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Market Signals Transmitted by Grid Pricing

Heather C. Johnson and Clement E. Ward

Grid pricing improves the flow of information to producers, but market signals sent by grids may not be clearly understood. This study uses a two-stage Coefficients of Separate Determination process, four sets of fed cattle carcass data, and sensitivity analyses to identify market signals sent by grid pricing. Weight sends a stronger market signal than carcass quality characteristics such as quality and yield grade. Although grids are shaping production, market signals indicate that lower quality carcasses are penalized more than higher quality carcasses are rewarded. Sensitivity analyses suggest changes in quality and yield grade discounts have the greatest impact on market signals.

Key words: beef cattle, Coefficients of Separate Determination, grid pricing, market signals, value-based marketing

Introduction

The beef industry's competitive position weakened relative to the pork and poultry industries during the 1980s and 1990s. Declining demand was attributed to the relative price of beef compared to other meats and to several nonprice determinates such as health and food safety concerns, changing consumer lifestyles, product quality issues, and product convenience problems (Capps and Schmitz, 1991; Kinnucan et al., 1997; Purcell, 2000; Unnevehr and Bard, 1993). Prior to the mid-1990s, average pricing was the primary mechanism to price cattle. Industry members questioned whether average pricing could send appropriate price signals through the marketing channel and adequately communicate consumer preferences. The National Cattlemen's Beef Association (NCBA) argued for a shift to value-based pricing, as it would support the industry's goals to provide clearer market signals and improve beef's quality and consistency (Value-Based Marketing Task Force, 1990).

Average pricing determines the value of cattle on a pen basis using the average weight (live or dressed) of the pen(s) sold. In contrast, value-based pricing, also referred to as grid pricing, determines value on an individual animal basis and incorporates quality characteristics into the valuation of a carcass—typically, yield grade and quality grade. Grid pricing attempts to bridge the information gap between retailers, packers, and producers/feeders. Monetary incentives and disincentives, which conceptually clarify the communication of market preferences, are the foundation of grid pricing.

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Ideally, grid prices reflect consumer preferences and transmit these signals through the marketing channel, thereby encouraging producers to improve the quality and consistency of beef. Producers selling cattle with a grid receive specific carcass merit and value data on each carcass sold. Carcass data enable producers to make specific changes to their breeding, feeding, and sorting programs.

While average pricing continues to dominate fed cattle marketing, the use of grid pricing has increased over time. In a 2002 survey, 316 feedlots across Iowa, Kansas, Nebraska, and Texas responded that grid pricing accounted for 16% of marketings in 1996, and 45% in 2001 (Schroeder et al., 2002). Three National Beef Quality Audits (NBQAs) found beef production encumbered with several quality and consistency problems (Smith et al., 1992, 1995, 2000). Packers surveyed in the three audits consistently cited heavy carcass weights, insufficient marbling/low quality grades, high yield grades (yield grade 4/5), and lack of uniformity as some of the greatest challenges encountered. Grid pricing's growing acceptance, its proposed role in improving the quality and consistency of beef, and the industry's continued struggles with improving quality make it necessary to evaluate whether this pricing mechanism sends cattle producers appropriate market signals that motivate quality improvements.

Accordingly, the overall goal of this study is to identify and quantify market signals transmitted by grid pricing through the marketing channel to producers. Specifically, the study's objectives are: (*a*) to identify market signals sent by weight, quality grades, and yield grades, which are the stimuli producers react to when selling on the grid; and (*b*) to determine how changes in grid premiums and discounts affect the information sent to producers about desirable carcass characteristics.

Previous Research

Recent fed cattle marketing and price discovery research related to grid pricing has primarily focused on uncertainty and risk, and revenue variability. A review of the literature indicates that less risk-averse cattle producers will more likely sell under a grid pricing mechanism, and more risk-averse producers will sell via average pricing (Feuz, Fausti, and Wagner, 1995). Therefore, uncertainty and risk on the part of producers sustains demand for alternative pricing mechanisms. However, uncertainty and risk on the part of buyers has an impact on prices received. Several studies examine the price differentials between average (live and dressed) and value-based pricing mechanisms (Fausti and Feuz, 1995; Fausti, Feuz, and Wagner, 1998; Feuz, Fausti, and Wagner, 1993, 1995; Schroeder and Graff, 2000). The literature makes a strong case for the existence of price differentials between average and value-based pricing because of incomplete carcass quality information when cattle are purchased at an average price. Fausti and Feuz (1995) found that risk-neutral, profit-maximizing buyers offer lower prices for the same quality cattle under average pricing as compared to value-based pricing. Moreover, price differentials are found to increase when buyers become more risk averse.

