DETERMINANTS OF CATTLE FINISHING PROFITABILITY

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Abstract

Data from a western Kansas feedlot were analyzed to estimate the quantitative impacts of price and performance variables on profits per head from finishing cattle. Sale prices, feeder prices, and corn prices had the most impact on profit variability over time. Differences in sale prices, feeder prices, and feed conversions were important in explaining the difference in steer and heifer profits over time. Results suggest that breakeven prices should be calculated for a range of fed cattle, feeder, and corn prices, and that these three variables need to be stochastic in representative farm modeling efforts.

Key words: cattle finishing profitability, feedlot closeouts, cattle performance

Net returns to cattle feeders vary substantially over time. Monthly average returns to a yearling steer feeding program in Kansas ranged from losses of $118 to profits of $170 per head from 1981 to 1990 (Langemeier). These large variations in profits result from variability in input costs, feeder cattle prices, fed cattle prices, and cattle performance.

Based on Kansas State University's 1990 estimate of average profits earned by finishing yearling steers, the aggregate net return to cattle feeding in 1990 likely exceeded $1 billion (Langemeier). Given the economic importance of the U.S. cattle feeding industry and the fluctuation in cattle feeding returns, there is a need for information regarding the relative importance of factors that affect the variability of cattle feeding profitability. Understanding these factors' contributions to profit variability will help cattle feeders, custom feedlot operators, and cow-calf producers considering retaining ownership through finishing identify which aspects of cattle feeding are most risky; such understanding will allow them to identify where they need to focus attention when managing risks associated with feeding cattle. This information is also important to researchers modeling profit risk with a farm planning model that includes cattle finishing activities.

The purpose of this study was to identify which factors most strongly influence the variability in profit per head for finishing steers and heifers over time. Specifically, this paper analyzes variability of profits per head for four placement weight categories of steers as well as variability in the difference in profits between steers and heifers.

PREVIOUS RESEARCH

The traditional approach to examining cattle feeding profitability focuses on allocating net returns into two components: (1) gain per head attributable to price changes from the time the feeder was purchased until it was sold, and (2) the returns associated with the increase in weight times the difference between the sale price per pound and feed cost per pound of gain (Heady and Jensen; Lambert and Sands). Swanson demonstrated that this typical division of returns to cattle feeding was based on an arbitrary accounting convention and could not be supported by the theory of the firm.

Swanson and West noted that allocating returns to the feeder animal's price margin and the feeding margin gives the erroneous impression that the level of net returns to cattle feeding can be completely explained by these two factors. They proposed using coefficients of separate determination (Wright) to statistically estimate the relative importance of the buying and selling operation versus the feeding operation. Using Illinois Farm Bureau Farm Management Service records, they were able to explain 82 percent of the variation in net cattle feeding returns with 38 percent attributable to the price margin and 44 percent explained by the feed cost per pound of gain.

More recently, Weimar and Hallam examined the risks and returns associated with three types of custom cattle feeding contracts. They concluded that the relationship among feed costs, feeder prices, slaughter prices, and cattle feeding performance affected the relative riskiness of the three contract types. However, they did not attempt to rank the relative impact of these factors on the riskiness of the contracts nor did they identify their impact on net feeding returns.

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In a related study focusing on the swine industry, Edwards et al. studied the relative importance of facility, feed, labor, operating, and health costs, sale prices, and reproductive performance on the profitability of farrow-to-finish swine operations in Iowa. They concluded that feed and facility costs were critical factors affecting variability in profits across producers.

The high degree of aggregation present in most existing studies means that little to no information is available regarding the specific impact of factors such as feeder prices, fed cattle prices, feed prices, and animal performance measures on profitability. Research by Edwards et al. on Iowa swine operations suggested that several of these individual factors can have significant impacts on the profitability of livestock feeding. The relative impact of various factors affecting profitability is an important ingredient in the development of cattle finishing risk management strategies. This information is also important in the development of partial budgets and marketing plans.

The present study adds to the current literature in several ways. First, it quantified the impacts on cattle feeding returns of a much more detailed set of price and performance variables than did existing research. Second, the relative importance of each factor affecting the variability in cattle finishing profits was quantified. In the process, the factors that should be included in the development of risk management strategies were identified. Third, differences in the profitability of feeding steers and heifers were analyzed.

METHODS

Regression analysis was used to explain variability in profits per head for steers and to explain variability in the difference between steer and heifer profits. Coefficients of separate determination were used to measure the influence of each independent variable upon the dependent variables.

