Predicting Feeding Cost Of Gain With More Precision

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Abstract:

Costs during the feeding period, commonly summarized as “feeding cost of gain”, are primary determinants of cattle feeding profits. This study provides a method of generalizing information available at placement time into a suitable feeding cost of gain prediction, so that feeders and ranchers can make more informed placement decisions.

Predicting Feeding Cost Of Gain With More Precision

Introduction:

Cattle feeding profits are determined by the three factors: the cost of the feeder animals at the beginning of the feeding period, the value of the finished animals at the end of the feeding period, and the cost of feeding the animals (including interest on the capital invested) (Langemeier, Schroeder, and Mintert; and Mark, Jones, and Schroeder). At the start of the feeding period the cost of the feeder animal is known, and futures markets as well as other market outlook sources provide public estimates of the value of finished cattle at the end of the feeding period. Projections for feeding costs are much less refined. Yet, depending on the initial weight of the cattle going on feed, and the relationship between feed costs and feeder cattle costs, the cost of feeding could easily be more than one half of the total investment in the feeding program. In order to make more informed cattle placement decisions, cattle feeding investors and ranchers considering retained ownership would benefit from more precise estimates of the cost of finishing cattle.

Per pound "feeding cost of gain" is a commonly used measure in the cattle feeding industry that represents all costs of feeding on a pay-weight in to pay-weight out basis, except interest on the feeder animal. In recent history, the monthly average feeding cost of gain for finished steers in Kansas has ranged from under 40 to over 75 cents per pound of gain (Jones). Individual pen variation has been much higher. Determinants of feeding cost of gain chiefly include feed ingredient costs (e.g., corn, grain sorghum, protein, and typically a forage source). In addition, feeding cost of gain is affected by animal performance (feed conversions, average daily gains, death loss). In a typical 750 lb. feeder steer finishing program, for example, a 10 cent per bushel change in the average corn price would typically result in a change in the feeding cost of gain of around 1.25 cents per pound (Jones). This, in turn, would result in a change in the finished animal break-even price of about $0.50 per cwt. The relative contributions of the various factors (feed costs and performance) to feeding cost of gain will vary seasonally, and by cattle sex, size, and type. Therefore, estimating or predicting feeding cost of gain for a particular pen of cattle is complex.

Albright, Schroeder, and Langemeier determined that over an eleven year period of time the volatility and seasonality of feed grain prices, and the seasonality of cattle performance explained the vast majority of steer feeding cost of gain variability. Corn prices explained the largest share of cost variability (63 - 66%, depending on placement weight), while variation in feed conversions were found to contribute as well. Anderson and Trapp investigated the expected impact of feed ingredient (corn) prices on feeder cattle prices. While the intent of the study was not directly to explore feeding cost of gain, the mechanism through which feeder cattle prices are determined in a derived demand framework is implicitly feeding cost of gain. The authors concluded that there is a multiplicative relationship involving feed prices, feed conversions, placement weights, and finished weights that affects feeding cost of gain on individual pens of cattle.

Farm management economists, feedlot managers, and cattle feeders have historically adjusted cattle feeding break-even or budgeting calculations to account for expected variations in feed ingredient costs. Limited information is available, however, to help refine feeding cost estimates to account for expected changes in cattle feeding productivity over time, changes in commercial feedyard fixed costs over time, or seasonality of cattle feeding performance. The objective of this research is to develop and test procedures for forecasting average monthly feeding cost of gain for various cattle feeding placement scenarios. As previously indicated, it is a complex interaction of numerous factors that determines cost of gain, so the goal is to generalize the information that is available at the time of cattle placement into simple, yet reasonably accurate feeding cost of gain predictive models. Specifically, to forecast average feeding cost of gain for cattle placed in Kansas feedyards during a given month, we want to account for expected productivity improvement over time, expected seasonal cattle performance, and feed cost projections at the time the cattle are placed on feed. We then test our model to see if it can predict feeding cost of gain more accurately than a naive forecast (the average historical feeding cost of gain) or a simple statistical model that only adjusts for corn prices.