Price differentials and the ensuing price variability lead to revenue variability between the alternative pricing mechanisms. Several studies provide empirical evidence that selling individual fed cattle on the grid increases per head and per hundredweight (cwt) revenue variability compared to selling cattle at an average price (Anderson and Zeuli, 2001; Fausti, Feuz, and Wagner, 1998; Fausti and Qasmi, 2002; Feuz, Fausti, and

Wagner, 1993, 1995; Schroeder and Graff, 2000). More specifically, Schroeder and Graff (2000) report that revenue variability in grid pricing is double that of live or dressed weight pricing. Anderson and Zeuli (2001) also found the difference in revenue variability between grid and live weight pricing increases as the carcass quality of the pen deteriorates.

The price discovery literature cited above provides empirical evidence supporting the conclusion that uncertainty, risk, and revenue variability are intrinsic components of selling on a grid. Within this framework of risk and revenue variability, a few studies examine the market signals grid pricing sends through the marketing channel. Feuz (1999a) uses Coefficients of Separate Determination on 85 pens (5,520 head) of fed cattle marketed throughout 1997, two price grids, and two time periods to study how marketing practices (i.e., selling cattle individually, in a pen, or in several pens) affect market signals sent through the marketing channel. His findings show that weight explains 96%–100% of variation in revenue when cattle are sold on a live or carcass weight basis, either in a pen or in several pens. Yield grade, dressing percentage, and percentage of cattle grading Choice or Prime explain any remaining variation in value. However, when cattle are sold on a grid at the pen level, carcass weight explains 71%–95% of the variation in revenue. The percentage of cattle grading Choice or better explains 2%–27% of the variation in revenue, and yield grades typically explain less than 1% of the variation. At the individual animal level, carcass weight accounts for 44%–85% of the variation in grid revenue; marbling score, 6%–24%; and fat thickness and ribeye area, less than 3%. Feuz also finds that market signals vary by grid and time period.

Using the same carcass data as above, Feuz (1999b) employs seemingly unrelated regression (SUR), three pricing grids, and six time periods to analyze the relationships between carcass characteristics and grid premiums and discounts at the pen level. The relationships identified are the market signals communicated by a grid. Adjusted R^2s range between 61%–81%. Feuz reports the following findings: marbling has a positive and nonlinear relationship with grid premiums/discounts; the relationship between fat thickness and grid premiums/discounts is positive at low levels, but becomes negative with increasing fat thickness; although carcass weight is statistically significant, its magnitude indicates a very weak relationship; and finally, carcass characteristic signals vary over time and across grids.

Schroeder and Graff (2000) estimate a regression model for data consisting of 71 pens (11,703 head) of fed cattle. They use a single price grid for a single time period to identify factors affecting the variability of grid price per cwt and revenue per head across carcasses within a specific pen. Their models explain 68%–88% of the variability in price and revenue, respectively. Their results show the Choice-Select boxed beef cutout value difference has the greatest impact on the variability of grid price per cwt. Further, while not as influential as the Choice-Select price spread, variability in quality grade of carcasses in a pen has an impact on grid price variability. Finally, carcass weight variability has a greater impact on variability of revenue per head than any other factor considered.

Market signal research to date indicates grid pricing market signals transmitted between packers and cattle producers are not clear and/or consistent—due in part to different models, statistical analyses, data sets, and/or grids used in past studies. If the industry is going to successfully motivate producers to improve quality, a better understanding of grid pricing market signals is needed. This study complements and extends the existing body of grid pricing market signal research in several important ways:

- While most previous studies use a single carcass data set, four carcass data sets are used here. Thus, this study's findings are more robust given the diverse carcass quality characteristics across the four groups of cattle and the larger number of cattle analyzed—a total of 18,267 head. Each of the four data sets has been used in published research (Cooper et al., 1999; Forristall, May, and Lawrence, 2002; Greer, Trapp, and Ward, 2000; Schroeder and Graff, 2000).

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

- A common statistical approach is applied to the four data sets to identify market signals transmitted through the marketing channel. A two-stage Coefficients of Separate Determination (CSD) process quantifies the proportion of variation in animal value under grid pricing explained by specific carcass 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 selling animals on a grid. Previous market signal studies use standardized betas, single-stage CSD, and regression.

- This study uses two years of weekly industry aggregated grid price data to generate a grid. Previous analyses use a selected grid or grids for a specific point or points in time to generate results. These studies often find that market signal results vary across grids and time. Base prices, premiums, and discounts vary across plants and time as they are frequently adjusted to reflect market/plant conditions (Feuz, 1999a, b). The use of a grid averaged over several packers and two year's time eliminates several potentially confounding factors (e.g., seasonality, packer bias, and atypical market conditions), allowing market signals to reflect typical market conditions.

