Determinants of Profit Variability in Fed Cattle Grid Pricing

by

R. Allen McDonald

and

Ted C. Schroeder*

Paper Presented at the 2000 Western Agricultural Economics Association Annual

Meeting, Vancouver, British Columbia, June 29-July1, 2000

* The authors are graduate research assistant and Professor, respectively, Department of Agricultural Economics, Kansas State University.

Determinants of Profit Variability in Fed Cattle Grid Pricing

Abstract

This study determines the relative impacts of price, cattle quality, and feeding performance factors on profit per head for fed cattle marketed via a grid structure. Two different data sets of cattle that were marketed in two different grid pricing systems are used in the analysis with comparisons of results made between grids. Grid base price and feeder cattle price are the most important determinants of profit over time in both grids. However, only considering non-price variables, the cumulative quality of cattle in a pen is the most important profit determinant followed by average daily gain in one grid and feed efficiency in the other.

Determinants of Profit Variability in Fed Cattle Grid Pricing

The beef industry has faced 20 years of declining consumer demand, decreasing per capita consumption, and loss of market share relative to pork and poultry (Purcell 1998). The decline in consumer demand may have come about for a number of reasons, but inconsistencies in beef quality related to pricing fed cattle on averages is often cited as a contributing factor (Fausti, Feuz, and Wagner 1998; Schroeder et al. 1998). Recently, the beef industry has responded by attempting to increase vertical coordination throughout the industry and ultimately change the way cattle are produced and marketed. At the fed cattle market level, these efforts have resulted in carcass merit pricing, in the form of value-based marketing, increasing tremendously over the past decade. The beef industry has focused on implementing an effective value-based coordinated market system that better meets consumer needs and reverses the 20-year demand decline. As a result, beef packers have developed grid pricing systems to derive a value for each carcass that is based on its overall quality. In this system, producers that market a higher quality animal receive premiums, and producers who market lower quality animals receive discounts.

Cattle feeding profits are determined by a large number of factors when cattle are marketed using a grid. The objective of this paper is to determine the relative impacts of price, cattle quality, and feeding performance factors on profit per head for fed cattle marketed using a grid. Furthermore, this analysis is done for cattle marketed using two distinctly different grid structures to establish whether or not factors determining profit change from one grid structure to another.

Review of Literature

Past research pertaining to the pricing of fed cattle has focused on analyzing the change in variability and mean levels of profit and revenue across the various pricing methods. Studies have found that profit and revenue variability per head increases when moving from live-weight to dressed-weight to grid pricing. Feuz, Fausti, and Wagner (1993) tested the equality of variance in profit across live-weight, dressed-weight, grade and yield, and value-based pricing. They found that variance in profit for the live-weight method was statistically lower than for any of the other three methods. Moreover, variance in profit for the dressed-weight method was statistically smaller than the variance for both grade and yield and value-base based pricing with no statistical difference between the latter. Fausti, Feuz, and Wagner (1998) found that pricing cattle under a grid pricing system increased standard deviation in revenue by $5.03 relative to dressed-weight pricing.

A consensus has not been formed on the effects of changing pricing method on mean levels of revenue or profit. This is probably due to differences in carcass quality and associated premiums and/or discounts for the varying data sets of cattle used to examine mean revenue levels. Fausti, Feuz, and Wagner (1998) concluded that being capable of estimating carcass quality is significant in determining which pricing method offers the highest average revenue. Schroeder and Graff (1999) found that knowing quality characteristics and marketing cattle according to the method that provided the highest price resulted in $34.74 per head additional revenue compared to selling all cattle on a live-weight basis. In addition, Feuz, Fausti, and Wagner (1995) determined that buyers charged a significant risk premium to sellers when buying cattle of unknown quality.

Feuz, Fausti, and Wagner (1993) and McDonald and Schroeder (1999) found somewhat conflicting results when analyzing the determinants of profit in grid pricing structures. The 1993 study found that quality grade was the most important factor when determining profit while the other study found that feeder price and grid base price had the greatest effect on changing profit with quality having little influence compared to other performance and price components. The main reason for conflicting results cited by McDonald and Schroeder (1999) was that the initial study used essentially cross-sectional data, whereas their study presented results over time. Temporal price variability tends to exceed and overshadow cross-sectional cattle quality variability. The analysis in this study estimates profit determinants over time and extends the investigation to compare results in two different grid pricing structures

No recent study has analyzed determinants of profit per head comparing results across two different grid pricing mechanisms. Since a number of different types of grids have been established, the comparison of grid structures and data used within those structures is important to producers that are trying to find or define a grid that best suits their operation.

Grid Structures

Grid pricing mechanisms are setup differently under different agreements and vary across packers (Ward, Feuz, and Schroeder 1999). The two grids (Grid A and Grid B) used in this analysis are outlined in this section.

As with all grids, a base price is the starting point from which premiums and discounts for carcass characteristics are applied in both grid structures. Grid A uses a weighted plant average base price. Price paid for and carcass characteristics of cattle bought live in the previous week are used to derive a base price for cattle delivered on a grid in the current week. The base price in grid B is based off the western Kansas direct weekly fed cattle price as reported by the USDA converted to a dressed price using the plant average hot yield for the previous week.

Premiums and discounts for quality and yield grade characteristics are added to the base price to determine the grid dressed price received. In grid A, the same premium is paid for yield grades 1 and 2. Yield grades 4 and 5 have separate discounts. Prime carcasses receive a premium, and Select carcasses receive a discount. The discount for Select carcasses follows the USDA boxed beef cutout Choice-to-Select price spread. Norolls receive the same discount as Selects in this grid. Miscellaneous grade carcasses (dark cutters, stags, heiferettes, etc.) receive discounts. Finally, heavy-weight (>950 lbs.) and light-weight (<525 lbs.) carcasses receive discounts. The same discount is assessed for light- and heavy-weight carcasses no matter the quality or yield grade. The premiums and discounts in this grid are additive. For example, a yield grade 2, Select carcass is paid a premium for yield grade and levied a discount for quality grade. Table 1 summarizes the premium/discount schedule for Grid A. A Choice, yield grade 3 carcass is the base and does not receive a premium or discount. It is important to note that premiums and discounts portrayed in table 1 are at a single point in time and may change.

Table 1. Premium/Discount Schedule for Grid A at a Point in Time.

Quality Grade		Yield Grade 1 and 2	3	4	5
		($/cwt carcass)			
Prime		11.00	10.00	-2.00	0.00
Choice		1.00	**BASE**	-12.00	-10.00
Select[a]		-5.00	-6.00	-18.00	-16.00
Misc		-19.00	-20.00	-32.00	-30.00
Heavy	-12.00				
Light	-25.00				

[a] Noroll carcasses are included with Select.

