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Impact of Beef Quality on Market Signals Transmitted by Grid Pricing

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Value-based marketing is shaping cattle production; however, market signals differ dramatically depending on carcass quality. This study applies a two-stage coefficients of separate determination procedure to four regional fed cattle datasets sorted by grid value and by carcass quality attributes. Weight is the strongest signal sent when higher valued cattle and better quality cattle are sold on a grid. Quality characteristics send stronger signals when lower valued cattle and poorer quality cattle are sold on a grid. Producers of lower quality cattle can potentially gain $52 to $149 per head by improving quality and $113 to $150 per head by adding weight.

Key Words: beef cattle, carcass quality, coefficients of separate determination, incentives, market signals, value-based marketing

JEL Classifications: Q11, Q13

The U.S. beef industry contended with problems related to carcass defects and carcass quality throughout the 1980s and 1990s. In addition to carcass quality problems, beef's competitive position against pork and poultry was limited because of health and food safety concerns, changing consumer lifestyles, product quality issues, and product convenience problems (Capps and Schmitz; Kinnucan et al.; Purcell; Unnevehr and Bard). Ultimately, these problems undermined the industry's ability to produce meat products that satisfied consumer preferences, and losses to quality deficiencies, such as heavy carcasses, excess external fat, insufficient marbling, and inadequate tenderness, began to mount.

The industry's ability to improve the overall quality of beef and its competitive advantage in the domestic meat market depended on (1) the marketing channel's ability to transmit accurate carcass quality information to the producer and (2) the producer's being rewarded for producing and selling higher quality cattle that fit consumer expectations (Smith et al. 1992).

Before the 1990s, average pricing was the most prevalent pricing method for fed cattle. With average pricing, all animals in a sale lot receive the same price; thus, above-average quality cattle sell for less than their true value and below-average quality cattle sell for more than their true value (Feuz, Fausti and Wagner 1993, 1995). As producers receive only market signals associated with weight, significant improvements in carcass quality traits are not as likely. With the focus on improving beef's quality during the 1990's, the industry slowly shifted to alternative pricing mechanisms that would send more accurate market signals and improve the flow of information from consum-

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ers to producers, while providing producers with incentives to change feeding and/or breeding practices. As a result, value–based marketing, commonly referred to as carcass–merit or grid pricing, began replacing average pricing. In a 2002 survey, feedlot respondents from Iowa, Kansas, Nebraska, and Texas indicated grid pricing accounted for 16% of marketings in 1996 and 45% in 2001 (Schroeder et al.). Grid pricing determines a price for each individual animal using actual carcass characteristics, thus is believed to improve the transmission of information and incentives to the producer (Feuz 1993; Fausti and Wagner 1995). Producers receive specific carcass merit and value data for each carcass sold and premiums if the carcass fits grid specifications.

Ideally, prices and associated market signals generated under a value-based system should encourage industry-wide changes. Carcass quality changes over time as measured by the National Beef Quality Audit (NBQA) are a good indicator of value-based marketing's success in encouraging the production of higher quality cattle. The first audit, conducted in 1991, was intended to identify baseline quality levels and establish quality targets (Smith et al. 1992). Subsequent audits, every 4 to 5 years, monitor changes in quality and reestablish quality targets. NBQA's focus in assessing carcasses at several federally inspected beef processing facilities is to provide data on quality and carcass deficiencies and identify the industry's top 10 "quality" concerns. Thereby, its objective is to enhance the industry's likelihood of addressing pertinent problems related to beef's quality, consistency, and competitiveness.

Audits in 1991, 1995, and 2000 indicate increased industry awareness, but actual quality changes are mixed. For example, yield grades 4 and 5 carcasses in the 2000 audit fell to 11.7%, 4.8 percentage points below 1991 levels, and the percentage of yield grades 1 and 2 cattle increased 17.4 percentage points to 61.3%. Standard quality grade carcasses in 2000 fell 2 percentage points from 1991 to 5.6%. However, when comparing the 2000 and 1991 audits, other quality measures deteriorated. The percentage of cattle grading Prime or Choice fell 3.9 percentage points to 51.1% and the number of Select cattle increased 5.4 percentage points to 42.3% (Smith et al. 2000). Overall, improvements resulted in reduced costs due to quality defects, but according to a Texas A&M University estimate, the industry still lost $100.10 per head to quality defects in 2000.

Losses to quality deficiencies remain high despite increased use of grid pricing. Therefore, it is important to identify grid price signals transmitted through the marketing channel while accounting for considerable differences in carcass quality. It is also important to quantify the incentives that grid pricing provides producers to improve carcass quality. The objectives of this study are to (1) quantify and compare market signals sent by grid pricing regarding carcass quality traits using four sets of regional feedlot data, (2) apply alternative sorting schemes on the regional datasets to identify how market signals change when carcass characteristics change, and (3) estimate the monetary incentive to improve quality of the cattle sold under grid pricing.