- Finally, sensitivity analyses determine how market signals are affected by changes in grid premiums and discounts. The grid changes are not intended to mimic any historical response of grid premiums and discounts to changing market conditions. Instead, we chose to isolate specific grid changes so their impact on market signals can be clearly identified. The sensitivity analyses, in combination with the multiple data sets and the CSD methodology, identify the premiums and discounts that can most effectively motivate the production of higher quality cattle.

Price and Carcass Data Description

Premiums and discounts in this study's grid are averaged over a two-year period using industry data. Weekly grid price reports, "National Carcass Premiums and Discounts for Slaughter Steers and Heifers" [U.S. Department of Agriculture/Agricultural Marketing Service (USDA/AMS)], from October 1996 to December 1998, are used to calculate averages. The grid is presented in table 1. As noted previously, averaging premiums and

Table 1. Base Grid from USDA/AMS Report, "National Carcass Premiums and Discounts for Slaughter Steers and Heifers," October 1996–December 1998 ($/cwt)

	Yield Grade				
Quality Grade	1	2	3	4	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
Weight Discounts:					
Light (< 550 lbs.)	-20.00				
Heavy (> 950 lbs.)	-20.00				

discounts over time and across packers eliminates potentially confounding factors. Therefore, this study's average grid identifies the economic signals sent by carcass characteristics when cattle are sold on a grid under typical market conditions. Sensitivity analyses address any differences in grid premiums and discounts relative to the period being considered. Grid premium and discount standard deviations, which are used in the sensitivity analyses, are calculated using the two years of weekly grid price reports, and appear in table 2.

The base grid price used in this analysis to calculate animal values is $96.08/cwt. This unadjusted base grid price is the boxed beef cutout value for Choice carcasses between 550 lbs. and 850 lbs. reported by USDA/AMS for the week ending December 26, 1998. Cattle feeders indicate the boxed beef cutout value is preferred over more common reference markets in price formulas to arrive at the base grid price (Schroeder et al., 2002). Boxed beef cutout value is an advantageous base grid price for the following reasons: (*a*) it is readily available from the USDA, (*b*) it is calculated on a carcass weight basis, and (*c*) it is one step closer to final demand, and thus should send clearer demand signals to producers.

Table 3 presents a summary of carcass characteristics for cattle in each of the four data sets. The first data set (Iowa) was used in research published by Forristall, May, and Lawrence (2002). Cattle are from the Tri-County Steer Carcass Futurity, a producer group affiliated with Iowa State University's extension service. The total number of cattle is 1,147 head, and of the four data sets these cattle have the lightest average live (1,156 lbs.) and dressed (705 lbs.) weights. Although 61% of the cattle in the Iowa data set grade Choice, yield grade 3 or better, cattle in the data set have the lowest average grid value ($660/head).

The second data set consists of 11,502 head of cattle fed in a commercial feedlot in Kansas and sold under a grid pricing formula as part of a marketing agreement with a large Midwestern beef packer. Data were previously used by Schroeder and Graff (2000). Compared to cattle in the other data sets, cattle in the Kansas data set have the heaviest average live and dressed weights (1,255 lbs. and 799 lbs., respectively). In addition to the largest percentage of cattle grading at or above Choice, yield grade 3 (62%), the Kansas cattle have the highest average grid value ($737/head).

Table 2. Standard Deviations for Premiums and Discounts, October 1996–December 1998 ($/cwt)

Premium/Discount	Std. Deviation	Premium/Discount	Std. Deviation
Prime	0.12	Yield Grade 1	0.06
Select	2.53	Yield Grade 2	0.06
Standard	1.99	Yield Grade 4	1.71
		Yield Grade 5	1.63

Table 3. Summary of Carcass Characteristics and Carcass Values for the Four Fed Cattle Data Sets

	Regional Data Set			
Carcass Characteristic	Iowa	Kansas	Nebraska	Oklahoma
Average Live Weight (lbs.)	1,156	1,255	1,234	1,200
Average Dressed Weight (lbs.)	705	799	778	779
	— Percent of Cattle —			
Prime / Yield Grade 1–3	1.0	1.3	0.7	0.5
Prime / Yield Grade 4–5	0.0	0.3	0.1	0.2
Choice / Yield Grade 1–2	41.4	27.1	26.2	23.3
Choice / Yield Grade 3	18.6	33.3	24.5	19.5
Choice / Yield Grade 4–5	0.7	4.2	3.8	7.6
Select	34.4	28.0	42.4	45.6
Standard	3.8	5.9	2.3	3.2
Yield Grade 1	13.3	17.6	18.1	13.0
Yield Grade 2	61.2	33.1	42.5	42.3
Yield Grade 4	0.8	5.1	4.5	10.6
Yield Grade 5	0.0	0.5	0.2	0.8
Light (dressed weight < 550 lbs.)	0.5	0.2	0.2	0.6
Heavy (dressed weight > 950 lbs.)	0.0	2.8	0.2	2.9
Average Base Grid Value ($/head)	$660	$737	$721	$705
Average Premium/Discount ($/cwt):				
Quality Grade	-$2.98	-$2.86	-$3.25	-$3.66
Yield Grade	$0.67	-$0.20	$0.05	-$1.01
Total Number of Animals	1,147	11,502	4,340	1,278

