# Market Signals in Value Based Pricing Premiums and Discounts

By

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Abstract

Present beef marketing practices may be impeding the transmission of economic signals from consumers to producers. Three grid pricing systems are evaluated over six marketing dates. Each grid sends the anticipated pricing signals in that marbling and leanness are rewarded. Magnitudes of price signals vary over time and across grids.

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Demand for beef has been declining for 20 years. Per capita consumption has declined from 95 pounds in 1976 to just over 65 pounds in the early 1990's and the real price of beef also has declined over that time period (Purcell, 1999). Purcell states that while many beef industry participants have wanted to blame declining demand on levels of consumers income or relative prices of beef substitutes, the real problem is consumer preferences. Some beef industry participants have faulted the fed cattle marketing system for the loss of demand. They content that a system of selling the majority of fed cattle on an average live or dressed weight price basis cannot possibly send consumer signals that would reveal consumer preferences. Since 1990 when the National Cattlemen's Association, Value Based Marketing Task Force released its final report there has been an increased interest in developing a value based fed cattle pricing system.

Studies by Feuz, Fausti, and Wagner, 1993 and 1995, addressed issues of individual price discovery. They looked at pricing signals received by producers from selling fed cattle by alternative pricing methods and examined how information uncertainty and risk impact producer selling decisions. In two recent articles by Schroeder et. al. 1998 and Fausti, Feuz and Wagner, 1998, issues dealing specifically with value based pricing in the beef industry were discussed. Both of these articles emphasized the need for additional research on value based pricing.

The objective objective of this research is to determine the economic signals being sent to producers who are selling on alternative value based "grid" pricing systems. Three value based pricing systems will be evaluated over six marketing dates.

## Methodology

Under the present fed cattle marketing practice of pricing an entire show list of market ready cattle at one price, profit on an individual pen of cattle can be defined as:

$$\textbf{(1)} \qquad Profit_{showlist} = Dressed\ Price\ X\ Dressed\ Weight - FeedingCosts - Feeder\ Price\ X\ Feeder\ Weight$$

where each variable is the average for the pen. Given that all pens sell for the same dressed price, the dressed price is a function of the overall supply and demand forces determining the general market level, but it is not a function of the carcass characteristics of the cattle. If cattle are sold on a carcass merit, value based pricing system, then profit on an individual pen of cattle can be defined as:

$$\textbf{(2)} \qquad Profit_{grid} = Grid\ Price\ f(Carcass\ Characteristics)\ X\ Dressed\ Weight - Feeding\ Costs - Feeder\ Price\ X\ Feeder\ Weight$$

where the grid, or value based, price is a function of the carcass characteristics for that pen of cattle. The grid price is still a function of the general market level and would be determine by the same supply and demand forces as the average dressed price. In fact, the Grid Price could be defined as:

$$\textbf{(3)} \quad Grid\ Price = Dressed\ Price + Price\ Premium/Discount\ f(CarcassCharacteristics)$$

By substituting Equation 3 into Equation 2 and subtracting Equation 1 from Equation 2 and canceling terms, it can be shown that the profit differences from selling on a grid compared to selling a show list at one dressed price can be explained by the grid price premium or discount multiplied by the dressed weight:

**(4)** $$Profit_{grid} - Profit_{showlist} = Price\ Premium/Discount\ f(Carcass\ Characteristics)\ X\ Dressed\ Weig$$

$Profit_{grid}$ - $Profit_{showlist}$ is the Profit Differential from selling on a value based pricing system compared to selling on an average dressed price. If dressed weight is moved to the left-hand side of equation 4, then it can be shown that the weight adjusted profit differential is equal to the price premium/discount from the value based pricing system:

**(5)** $$\frac{Profit\ Differential}{Dressed\ Weight} = Price\ Premium/Discount\ f(Carcass\ Characteristics)$$

Equations 4 and 5 are based on the assumption that only the pricing method changed. It is assumed that feeding and cattle procurement practices remain constant regardless of fed cattle pricing method. This assumption is likely correct for the short-run, i.e., for the first few pens of cattle a producer sells on a value based pricing system. However, if there are market signals being sent to producers in the form of price premiums or discounts, and if those premiums or discounts can be associated with specific carcass characteristics, and if management decisions can impact those characteristics, then rational producers would be expected to alter feeding and procurement practices to receive greater premiums and smaller discounts. Therefore in the long-run, equation 4 would be:

**(6)** $$\begin{aligned} Profit_{grid} - Profit_{showlist} = {} & [Grid\ Price\ f(Carcass\ Characteristics)\ X\ Dressed\ Weight\ f(Management) \\ & - FeedingCosts\ f(Management) - Feeder\ Price\ f(Management)\ X\ Feeder\ Weight\ f(Management)] \\ & -[Dressed\ Price\ X\ Dressed\ Weight\ f(Management) - FeedingCosts\ f(Management) \\ & - Feeder\ Price\ f(Management)\ X\ Feeder\ Weight\ f(Management)] \end{aligned}$$

and long-run profit differentials are not only a function of price premiums and discounts, but also are dependent upon dressed weights, feeding costs, and feeder costs which according to management practices may vary. Producers who have changed management practices cannot simply compare the value based revenue (grid price X dressed weight) to the average dressed revenue (dressed price X dressed weight) and assume the difference is their change in profit. Feeding costs and purchased feeder costs must also be examined.

What short-run market signals are conveyed in the price premiums/discounts of a value based pricing system? Most value based pricing systems rely on USDA quality and yield grades to differentiate premiums and discounts. Frequently, discounts are applied to "out cattle", e.g. too light or too heavy carcass weights, hard bones and dark cutters. Most value based pricing systems will supply the producer with pen average carcass data. For an additional fee, producers can receive individual carcass data.

At the pen level, data are typically the average dressed or hot carcass weight, the percentage of cattle in each of the USDA quality grades (Prime, Choice, Select, Standard) and yield grades (1-5), the percentage of the pen with light or heavy carcasses, and the percentage of the pen that are "Out Cattle", discounted for various non-conformance criteria. On an individual animal level, individual carcass weights, quality grade, yield grade, marbling score, fat depth over the $12^{th}$ rib , percentage kidney-pelvic-heart fat (KPH), rib eye area, and specific out cattle are reported to producers.

Research has shown that consumers want a consistent, tender, palatable cut of beef with minimal outside fat cover (Smith et al. 1995). Consumers want quality lean meat. Therefore, if the marketing system were functioning efficiently, production of fat should

be penalized; higher yielding, heavier muscled cattle should receive a price premium; and cattle with a more tender, palatable carcass should also receive a premium. At the individual animal level, the measure of fat depth should be negatively related to price and be non-linear as increasing fat becomes increasingly less desirable and KPH should also be negative. Rib eye area, a measure of muscling, should be positively related to price, and marbling score a subjective measure of tenderness and palatability should be positively related to price and may be non-linear. Non-conforming carcasses should also be negatively related to price.

## Data and Procedures

Detailed carcass data on 85 pens of fed cattle, 5,520 head, marketed throughout 1997 from numerous feedlots were collected. Table 1 contains summary statistics of carcass characteristics for these cattle. Pens ranged in number of head from 20 to 205 and averaged 65 head per pen. The average live weight was just over 1200 pounds, dressing percent averaged 62.8 percent, 61 percent graded Choice or above, and yield grade averaged 2.2. The range in the percent of the pen grading Choice or above was from 15 to 96 percent. The cattle appear to be typical of the cattle killed in USDA regions 7-8 (IA, KS, MO, NE, CO, MT, ND, SD, UT, and WY). From October 1995 through September 1998 cattle slaughter in this region have averaged 58 percent Choice or above, 52 percent have been yield grade 1 or 2, and 1.5 percent have been yield grade 4 or 5 (USDA, 1998).

Actual sale price and pricing method are not known on the 85 pens. However, sale prices were computed for three value based pricing systems and six different

marketing dates. The value based pricing systems used in this analysis were actual grids offered by three different beef packers.