Previous Research

Of the "Top Ten Quality Challenges" for the U.S. beef industry cited in the 2000 NBQA, low uniformity and consistency of cattle, carcasses, and cuts topped the list (Smith et al. 2000). Inappropriate carcass size and weight as well as issues relating to poor U.S. Department of Agriculture (USDA) quality and yield grades dominated the rest of the list. Published price discovery literature has identified several reasons for the resistance to widespread adoption of grid pricing and continued production of carcasses with quality defects. Those discussed here include (1) selling cattle on a grid increases per-head and per-hundred weight (cwt) revenue variability compared with average pricing, (2) current grids do not send clear and/or consistent market signals to cattle producers, and (3) incentives to market on a grid vary over time.

Revenue variability arises in part from uncertainty over carcass quality. Studies have found that incomplete information regarding carcass quality with live and dressed weight pricing and risk-averse behavior lead to price differentials between average pricing and grid pricing (Fausti, Feuz, and Wagner; Feuz, Fausti, and Wagner 1993, 1995; Schroeder and Graff). Price differentials increase revenue variability between pricing mechanisms and sustain the demand for alternative pricing mechanisms. Per-head and per-hundred weight revenue variability for cattle sold on a grid has been shown to be higher than that for cattle sold for an average price (Anderson and Zeuli; Fausti, Feuz, and Wagner; Fausti and Qasmi; Feuz, Fausti, and Wagner 1993, 1995; Schroeder and Graff). More specifically, Schroeder and Graff found that revenue variability in grid pricing was double that of live or dressed weight pricing. This suggests that less risk-averse cattle producers will use grid pricing and more risk-averse producers will use average pricing (Feuz, Fausti and Wagner 1995).

Although revenue variability and risk are intrinsic components of grid pricing, the market signals sent by grid premiums and discounts associated with individual carcass characteristics should provide producers with an incentive to sell on the grid. However, market signal research to date indicates that current grids are not transmitting clear and/or consistent market signals between packers and cattle feeders. Feuz (1999a) used coefficients of separate determination (CSD) to determine that weight explains more variation in grid pricing revenue at the individual animal level and sends a stronger price signal than do other carcass quality characteristics. Feuz (1999b) used regression analysis to study the relationship between grid pricing premiums/discounts and carcass characteristics. He determined that marbling (a determinate of carcass quality grade) is important in explaining premiums/discounts but that its impact varies across grids.

Johnson and Ward used a two-stage CSD process to substantiate Feuz's finding that weight sends the strongest price signal in a grid marketing system. They also found that quality and yield grades associated with carcass discounts send stronger signals than do quality and yield grades associated with carcass premiums. The authors concluded that grid pricing is shaping production by penalizing poor-quality carcasses rather than rewarding higher quality carcasses.

Schroeder and Graff used regression to identify that Choice-Select wholesale boxed beef cutout price spread had the greatest impact on variability of grid price. Carcass weight variability had a greater impact on variability of grid revenue per head than did any other factor considered.

Fausti and Qasmi established that premiums (incentives) for above-average cattle and discounts (disincentives) for below-average cattle both increased over a 206-week period but that discounts increased more than premiums. This suggests that producers have an incentive to produce what cattle packers are demanding and paying premiums for, thus avoiding large price discounts. Fausti and Qasmi also found incentives were influenced by seasonal market conditions.

To date, no studies have attempted to isolate how carcass quality variation affects market signals and the monetary incentive to improve quality of lower quality cattle when selling on a grid. This study complements and extends existing grid pricing market signal and incentive research in several ways. As noted, previous research studies each used a single dataset of cattle. Research reported here isolates and estimates the impact of carcass quality characteristics on market signals across multiple datasets, each of which was used previously in grid pricing research (Cooper et al.; Forristall, May, and Lawrence; Greer, Trapp, and Ward; Schroeder and Graff). Cattle in each regional dataset were sorted in two ways: (1) in thirds based on grid value and (2) better versus poorer quality groups (i.e., better quality was defined as Choice quality grade, yield grade 3 or better). The sorted datasets used in this study allow for more precise price signal identification because a significant amount of variability at the pen level is removed. This precision is necessary in identifying whether different carcass characteristics from the two sorting schemes send different signals.