The third data set consists of 4,340 head of commercially fed cattle slaughtered in a University of Nebraska sorting experiment (Cooper et al., 1999). In terms of quality, the Nebraska data set is more balanced because 53% of the cattle grade Choice, yield grade 3 or above. This data set has the smallest percentage of Standard cattle (2.3%) and "out" or heavily discounted cattle (0.2% light carcasses and 0.2% heavy carcasses).

The fourth data set is comprised of 1,278 head of cattle fed by a major Oklahoma feedlot (Greer, Trapp, and Ward, 2000). Compared to its three counterparts, the Oklahoma data set has the largest percentage of poor quality cattle, with only 43% of the cattle grading at or above Choice, yield grade 3. Additionally, this data set has the largest percentage of cattle with a yield grade 4 or 5 (11.4%).

Since the late 1990s, some within the beef industry have used the 1995 Beef Quality Audit to build support for a target where 70% of carcasses achieve a Prime or Choice quality grade, 70% are yield grade 1 or 2, and 0% are Standard quality grade, yield grade 4 or 5, under- or over-weight, or "out" (Ritchie, 2003). Using this target, the carcasses in all four data sets are below targeted standards. However, the 2000 National Beef Quality Audit found that 49.3% of the surveyed carcasses graded Prime or Choice, 49.6% were yield grade 1 or 2, and 4% were yield grade 4 or 5 (McKenna et al., 2002). Hence, when compared to industry carcass data, the cattle in all four of our data sets are above average in quality grade and yield grade.

Methodology and Procedures

A carcass characteristic with more influence on grid value sends a stronger market signal through the marketing channel than a less influential characteristic. This study's focus is on measuring how much influence specific carcass characteristics (carcass weight, quality grade, and yield grade) have on the variation in grid value, which is tantamount to a market signal.

The CSD method is more effective in identifying market signals compared to other methods used in previous research. The CSD process integrates ordinary least squares (OLS) regression coefficients, standard deviations, and correlation coefficients (Feuz, 1999a). Each CSD value represents the effect of the independent variable (variance effects) as well as the interaction among related independent variables (covariance and correlation effects) on the dependent variable. The sum of the CSD values is equal to the Coefficient of Multiple Determination, R^2. Previous studies use seemingly unrelated regression (SUR) (Feuz, 1999b), standardized betas (McDonald and Schroeder, 2003), and OLS regression (Schroeder and Graff, 2000) to quantify market signals. However, most of these approaches only account for the individual effects of an independent variable on the dependent variable, and do not inherently allow for interaction effects. Because the CSD method considers the relationship between independent variables, it 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 (Ward, Feuz, and Schroeder, 1999). However, the most common factors used to value an individual animal under a grid pricing system are included below:

$$\text{(1)} \qquad Grid\ Value = f(HCW, Base\ Price, QG, YG, LH),$$

where *HCW* is hot carcass weight, *Base Price* is price/cwt each packing firm establishes,[1] *QG* is quality grade premiums and discounts, *YG* is yield grade premiums and discounts, and *LH* is light or heavy weight discounts. *Grid Value* is calculated by multiplying hot carcass weight by the sum of the base price and premiums and discounts for quality grade, yield grade, and weight.

CSD methodology requires a linear and additive relationship between the independent variables and the dependent variable whose variation is being explained (Ezekiel

[1] A general discussion of grid base price determination appears in Ward et al. (1999).

and Fox, 1959). A two-stage modeling approach is used as *HCW* has a multiplicative relationship with the other variables on the right-hand side of equation (1). Both models are identities, and the objective is to decompose the relationship between grid value and carcass characteristics whereby 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:

$$\text{(2)} \qquad \text{Log}(\mathit{Grid\ Value}) = g\big[\text{Log}(\mathit{Grid\ Price}), \text{Log}(\mathit{HCW})\big],$$

where *Grid Price* is the sum of the base price and premiums and discounts for quality grade, yield grade, and weight. Because the *Grid Value* relationship 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 lbs. to 950 lbs. is the base carcass weight:

$$\text{(3)} \qquad \mathit{Grid\ Price} = h(\mathit{QG1}, \mathit{QG3}, \mathit{QG4}, \mathit{YG1}, \mathit{YG2}, \mathit{YG4}, \mathit{YG5}, \mathit{LH}),$$

where each independent variable is a zero-one dummy variable; *QG1* is Prime quality grade, *QG3* is Select quality grade, *QG4* is Standard quality grade; *YG1* is yield grade 1, *YG2* is yield grade 2, *YG4* is yield grade 4, *YG5* is yield grade 5; and *LH* is a light or heavy weight discount. 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, in equations (2) and (3):