Net return per head, or profit, was calculated by taking total revenue minus total cost. Factors that influence total revenue are sale price and sale weight. Factors that influence total cost are input prices, initial weight, and animal performance. Thus, profits per head for steers were hypothesized to be a function of input prices (IP), performance factors (PERF), and sale prices (SP). This relationship can be formulated as:

$$(1) \quad \text{Profit} = f(\text{IP, PERF, SP}),$$

where input prices were expected to be negatively related to profit, and sale prices were expected to be positively related to profit. The expected impact of performance on profit varies with the performance factor. Specific variables included in these categories were corn prices, hay prices, interest rates, and feeder cattle prices in the input price category, and average daily gain, feed conversion, and death loss in the performance category.

The difference in profits per head across sex was defined as steer profit minus heifer profit. Differences in profits per head were hypothesized to be a function of differences in input costs (DIFIC), performance (DIFPERF), feeder prices (DIFFP), and sale prices (DIFSP). All of these differences were calculated by subtracting the heifer quantity from the steer quantity. This relationship can be formulated as:

$$(2) \quad \text{DIFPROFIT} = f(\text{DIFIC, DIFPERF, DIFFP, DIFSP}).$$

Specifically, differences in profits per head were related to differences in feed costs, interest costs, death losses, feed conversions, average daily gains, feeder prices, and sale prices.

Expected signs for these parameters varied by factor. Steers become relatively more profitable as the fed steer price increases relative to the fed heifer price. Conversely, as feeder steer prices increase relative to feeder heifer prices, steers become relatively less profitable. Therefore, the differences in sale and feeder prices, respectively, were expected to be positively and negatively related to the difference in profits per head. If feed conversion for heifers declines or feed conversion for steers increases, steers become relatively less profitable. Thus, the difference in feed conversions was expected to be negatively related to the difference in profits per head. Using similar analogies, the differences in average daily gains were expected to be positively related to the difference in profits, and the difference in feeder interest costs, feed costs, and death losses were hypothesized to be negatively related to the difference in profits.

Coefficients of separate determination were used to measure the influence of each independent variable upon the dependent variables. The sum of these coefficients for a particular regression equation equals the R^2 goodness of fit measure. One minus the sum of these coefficients equals the unexplained variation. Calculation of the coefficients of separate determination effectively allocates the explained variation for the regression among the independent variables. Each coefficient represents the portion of the variation in the dependent variable explained by a particular variable. Coefficients of separate deter-

mination for n variables can be shown to equal (Burt and Finley):

$$
\begin{aligned}
C_1 &= \sum_{i=1}^{n} \beta_1 \beta_i r_{1i} \\
C_2 &= \sum_{j=1}^{n} \beta_2 \beta_j r_{2j} \\
&\bullet \\
&\bullet \\
&\bullet \\
C_n &= \sum_{k=1}^{n} \beta_n \beta_k r_{nk}
\end{aligned}
\qquad (3)
$$

where β is the beta coefficient, and r is the simple correlation coefficient. The regression equation coefficients and the standard deviations of the independent and dependent variables are used to calculate the beta coefficients. Specifically, the beta coefficient for a particular variable is calculated by multiplying the regression coefficient for that variable by the ratio of its standard deviation to the standard deviation of the dependent variable (Ezekiel and Fox).

DATA DESCRIPTION

Feedlot data pertaining to date in, date out, days on feed, average daily gain, feed conversion (as-fed basis), death loss, feed cost per pound, feed cost per head, weight in, weight out, and sale price were collected from a western Kansas commercial feedyard's fed cattle customer closeout sheets. Data were collected for all steers and heifers placed on feed from January 1980 through December 1989. Over 2600 pens (540,000 head) of steers and 700 pens (132,000 head) of heifers were represented in the sample. Individual pen data were used to compute monthly average performance information for four placement weight categories of steers and two placement weight categories of heifers.

Other data used in the analysis included corn prices, hay prices, interest rates, and feeder prices. Interest rates were obtained from various issues of the *Federal Reserve Bulletin*. Corn prices were obtained from various issues of *Agricultural Prices*. Various *Hay Market News* reports were used to obtain a series of hay prices for southwest Kansas. Corn and hay prices were needed to isolate the effects that these two feed price items had on the variability in profits per head over time. Feed cost data from the closeout sheets were used to calculate actual profits per head. The relevant corn and hay prices for a particular pen of cattle were calculated using a simple average of prices during the time the cattle were fed. Days on feed for each pen of cattle were used to calculate the appropriate corn and hay prices. For example, if a pen of cattle was on feed for 120 days, then a four-month average of corn and hay prices was used to represent the relevant prices.