Four datasets (a total of 18,267 head of fed cattle) result in potentially more robust find-

Table 1. Base Grid Utilizing Published USDA National Carcass Premiums and Discounts for Slaughter Steers and Heifers Average Premiums and Discounts Between October 1996 and December 1998 ($/cwt)

	Yield Grade 1	Yield Grade 2	Yield Grade 3	Yield Grade 4	Yield Grade 5
Prime	7.41	6.58	5.69	(8.01)	(13.51)
Choice	1.72	0.89	0.00	(13.70)	(19.20)
Select	(5.20)	(6.03)	(6.92)	(20.62)	(26.12)
Standard	(15.33)	(16.16)	(17.05)	(30.75)	(36.25)
Light carcass (< 550 lb)	(20.00)				
Heavy carcass (> 950 lb)	(20.00)				

ings compared with previous studies that typically used a single dataset. A common statistical approach was applied to identify grid pricing signals. A two-stage CSD process quantifies the proportion of variation in animal value under grid pricing explained by specific carcass quality characteristics. The proportion of variation in grid value explained by a particular characteristic is tantamount to a market signal that producers and feeders respond to when they sell animals on a grid. Previous market signal studies have used standardized betas, single-stage CSD, and regression.

This study identifies market signals sent by weight, quality grades, and yield grades, which are the factors producers respond to when selling cattle on a grid. Some previous market signal studies considered carcass weight and the underlying carcass traits used to determine quality and yield grade (marbling score, fat depth over 12th rib, etc.), but producers often do not receive information about these underlying traits from packers (Feuz 1999a, b).

Two years of weekly grid price data provide the base for developing a grid. Feuz (1999a, b) indicates that base prices, premiums, and discounts vary across plants and time as they are frequently adjusted for changing market and plant conditions. Previous market signal studies used a selected grid or grids for a specific point or points in time. Often, these studies found market signal results varied across different grids and time. This study's use of a grid averaged over several packers and 2 years' time eliminates several potentially confounding factors (e.g., seasonality, packer bias, atypical market conditions). From all this, the authors quantify the monetary incentive for producers to improve cattle quality.

Price and Carcass Data

Premiums and discounts in this study's grid are two-year averages based on a USDA weekly report, "National Carcass Premiums and Discounts for Slaughter Steers and Heifers" (USDA-AMS), from October 1996 to December 1998. The grid is presented in Table 1.[1] Averaging over time and packers eliminates potentially confounding factors and allows identifying market signals under typical market conditions.

A base grid price of $96.08/cwt was used in this analysis. The unadjusted base price is the boxed beef cutout value for Choice carcasses, 550 to 850 lb as reported by USDA-AMS for the week ending December 26, 1998.[2] Survey data from feeders indicated that

[1] A reviewer correctly noted that a carcass premium or discount depends on what is defined as a base or par carcass attribute. If industry convention used a Prime quality grade, yield grade 1 as par carcass in a grid, then all values in the grid would be discounts. Conversely, if industry used a Standard quality grade, yield grade 5 carcass as par, then all values in the grid would be premiums. In this research and throughout the article, we use premiums and discounts to reflect the common industry convention that a Choice quality grade, yield grade 3 carcass is par in grids. Thus, all discussion of premiums and discounts assume this par quality carcass and is consistent the premiums and discounts used in cited grid pricing literature.

[2] A simple average of the prices reported at the time for 550- to 700-lb animals and 700- to 850-lb animals.

Table 2. Carcass Characteristics and Estimated Values for Iowa Cattle in Base and Sorted Groups

		Grid Value		Quality	
	Base	Top 1/3	Bottom 1/3	Better	Poorer
Number of animals	1,147	245	165	700	447
Avg. live weight (lb)	1,156	1,262	1,053	1,155	1,157
Avg. dressed weight (lb)	705	780	626	705	704
% above choice, YG3	42	54	13	70	0
% below choice, YG3	39	17	82	0	100
% light or heavy	0.5	0.0	3.6	0.0	1.3
Avg. grid value	$660	$747	$553	$683	$625
Avg. live value	$694	$757	$632	$693	$694
Avg. dressed value	$634	$702	$563	$635	$634

boxed beef cutout value is the preferred reference market for formula pricing with grids (Schroeder et al.). Boxed beef cutout value is a readily available carcass weight price basis at the wholesale level and thus one step closer to final demand such that it should send clearer demand signals to producers. Grid value is calculated by multiplying hot carcass weight by the sum of the base price plus premiums and discounts for weight, quality grade, and yield grade.

Incentives to improve quality are compared with live and dressed prices of $60.00/cwt and $90.00/cwt, respectively. Live and dressed prices are weekly, weighted average prices in Dodge City, KS, for the week ending December 31, 1998. Live value is calculated by multiplying live weight times live price, and dressed value is the product of hot carcass weight and dressed price.

Datasets were sorted based on two criteria to distill and validate market signals and identify incentives for producers to make carcass quality improvements. Each regional fed cattle dataset was sorted into thirds based on grid value and into two quality groups: better quality (Choice, yield grade 3 and above) and poorer quality (below Choice, yield grade 3). Market signals for the top and bottom third for each regional dataset were expected to differ. Similarly, market signals for better and poorer quality cattle were expected to differ.