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

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, 1959). The third step is the calculation of the CSD value. In an n independent variable equation, the CSD calculation is written as:

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

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 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 the impact of quality grade, yield grade, or weight premiums/discounts on grid price. To be more meaningful, the CSD values for the variables in the *Grid Price* equation are converted to ascertain the influence of each of these variables on grid value. Conversion 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. Therefore, the methodology identifies market signals producers receive regarding carcass characteristics when cattle are priced on a grid. Unlike previous research, this methodology is applied to four independent data sets of fed cattle and is used in sensitivity analyses that vary grid premiums and discounts and the base price.

Coefficients of Separate Determination Findings

Base Grid Results

OLS coefficients used to generate the CSD results are given in table 4. CSD values for the base grid are reported in table 5. The "total" row in part 1 of table 5 indicates the sum of the grid price and weight CSDs in each of the four regional models (i.e., 100%) is equivalent to an R^2 of 1.0. As observed from the CSD results in table 5, carcass weight explains more variation in grid value than carcass quality characteristics. Weight explains 61%–71% of the variation in value under grid pricing, with carcass quality characteristics accounting for the remaining 29%–39%. These findings corroborate Feuz's (1999a) CSD findings that selling individual cattle under a grid allows carcass quality characteristics to send stronger market signals than under average pricing, but weight still sends the strongest market signal.

Table 5 also reveals that quality grade explains a majority of the variation in grid value ascribed to carcass quality characteristics. On average, quality grade, yield grade, and light/heavy carcass premiums and discounts explain 18%, 9%, and 7% of the variability in grid value, respectively. This result is consistent with Schroeder and Graff's (2000) finding that quality grade variability has a greater impact on revenue per head than yield grade or any other grid component. Likewise, it supports the result reported by McDonald and Schroeder (2003) that quality grade has the greatest effect on grid profitability compared to other individual grid components, except for base price.

Initially, one might theorize that these carcass quality signals are driven by the higher quality cattle in each data set. However, analysis of individual data sets in table 5 reveals a different dynamic. Of the four data sets, the Kansas data set generates the strongest grid price (premiums and discounts) signal. Grid price explains 39% of the variation in grid value, and weight explains the remaining 61%. While this data set has more Prime cattle (1.6% of the data set; table 3) than any other, Prime quality grade only explains 1 percentage point of the 19% variation in grid value associated with quality grade. However, Standard carcasses (5.9%) explain 14 percentage points, and Select carcasses (28%) account for 4 percentage points. Therefore, lower quality cattle in the data set are the main drivers of quality grade signal, not higher quality cattle.

The second strongest grid price signal is sent by carcasses in the Oklahoma data set. Grid price explains 34% of the variation in grid value, and weight explains the remaining 66%. This data set has the highest yield grade signal of the four data sets, with yield grade explaining 14% of the variation in grid value. However, the data set's lower yielding carcasses stimulate the strong yield grade signal. Specifically, 11.4% of carcasses are yield grades 4 and 5, and these yield grades explain 13 of 14 percentage points of the variation in grid value captured by yield grade.

Table 4. OLS Coefficients Used to Calculate Coefficients of Separate Determination

PART 1		PART 2	
Variable	OLS Coefficient	Variable	OLS Coefficient
Intercept	-2.00	Intercept	106.08
Log(*Grid Price*)	1.00	*Prime*	5.69
Log (*Weight*)	1.00	*Select*	-13.86
		Standard	-22.43
		YG1	1.72
		YG2	0.89
		YG4	-17.12
		YG5	-22.46
		Light/Heavy	-20.00

Table 5. Coefficients of Separate Determination by Carcass Characteristic for the Four Fed Cattle Data Sets Using the Base Grid

	Regional Data Set				
Characteristic	Iowa	Kansas	Nebraska	Oklahoma	Average
PART 1:	**— Percentage of Variation in Grid Value —**				
Grid Price	30	39	29	34	33
Weight	70	61	71	66	67
TOTAL PART 1 VARIATION	**100**	**100**	**100**	**100**	**100**
PART 2:	**— Percentage of Variation in Grid Value —**				
Prime	1	1	0	0	1
Select	12	4	11	6	8
Standard	12	14	6	4	9
Total Quality Grade Variation	25	19	17	10	18
YG1	0	0	0	0	0
YG2	0	0	0	1	0
YG4	1	9	8	11	8
YG5	0	1	1	2	1
Total Yield Grade Variation	1	10	9	14	9
Light/Heavy (weight discounts)	4	10	3	10	7
TOTAL PART 2 VARIATION	**30**	**39**	**29**	**34**	**33**
	— Dollars / Head —				
Average Grid Value	\$660	\$737	\$721	\$705	\$706

Note: Columns may not sum due to rounding error.