Grid B pays premiums only on the percent of a pen above pre-set thresholds for desirable quality traits (discounting pens below target) and discounts pens having undesirable traits present above target levels. No premiums or discounts are applied to Select, yield grade 3 carcasses. The targets and associated premium or discount are reported in table 2. The premiums or discounts have been consistent over time except for the premium for Choice or higher quality grade. This value is equal to the USDA Choice-to-Select price spread. The total premium or discount is the difference in the actual percentage and the target percentage multiplied by the particular premium or discount for each quality attribute. For example, if the pen exceeds the threshold for Choice or higher quality grade, a premium is paid on the percent of cattle grading Choice or higher exceeding 55 percent of the pen. However, a discount is accessed if the pen has fewer Choice or higher cattle than the target.

Table 2. Target Percentages and Premiums/Discounts for Grid B.

Carcass Characteristics	Threshold	Premium/Discount ($/cwt carcass)
Quality Grade		
Choice and Higher	>55%	Varies[a]
Prime	>1%	$8.00
CAB	>5%	$3.50
Select	0%	$0.00
Noroll	<5%	-$2.00
Yield Grade		
Yield Grade 1	>5%	$3.00
Yield Grade 2	>35%	$1.50
Yield Grade 3	>56%	$0.00
Yield Grade 4 and 5	<3.5%	-$12.00
Carcass Weight		
<550	0%	-$10.00
>950	0%	-$10.00

[a] Varies with USDA boxed beef cutout Choice-to-Select price spread over time.

Models and Procedures

Ordinary Least Squares (OLS) regression is used to explain the variability in profit per head (*profithd*) for fed cattle sold on a grid. Factors that are expected to influence profit are dressed price (*dresspr*), cost of feeder cattle (*costin*), corn price (*cornp*), average daily gain (*adg*), feed conversion (*conv*), hot yield (*hyld*), and days on feed (*dof*).

$$profithd = f(dresspr, costin, cornp, adg, conv, hyld, dof) \qquad \textbf{(1)}$$

The net dressed price received can be further broken down into its grid components. Grid pricing mechanisms differ across agreements and packers (Ward, Feuz, and Schroeder 1999). Therefore, determinants of dressed price and marginal values of carcass attributes can change from one grid to the next. However, common components include the base price (*base*), the percentage of carcasses having different quality (*prime*, *choice*, *select*, *noroll*) and yield grades (*yg1*, *yg2*, *yg3*, *yg4*, *yg5*), the percentage of miscellaneous (*misc*) and condemned (*cond*) carcasses, and the percentage of light-weight (*light*) and heavy-weight (*heavy*) carcasses. The following equation summarizes the price components:

$$dresspr = \mathrm{f}(base, prime, choice, select, noroll, yg1, yg2, yg3, yg4, yg5, misc, cond, light, heavy) \qquad \textbf{(2)}$$

The factors in the grid that determine dressed price can be substituted into the original profit equation (1) to yield:

$$profithd = \mathrm{f}(base, prime, choice, select, noroll, yg1, yg2, yg3, yg4, yg5, misc, cond, light, heavy, costin, cornp, adg, conv, hyld, dof) \qquad \textbf{(3)}$$

Equation (3) is the primary equation of interest in this analysis. Of particular interest are the impacts of each regressor on profitability. Standardized beta coefficients (SBC) are used to compare the relative influence of the independent variables on the dependent variable. The SBC's are calculated by multiplying the beta coefficient for each independent variable by the ratio of the standard deviation of the independent variable divided by the standard deviation of the dependent variable (Pindyck and Rubinfeld 1998). The calculation of the SBC for base price is demonstrated in equation (4). This calculation method is used for each independent variable.

$$\mathrm{SBC} = \beta_{\mathrm{base}} * \frac{\sigma_{\mathrm{base}}}{\sigma_{\mathrm{profithd}}} \qquad \textbf{(4)}$$

To interpret the SBC, if it has a value of 2.0 for example, a one standard deviation increase in base price would lead to a 2.0 standard deviation increase in profit per head. These coefficients are proportions, and thus, can be used to rank the relative importance of the independent variables.

Data Discussion

Analysis of profit is based on two distinct data sets for cattle sold using two different grid pricing systems (Grid A and Grid B). Cattle sold using grid A were marketed by a large mid-western feeding operation from January 1992 to December 1998. Feedlot closeout data and kill sheet data for 3,483 pens of cattle comprise this data set. The data set corresponding to grid B is for cattle fed and slaughtered under an alliance in western Kansas from May 1995 to September 1998. These data consist of feedlot closeout data and kill sheet data for 1,011 pens of cattle.

Feedlot closeout data associated with cattle sold using grid A include profit per head, cost of feeder cattle, average daily gain, dry matter feed conversion, and days on feed for individual pens. Kill sheet data include percentage of yield grade 1, 2, 3, 4, and 5 carcasses, as well as percentage of carcasses in the pen grading Prime, Choice, Select (including noroll), and miscellaneous for each pen of cattle. The data also include percentage of light- and heavy-weight carcasses, percentage of condemned carcasses, a hot yield, and a grid dressed price. Table 3 presents summary statistics of cattle sold under Grid A.

Table 3. Summary Statistics for Cattle Fed and Marketed Under Grid A, 1992-1998.