Methods:

Three approaches are used to forecast steer feeding cost of gain out of sample, all based on historical data and/or current (at the time cattle are placed on feed) futures prices. The first approach, referred to as *NAIVE*, assumes the expected feeding cost of gain for current steer placements that will exit Kansas feedlots five months (20 weeks) later is the current closeout month steer feeding cost of gain. This approach can be expressed as

(1) *NAIVE:* $$E[COG_{ti}] = COG_{t,i-5} ,$$

where E[COG_{ti}] is the expected feeding cost of gain for steers closing out in the *i*th month of year *t*, and $COG_{t,i-5}$ is the observed average feeding cost of gain for steer closeouts during the placement month, assumed to be five months prior to closeout (when the expectation is taken).

The other two approaches are based on forecasting models, which need to be estimated using historical data in order to arrive at predictions for future months. For simplicity, the monthly forecasts are made in one year ahead blocks. For example, data encompassing the 1981 through 1995 period are used estimate models to forecast monthly feeding cost of gain for 1996 steer closeouts. Subsequently, estimates from 1981 through 1996 data are used to predict monthly values for 1997 (conditional on observed values of independent variables during 1997). Similarly, monthly predictions for 1998 are obtained. The simplest of the two models, referred to as the *CORNFUT* method, assumes that feeding cost of gain is a simple linear function of the nearby contract corn futures price at the time of placement (assumed to be 5 months prior to closeout). This approach can be specified as

(2) *CORNFUT:* $$E[COG_{ti}] = \hat{\alpha} + \hat{\beta} CF_{t,i-5}^{t,i-5} ,$$

where the estimated parameters are taken from the regression:

(3) $$COG_{ti} = \alpha + \beta CF_{t,i-5}^{t,i-5} + \varepsilon_{ti} ,$$

and where CF_n^m is the monthly closing price observed in month *n* for the corn futures contract that is nearby in month *m* (here, the nearby corn futures price for the placement month), α is the intercept term that captures all influences other than corn price, β is the slope parameter, ε_{ti} is the regression error term, and COG_{ti} has already been defined at equation 1. The *CORNFUT* regression model is estimated using ordinary least squares regression.

The third forecasting approach, referred to as *MODEL1*, utilizes a slightly more complex corn cost estimation, accounts for changes in productivity over time, and incorporates seasonal changes in animal performance and feedyard costs. The expectation model is

(4) *MODEL1:* $$E[COG_{ti}] = \hat{\alpha}_i + \hat{\beta}t + \hat{\delta}_i[\hat{\gamma}CF_{t,i-5}^{t,i-5} + (1-\hat{\gamma})CF_{t,i-5}^{t,i}] \quad ,$$

and the associated regression model is:

(5) $$COG_{ti} = \alpha_i + \beta t + \delta_i[\gamma CF_{t,i-5}^{t,i-5} + (1-\gamma)CF_{t,i-5}^{t,i}] \quad ,$$

where t denotes the closeout year, α_i is a vector of intercepts unique by closeout month, γ and β are parameters to be estimated, and δ_i is a vector of parameters to be estimated, with each value unique to a closeout month. CF_n^m and COG_{ti} are as defined earlier. In this model each month (i) is allowed to have a different intercept to account for possible seasonal differences in the non-feed component of feeding cost of gain (yardage, death loss, etc.). The year variable is included in the model to capture average productivity increases or technological improvements in cattle feeding over time. The γ parameter allows for the calculation of a weighted expected corn price based on nearby futures and five month out deferred futures at the time of cattle placement. This weighted corn price is then multiplied by a month specific corn feed conversion estimate (δ_i), thus allowing the assumed animal performance (feed conversion) to vary by closeout month.[1] The parameters of *MODEL1* are estimated utilizing optimization software to minimize the sum of squared errors between actual and predicted cost of gain.

Forecasts based on the three methods are compared on the basis of root mean squared forecast error (RMSE) for the string of out of sample monthly forecasts for the years 1996 through 1998. In order to determine whether the more complete model, *MODEL1*, statistically outperformed the simple regression model, *CORNFUT*, RMSE's were compared using the Ashley, Granger, Schmalensee (AGS) test (Ashley, Granger, and Schmalensee; Bessler and Brandt).