The grid price signal in the Iowa data set is only 30%, even though over 42% of the cattle grade Prime/yield grade 1–3, or Choice/yield grade 1–2. The weight signal is 70%. The weaker grid price signal for Iowa, compared to the Kansas or Oklahoma grid signal, is attributed to three factors: (*a*) low average dressed weights, (*b*) fewer "out" cattle, and (*c*) high-yielding carcasses—no yield grade 5 carcasses and only 0.8% are yield grade 4. Most of the strength in the Iowa grid price signal is attributed to quality grade, with a CSD of 25%. The Iowa quality grade signal is stronger than for other data sets; as before, most of this signal's strength is ascribed to the data set's lower quality carcasses. Of the variation in grid value attributed to quality grade, Select and Standard quality grades each explain 12 percentage points.

Cattle in the Nebraska data set generate the weakest grid price signal (29%) and the strongest weight signal (71%). Fewer "out" cattle and yield grade 4/5 cattle cause light/heavy weight discounts and yield grade to explain only 3% and 9% of the variation in grid value, respectively. Therefore, much of the data set's grid price signal is driven by the 17% quality grade signal, which is mostly credited to the large percentage of cattle grading below Choice (44.7%). Of Nebraska's total variation in grid value explained by quality grade, the Select quality grade accounts for 11 percentage points, and the Standard quality grade explains another 6 percentage points.

Several points require emphasis from the above CSD analysis results (table 5). First, quality grade and yield grade information determine a portion of the net grid price, but weight consistently sends the strongest signal—67% on average. However, weight's signal under grid pricing is sharply lower than the 96%–100% market signals generated under traditional average pricing methods (Feuz, 1999a). Second, grids attempt to shape cattle production because carcass quality characteristics explain between 29%–39% of the variation in grid value. The primary way grids shape cattle production is by penalizing poor quality carcasses rather than rewarding better quality carcasses. This finding supports conclusions in the literature regarding penalties associated with grid pricing (Fausti and Qasmi, 2002) and outlier cattle (McDonald and Schroeder, 2003).[2] Quality grades or yield grades linked to a discount explain most of the variation in grid value in this study's four data sets. Of the average variation in grid value explained by quality grade, the Prime premium explains only 1 percentage point, but Select and Standard discounts combined explain 17 percentage points. Of the average variation in grid value explained by yield grade, the yield grade 4 and 5 discounts account for 9 percentage points, while the yield grade 1 and 2 premiums explain less than 1 percentage point. Finally, a stronger (weaker) grid price signal is typically attributed to a larger (smaller) presence of cattle receiving carcass discounts (Select, Standard, yield grade 4, yield grade 5, light/heavy carcass).

Sensitivity Analysis Results

Given the strong weight signals in all data sets, sensitivity analyses will help establish whether changes in grid structure can more effectively promote the production of carcasses with higher quality and yield grades. Alternative grids are analyzed to assess how different premium/discount structures affect the carcass quality signals sent through the marketing channel.

Seven different sensitivity analyses are performed to determine how grid changes affect market signals. Grid premiums and discounts are based on market supply and demand, and changes are interrelated; however, this study's sensitivity analyses do not preserve these behaviors. Rather, the analyses isolate grid changes so the direct impact on market signals can be identified. The seven sensitivity analyses are: (*a*) changing Select and Standard discounts, (*b*) changing yield grade 4 and 5 discounts, (*c*) increasing yield grade 1 and 2 premiums, (*d*) increasing the Prime premium, (*e*) increasing the base

[2] Note that premiums and discounts are relative to the base price's par carcass attributes. Thus, moving the par attributes significantly could alter which attributes receive a premium and which a discount.

Table 6. Coefficients of Separate Determination by Carcass Characteristic for the Four Fed Cattle Data Sets, Given a 2 Standard Deviation Increase in Select and Standard Discounts

	Regional Data Set				
Characteristic	Iowa	Kansas	Nebraska	Oklahoma	Average
PART 1:		**— Percentage of Variation in Grid Value —**			
Grid Price	45	50	44	45	46
Weight	55	50	56	55	54
TOTAL PART 1 VARIATION	**100**	**100**	**100**	**100**	**100**
PART 2:		**— Percentage of Variation in Grid Value —**			
Prime	1	1	0	0	1
Select	29	15	29	18	23
Standard	12	17	7	6	10
Total Quality Grade Variation	42	33	36	24	34
YG1	0	0	0	0	0
YG2	0	0	0	0	0
YG4	0	7	6	10	6
YG5	0	1	0	2	1
Total Yield Grade Variation	0	8	6	12	7
Light / Heavy (weight discounts)	3	9	2	10	6
TOTAL PART 2 VARIATION	**45**	**50**	**44**	**45**	**46**
			— Dollars / Head —		
Average Grid Value	$647	$724	$704	$686	$690

Notes: An $11.98/cwt Select discount and a $21.03/cwt Standard discount are used in this analysis. Columns may not sum due to rounding error.

price, (*f*) increasing quality grade premiums and discounts while decreasing yield grade premiums and discounts, and (*g*) increasing yield grade premiums and discounts while decreasing quality grade premiums and discounts.