Summary characteristics for the four datasets and average animal values are shown in Tables 2–5. Each dataset is described and contrasted briefly here. Data on 1,147 head of fed cattle were collected and donated to this study by the Tri-County Steer Carcass Futurity, which is a producer group assisted by Iowa State University's Extension Service. Cattle in

Table 3. Carcass Characteristics and Estimated Values for Kansas Cattle in Base and Sorted Groups

		Grid Value		Quality	
	Base	Top 1/3	Bottom 1/3	Better	Poorer
Number of animals	11,502	7,263	278	7,086	4,416
Avg. live weight (lb)	1,255	1,311	1,087	1,262	1,245
Avg. dressed weight (lb)	799	835	688	803	792
% above choice, YG3	28	35	3	46	0
% below choice, YG3	38	21	95	0	100
% light or heavy	3.0	2.7	11.9	2.9	3.1
Avg. grid value	$737	$789	$508	$771	$684
Avg. live value	$753	$787	$652	$757	$747
Avg. dressed value	$719	$752	$620	$723	$713

Table 4. Carcass Characteristics and Estimated Values for Nebraska Cattle in Base and Sorted Groups

		Grid Value		Quality	
	Base	Top 1/3	Bottom 1/3	Better	Poorer
Number of animals	4,340	2,447	286	2,231	2,109
Avg. live weight (lb)	1,234	1,295	1,045	1,239	1,229
Avg. dressed weight (lb)	778	816	659	780	774
% above choice, YG3	27	35	7	52	0
% below choice, YG3	49	31	91	0	100
% light or heavy	0.4	0.0	4.5	0.2	0.7
Avg. grid value	$721	$771	$569	$754	$686
Avg. live value	$740	$777	$627	$743	$737
Avg. dressed value	$700	$734	$593	$702	$697

the Iowa dataset, which was originally used in research by Forristall, May, and Lawrence, have a higher percentage of better quality cattle but lower average grid values compared with cattle from other regions. Additionally, average dressed weights were below those in other regional datasets. For example, cattle in the top third sorted by grid value had the lightest average dressed weight of 780 lb; highest percentage of animals grading Choice, yield grade 3 and above (54%); and the lowest average grid value of $747 per head.

The second dataset contained 11,502 head of cattle fed in Kansas and sold under a marketing agreement using grid pricing to a large Midwestern beef packer. Cattle in this dataset, first used in the Schroeder and Graff study, were the heaviest and had the highest average grid value. For the top third of the dataset based on grid value, average carcass weight was 835 lb and average grid value was $789 per head.

Data for 4,340 head of commercially fed cattle in the third dataset came from a University of Nebraska sorting experiment (Cooper et al.). Cattle in this dataset were the least remarkable of the four datasets, having no particularly unique aspects relative to the other datasets.

The 1,278 head of fed cattle in the last dataset were fed in a major Oklahoma feedlot (Greer, Trapp, and Ward). Cattle in this dataset were the poorest quality on average, as 57% graded below Choice, yield grade 3.

Across the four regions, cattle grading above Choice, yield grade 3 in the top third based on grid value ranged from 31% to 54% and from 3% to 13% in the bottom third. Average grid values based on quality ranged from $683 to $771 per head in the better quality

Table 5. Carcass Characteristics and Estimated Values for Oklahoma Cattle in Base and Sorted Groups

		Grid Value		Quality	
	Base	Top 1/3	Bottom 1/3	Better	Poorer
Number of animals	1,278	618	318	554	724
Avg. live weight (lb)	1,200	1,274	1,085	1,193	1,205
Avg. dressed weight (lb)	779	829	698	772	784
% above choice, YG3	24	31	13	55	0
% below choice, YG3	57	39	80	0	100
% light or heavy	3.5	2.3	6.6	2.9	4.0
Avg. grid value	$705	$771	$598	$742	$676
Avg. live value	$720	$764	$651	$716	$723
Avg. dressed value	$701	$746	$628	$695	$705

groups and \$625 to \$686 per head in the poorer quality groups. Therefore, market signals across the regional datasets account for a wide range of cattle quality and value.

Methodology and Procedures

The more influence a carcass characteristic has on grid value, the stronger the market signal that characteristic will send through the marketing channel. The objective of this study was to determine how market signals are affected by carcass quality differences. To achieve this objective, the influence of each carcass characteristic (carcass weight, quality grade, and yield grade) on grid value, equivalent to a market signal, was estimated for each of the sorted datasets. Two methods of identifying market signals are standardized beta coefficients (SB) and CSD.