As this analysis is concerned with value based price premiums or discounts compared to the average dressed price, the general price level was not a concern. However, the six different marketing dates represent time periods when there was a higher/lower percentage of cattle grading Choice and a narrower/wider Choice-Select price spread. This information is displayed in Table 2.

Regression analysis was used to analyze the relationship between the carcass characteristics and the value based pricing premiums and discounts, the right hand side of equation 5. These relationships are the marketing signals that the value based pricing systems were sending to producers. The following equation was estimated:

$$\textbf{(7)} \qquad VBP = b_0 + b_1 Marbling + b_2 Marbling^2 + b_3 Marbling^3 + b_4 Fat + b_5 Fat^2 + b_6 Ribeye + b_7 KPH + b_8 Weight + b_9 Out + e$$

where VBP is the value based price premium or discount compared to the average dressed market price; Marbling is the USDA reported degree of marbling for each carcass and is coded as 1.00-1.90 - Practically Devoid, 2.00-2.90 - Traces, 3.00-3.90 -Slight, 4.00-4.90 - Small, 5.00-5.90 -Modest, 6.00-6.90 -Moderate, 7.00-7.90 -Slightly Abundant, 8.00-8.90 -Moderately Abundant, and 9.00-9.90 -Abundant; Fat is the fat thickness over the $12^{th}$ rib in inches; Ribeye is the size of the rib eye in square inches; KPH is the percentage Kidney-Pelvic-Heart fat; Weight is the hot carcass weight; and Out is a dummy variable for all non conforming carcasses. The minimum marbling score for each of the USDA quality grades is a $Slight^0$ for Select, $Small^0$ for low Choice, and $Slightly\ Abundant^0$ for Prime.

Equation 7 was estimated for three grid pricing systems and for six marketing dates. Regression parameters were tested for stability across grids and marketing dates. Because of the error terms being contemporaneously correlated across the three grids, the equations were estimated using Seemingly Unrelated Regression procedures.

## Results

Results of estimating equation 7 using individual data on 5520 head across the three grids and six marketing dates are presented in Table 3. Marbling has a significant positive but non-linear impact on the premium/discount received from pricing on a grid compared to pricing a show list at the average dressed price. The impact of marbling varies significantly across grids and over time as the Choice-Select price spread varies. However, the marbling response is impacted more by the grid pricing scheme than by the Choice-Select spread. The impact of marbling is graphically depicted in Figure 1. This is based on the results from the 12/19/97 time period and all variables, with the exception of marbling, are held constant at their mean value. The management implication from this estimated impact of marbling on the price premium/discount could well be that it is profitable to feed animals to just reach the Choice grade. Given the flatness of the curves through the mid-Choice and high-Choice grades (marbling score of 5.00 - 6.90), feeding costs may exceed any additional revenue.

One would expect that fat thickness may be positively related to price premiums at low levels of outside fat thickness but then become negative with increasing fat thickness. The estimated regression parameters substantiate this hypothesis. The impact of fat thickness on the price premium/discount varies across pricing grids and over time. The premium/discount associated with varying fat thickness is plotted in Figure 2 for the

12/19/97 time period. All other variables are held constant at their mean values, so these fat response curves are based on animals that would quality grade low Choice.

Rib eye area is not significant in explaining premiums/discounts from grid A but is significant with grids B and C and is positive as expected. The estimated coefficients vary across grids but are consistent over time. The percentage of kidney-pelvic-heart fat is not significant in explaining price premiums/discounts. Carcass weight is statistically significant across all grids. However, it may not be economically significant given the magnitude of the coefficient. Discounts for too light or too heavy of carcasses are accounted for in the Out Cattle coefficients. Out Cattle also include quality defects of hard bones, dark cutters, stags, etc., and there is a significant discount for Out Cattle on each of the grids. The discount are consistent for grids A and C but differ for grid B.

