squared Error (% RMSE)	5.17 (6.7%)	10.35 (13.5%)	4.86 (6.3%)	8.39 (10.9%)	13.11 (17.1%)	8.82 (11.5%)
Thiel's Inequality coefficient	1.13	4.53	1.0	0.90	2.20	1.0

[a] One-quarter lagged cash feeder steer price.

[b] Two-quarter lagged cash feeder steer price.

perfect and naive exogeneous information. One-quarter FSPM* and naive feeder price forecasts are very similar with respect to relative accuracy, variance in forecast error, and the value of improved exogeneous information. Over a two-quarter forecast horizon, FSMP* error levels are 10 and 69 percent lower than the variation in market prices for the naive and perfect exogeneous information forecasts, respectively. The value of improved exogeneous information appears substantial and the potential value of the forecast is increased over a two-quarter horizon.

The loss of forecasting accuracy in changing from perfect to one and finally two-quarter naive exogeneous information appears slow compared to the decline in accuracy of the exogeneous forecasts. It is of interest to determine whether this slow loss of accuracy is due to one; the model's ability to project trends or two; compensating model and exogeneous errors. The perfect information forecast in one quarter, and the naive forecasts for the following two quarters, utilize identical exogeneous forecasts for slaughter and corn prices. The differences in the successive feeder forecasts may be attributed to the profit and trending components of the FSPM*. The trends projected by the model may be compared to actual price trends. For both the one-quarter and two-quarter naive information forecasts, the model projects a false trend in over 50 percent of the observations. Hence, the relative slow loss of forecast accuracy in changing from perfect to naive information is most likely due to compensating errors. This is not an unanticipated result. Both the feeder and slaughter markets exhibit erratic rather than trending price movements over the historical forecast period. The trending components of the model designed to anticipate market trends should perform poorly.

Despite this limitation, FSPM* performance compares favorably with simple break-even analysis. A simple break-even model was estimated with OLS from the estimation period and allowed to forecast the historical forecast period.[1] For each set of forecasts, with perfect and naive exogeneous information, the FSPM* performed better than the simple break-even model. The RMSEs for the break-even model are $5.04, $5.55, and $9.48 per hundredweight for the perfect, one-quarter naive and two-quarter naive information forecasts, respectively.

The FSPM* forecasts compare favorably with the general error levels reported for live cattle forecasts reported by Just and Rausser (1981). The percentage RMSE for five major econometric models and the futures market forecasts ranged from 9.9 to 12.9 percent for a one-quarter forecast horizon. Over a two-quarter forecast horizon, Just and Rausser's reported model errors ranged from 12.4 to 18.9 percent. Our RFPM* naive information forecast errors are below these ranges. This may be significant due to the greater volatility of feeder as opposed to slaughter cattle prices. FSPM* forecasts appear to be comparatively sound over an unfavorable period. Given the model's ability to track the major feed price trends in the 1970s, the FSPM* offers the potential for improved forecasting performance when feeder and slaughter markets are exhibiting the trends which often characterize beef markets.

Historical forecasting performance, quality of the regression estimation, and consistency of the empirical and theoretical models, support the following conclusion. The extension of break-even analysis, the FSPM*, shows the potential for improved forecasting without any increase in the cost of exogeneous information. These results do not support the conclusion that the FSPM* makes the best possible use of that information. Our modeling of the expectation terms is simplistic and sensitive to erratic price movements. An alternative formulation of the trend terms with Newton's discrete interpolation (a differencing formula which is a discrete counterpart to a Taylor's expansion) is one area under current consideration. Newton's formula incorporates more past information and may possibly improve model performance under stable or erratic market conditions. Improving the estimates of current feeding costs and expected returns is another area of current investigation. Escalation of costs over the last several years has resulted in the tendency of the model to overestimate both returns to feeding and expected profit; an off-setting result. However, as feeding costs continue to increase, the quality of the model estimation declines. This is evident from the structural interpretation of the model coefficients (see Equations 7 through 10). Indexing costs or revising the estimation period may help in adapting the model to changes in market structure.