The SB approach uses ordinary least squares (OLS) regression and normalizes each coefficient so it has a mean of 0 and standard deviation of 1 (McDonald and Schroeder). The SB approach only accounts for the individual effects of an independent variable on the dependent variable and does not allow for interaction effects. The CSD process, however, integrates OLS regression coefficients, standard deviations, and correlation coefficients (Feuz 1999a). CSD values represent the effect for each independent variable (variance effect), as well as the interaction among related independent variables (covariance and correlation effects) on the dependent variable. The sum of the CSD values equals the coefficient of multiple determination (R^2). Given that the SB approach does not consider the relationship between independent variables, the CSD method provides more information and insight into the identification and analysis of market signals.

Estimating the CSD values begins with estimating grid value. Determinates of grid value differ by marketing agreement and grid, but common factors used to value an individual animal under a grid pricing system include:

$$\text{(1)} \quad \textit{Grid value} = f(\textit{HCW, base price, QG, YG, LH})$$

where *HCW* is hot carcass weight, *base price* is dressed weight price from a formula or negotiated with a packer, *QG* is quality grade (included in the regression as 0–1 dummy variables for grades Prime, Select, and Standard), *YG* is yield grade (included in the regression as 0–1 dummy variables for yield grades 1–5), and *LH* is light or heavy carcass weights (included in the regression as 0–1 dummy variables for light or heavy carcass weight). This model assumes a Choice, yield grade 3 carcass as the base or par.

The CSD methodology requires a linear and additive relationship between the independent variables and the dependent variable whose variation is being explained (Ezekiel and Fox). A two-stage modeling approach is used because *HCW* has a multiplicative relationship with the other variables on the right side of Equation (1). Both models are identities, and the objective is to decompose the relationship between grid value and carcass characteristics so market signals can be identified.

The first model is a double log function that describes the relationship between grid value, grid price, and hot carcass weight.

$$\text{(2)} \quad \text{Log}(\textit{grid value}) = g[\text{Log}(\textit{grid price}), \text{Log}(\textit{HCW})]$$

where *grid value* is the sum of premiums and discounts for quality grade, yield grade, and weight. Because the grid value equation is specified in logs, it is linear and additive.

The second model uses dummy variables to describe the relationship between grid price and quality grade and yield grade premiums and discounts and carcass weight discounts. This model is specified such that Choice is the base quality grade, yield grade 3 is the base yield grade, and 550 to 950 lb is the base carcass weight.

$$\text{(3)} \quad \textit{Grid price} = h(\textit{QG1, QG3, QG4, YG1, YG2, YG4, YG5, LH})$$

where *grid price* is the net sale price; *QG1–4* are 0–1 dummy variables for quality grades

Prime, Choice, and Select with Choice as the omitted variable; *YG1–5* are 0–1 dummy variables for yield grades 1 to 5 with yield grade 3 as the omitted variable; and *LH* is a 0–1 dummy variable for light or heavy carcass weight. This model is linear and additive as well. Each dummy variable's coefficient is equal to the respective premium or discount.

The CSD process occurs in three steps. The first step in calculating a CSD is to separately estimate Equations (2) and (3) using OLS. The second step is to calculate a beta coefficient (β) for each independent variable, *x*,

$$(4) \qquad \beta_x = b_x \times \left(\frac{s_x}{s_y}\right)$$

where b_x is an OLS regression coefficient for variable x, s_x is the standard deviation for variable x, and s_y is the standard deviation for the dependent variable (Ezekiel and Fox). The third step is the calculation of the CSD value. In an n independent variable equation, the CSD calculation is:

$$(5) \qquad CSD_n = \sum_{k=1}^{n} \beta_n \beta_k r_{nk}$$

where β is the beta coefficient calculated in Equation (4) and r is the Pearson correlation coefficient. As stated above, the sum of the CSD values for a specific equation equals the coefficient of multiple determination, R^2.

CSD values calculated in Equation (5) for variables in the grid value equation (Equation [2]) identify what influence weight and grid price have on grid value. CSD values for the variables in the grid price equation (Equation [3]) identify what impact quality grade, yield grade, or weight premiums/discounts have on grid price. To be more meaningful, the CSD values associated with variables in the grid price equation are converted so the influence of each of these variables on grid value is ascertained. The conversion process involves multiplying the CSD value for each variable in Equation (3) by Equation (2)'s grid price CSD value.

The two-stage modeling process and conversion of the grid price equation CSDs identify the relative importance of weight, quality grades, and yield grades in explaining variation in grid value. This methodology identifies the market signals producers receive regarding carcass characteristics when cattle are priced on the grid. This procedure goes beyond previous research and applies the methodology to regional datasets of fed cattle to differentiate the impact of carcass quality differences on market signals.

CSD Results

Results are presented in two sections, the first addressing market signals of the sorted groups and the second discussing incentives for improving quality and management.