Dodge City, Kansas, feeder cattle auction summaries reported by USDA and a linear price slide were used to estimate feeder steer and feeder heifer prices for each pen of cattle because actual prices paid for feeder cattle were not available. For example, the price of a pen of 675 pound heifers was obtained as follows:

$$((750-675)/100)*P_{650} + ((675-650)/100)*P_{750} \qquad (4)$$

where P_{650} is the feeder price for heifers weighing between 600 and 700 pounds and P_{750} is the feeder price for heifers weighing between 700 and 800 pounds.

Monthly average cattle performance, costs, interest rates, and prices were calculated using the data described above. Monthly profits per head were estimated by subtracting feeder costs, feed costs, interest costs, processing costs, and yardage fees from gross returns.

Table 1 presents a summary of monthly performance, cost, and profit information for four steer placement weight categories. All costs and returns in Table 1 are expressed in 1989 dollars. The series were inflated to 1989 dollars using the implicit price deflator for personal consumption expenditures (United States Department of Commerce).

Different placement weight categories were used in the analysis to estimate the relative importance of factors across placement weights. For example, feed conversion and corn prices, important components of feed costs, were expected to have less influence on profits per head for heavier weight placements because they would be on feed fewer days. On the other hand, feeder cattle prices were expected to be relatively more important for heavier weight placements.

The same months across all weight ranges were used to calculate the performance, cost, and profit information for steers in Table 1. Due to seasonal trends in placement weights, placement data were not available for all the weight categories during some of the months, as noted in Table 1. Analysis of the difference in profits per head between steers and heifers used data for the months during which placement data were available for both steers and heifers.

Table 1. Average Costs, Returns,and Performance by Placement Weight for Steers in Western Kansas, 1980-1989[a]

	Placement Weight			
	600-700# Steers	700-800# Steers	800-900# Steers	All Weight Steers
Placement weight (lbs)	664	747	835	743
Days on feed	151	134	122	137
Sale Weight (lbs)	1122	1164	1220	1166
Average daily gain (lbs / day)	3.02	3.09	3.14	3.08
Feed conversion[b] (lbs feed / lb gain)	8.55	8.81	9.09	8.81
Death loss (%)	0.78	0.51	0.43	0.57
Feeder cost ($ / hd)[c]	557.59	617.66	680.41	612.57
Feeding cost ($ / hd)	265.20	247.97	233.42	251.70
Interest ($ / hd)	24.57	23.44	22.80	23.95
Total costs ($ / hd)	847.36	889.07	936.63	888.22
Gross Returns ($ / hd)	900.26	933.25	972.58	932.03
Profit ($ / hd)	52.90	44.18	35.95	43.81

[a]All costs and returns are expressed in 1989 dollars. Data for steers placed in the following months were not available: 2/81, 8/81, 3/82, 9/82, 1/83, 2/83, 3/83, 4/83, 2/85, 3/85, 6/86, 12/88, 1/89, and 2/89.
[b]Feed conversion is expressed on an as-fed basis.
[c]Feeding costs include feed costs, processing, and yardage.

As placement weights increased, feeder costs increased, and interest and feed costs decreased. Average sale weights for steers increased from 1122 pounds to 1221 pounds as placement weights increased from 600-700 pounds to 800-900 pounds. As a result, gross returns were lower, on average, for lighter weight placements. However, lighter weight placements were more profitable than heavier weight placements.

ECONOMETRIC RESULTS

The econometric results of regressing price and performance variables on profits per head are reported in Table 2. Sale prices, feeder prices, corn prices, interest rates, feed conversion, and average daily gain explained about 98 percent of the variability in profits per head for each weight breakdown depicted in Table 2. All of the independent variables were significant at the 1 percent level in each equation. Hay prices and death losses were not included in the final results because they did not have a significant impact on profits. Hay prices were insignificant because hay represents a minor portion of the feed cost in high energy rations. Death losses were insignificant because, on a monthly average basis, they were relatively stable over the study period. Death losses would be more important in comparisons across individual pens of cattle.

Table 3 presents the coefficients of separate determination for the independent variables in Table 2. Sale price had the largest effect on profits per head. Feeder prices and corn prices had the next largest effects. The other remaining variables—interest rates, feed conversion, and average daily gain—had considerably less influence on profits per head.

Corn prices tended to have less influence on profits per head as placement weight increased. This is consistent with Buccola's conclusion that feed price changes will have a larger impact on light weight feeder cattle prices relative to heavy weight feeder prices. This also parallels Marsh's argument that with high grain prices, placement demand for yearlings will decline less than that for calves because total cost of gain is expected to be relatively less expensive.