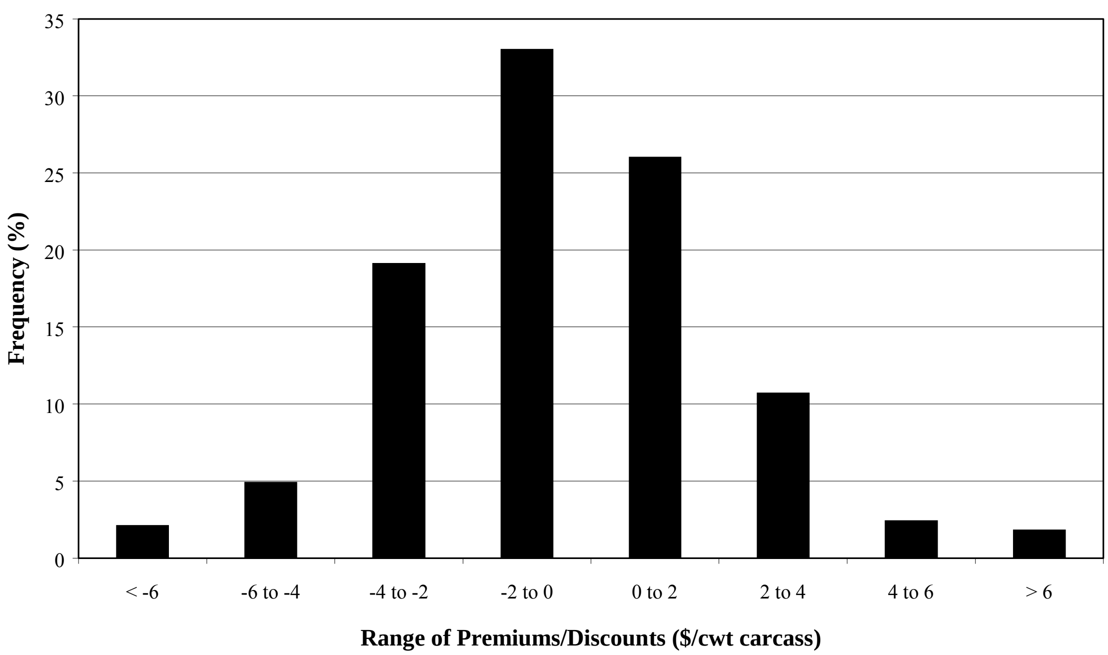
Variable	Mean	Std. Dev.	Minimum	Maximum
Profit ($/hd)	2.17	67.37	-257.67	243.56
Grid Dressed Price ($/cwt carcass)	107.89	9.35	86.02	138.05
Base Price ($/cwt carcass)[a]	108.34	9.01	90.14	134.98
Premium/Discount ($/cwt carcass)	-0.45	2.80	-20.96	28.53
Cost of Feeder Cattle ($/cwt)	77.20	13.00	37.48	127.77
Average Daily Gain (lbs/day)	2.92	0.38	0.56	4.35
Feed Conversion (lbs feed/lb gain)	6.79	0.93	4.53	37.53
Hot Yield (%)	63.71	0.83	49.24	72.35
Carcass Weight (lbs)	758.20	66.78	542.63	935.54
Days on Feed	171.66	34.93	62	376
Death Loss (%)	0.98	1.36	0	24.82
Yield Grade 1 (%)	14.83	9.22	0	69.60
Yield Grade 2 (%)	43.26	11.25	8.75	88.82
Yield Grade 3 (%)	38.13	12.59	1.28	86.25
Yield Grade 4 (%)	3.55	3.47	0	27.57
Yield Grade 5 (%)	0.23	0.52	0	8.57
Prime (%)	1.14	1.57	0	18.63
Choice (%)	55.33	14.44	0.08	87.67
Select (%)[b]	42.35	15.55	0	97.10
Miscellaneous (%)	1.18	4.17	0	56.49
Condemned (%)	0.01	0.05	0	0.99
Heavy Carcasses (%)	1.88	3.38	0	42.10
Light Carcasses (%)	1.54	3.47	0	44.88
Number of Observations (pens)	3,483			

[a] USDA reported dressed price for week prior to slaughter was used as base price.
[b] Norolls are included in Select.

The actual base price for each pen of cattle was not available. Therefore, a weekly average dressed price was obtained from USDA's *Weekly 5 Area Weighted Average Direct Slaughter Cattle Prices* and is used in place of the actual base price for this grid. The five areas represented in this report are Texas-Oklahoma, Kansas, Colorado, Nebraska, and Iowa-Southern Minnesota. The reported price represents 65-80 percent Choice carcasses. Reported price for the week prior to slaughter was used for each pen. Across the 3,483 pens, base price averaged $108.34/cwt ranging from $90.14/cwt to $134.98/cwt (table 3).

On average, dressed price received was less than base price leading to an average discount of -$0.45/cwt (table 3). The premiums/discounts ranged from -$20.96/cwt to $28.53/cwt with a standard deviation of $2.80/cwt. Figure 1 shows the distribution of the average premiums/discounts across pens. Roughly 41 percent of pens received premiums greater than zero. Approximately 60 percent of pens fell within +/- $2.00/cwt of zero with roughly 90 percent falling inside +/- $4.00/cwt of zero. Less than four percent of all pens received an average premium of greater than $6.00/cwt or an average discount of less than -$6.00/cwt.

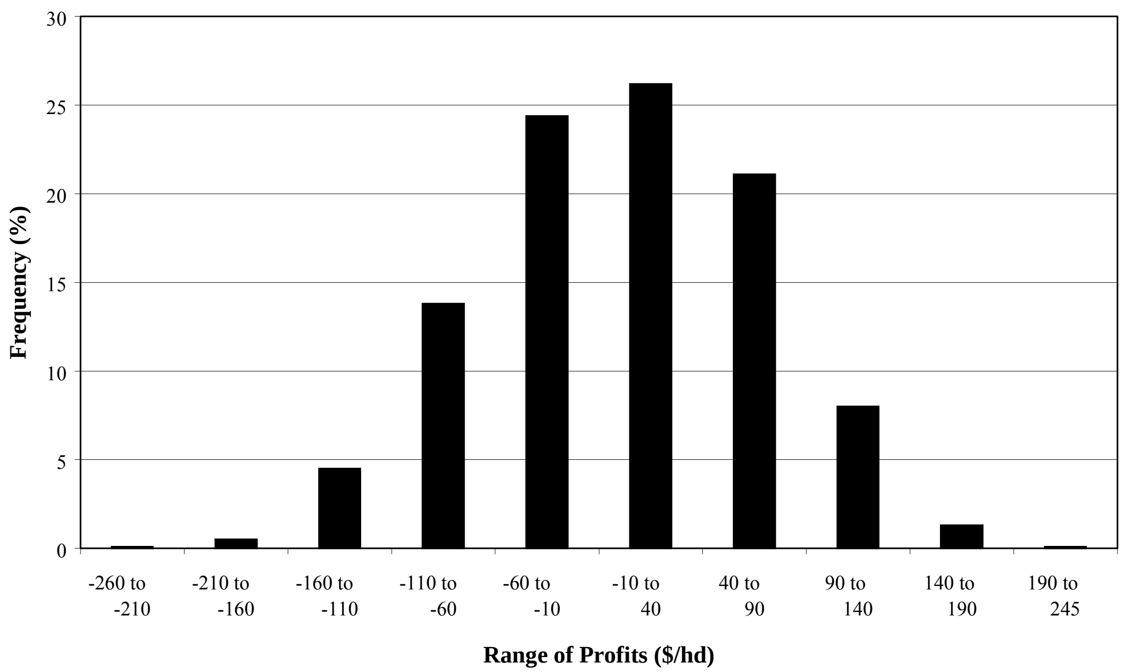
Figure 1. Distribution of Premiums/Discounts per cwt, Grid A



Profit per head was positive on average with a mean of $2.17/head and ranged from a loss of $258/head to a profit of $243/head (table 3). Figure 2 presents the distribution of profit per head. The range that includes zero contains the largest number of pens (~ 26 percent), and just less than 50 percent of pens lost money with a little over

50 percent of pens making money. Additionally, just above 85 percent of pens had profits between -$110/head and $90/head.