Market Signals

Cattle in the top third of datasets sorted by grid value earned 29% to 55% more on the grid than did cattle in the bottom third. Sorting cattle by quality grade and yield grade leads to better quality animals (cattle grading Prime and Choice, yield grades 1–3) earning 9% to 13% more on the grid than poorer quality animals (cattle grading Choice, yield grades 4 and 5, and Select and Standard, yield grades 1–5). CSDs presented in Tables 6 and 7 indicate that weight and carcass quality traits are both drivers of the larger earnings. However, the strength of these two signals differs dramatically across the sorted datasets. Comparisons of CSDs within and across datasets specify the impact of carcass quality on market signals.

Weight explained between 72% and 92% of the variation in grid value in the top third of each regional dataset and 79% on average (Table 6). However, across the bottom third groups, weight explained considerably less of the variation, from 39% to 56% and 50% on average. Thus, quality and yield grade signals were much stronger for the bottom third (44%–61%) than the upper third (8%–28%).

For the top third groups based on grid value, 31% to 54% of the cattle graded Choice, yield grade 3 or better (Tables 2–5). Only 2% to 13% of cattle in the bottom third achieved

Table 6. Coefficients of Separate Determination for Cattle Sorted into Top and Bottom Thirds of Grid Value for Each Dataset

	Iowa		Kansas		Nebraska		Oklahoma		Average	
	Top 1/3	Bottom 1/3	Top 1/3	Bottom 1/3	Top 1/3	Bottom 1/3	Top 1/3	Bottom 1/3	Top 1/3	Bottom 1/3
Part 1:	*Percentage of Variation in Grid Value*									
Quality	8	61	28	44	23	46	24	49	21	50
Weight	92	39	72	56	77	54	76	51	79	50
Total	100	100	100	100	100	100	100	100	100	100
Part 2:										
Prime	1	0	1	0	1	0	0	0	1	0
Select & Std.	7	38	11	13	20	16	8	8	11	19
Quality Grade[a]	9	38	12	13	20	16	9	9	12	19
1 & 2	(0)	(1)	(0)	2	(0)	0	0	1	(0)	0
4 & 5	0	4	2	19	3	13	7	22	3	14
Yield grade[a]	(0)	2	2	21	3	13	8	23	3	15
Light/heavy	0	20	14	11	0	16	8	17	6	16
Quality total[a]	8	61	28	44	23	46	24	49	21	50

[a] Individual quality coefficients of separate determination may not sum to total because of rounding.

these same grades. With higher proportion of better quality cattle in the top third groups, carcass weight explained more of the variation in grid value than in the bottom third groups.

When the second sorting process is considered, the market signals for the better and poorer quality groups might seem surprising on the surface. Weight explained 95% to 99% of the variation in grid value in the better quality group across cattle datasets (Table 7). For the poorer cattle group, weight explained 61% to 81% of the variation in grid value and 72% on average. However, having sorted cattle into quality groups, it makes sense that quality and yield grade signals would be swamped by weight for the better quality cattle. For the

Table 7. Coefficients of Separate Determination for Cattle Sorted into Better and Poorer Quality Groups for Each Dataset

	Iowa		Kansas		Nebraska		Oklahoma		Average	
	Better	Poorer	Better	Poorer	Better	Poorer	Better	Poorer	Better	Poorer
Part 1:	*Percentage of Variation in Grid Value*									
Quality	1	26	4	39	3	19	5	29	3	28
Weight	99	74	96	61	97	81	95	71	97	72
Total	100	100	100	100	100	100	100	100	100	100
Part 2:										
Prime	1	0	0	0	1	(0)	0	0	0	0
Select & Std.	0	13	0	10	0	1	0	(1)	0	6
Quality Grade[a]	1	13	0	10	1	1	0	(1)	0	6
1 & 2	0	0	0	1	1	1	0	1	0	1
4 & 5	0	3	0	16	0	13	0	17	0	12
Yield grade[a]	0	3	0	17	1	14	0	18	0	13
Light/heavy	0	9	3	12	1	4	5	12	2	9
Quality total[a]	1	26	4	39	3	19	5	29	3	28

[a] Individual quality coefficients of separate determination may not sum to total because of rounding.

poorer quality group, market signals derived from discounts for selected carcass traits have a more significant effect.

Selling under a grid allows quality characteristics to send stronger market signals than under average pricing, where weight accounts for 100% of the variation in value for any given price. However, the strong signal sent by weight when selling under a grid corroborates findings by Feuz (1999a). Both the absolute weight of cattle marketed and the percentage of animals that received a weight discount affect weight's market signal. Average carcass weights in the top third group based on grid value weighed 131 to 157 lb more than cattle in the bottom third (Tables 2–5). However, cattle receiving a weight discount averaged 1.3% in the top third and 6.6% in the bottom third. Although carcass weights are more similar in the quality sorted groups, a smaller percentage of cattle in the better quality group received weight discounts.