The adjusted $R^2$ values ranged from 61.20 to 81.37 and the system weighted $R^2$ values from the seemingly unrelated regressions ranged from 59.24 to 67.45. Generally, as the Choice-Select price spread widened, the proportion of variation explained by the models increased. As the Choice-Select price spread widens, quality grade and hence marbling score becomes increasingly more important in explaining price premiums/discounts and yield grade and its components become less important.

## Summary

Clearly, market signals are more likely to reach producers if cattle are priced individually. However, present grid pricing practices are sending different price signals to producers over time and across grids. Is one of the grids more efficient at transmitting consumer preferences to producers? This study cannot answer that question. However, not all consumers have the same preference and if different grids are designed with a

different consumer targets in mind, then it is logical that the grids should send different signals to producers. Producers then need to match the type of cattle they are producing to the grid that rewards that type of cattle. If this is accomplished, then there should be an increase in efficiency in the beef industry. However, there is often additional costs to selling on a grid and producers may incur more costs in sorting cattle to "fit" a grid.

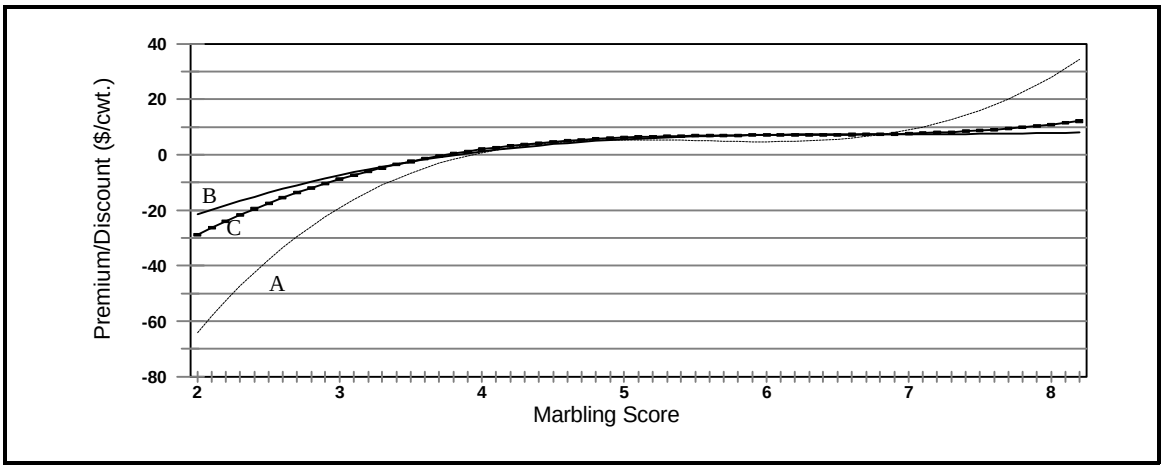


**Figure 1**. Impact of Marbling on Price Premiums/Discounts for Grids A, B, and C for the 12/19/97 Time Period.

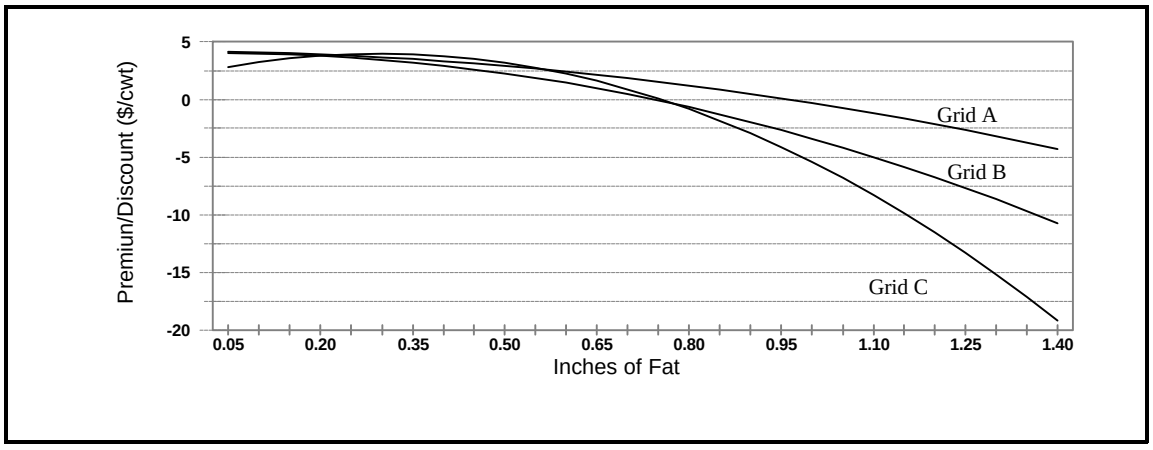