Summary

Our objective was to develop a useful forecasting model of feeder cattle prices. Desirable elements of the model include simplicity, adaptability to various users' needs, a high level of reliability, and the ready availability of appropriate secondary data.

The break-even equation yielded a compelling and logically structured model from which to start. The key to applying the break-even equation to forecasting was obtaining appropriate expressions for expected slaughter prices, feed prices and expected profit. Two extensions of traditional break-even analysis were made. First, expected profit, often treated as a constant or target profit, was treated as a variable. Estimates of current and recent profits were used as a proxy for expected profits. The apparent variability in the expectation of profits appears to be an important aspect of feeder price determination. Second, and perhaps most importantly, alternative formulations of producer expectations were considered when the assumption that producer expectations are based upon current values, appeared inadequate.

A trend variable, computed as a four-quarter moving average of the change in slaughter cattle prices plus the current slaughter price, was used as an expected slaughter price. Current profits plus a two-quarter moving average of the change in profits were selected to compute expected profits. A weighted average corn price, based upon the crop year, was used as an expected feed price. Using

OLS, these expectation variables were substituted for the current prices and the initial models were reestimated. The revised model resulted in a 47 percent reduction in the variation in prices not explained by the initial feeder steer model. In addition, the reestimated price model appears free from the high degree of autocorrelation which was present in the initial model.

The statistical properties of the forecasting model indicate acceptable fits, with high R^2 and overall significance values with no significant autocorrelation at the 95% confidence level. In addition, the coefficients for all the independent variables are consistent with theoretical _a priori_ values of the break-even model.

Both the steer and heifer price models do well in tracking an extremely volatile period of feeder cattle prices. The accuracy of the feeder cattle forecasts compares favorably with published private and public price forecasts of slaughter cattle prices. This is quite encouraging in view of the much greater volatility of feeder prices relative to slaughter prices. For example, the variance of feeder cattle prices is nearly 50 percent greater than the variance of slaughter cattle prices during the period of this study.

The computations for these forecasts can easily be completed on a hand-held calculator, such as the HP-41C or HP-67. Secondary data on slaughter, corn, and feeder cattle prices are also readily available. Because of the low cost of computation and data, the model should be readily adaptable to applied commodity price analysis and forecasting.

Footnotes

[1]The break-even model is estimated in the following form:

$$P_{Fs} = 0.85P + 0.83RFS - 0.89$$
$$(9.07) \quad (5.48) \quad (0.27)$$

The adjusted R^2 for the regression is .823, the standard error $4.73/cwt. (Coefficient "t" values are in parentheses.)

References

Brokken, R. F. "Economics of Grain-Roughage Substitution in the Beef Sector." Forage-Fed Beef: Production and Marketing Alternatives in the South, ed. J. Stuedemann, pp. 45-76. Bulletin 220, Southern Cooperative Series, 1977.

Buccola, S. T. "An Approach to the Analysis of Feeder Cattle Price Differentials." American Journal of Agricultural Economics. 62:3, (1980):574-580.

Buccola, S. T. and Carmichael, F. M. Feeder Cattle Price Differentials: An Analysis by Animal Characteristic. Research Division Bulletin 158, Virginia Polytechnic Institute and State University, 1980.

Intriligator, M. D. Econometric Models, Techniques and Application. Prentice Hall, Englewood Cliffs, N.J., 1978.

Just, R. E. and Rausser, G. C. "Commodity Price Forecasting with Large Scale Econometric Models and the Futures Market." American Journal of Agricultural Economics 63:2, (1981):197-208.

Thiel, H. Applied Econometric Forecasting. North-Holland Publishing Co., Amsterdam. Rand McNally and Co., Chicago (1966).

U.S. Department of Agriculture. Economics, Statistics and Cooperative Service. Livestock and Meat Situation and Feed Situation. Washington, D.C., various issues.