Changes to Quality Grade Discounts

The Select quality grade discount has been the most volatile historically. Fluctuations in the Standard discount typically mirror changes in the Select discount, so this behavior is preserved in this analysis. The Select and Standard discounts are increased two standard deviations,[3] to $11.98 and $21.03/cwt, respectively. Results of increasing the quality grade discounts are reported in table 6.

An increase in the Select and Standard discounts causes several changes. Average grid values fall $13–$19/head compared with the base grid (see table 5). The higher penalty on low quality grades causes the variation in grid value explained by weight to drop from 61%–71% in the base grid analysis to 50%–56%. Grid price now explains 44%–50% of the variation in grid value. In this case, the market signal associated with carcass quality traits is stronger and almost on par with weight's market signal (equal

[3] Standard deviations used in the sensitivity analyses appear in table 2.

in the Kansas data set). A larger quality grade discount causes the quality grade signal to increase 14–19 percentage points from the base grid analysis to 24%–42%. Of the variation in grid value explained by quality grade given larger quality grade discounts, Select and Standard quality grades explain 33 percentage points, and the Prime quality grade accounts for 1 percentage point, on average. Within quality grades, a significantly stronger Select quality grade signal is the primary driver of the stronger grid price and quality grade signals. On average, a 15 percentage point increase in the Select quality grade CSD and a 2 percentage point increase in the Standard quality grade CSD causes the grid price CSD to increase to 46%, while the Prime signal remains stable and the yield grade and light/heavy signals weaken.

Although the effect of a small (1 standard deviation) reduction in the quality grade discounts is not shown here, the variation in grid value explained by quality grade falls 5–7 percentage points from the base grid analysis to 5%–18%. A small reduction in the quality grade discounts results in slightly stronger market signals for all yield grades, but weaker Select and Standard signals cause weight's signal to strengthen. In addition, average grid values across the data sets are $7–$9/head higher.

Changes to Yield Grade Discounts

Historically, yield grade 4 and 5 discounts are more volatile than the yield grade 1 and 2 premiums. Like the Select and Standard quality grade discounts, the yield grade 4 and 5 discounts are increased two standard deviations to $17.12 and $22.46/cwt, respectively. Results presented in table 7 indicate that larger yield grade discounts have a small impact on weight and carcass quality characteristic signals and average grid values. Weight explains 57%–69% of the variation in grid value, which is 4–9 percentage points lower than in the base grid (see table 5). The greatest impact of the larger discount for lower yielding cattle is on a yield grade signal, which increases 1–7 percentage points from the base grid to 2%–21%. The primary driver of the stronger yield grade signal is yield grade 4. The larger yield grade discounts cause average grid values to drop $0.19–$3.30/head.

When examining a small reduction (1 standard deviation) in the yield grade discounts (not shown here), yield grade market signals are the only carcass quality characteristics to respond to the change. Weaker individual yield grade signals reduce the amount of variation in grid value explained by yield grade to 1%–11%, which is 1–3 percentage points below the base grid analysis. Average grid values increase $0.09–$1.64/head with smaller yield grade discounts.

Increasing Yield Grade Premiums

While not shown because of space constraints, a 100% increase[4] in yield grade 1 and 2 premiums from the base grid has a small effect on average grid values but does not appreciably affect the carcass quality signals in any data set. A 100% increase in yield grade premiums causes average grid values to increase $4–$5/head compared to the base grid. Larger yield grade premiums cause variation in grid value explained by yield grade to increase to 1%–15%, which is nearly unchanged from the base grid signal.

[4] A 100% increase is used because both yield grade premiums have standard deviations close to zero.