**Figure 2**. Impact of Fat Thickness over the 12th Rib on the Price Premiums/Discounts for Grids A, B, and C for the 12/19/97 Time Period.

**Table 1. Summary Statistics on the Carcass Characteristics of the 85 Pens and 5520 Individual Fed Cattle.**

| | 85 Pens | | 5520 Individual Fed Cattle | |
|---|---|---|---|---|
| | Mean | Std. Dev. | Mean | Std. Dev. |
| Live Weight (lbs) | 1203.24 | 74.91 | NA | NA |
| Dressing Percent (%) | 62.81 | 1.15 | NA | NA |
| Hot Carcass Weight (lbs) | 755.80 | 49.20 | 758.41 | 80.17 |
| Marbling Score ([1]) | 4.32 | 0.44 | 4.30 | 0.90 |
| Percent Choice or Above (%) | 60.99 | 19.01 | NA | NA |
| Yield Grade (1-5) | 2.21 | 0.37 | 2.23 | 0.71 |
| Fat Thickness (inch) | 0.41 | 0.11 | 0.41 | 0.19 |
| Kidney-Pelvic-Heart (%) | 1.95 | 0.09 | 1.96 | 0.20 |
| Rib eye Area (sq. inch) | 12.81 | 0.85 | 12.74 | 1.45 |
| Out Cattle (%) | 1.85 | 3.41 | NA | NA |

[1]Marbling Score: 1-2=Standard, 3=Select, 4=Low Choice, 5=Choice, 6=High Choice, 7-8=Prime.

**Table 2. Prices (Dollars/cwt.) and Grading Percentage Used for the Analysis.**

| | 2/6/98 | 2/21/97 | 6/20/97 | 12/19/97 | 10/24/97 | 12/6/96 |
|---|---|---|---|---|---|---|
| Nebraska Dressed Price | $98.47 | $106.25 | $105.17 | $104.84 | $107.85 | $114.76 |
| Choice-Select Carcass Spread | $1.15 | $3.26 | $5.62 | $7.85 | $10.13 | $15.81 |
| US Carcass % Grading Choice | 63.58 | 52.71 | 48.75 | 51.86 | 45.34 | 44.44 |
| USDA Rg7-8 % Grading Choice | 61.30 | 59.68 | 54.49 | 57.75 | 55.63 | 52.35 |
| USDA Rg7-8 % Yield Grade 1-2 | 50.70 | 55.59 | 55.54 | 54.50 | 49.13 | 56.42 |
| USDA Rg7-8 % Yield Grade 4-5 | 1.56 | 1.09 | 1.16 | 1.00 | 1.19 | 1.01 |

**Table 3. Estimated Impact of Various Individual Animal Carcass Characteristics for 5,520 Head on the Premium/Discount ($/cwt.) from Pricing on Three Grids over Six Marketing Dates.**[1]