The impact of average daily gain on profit increases with placement weight. This result seems plausible. Feeder costs are higher and feeding costs are lower for heavier placements. Thus, as placement weights increase, relatively more money is invested in the feeder. Improving daily gains tends to reduce feeder interest costs and the cost of gain. Based on this information, as placement weight increases, we would expect feed prices to have relatively less influence and average daily gain to have relatively more influence on profit variability.

The econometric results that analyze the difference in profits per head for steers and heifers are shown in Table 4. Results are presented for 600 to 700 pound steers and heifers, for 700 to 800 pound steers and 600 to 700 pound heifers, and for all steers and

Table 2. Estimated Profit Equations for Steers, 1980-1989[ab]

Independent Variable	Placement Weight 600-700# Steers	700-800# Steers	800-900# Steers	All Weight Steers
Intercept	24.56	-58.68	-80.34	28.82**
	(0.46)	(-1.22)	(-1.92)	(0.56)
Sale price	10.74**	11.29**	11.88**	11.23**
	(59.56)	(69.56)	(65.51)	(65.44)
Feeder price	-6.18**	-7.39**	-8.21**	-7.01**
	(-44.12)	(-51.39)	(-48.99)	(-50.99)
Corn price	-54.59**	-49.07**	-47.80**	-47.92**
	(-35.93)	(-36.35)	(-28.58)	(-33.79)
Interest rate	-2.33**	-2.17**	-2.40**	-2.46**
	(-7.67)	(-7.57)	(-7.24)	(-8.53)
Feed conversion	-24.53**	-16.43**	-14.17**	-23.02**
	(-7.06)	(-5.54)	(-5.37)	(-7.82)
Average daily gain	28.51**	40.59**	43.60**	22.95**
	(3.31)	(4.77)	(6.06)	(2.49)
Adjusted R^2	0.98	0.98	0.98	0.98

[a]The dependent variable in each equation is profit per head. The t-ratios are in parentheses. One asterisk denotes significance at the 5 percent level and two asterisks denote significance at the 1 percent level (two-tailed test).
[b]Sale price and feeder price are expressed in dollars per cwt. Corn prices are expressed in dollars per bushel. Interest rates are expressed as a percent. Feed conversion and average daily gain are expressed in pounds of feed per pound of gain and pounds gained per day, respectively.

heifers placed. The 600 to 700 pound steer and heifer results illustrate the difference in profits for similar steer and heifer placement weights. The 700 to 800 pound steer and 600 to 700 pound heifer results illustrate the difference in profits for steers and heifers fed a similar number of days.

Differences in sale prices, feeder prices, feed conversions, and daily gains explained 86 to 87 percent of variation in profits between steers and heifers. Results in Table 5 indicate that differences in sale prices explained a large proportion of variability in profit differences. Differences in feed conversions and feeder prices had the next largest effects on the difference in profits. Differences in average daily gains had relatively less influence on profit differences than did other independent variables. Differences in feeder interest costs, feed costs, and death losses were not included in the results because of lack of significance. This is not surprising given that, on a monthly basis, these costs did not vary considerably between steers and heifers.

CONCLUSIONS AND IMPLICATIONS

Analysis of historical closeout summaries of actual feedlot data provided considerable information to quantify factors affecting profitability and risks in finishing cattle. Overall, movement in fed cattle prices explained roughly 50 percent of the variability over time in cattle feeding profits. Feeder cattle price risk, which is important prior to placement of cattle on feed, contributed approximately 25 percent of the risk. Changes in corn prices contributed up to 22 percent of the variability in profits.

Placement weight of cattle had a pronounced effect on the relative importance of performance and cost factors on profits. For lighter weight cattle, profit variability was strongly influenced by the average price of feed. Profits for cattle placed on feed at heavier weights were influenced more directly by the costs of the feeder cattle and daily gain.

Profitability differences between steers and heifers were largely (50 percent) caused by differences in sale prices during the study period. Profitability differences between steers and heifers were also explained by feeder cattle price and feed conversion differences.