Figure 2. Distribution of Profit per Head, Grid A



Included in table 3 are summary statistics for percentage death loss in each pen. This variable is included for comparison with performance factors. The maximum value of feed conversion is 37.53 pounds of feed/pound of gain and the minimum value of average daily gain is 0.56 pounds/day. These extreme values are for the same pen of cattle that suffered a death loss of 24.82 percent. The small average daily gain and large feed conversion for this pen are extreme outliers; however, because they occurred, justifies including them in the data set.

Feedlot data for cattle sold using grid B include individual pen data for profit per head, cost of feeder cattle, average daily gain, dry matter feed conversion, and days on feed. Kill sheet data include percentage of carcasses in yield grades 1, 2, 3, 4, and 5 and percentage of carcasses in the pen grading Prime, CAB, Choice, Choice and up, Select, and noroll. Kill sheet data also includes percentage of light- and heavy-weight carcasses, hot yield, base price, and grid dressed price. Table 4 tabulates summary statistics of cattle sold in Grid B.

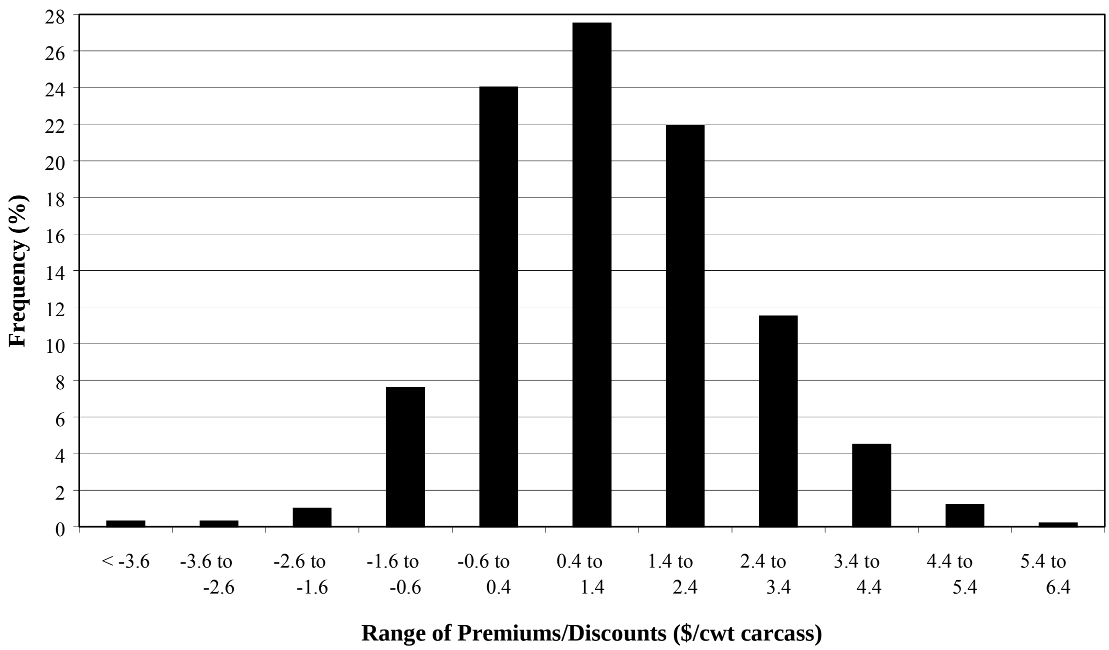
Table 4. Summary Statistics for Cattle Fed and Marketed Under Grid B, 1995-1998.

Variable	Mean	Std. Dev.	Minimum	Maximum
Profit ($/hd)	-10.65	80.06	-272.09	208.87
Grid Dressed Price ($/cwt carcass)	102.66	5.82	88.17	118.46
Base Price ($/cwt carcass)	101.57	5.56	88.99	114.96
Premium/Discount ($/cwt carcass)	1.09	1.53	-15.87	6.18
Cost of Feeder Cattle ($/cwt)	69.92	8.69	45.83	106.70
Average Daily Gain (lbs/day)	3.29	0.38	2.08	4.49
Feed Conversion (lbs feed/lb gain)	6.31	0.50	5.21	8.97
Hot Yield (%)	63.76	0.87	60.43	66.23
Carcass Weight (lbs)	761.82	64.29	574	1041
Days on Feed	131.54	21.70	79	250
Yield Grade 1 (%)	4.32	5.00	0	49.67
Yield Grade 2 (%)	35.17	15.54	1.04	91.01
Yield Grade 3 (%)	55.46	16.00	0	94.76
Yield Grade 4 (%)	5.04	5.29	0	43.55
Yield Grade 5 (%)	0.003	0.054	0	1.40
Prime (%)	2.96	4.28	0	31.61
CAB (%)	19.18	11.63	0	69.43
Choice (%)	43.54	10.08	3.63	77.22
Select (%)	32.59	14.53	3.05	83.08
Noroll (%)	1.73	2.60	0	40.85
Heavy Carcasses (%)	1.81	3.82	0	42.08
Light Carcasses (%)	0.93	2.66	0	24.91
Number of Observations (pens)	1,011			

Dressed price received was higher than base price on average leading to an average premium of $1.09/cwt (table 4). Premiums/discounts ranged from a value of -$15.87/cwt to $6.18/cwt with a standard deviation of $1.53/cwt. Figure 3 shows the distribution of the premiums/discounts paid across pens. The majority of the pens lie in a range around zero, although approximately 80 percent received premiums greater than zero. Additionally, just over 73 percent of pens received a discount between -$0.60/cwt and $2.40/cwt. Roughly 3.5 percent of all pens received an average discount less than