| | 2/6/98 | | | 2/21/97 | | | 6/20/97 | | |
|---|---|---|---|---|---|---|---|---|---|
| Characteristic[2] | Grid A | Grid B | Grid C | Grid A | Grid B | Grid C | Grid A | Grid B | Grid C |
| Intercept | -252.04* (3.912) | -65.15* (1.636) | -107.56* (2.252) | -263.74* (3.860) | -68.22* (1.776) | -106.88* (2.248) | -266.82* (3.811) | -69.59* (1.792) | -114.17* (2.494) |
| Marbling | 150.78*[a] (2.553) | 40.18*[e] (1.068) | 62.45*[b] (1.470) | 155.08*[a] (2.519) | 34.64*[f] (1.159) | 62.36*[b] (1.467) | 153.38*[a] (2.488) | 36.93*[f] (1.169) | 56.28*[c] (1.628) |
| Marbling Squared | -29.13*[a] (0.547) | -8.00*[f] (0.229) | -12.09*[d] (0.315) | -29.52*[a] (0.539) | -5.66*[h] (0.248) | -12.05*[d] (0.314) | -28.58*[a b] (0.533) | -6.20*[g] (0.250) | -8.68*[f] (0.348) |
| Marbling Cubed | 1.85*[a] (0.038) | 0.53*[e] (0.016) | 0.77*[d] (0.022) | 1.85*[a] (0.037) | 0.32*[g] (0.017) | 0.77*[d] (0.022) | 1.76*[a] (0.037) | 0.36*[g] (0.017) | 0.44*[f] (0.024) |
| Fat | 1.40 [d e] (1.514) | 3.44*[c] (0.633) | 6.99*[b] (0.871) | 0.76 [d e] (1.493) | 3.02*[cd] (0.687) | 6.96*[b] (0.870) | 0.05 [d e] (1.474) | 2.08*[c d] (0.693) | 4.41*[b c] (0.965) |
| Fat Squared | -6.17*[d e] (1.532) | -10.79*[b c] (0.641) | -13.10*[b] (0.882) | -5.23*[e] (1.512) | -10.01*[c] (0.696) | -13.072*[b c] (0.880) | -4.52*[e] (1.493) | -9.47*[c] (0.702) | -10.62*[b c] (0.977) |
| Rib Eye Area | 0.02 [c] (0.060) | 0.31*[a] (0.025) | 0.15*[b] (0.035) | 0.00 [c] (0.060) | 0.30*[a] (0.027) | 0.15*[b] (0.035) | 0.01 [c] (0.059) | 0.32*[a] (0.028) | 0.17*[b] (0.039) |
| Kidney-Pelvic-Heart | 0.54 [a] (0.406) | -0.25 [a] (0.170) | 0.06 [a] (0.234) | 0.51 [a] (0.400) | -0.16 [a] (0.184) | 0.06 [a] (0.233) | 0.54 [a] (0.395) | -0.18 [a] (0.186) | 0.18 [a] (0.259) |
| Carcass Weight | -0.00 [a] (0.001) | -0.00*[a] (0.000) | 0.00*[a] (0.001) | -0.00 [a] (0.001) | -0.00*[a] (0.000) | 0.00*[a] (0.001) | -0.00 [a] (0.001) | -0.00*[a] (0.000) | 0.00 [a] (0.001) |
| Out Cattle | -16.40*[c] (0.531) | -20.73*[a] (0.222) | -16.94*[c] (0.306) | -16.27*[c] (0.524) | -20.41*[b] (0.241) | -16.93*[c] (0.305) | -16.12*[c] (0.517) | -20.44*[b] (0.243) | -16.38*[c] (0.339) |
| Adjusted $R^2$ | 63.82 | 72.41 | 61.20 | 68.42 | 77.68 | 61.57 | 72.63 | 77.00 | 77.87 |
| System Weighted $R^2$ | | 59.24 | | | 62.93 | | | 67.45 | |