Two specific comparisons highlight the impact of quality characteristics and weight discounts on weight's market signal. The first comparison examines market signals from two of the top third groups. Iowa had the largest percentage of cattle grading equal to or better than Choice, yield grade 3 (54%), and no cattle received a heavy or light weight discount. As a result, 92% of the region's variation in grid value is attributed to weight. The weakest market signal from weight occurred in the Kansas dataset, with 72% of the variation in grid value explained by weight. Two factors explain Kansas' weaker weight signal: (1) only 35% of the Kansas cattle were in the better quality group, and (2) heavier carcass weights resulted in almost 3% of cattle receiving a heavy weight discount.

The second comparison identifies differences in carcass characteristics and market signals across Iowa's top and bottom third grid value sort groups. The quality of cattle in the bottom third group was much lower than that of the top third, in that 82% of the bottom third graded below Choice, yield grade 3 compared with 17% in the top third. Additionally, 3.6% of cattle received a weight discount in the bottom third compared with 0% in the top third. Both factors pushed the variation in grid value explained by weight down to 39% in the bottom third.

Tables 6 and 7 show that in all cattle datasets, discounted carcass characteristics explained most of the remaining variation in quality not associated with weight. For example, in the better quality groups, 8% to 28% of the variation in grid value was affiliated with carcass quality characteristics. Discounted carcass characteristics explained 7% to 27% of the overall quality signal. With the strong signals generated by discounted characteristics, it is not surprising that the strongest quality market signals were found in the bottom third and poorer quality groups across the four cattle datasets. Quality, on average, explained 50% of the variation in grid value in the bottom third groups and 28% in the poorer quality groups. The variation in grid value explained by carcasses receiving discounts averaged 49.4% and 27.5% in the bottom third and poorer quality datasets, respectively.

Examples from the bottom third groups highlight the strong signals sent by discount-bearing carcass characteristics; weaker signals in the poorer quality datasets exhibit similar patterns. Select and Standard quality grades explained 19% on average of variation in grid value explained by quality grade. Of the 14% average variation in grid value associated with yield grade, nearly all is associated with yield grades 4 and 5. Additionally, although only 4% to 12% of the cattle in the bottom third groups earned a weight discount, this quality characteristic explained 11% to 20% of the variation in grid value across the four cattle datasets. The stronger market signals sent by carcass characteristics receiving discounts in these sorted groups, whether sorted by grid value or carcass quality, concur with Johnson and Ward's findings for each of the regional datasets as a whole.

Based on findings reported here, grids are attempting to shape production by sending quality and weight price signals to producers. Although weaker than under average pricing, weight still sends the strongest overall signal in most cases. Additionally, lower quality, discount-earning carcass characteristics send much stronger signals than higher quality, premium earning characteristics. These results are consistent with previous research conducted with different methodology, suggesting very robust results across methodologies and data. Grids appear to be shaping production by (1) stimulating the production of heavy carcasses that are not overweight and (2) penalizing lower quality carcasses more than rewarding higher quality carcasses. Conceptually, heavier carcasses result in more useable meat products, and strong quality signals for discount-bearing quality characteristics should remove the poorest quality cattle from the grid marketing channel over time.

Quality Improvement Incentives

Do producers have a sufficient monetary incentive to improve the quality of cattle and sell them on the grid? Up to now the focus has been on the signals generated by weight and quality characteristics when selling cattle under a grid. The conclusion from the previous sections that grids shape cattle production by penalizing poor-quality carcasses more than rewarding high-quality carcasses coincides with animal values in Tables 2 to 5. The bottom third of cattle based on grid value and the poorer quality cattle earn significantly more on a live or dressed weight basis than under a grid. More specifically, the average gain from selling these cattle on a live weight basis is $70.70 per head and $31.70 per head on a dressed weight basis. Is there a sufficient monetary incentive to improve the quality of these cattle and sell them with a grid?

Calculating the incentive for selling higher quality cattle on a grid begins with taking the difference in average grid value between the regional top third and bottom third datasets based on grid value. The difference in average grid value between these two groups is $194 per head in Iowa, $282 per head in Kansas, $202 per head in Nebraska, and $173 per head in Oklahoma. On the surface, this appears to be an adequate incentive to produce higher quality cattle, but the monetary value of weight and quality needs to be disaggregated.