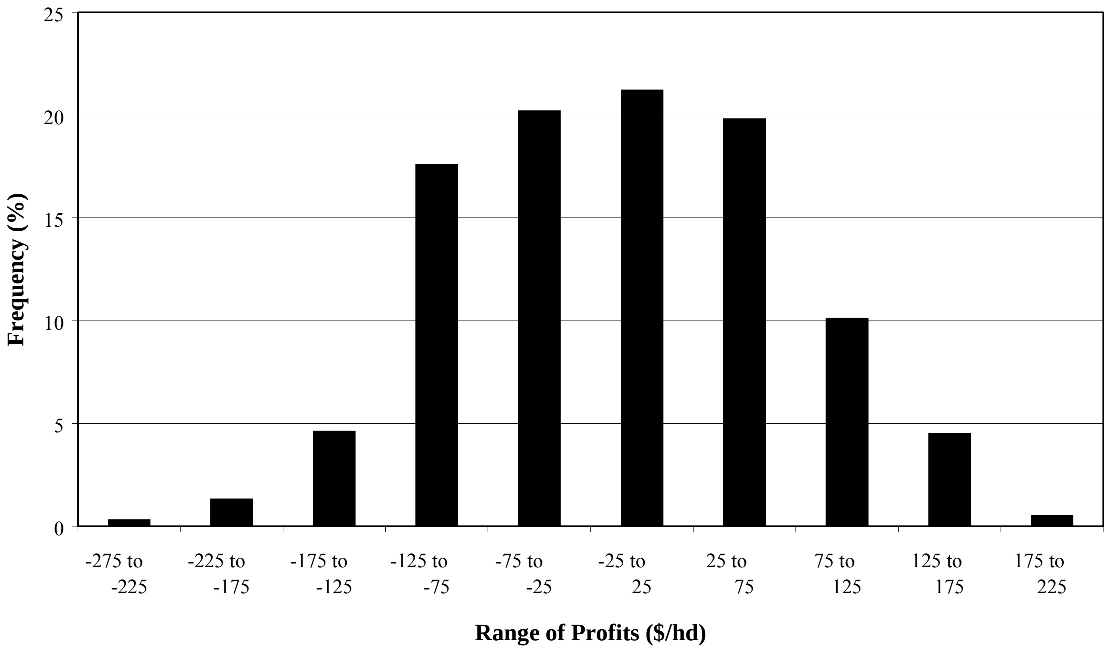
-$3.00/cwt or an average premium greater than $4.00/cwt.

Figure 3. Distribution of Premiums/Discounts per cwt, Grid B



Profit per head averaged -$10.65/cwt ranging from a loss of $272 to a profit of $209 (table 4). The distribution of profit per head for the 1,011 pens is shown in figure 4. Approximately 21 percent of pens are contained in the range that includes zero, and a larger number of pens over the time period lost money (~ 55 percent) than made money (~ 45 percent). Furthermore, slightly less than 90 percent of all pens had profits between -$125/cwt and $125/cwt.

Figure 4. Distribution of Profit per Head, Grid B



Additional data were needed for both data sets of cattle to complete this analysis. These data include corn prices and the boxed beef cutout Choice-to-Select price spread. Monthly average corn prices for Kansas were obtained from Kansas Agricultural Statistics (KAS) *Agricultural Prices*. Additionally, weekly wholesale Choice-to-Select boxed beef price spreads were obtained from USDA's *Livestock, Meat, and Wool Market News*.

Corn price for a particular pen of cattle was calculated using a simple average of monthly prices over the time period that cattle were on feed. For example, if a pen of cattle were on feed from January 10, 1992 to May 20, 1992, average corn price across January, February, March, April, and May was assigned to that particular pen. The Choice-to-Select price spread for the week prior to slaughter was used. Table 5 includes summary statistics for both corn price and Choice-to-Select price spread. Statistics are included for the values of each variable within each data set.

Table 5. Summary Statistics for Corn Price and Choice-to-Select Price Spread, 1992-1998.

Variable	Mean	Std. Dev.	Minimum	Maximum
Corn Price ($/bu)				
Grid A	2.75	0.62	1.89	4.71
Grid B	2.90	0.72	1.89	4.66
Choice/Select Spread ($/cwt)				
Grid A	7.01	3.72	0.24	20.21
Grid B	6.22	3.04	0.24	20.21

Empirical Results

Estimation of Profit per Head in Grid A

Parameter estimates for equation (3) were calculated using OLS. Equation (3) was specified in a linear model to accommodate grid A as:

$$\begin{aligned} profithd = {} & \beta_0 + \beta_1\, base + \beta_2\, yg12 + \beta_3\, yg4 + \beta_4\, yg5 + \beta_5\, prime + \beta_6\, select + \\ & \beta_7\, misc + \beta_8\, cond + \beta_9\, light + \beta_{10}\, heavy + \beta_{11}\, costin + \beta_{12}\, cornp + \\ & \beta_{13}\, adg + \beta_{14}\, conv + \beta_{15}\, hyld + \beta_{16}\, dof + \varepsilon \end{aligned} \tag{5}$$

where ε is the error term. Equation (5) differs some from the conceptual model presented in equation (3). The base quality and yield grade for grid A is a Choice, yield grade 3 carcass. Hence, these variables are left out of equation (5) (i.e. they are the default categories). Additionally, recall that yield grades 1 and 2 receive the same premiums in grid A. Therefore, *yg1* and *yg2* from the conceptual model are added together in equation (5) as *yg12*. Finally, grid A discounts Select and noroll carcasses at the same rate. Thus, *select* in equation (5) is the sum of percent Select and noroll carcasses.

Ideally the discount for Select carcasses would be allowed to vary with the spread since the Choice-to-Select price spread has the most variation over time of all premiums and discounts. This could be accomplished by multiplying the spread by percentage of

Select carcasses, then using that variable in equation (5) instead of *select*. This would allow the "value" of each percent Select to vary with the spread. However, base price was not available for the data set corresponding to grid A, and the 65-80 percent Choice USDA reported dressed price was used as a proxy. The difference between the price for 100 percent Choice and 100 percent Select would be equal to the price spread. The price for 65-80 percent Choice would fall between these two prices and would include a part of the price spread. Therefore, the spread is captured in the base price and thus percent Select alone is used in the model.

The potential for heteroskedasticity in model (5) was a concern due to the cross-sectional nature of the data set. To correct for heteroskedasticity, White's procedure in SAS was used to generate a consistent variance-covariance matrix for parameter estimates ($\beta_0 \ldots \beta_{16}$). This correction procedure only changes the standard errors and t-statistics and does not change the already unbiased parameter estimates.

Collinearity was also a concern when estimating model (5). The variance decomposition procedure suggested by Belsley, Kuh, and Welsch (1980) was conducted to determine if collinearity was a problem in model (5.1). This procedure diagnoses degrading collinearity under two conditions: 1) a condition index greater than 30, and 2) a variance decomposition proportion for two or more coefficient estimates that is greater than 0.5. The largest condition index was 389.318 corresponding to variance decomposition proportions greater than 0.5 for the intercept (0.976) and dressing percent (*hyld*) (0.956). Since dressing percent did not vary much over time, this outcome would be expected. Another condition index was 86.966 corresponding to a variance decomposition proportion for average daily gain (*adg*) of 0.648 with the proportion for dry matter feed conversion (*conv*) at 0.476. Average daily gain and feed conversion would also be expected to move together in this model since cattle that have a high average daily gain are likely to also exhibit low feed conversion. Additionally, there was evidence of slight collinearity between base price (*base*) and cost of feeder cattle (*costin*) and between cost of feeder cattle and corn price (*cornp*). Although condition indices exceeded 30, variance proportions were not greater than 0.5. Collinearity would be expected in these cases as well since prices likely follow each other, either directly or inversely, during varying time periods. Because all of the parameter estimates for variables where possible degrading collinearity was detected were statistically different from zero, apparently the impact of collinearity was not overly degrading. Therefore, no adjustments were made to the model to address collinearity concerns.