**Table 3 (Continued).**

| | 12/19/97 | | | 10/24/97 | | | 12/6/96 | | |
|---|---|---|---|---|---|---|---|---|---|
| Characteristic[2] | Grid A | Grid B | Grid C | Grid A | Grid B | Grid C | Grid A | Grid B | Grid C |
| Intercept | -269.50* (3.818) | -71.87* (2.111) | -114.29* (2.660) | -271.38* (3.873) | -74.26* (2.298) | -117.12* (2.540) | -277.63* (4.215) | -74.77* (3.175) | -123.17* (3.234) |
| Marbling | 151.74*[a] (2.492) | 34.30*[g] (1.378) | 56.94*[c] (1.736) | 150.08*[a] (2.528) | 33.65*[g] (1.500) | 55.91*[c] (1.658) | 145.95*[a] (2.751) | 26.58*[h] (2.072) | 51.77*[d] (2.111) |
| Marbling Squared | -27.68*[b] (0.533) | -4.93*[i] (0.295) | -9.29*[e] (0.372) | -26.76*[b] (0.541) | -4.39*[j] (0.321) | -8.48*[f] (0.355) | -24.48*[c] (0.589) | -1.52*[k] (0.444) | -6.20*[g] (0.452) |
| Marbling Cubed | 1.67*[b] (0.037) | 0.24*[h] (0.020) | 0.51*[e] (0.026) | 1.58*[c] (0.038) | 0.18*[i] (0.022) | 0.43*[f] (0.025) | 1.36*[c] (0.041) | -0.07*[j] (0.031) | 0.21*[h i] (0.031) |
| Fat | -0.63 [e] (1.477) | 0.36 [d e] (0.817) | 11.37*[a] (1.029) | -1.33 [e] (1.499) | 0.70 [d e] (0.889) | 4.25*[b c] (0.983) | -3.07 [e] (1.631) | -0.99 [e] (1.228) | 2.52*[c d] (1.251) |
| Fat Squared | -3.88*[e] (1.495) | -7.79*[c d] (0.827) | -19.06*[a] (1.042) | -3.21*[e] (1.517) | -8.15*[c d] (0.900) | -10.47*[c] (0.995) | -1.54 [e] (1.651) | -6.51*[d e] (1.244) | -8.80*[c] (1.266) |
| Rib Eye Area | 0.01 [c] (0.059) | 0.34*[a] (0.033) | 0.19*[b] (0.041) | 0.02 [c] (0.060) | 0.33*[a] (0.035) | 0.17*[b] (0.039) | 0.03 [c] (0.065) | 0.35*[a] (0.049) | 0.18*[b] (0.050) |
| Kidney-Pelvic-Heart | 0.58 [a] (0.396) | -0.30 [a] (0.219) | 0.04 [a] (0.276) | 0.61 [a] (0.402) | -.12 [a] (0.238) | 0.18 [a] (0.264) | 0.69 [a] (0.437) | -0.04 [a] (0.329) | 0.26 [a] (0.335) |
| Carcass Weight | -0.00 [a] (0.001) | -0.00*[a] (0.001) | 0.00 [a] (0.001) | -0.00*[a] (0.001) | -0.00*[a] (0.001) | 0.00 [a] (0.001) | -0.00*[a] (0.001) | -0.00*[a] (0.001) | 0.00*[a] (0.001) |
| Out Cattle | -15.97*[c] (0.518) | -20.24*[b] (0.286) | -16.64*[c] (0.361) | -15.81*[c] (0.526) | -20.14*[b] (0.312) | -16.34*[c] (0.345) | -15.44*[c] (0.572) | -19.73*[b] (0.431) | -15.97*[c] (0.439) |
| Adjusted $R^2$ | 75.72 | 77.14 | 71.94 | 78.08 | 77.61 | 78.19 | 81.37 | 76.45 | 79.48 |
| System Weighted $R^2$ | | 62.67 | | | 63.06 | | | 64.07 | |

[1] A single asterisk denotes that the parameter is significantly different than zero at $\alpha = .05$. Parameters with different letter superscripts in the same row are significantly different over time or across grids at the .05 level.

[2] Marbling 1.0-2.9=Standard, 3.0-3.9=Select, 4.0-6.9=Choice, 7.0-9.9=Prime; Fat is in inches; Rib Eye Area is in square inches; Kidney-Pelvic-Heart is in percentage; Carcass Weight is in pounds; and Out Cattle is a 0/1 dummy variable.

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