Differences in average live and dressed weight values between the top and bottom third datasets are wholly due to weight. The value attributed to quality characteristics is found by subtracting the live and dressed value differences from the grid value differences. Weight explained $125 per head (live weight) to $139 per head (dressed weight) of Iowa's grid difference, and $55 per head to $69 per head of the grid difference was associated with quality characteristics. Weight explained $135 per head (live weight) to $132 per head (dressed weight) of Kansas' grid difference, so $147 per head to $149 per head of the difference was connected with quality traits. Because $150 per head (live weight) to $141 per head (dressed weight) of Nebraska's grid difference was explained by weight, $52 to $60 per head of the difference was related to quality characteristics. With $113 per head (live weight) to $118 per head (dressed weight) of Oklahoma's grid difference explained by weight, quality traits explained $55 to $60 per head of the difference.

When selling on a grid, producers can potentially gain $113 to $150 per head by adding weight to cattle in the bottom third group, and $52 to $149 per head by improving the carcass quality of these animals. Whether these quality improvement premiums from selling on the grid are large enough to provide producers sufficient incentive to make cow/calf genetic selection decisions and adjust feedlot production practices is totally dependent on the costs of making such changes. Without accounting for production costs, it is difficult to assess whether these incentives will provide producers with a profit or directly compare the incentives to the average cattle feeding profits of $15 to 20 per head.

This analysis corroborates the conventional wisdom that there is a significant incentive to sell poorer quality cattle on a live weight or dressed weight basis. Therefore, this market signal provides an incentive to sort cattle once or more before marketing. In the bottom third datasets based on grid value, additional weight is not likely to significantly improve quality so sorting cattle is not an attempt to improve quality or eliminate poorer quality cattle from the industry. Sorting it is an attempt to determine the most profitable pricing method based on specific carcass characteristics, as shown to be advantageous in previous research (Schroeder and Graff).

This analysis also identifies that often there is a substantial difference between the incentive to improve animal quality and the incentive to add weight to cattle from increasing days on feed when selling with a grid. This difference may help explain the increasing average carcass weight of cattle over the last few years, despite a large percentage of animals being marketed with a grid. Given the larger weight incentives and the availability of alternative marketing channels (live, dressed, etc.), putting weight on animals is less risky and more lucrative than attempting to improve animal quality.

Summary

Over the last two decades, a reliance on average pricing has contributed to the beef industry's persistent problems of carcass inconsistencies and large losses due to quality deficiencies. Increased use of value-based marketing (or grid pricing) during the mid-1990s appeared to have a small, positive impact on certain carcass quality characteristics within the U.S. beef herd. However, the industry continues to see increasing carcass weights and declining yield grades, which contribute to losses due to quality deficiencies. This study assesses market signals transmitted by grid pricing through the marketing channel using a two-stage CSD process while controlling for considerable differences in cattle quality. Additionally, it identifies the monetary incentives producers receive to raise higher quality cattle and sell them on a grid.

The empirical analysis in this study was conducted on four sets of cattle from previous research studies. Cattle in the four regional datasets (Iowa, Kansas, Nebraska, and Oklahoma) were sorted by grid value and carcass quality attributes. It was found that several factors influence market signals sent by grid pricing to producers. Weight was the strongest market signal sent to producers when higher valued cattle or better quality cattle were sold on a grid. The market signal associated with weight averaged 79% across the top third of cattle across the four datasets when sorted by grid value. When sorted by cattle quality, the weight signal averaged 97% across the four better quality groups. Weight's signal, however, only averaged 50% across the four bottom third groups and 72% in the poorer quality groups.

Carcass quality characteristics sent much stronger signals for cattle in the lower third of the grid value group or poorer quality group when sold on a grid. The carcass quality market signal averaged 50% in the bottom third group based on grid value and 28% in the poorer quality group. But, in all sorted datasets, a majority of the quality signal was associated with quality characteristics linked to a discount, not characteristics associated with a premium. For example, the average market signals for the discount [premium]-bearing carcass characteristics in the top and bottom grid value groups were 20% [1%] and 49.5% [0.5%], respectively. Therefore, grids attempt to shape production by penalizing poorer quality carcasses more than rewarding higher quality carcasses. Over time, this pricing system could conceptually force lower quality cattle out of the marketing channel.

The next step was to establish whether there is a monetary incentive to improve the quality of these animals and sell them under a grid. Because an average of $31 to $71 per head can be gained from selling lower valued cattle on a live weight or dressed weight basis, there is an incentive to physically sort cattle and not market these on a grid. However, the study also identifies a large, positive difference between the monetary incentive to producers to put weight on the animals and the incentive to improve the quality of those animals when they are sold on a grid. Under grid pricing, producers can potentially gain $113 to $150 per head by putting weight on cattle in the bottom third group based on grid value, while the incentive to improve quality ranged between $52 per head and $149 per head. Whether the quality improvement incentive is large enough to encourage production of higher quality cattle is primarily dependent on costs, which are not accounted for in this study. However, under the current grid pricing structure, the weight incentive and the availability of alternative marketing channels make increasing the weight of most lower valued cattle a less risky and more lucrative endeavor than attempting to improve animal quality.

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