Table 6 displays regression results for equation (5). The R^2 value for this model was 0.826 indicating that independent variables explain approximately 82.6 percent of variation in profit per head. Signs on coefficients match expected signs for all independent variables except for light-weight carcasses. This might be due to the relatively small percentage of cattle (1.5 percent) that fell into this category in this data set. All variables are significantly different from zero at the 0.05 level except for percentage of condemned carcasses, percentage of yield grade 1 and 2, percentage of Prime, and percentage of light-weight carcasses.

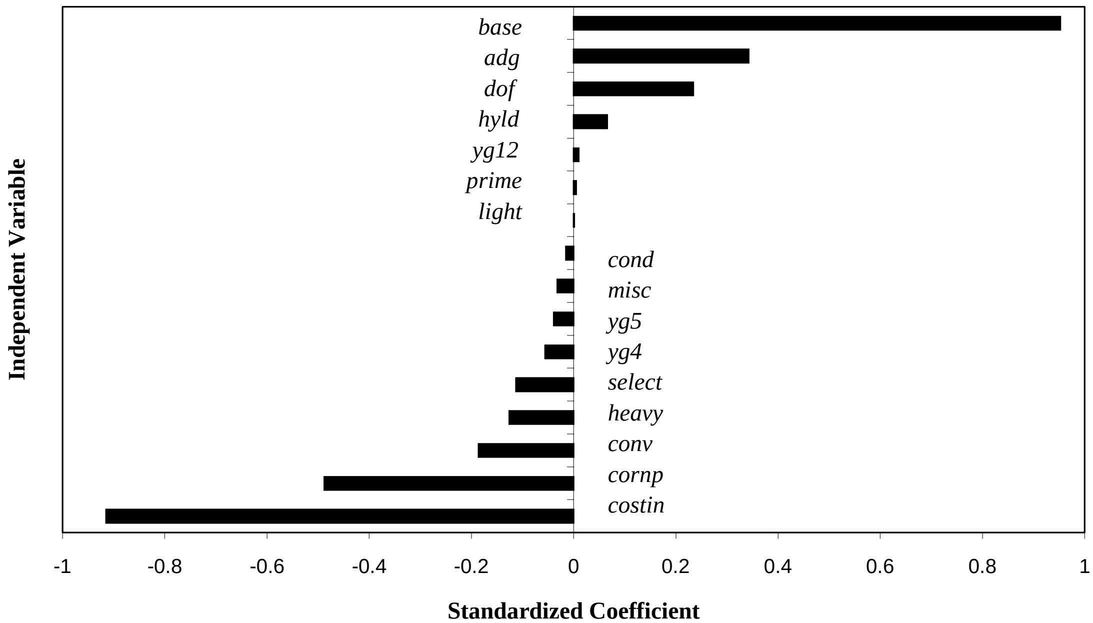
Table 6. Profit Equation Regression Estimates for Cattle Fed and Marketed Under Grid A, 1992-1998.

Independent Variables	Parameter Estimates	t-statistics[a]	Standardized Coefficient
Intercept	-736.474*	-8.594	0.000
base	7.117*	74.159	0.952
yg12	0.045	0.777	0.010
yg4	-1.089*	-3.687	-0.056
yg5	-5.017*	-3.742	-0.039
prime	0.199	0.486	0.005
select	-0.489*	-12.252	-0.113
misc	-0.510*	-3.670	-0.031
cond	-18.707*	-2.850	-0.015
light	0.024	0.102	0.001
heavy	-2.514*	-10.912	-0.126
costin	-4.740*	-46.346	-0.915
cornp	-52.903*	-36.640	-0.488
adg	61.353*	8.898	0.342
conv	-13.478*	-2.996	-0.186
hyld	5.370*	6.405	0.066
dof	0.451*	9.039	0.234
R^2	0.826		
Observations	3,483		

* indicates statistically different from zero at the 0.05 level.
[a] standard errors were corrected for heteroskedasticity and t-statistics reflect this correction.

Figure 5 displays values of standardized beta coefficients (SBC) for each independent variable in equation (5). Grid base price for the carcass has the largest impact on profit per head (SBC=0.952) followed by feeder cattle purchase price (SBC= -0.915). Corn price (-0.488) and average daily gain (0.342) have relatively larger effects than days on feed (0.234) and dry matter feed conversion (-0.186), but have approximately one-half or less the importance relative to base price and feeder price. Disregarding base price, grid factors have considerably less influence on profit per head with all SBC's less than 0.15. Therefore, over time, base price is the most important component of dressed price affecting profit per head. However, considering only cross sectional factors (i.e., ignoring feeder price, corn price, and base price), suggests that grid factors together, summing the absolute values of SBC's, are the most important profit determinants with the sum of absolute values of 0.397 compared to the next most important factor, average daily gain (0.342).

Figure 5. Standardized Beta Coefficients for Variables in Equation (5)



Estimation of Profit per Head in Grid B

OLS was used to calculate parameter estimates for equation (3). Grid B was used to specify equation (3) in a linear model as:

$$\begin{aligned} profithd = \beta_0 + \beta_1\, base + \beta_2\, yg1 + \beta_3\, yg2 + \beta_4\, yg45 + \beta_5\, prime + \beta_6\, cab\, + \\ \beta_7\, noroll + \beta_8\, chsprd + \beta_9\, heavy + \beta_{10}\, light + \beta_{11}\, costin\, + \\ \beta_{12}\, cornp + \beta_{13}\, adg + \beta_{14}\, conv + \beta_{15}\, hyld + \beta_{16}\, dof + \varepsilon \end{aligned} \qquad \textbf{(6)}$$

where ε is the error term. Specification of equation (6) differs from the conceptual model. First, a Select, yield grade 3 carcass is the base quality and yield grade in grid B, and independent variables relating to these attributes have been dropped in equation (6). Second, grid B has the same discount for yield grades 4 and 5 explaining that these variables were added together in this model (*yg45*). Third, unlike data corresponding to grid A, a base price was available for cattle sold in grid B. This leads to the addition of a variable (*chsprd*) that allows percent Choice carcasses to vary with the Choice-to-Select price spread. Finally, grid B has thresholds for each carcass attribute (table 2) that must be attained before premiums and discounts are applicable for each trait. Therefore, thresholds for each characteristic must be subtracted from percentages of cattle in each category in order to find the actual percentage of cattle that were discounted or given a premium. For example, *chsprd* is equal to percent of cattle grading Choice and higher minus the 55 percent threshold for Choice and higher, multiplied by the Choice-to-Select price spread.