Data:

Monthly average feeding cost of gain data from a sample of Kansas commercial feedlots representing steer closeouts from January of 1981 through December of 1998 are used for the analysis. The values are based on a monthly survey of feedyard managers (Kuhl). These data are supplemented with monthly average corn futures closing prices for the relevant feeding period.[2] To facilitate a more direct interpretation of the results, the corn futures data are converted to cents per pound, the same unit of measure as the the feeding cost of gain series. The data

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[1]Additional specifications were tested that included a soybean meal component, specified similarly to the corn component in *MODEL1*. These alternative specifications increased the complexity of the model without adding out of sample predictive accuracy.

[2]Futures data were based on Wednesday closes in a 4 weeks per month framework—months with 5 Wednesdays reported the average of the last two Wednesdays prices as the 4th Wednesday price. Nearby contracts are assumed to end with the 2nd week in the delivery month. Thus the nearby corn futures price for May is the average across the May contract's prices for the first two weeks, and the July contract's prices for the last two weeks of May.

required for each forecasting method are intentionally kept to a minimum, so that the resulting method can be easily and practically implemented.

Results:

Table 1 presents the estimates resulting from each modeling method, and the RMSE of the series of out of sample predictions from each of the forecasting approaches. As expected, both the simple statistical model based solely on corn prices (*CORNFUT*) and the more comprehensive model (*MODEL1*) predict more accurately than the most simple method (*NAIVE*), which relies only on current feeding cost of gain. The out of sample RMSE from the *CORNFUT* model is about 10% lower than the RMSE from the *NAIVE* model, and the RMSE from *MODEL1* is about 30% lower than that of the *NAIVE* model. Results of the AGS test for a difference between the RMSE resulting from *MODEL1* and the RMSE resulting from *CORNFUT* are highly significant. Since only three forecasting approaches are compared, this comparison is sufficient to conclude that *MODEL1* is superior to the other two in terms of forecasting monthly average steer feeding cost of gain.

The β estimates from the estimation of the *CORNFUT* model provide a rough estimate of the average pounds of corn required to produce a pound of gain in steer feeding, since the corn price variable was converted to a price per pound.[3] The estimates obtained are reasonable (3.318 to 4.154, depending on the estimation period), providing some evidence that this model could be used to crudely predict feeding cost of gain based simply on current corn prices.

Our results, however, suggest that estimates of performance and feeding cost of gain

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[3]This estimate is not to be confused with a measure of overall feed conversion, that would include additional ingredients in the ration.

obtained from the *CORNFUT* model can be improved with little additional complexity using *MODEL1*. The β parameter estimates from the more complete model suggest that feeding cost of gain is increasing over time at a rate of just over 0.5 cents per pound per year. The non-feed component of feeding cost of gain (represented by the α_i parameters in the estimation of *MODEL1*) is generally lower for cattle finished in the late summer and early fall.[4] The corn feed conversion parameter (δ_i) ranges from a low of around 4 to a high of nearly 6, depending on the estimation period and closeout month. The values tend to be higher (more corn per pound of gain) for steers finished in the late summer, and lower for steers finished in the very late fall or early winter. This result is consistent with the findings of Jones, Mintert, and Albright in their study of the seasonality of steer feeding performance. The γ parameter estimates provide an indication of the relative weight to place on nearby corn futures price compared to the five month deferred corn futures price. The estimates suggest that between 30% and 58% of the weight should go to the nearby corn futures price. The estimates derived from the longest and most recent data series (1981-1997) suggest the weight on the nearby contract should be about 55%, implying about a 45% weight on the five month deferred futures price.

Using the most recently estimated model (1981 - 1997 estimates), the following example demonstrates how the model can be used to predict feeding cost of gain for steers placed in Kansas feedlots during May of 1999, at the time of placement. Assume the nearby (May) corn futures contract is trading at $2.15 per bushel (3.84 cents per pound at 56 pounds per bushel), and the 5 month deferred corn futures contract (in this case the December contract) is trading at

[4]This result is based on the generally smaller (more negative) α_i parameters for the July through September or October months relative to other closeout months.