The results of this study have important implications for cattle feeders, extension specialists, and cattle marketing consultants. Becuase 50 percent of the variation in profits was attributable to movement in sale prices, cattle feeders should consider actively managing fed cattle price risk. Because sale prices, feeder prices, and corn prices had a large impact on profit per head, breakeven prices should be calculated for a range of feeder cattle and corn prices. The information from this breakeven sensitivity analysis can be incorporated into production and marketing plans. Moreover, anecdotal evidence suggests that many cattle feeders do not attempt to manage feeder

Table 3. Coefficients of Separate Determination for Each Independent Variable, 1980-1989

Independent Variable	Placement Weight 600-700# Steers	700-800# Steers	800-900# Steers	All Weight Steers
Sale price	0.4849	0.5262	0.4829	0.5080
Feeder price	0.2223	0.2653	0.2567	0.2655
Corn price	0.2255	0.1654	0.1524	0.1713
Interest rate	0.0146	0.0057	0.0093	0.0118
Feed conversion	0.0316	0.0176	0.0347	0.0200
Average daily gain	-0.0023[a]	0.0015	0.0446	0.0027
Total	0.9766	0.9817	0.9806	0.9793
Unexplained variation	0.0234	0.0183	0.0194	0.0207

[a]A negative coefficient indicates that average daily gain does not help explain variation in the dependent variable. Using equation (3) in the text, it is possible to obtain a negative coefficient of separate determination. In this case, equation (3) has six terms denoting the relationship between average daily gain and the other independent variables. The term associated with the sale price variable was a large enough negative number to outweigh the other terms. The correlation coefficient between sale price and average daily gain was -0.30. The high correlation between these two variables is related to seasonal patterns.

Table 4. Estimated Equations for the Difference in Profits Between Steers and Heifers, 1980-1989

Independent Variable[a]	Placement Weight 600-700# Steers and Heifers	700-800# Steers and 600-700# Heifers	All Steers and Heifers
Intercept	21.55**	9.43*	3.28
	(3.64)	(2.00)	(0.71)
DIFSP	9.18**	11.64**	10.41**
	(18.29)	(21.00)	(20.89)
DIFFP	-7.93**	-8.19**	-6.27**
	(-9.51)	(-12.55)	(-9.87)
DIFFCON	-31.22**	-29.12**	-29.02**
	(-8.35)	(-7.14)	(-9.83)
DIFADG	11.62	5.20	5.28
	(1.31)	(0.50)	(0.75)
Adjusted R^2	0.86	0.87	0.86

[a]The dependent variable for each equation is defined as profit per head for steers minus profit per head for heifers. The t-ratios are in parentheses. One asterisk denotes significance at the 5 percent level and two asterisks denote significance at the 1 percent level (two-tailed test). The independent variables are defined as: DIFSP is the sale price for steers minus the sale price for heifers, DIFFP is the feeder price of steers minus the feeder price of heifers, DIFFCON is the feed conversion for steers minus the feed conversion for heifers, and DIFADG is the average daily gain for steers minus the average daily gain for heifers.

Table 5. Coefficients of Separate Determination for Difference in Profits Results

Independent Variable[a]	Placement Weight 600-700# Steers and Heifers	700-800# Steers and 600-700# Heifers	All Steers and Heifers
DIFSP	0.5103	0.5365	0.6754
DIFFP	0.1060	0.1477	0.0660
DIFFCON	0.2202	0.1801	0.1240
DIFADG	0.0192	0.0087	-0.0053[b]
Total	0.8557	0.8730	0.8601
Unexplained variation	0.1443	0.1270	0.1399

[a]The dependent variable for each equation is defined as profit per head for steers minus profit per head for heifers. The independent vaiables are defined as: DIFSP is the sale price for steers minus the sale price for heifers; DIFFP is the feeder price of steers minus the feeder price of heifers; DIFFCON is the feed conversion for steers minus the feeder price for heifers; and DIFADG is the average daily gain for steers minus the average daily gain for heifers.
[b]A negative coefficient indicates that DIFADG does not help explain variation in the dependent variable. Using equation (3) in the text, it is possible to obtain a negative coefficient of separate determination. In this case, equation (3) has four terms denoting the relationship between DIFADG and the other independent variables. The term associated with DIFSP was a large enough negative number to outweigh the other terms. The correlation coefficient between DIFSP and DIFADG was -0.59. The high correlation between these two variables is related to seasonal patterns.

cattle or feed price risk using either forward cash contracts or hedging. These results indicated that 40 to 45 percent of the variation in cattle feeding profits was attributable to movement in feeder cattle prices and corn prices. As a result, cattle feeders should strongly consider attempting to manage their input price risk. Survey results summarized by Schroeder and Blair indicate that a large percentage of the custom feedlots in Kansas offer feed cost forward pricing and the prepayment of feed costs as services.

The results also have implications for other researchers. Farm planning models in which sale prices, feeder prices, or corn prices are nonstochastic are inadequate. To reflect profit risk accurately, these three variables should be modeled in a stochastic framework.

More research is needed to determine whether the results in this paper are applicable to other regions. The same profitability factors are probably important for feedlots in other regions. However, the relative importance of each factor might differ across regions.

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