Heteroskedasticity was also a concern in this model, and the same steps were taken to correct standard errors and t-statistics for individual parameter estimates as in model (5). Collinearity was a concern in model (6) and the same procedures were used to detect its presence as in the previous model. Similar to the previous model, the largest condition index (467.403) corresponded to variance proportions greater than 0.5 for the intercept (0.984) and dressing percent (*hyld*) (0.936). The next largest condition index was 106.9 which related to variance proportions of 0.597 and 0.451 for feed conversion and average daily gain, respectively. The same variables were collinear in model (5) and would be expected to demonstrate a negative linear relationship. There were two more condition indices greater than 30; however, only one corresponded to two or more variance proportions greater than 0.5. The condition index was 44.057 with variance proportions greater than 0.5 for cost of feeder cattle (*costin*) (0.875) and corn price (0.580). At various points in time, particular prices would be expected to move together in either a direct or inverse relationship. Because all of the coefficient estimates where collinearity may have been degrading were statistically significant, no adjustments were made to the model.

Table 7 reports regression results for equation (6). Grid components, costs, and performance measures explain approximately 94.5 percent of variation in profit per head. All variables are significant at the 0.05 level except percent yield grade 1, percent noroll, and percent light-weight carcasses. Means across all pens of cattle sold in grid B are approximately 4 percent for yield grade 1, 2 percent for noroll, and 1 percent for light-weight carcasses (table 4). As a result, significance levels might be affected by small percentages of carcasses falling into these three categories. Signs are consistent with expectation for every coefficient except *yg1*.

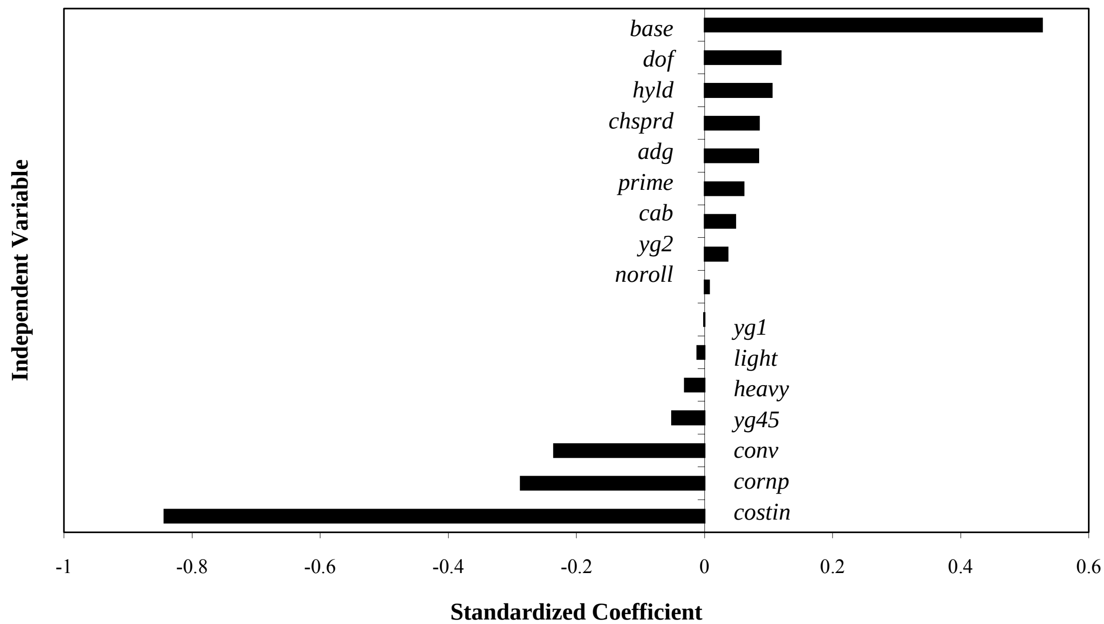
Table 7. Profit Equation Regession Estimates for Cattle Fed and Marketed Under Grid B, 1995-1998.

Independent Variables	Parameter Estimates	t-statistics[a]	Standardized Coefficients
Intercept	-649.547*	-8.888	0.000
base	7.596*	62.378	0.527
yg1	-0.020	-0.152	-0.001
yg2	0.184*	3.820	0.036
yg45	-0.775*	-5.079	-0.051
prime	1.144*	7.224	0.061
cab	0.328*	5.132	0.048
chsprd	0.066*	8.547	0.085
noroll	0.232	1.212	0.007
heavy	-0.650*	-2.221	-0.031
light	-0.337	-1.397	-0.011
costin	-7.763*	-55.291	-0.843
cornp	-31.730*	-19.943	-0.287
adg	17.480*	5.384	0.084
conv	-37.165*	-17.760	-0.235
hyld	9.630*	11.106	0.105
dof	0.438*	12.162	0.119
R^2	0.945		
Observations	1,011		

* indicates statistically different from zero at the 0.05 level.
[a] standard errors were corrected for heteroskedasticity and t-statistics reflect this correction.

Figure 6 graphically depicts standardized beta coefficients calculated for equation (6). As in equation (5), the cost of feeder cattle (-0.843) and grid base price (0.527) are the two most important factors determining profit; however, unlike the first model, feeder price is more important than base price. Corn price (-0.287) and feed conversion (-0.235) have relatively larger affects than days on feed (0.119) and hot carcass yield (0.105). This compares to the first model where feed conversion was quite a bit less important than either average daily gain or days on feed. Not including base price, grid factors determining grid dressed price have considerably less influence on profit per head with all SBC's less than 0.1. On the other hand, absolute values of SBCs for grid factors sum to a value of 0.331, which is higher compared to the next most important factor when considering only cross-sectional factors, feed conversion (-0.235). The same was true in the first model except average daily gain was the second most important factor. The variable (*chsprd*) allowing percent Choice and higher to vary with the price spread is the most important grid factor besides base price. It is interesting to notice that, again ignoring base price, percent Select is the second most important grid component in equation (5) behind percent of heavy-weight carcasses. This is important because the discount for Select carcasses in grid A and premium for Choice carcasses in grid B are the most variable premium/discount in either grid since they both relate to the highly variable Choice-to-Select price spread. These factors would be expected to have a larger effect on profits than other grid factors.

Figure 6. Standardized Beta Coefficients for Variables in Equation (6)



The main objective in analyzing profit was to determine the relative impacts of price, cattle quality, and feeding performance factors on profit per head. More specifically, the objective was to determine if these impacts change from one grid system to another using two different data sets of cattle. This section has dealt with analyzing profit determinants under the two different pricing mechanisms. Results have shown that, while some differences exist, overall the factors determining profit are the same.