$2.31 per bushel (4.13 cents per pound). The γ parameter suggests that the weighted average corn prices in cents per pound would be ((.5529 * 3.84)+((1 - .5529)*4.13)), or 3.97 cents per pound. The α estimate for May is -1060.00, and the corn feed conversion (δ) parameter for May is 5.497. Using these estimates from *MODEL1*, the feeding cost of gain prediction for steers placed on feed in May of 1999, expecting to closeout in October is:

$$COG_{oct,1999} = -1060.00 + .5465*(1999) + 5.497*(3.97) = 54.28 \ \ cents \ \ per \ \ lb.$$

As demonstrated, the easily updated model results in an easily implemented prediction.

Conclusions:

In this study we examine the predictive ability of three different approaches to forecasting feeding cost of gain for cattle feeding. Since the cost of feeding can easily represent over half of the total investment in a cattle feeding program, investors and ranchers considering retained ownership need reasonably accurate feeding cost of gain projections at the time the cattle enter the feeding program. At the same time, in order to be useful the forecasts must be relatively simple to implement, and rely on data that are readily available at the time of cattle placement. The approaches we compared all rely on readily available historical cattle feeding performance and cost of gain information, and readily available futures market prices. In addition, the estimates for each of the forecasting techniques were calculated using commonly available spreadsheet software.

Our results suggest that feeding cost of gain forecast accuracy is improved when the forecast includes adjustments for seasonality in cattle feeding performance, and changes in cattle feeding technology or productivity over time. Based on forecast errors, the feeding cost of gain for steers exiting feedlots in the current month is not a particularly good prediction of the actual feeding cost of gain for steers being placed on feed in the current month that are expected to finish in five months. Similarly, cattle feeding budget projections that rely on current corn prices alone to estimate feeding cost of gain can be improved upon. Using historical data to adjust performance expectations by month and to adjust for expected long term trends, and weighting the corn price component to accommodate expectations of both early and late feeding period corn prices yields a significantly more accurate prediction.

The preferred forecasting model developed for this study can be continuously updated in real time, and is easily implemented by extension economists, cattle feeders, and others. The results of this study will help cattle industry participants in making more informed cattle feeding decisions. As recent year's equity losses in cattle feeding suggest, financial risk management is perhaps more important than ever in the cattle feeding industry. This research will provide valuable information to assist the industry in managing the inherent risks of cattle feeding.

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Table 1: Regression Estimates and Out of Sample Predictive Accuracy For Cattle Feeding Cost of Gain; estimations over 1981-1997; forecasts over 1996-1998.

Model / Parameters		1981 - 1995 Data for 1996 Forecasts		1981 - 1996 Data for 1997 Forecasts		1981 - 1997 Data for 1998 Forecasts		RMSE
NAIVE								7.20
CORNFUT								6.57
α		35.64		32.21		32.38		
β		3.318		4.154		4.153		
MODEL1								4.99
β		0.5238		0.6031		0.5465		
γ		0.2943		0.5770		0.5529		
α_{jan}	δ_{jan}	-1014.94	5.469	-1173.24	5.719	-1057.12	4.837	
α_{feb}	δ_{feb}	-1011.34	5.195	-1169.86	5.473	-1054.33	4.702	
α_{mar}	δ_{mar}	-1008.95	4.754	-1167.11	4.932	-1053.74	4.673	
α_{apr}	δ_{apr}	-1008.02	4.263	-1166.46	4.513	-1053.67	4.419	
α_{may}	δ_{may}	-1015.36	5.583	-1172.54	5.544	-1060.00	5.497	
α_{jun}	δ_{jun}	-1013.56	4.554	-1173.16	5.065	-1060.56	5.035	
α_{jly}	δ_{jly}	-1014.46	4.736	-1175.88	5.669	-1063.31	5.617	
α_{aug}	δ_{aug}	-1013.99	4.666	-1177.16	5.963	-1064.27	5.838	
α_{sep}	δ_{sep}	-1013.92	4.655	-1176.70	5.794	-1064.16	5.762	
α_{oct}	δ_{oct}	-1017.16	5.456	-1174.48	5.356	-1062.32	5.422	
α_{nov}	δ_{nov}	-1019.22	5.785	-1173.87	5.089	-1060.86	5.044	
α_{dec}	δ_{dec}	-1012.29	4.516	-1167.92	4.053	-1054.97	4.002	