Examining standardized beta coefficients, feeder price and grid base price have the most affect on profit per head over time in both grid structures. These two components have a larger affect on profit than any other variable. One of the most notable differences in results is that the feeder price SBC is smaller than the base price SBC for grid A relative to grid B. This is probably due to different time periods spanned by each corresponding data set. Recall, data related to grid A and equation (5) covers the period 1992 to 1998 whereas data for grid B and equation (6) spans 1995 to 1998. Cost of feeder cattle would be expected to be more variable than base price in the short run. For example, during a specific month, little variability may be present in base price while feeder price still displays greater variability because feeder cattle prices vary by weight of cattle.

Results of reducing the time period for data in grid A to correspond to the same time period as data in grid B and estimating equation (5) again are reported in table 8. Data related to grid A was reduced in size from 3,483 to 1,876 pens of cattle and independent variables explained approximately 90.4 percent of the variation in profit per head. The absolute value of SBC's showed that feeder price (-0.731) became larger than base price (0.666). This is consistent with results from grid B over the same time period. Additionally, percent select is increasingly important relative to other factors across the shorter time frame, and average daily gain is less important with feed conversion becoming more important. The time frame covered by each data set has an effect on the results of the estimation.

Table 8. Profit Equation Regression Estimates for Cattle Fed and Marketed Under Grid A, 1995-1998.[a]

Independent Variables	Parameter Estimates	t-statistics[b]	Standardized Coefficient
Intercept	-407.557*	-4.788	0.000
base	8.355*	63.348	0.666
yg12	-0.112	-1.770	-0.023
yg4	-1.626*	-5.642	-0.081
yg5	-3.897*	-3.393	-0.032
prime	-0.411	-0.986	-0.009
select	-0.579*	-11.886	-0.117
misc	-0.679*	-5.355	-0.044
cond	-9.502	-1.041	-0.007
light	1.111*	3.034	0.033
heavy	-1.229*	-7.874	-0.069
costin	-5.595*	-50.225	-0.731
cornp	-60.249*	-48.294	-0.525
adg	23.307*	5.625	0.107
conv	-29.596*	-13.307	-0.224
hyld	3.911*	3.651	0.048
dof	0.150*	3.896	0.069
R^2	0.9037		
Observations	1,876		

* indicates statistically different from zero at the 0.05 level.
[a] May 1995 to September 1998
[b] standard errors were corrected for heteroskedasticity and t-statistics reflect this correction.

Conclusions

Cattle feeding profitability is highly variable over time and across pens. When cattle feeders sell cattle on grids with premiums and discounts for varying animal quality attributes, profit variability increases. This study quantified profit determinants for fed cattle sold using grid pricing. Feeder cattle price and the grid base price had the greatest impact on profit per head over time in two different grid structures and were quite a bit more important than any of the other variables. This suggests that the intense management of these price factors offers the largest opportunity for managing profit risk over time. Corn price was the third largest determinant of profit in both grids. Only considering variables with cross-sectional variability, average daily gain was the most important determinant of profit per head in grid A, and feed conversion was the most important in grid B. However, grid factors together (sum of absolute values), holding constant feeder and fed cattle and corn prices, were the most important profit determinants in both grids followed closely by average daily gain in grid A and feed conversion in grid B.

Results of this study have important implications for producers feeding for and marketing cattle on a grid. Some producers place great emphasis on price received when making marketing decisions, and this sometimes leads to cattle quality characteristics receiving a high degree of importance since they are related to premiums above and discounts below a base price. However, these results show that while these factors are important, other cost and performance measures have as much or more influence in determining profit per head. It is generally known that as days on feed increase, average daily gain decreases and feed conversion increases. Decreased average daily gain and increased feed conversion lead to higher costs of gain. Therefore, a producer feeding cattle an extended number of days to achieve a higher quality grade may at the same time be decreasing performance factors and increasing cost beyond the point that makes the higher quality grade more profitable. Moreover, if the animal is fed too long, the additional weight and fat gained by the animal may lead to a lower yield grade resulting in a large discount. Therefore, a profit-maximizing producer should jointly manage cost and performance factors along with carcass attributes.

References

Belsley, D.A., E. Kuh, and R.E. Welsch. *Regression Diagnostics*. New York: John Wiley and Sons, Inc., 1980.

Fausti, S.W., D.M. Feuz, and J.J. Wagner. "Value Based Marketing for Fed Cattle: A Discussion of the Issues." *International Food and Agribusiness Management Review* 1(1998):73-90.

Feuz, D.M., S.W. Fausti, and J.J Wagner. "Analysis of the Efficiency of Four Marketing Methods for Slaughter Cattle." *Agribusiness: An International Journal* 9(1993):453-463.

Feuz, D.M., S.W. Fausti, and J.J. Wagner. "Risk and Market Participant Behavior in the U.S. Slaughter Cattle Market." *Journal of Agricultural and Resource Economics*. 20(1995):22-31.

Kansas Department of Agriculture, *Agricultural Prices*. Topeka, KS: Kansas Agricultural Statistics. Various issues, 1992-January 1999.

McDonald R.A. and T.C. Schroeder. "Factors Determining Profit for Fed Cattle Under a Value-Based Alliance." Paper presented at Western Agricultural Economics Association Annual Meeting, Fargo, ND, 11-14 July, 1999.

Pindyck, R.S. and D.L. Rubinfeld. *Econometric Models and Economic Forecasts*. 4th Edition, Boston, MA: McGraw Hill, 1998.

Purcell, W.D. "A Primer on Beef Demand." Research Bulletin 2-98, Research Institute on Livestock Pricing, Virginia Tech, Blacksburg, VA. April 1998.

SAS Institute Inc. SAS® User's Guide, Version 5 Edition. Cary, NC: SAS Institute Inc., 1985.

Schroeder, T.C. and J.L. Graff. "Comparing Live Weight, Dressed Weight, and Grid Pricing: Assessing the Value of Cattle Quality Information." Research Bulletin 1-99, Research Institute on Livestock Pricing, Virginia Tech, Blacksburg, VA. January 1999.

Schroeder, T.C., C.E. Ward, J. Mintert, and D.S. Peel. "Beef Industry Price Discovery: A Look Ahead." Research Bulletin 1-98, Research Institute on Livestock Pricing, Virginia Tech, Blacksburg, VA. March 1998.

United States Department of Agriculture, Agricultural Marketing Service. *Livestock, Meat, and Wool Market News, Weekly Summary and Statistics*. Washington DC: Agriculture Marketing Service. Various issues, 1992-January 1999.

United States Department of Agriculture, Agricultural Marketing Service. *Weekly 5 Area Weighted Average Direct Slaughter Cattle Prices*. WH_LS725, various issues, 1992-January 1998.

Ward, C.E., D.M. Feuz, and T.C. Schroeder. "Formula Pricing and Grid Pricing Fed Cattle: Implications for Price Discovery and Variability." Research Bulletin 1-99, Research Institute on Livestock Pricing, Virginia Tech, Blacksburg, VA. January 1999.