Table 7. Coefficients of Separate Determination by Carcass Characteristic for the Four Fed Cattle Data Sets, Given a 2 Standard Deviation Increase in Yield Grade 4–5 Discounts

Characteristic	Region Data Set: Iowa	Kansas	Nebraska	Oklahoma	Average
PART 1:	— Percentage of Variation in Grid Value —				
Grid Price	31	43	33	40	37
Weight	69	57	67	60	63
TOTAL PART 1 VARIATION	**100**	**100**	**100**	**100**	**100**
PART 2:	— Percentage of Variation in Grid Value —				
Prime	1	0	0	0	0
Select	12	4	10	5	8
Standard	12	14	6	4	9
Total Quality Grade Variation	25	18	16	9	17
YG1	0	0	0	0	0
YG2	0	0	0	1	0
YG4	2	13	13	18	11
YG5	0	2	1	2	2
Total Yield Grade Variation	2	15	14	21	13
Light / Heavy (weight discounts)	3	10	2	10	7
TOTAL PART 2 VARIATION	**31**	**43**	**33**	**40**	**37**
	— Dollars / Head —				
Average Grid Value	$660	$736	$720	$701	$704

Notes: A $17.12/cwt yield grade 4 discount and a $22.46/cwt yield grade 5 discount are used in this analysis. Columns may not sum due to rounding error.

Increasing the Prime Premium

Typically, the largest premium is given to Prime carcasses, and this has remained very stable since premium-discount reporting began. However, the base grid CSD analysis indicates the historical Prime premium does not send a strong signal through the marketing channel. In this sensitivity analysis, the Prime premium is increased 100%,[5] to $11.39/cwt. Although not shown here, the premium becomes only slightly more instrumental in explaining variation in grid value despite the large increase. The other quality characteristic signals remain relatively unchanged, and average grid values increase only $0.33–$0.69/head.

Increasing the Base Price

As the base price used in the base grid is from a time of low prices, the original base price is increased $10/cwt, to $106.08/cwt. While again not shown here, the increase causes weight to explain more of the variation in grid value and average grid values to increase significantly. Weight explains 67%–75% of the variation in grid value, which

[5] Again, a 100% increase is used because the Prime premium has a standard deviation close to zero.

Table 8. Hypothetical Grids Used to Represent Divergent Market Conditions ($/cwt)

	Yield Grade				
Quality Grade	1	2	3	4	5
Quality Grid:					
Price	7.47	6.64	5.81	-6.18	-11.76
Choice	1.66	0.83	0.00	-11.99	-17.57
Select	-7.79	-8.62	-9.45	-21.44	-27.02
Standard	-17.38	-18.21	-19.04	-31.03	-36.61
Yield Grid:					
Price	7.35	6.52	5.57	-9.84	-15.26
Choice	1.78	0.95	0.00	-15.41	-20.83
Select	-2.61	-3.44	-4.39	-19.80	-25.22
Standard	-13.28	-14.11	-15.06	-30.47	-35.89

Note: A $20/cwt light weight discount and a $20/cwt heavy weight discount are used in both grids.

is 4–7 percentage points higher than in the base grid analysis. Grid price premiums and discounts therefore explain less of the variation in grid value in each data set compared to the base grid analysis. However, the overall drop in the grid price CSD value is evenly distributed across quality grade, yield grade, and light/heavy discount variables. Compared to previous analyses, this grid adjustment causes a more marked change in average grid values, with an increase of $70–$80/head.

Quality Grid and Yield Grid

The above analyses change one grid component at a time to isolate the impact of grid changes on market signals. However, to consider the full impact of grid changes on market signals, two additional grids are analyzed. Grids typically reflect market conditions, and the two additional grids represent divergent market conditions. These grids are derived from this study's base grid and are similar to the grids used by Feuz (1999a). Both grids appear in table 8. The first grid—referred to as a "quality" grid—has larger quality premiums and discounts but smaller yield grade premiums and discounts.[6] The second grid—referred to as a "yield" grid—has larger yield grade premiums and discounts but smaller quality grade premiums and discounts.

CSD results from these two analyses are not shown. However, weight's market signal under the quality grid is 3–8 percentage points below the base grid at 57%–65%. The primary reason for weight's weaker signal is a stronger Select quality grade signal. As expected, the grid price market signal increases 3–8 percentage points from the base grid analysis, to 35%–43%. This finding is consistent with previous sensitivity results. Compared to the base grid, average grid values under the quality grid decline $6–$8/head.

In contrast, weight's signal strengthens under the yield grid. Given a 1–6 percentage point increase from the base grid analysis, weight explains 63%–76% of the variation in grid value. Weight's market signal strengthens despite a stronger yield grade signal in

[6] In both grids, the larger (smaller) premium or discount is one standard deviation above (below) its base grid value.

all data sets. All individual yield grades have stronger market signals, but most of the change in yield grade's signal strength is derived from yield grade 4. Weight's stronger signal is attributed to a drop in the quality grade signal. Compared to the base grid analysis, the quality grade signal is 5–8 percentage points lower, while the yield grade signal is only 1–5 percentage points higher. These results are also consistent with previous sensitivity findings. Average grid values increase $6–$8/head under the yield grid, compared to a decline under the quality grid.

The sensitivity analyses identify that changes in the quality and yield grade discounts have the greatest impact on grid price market signal across all data sets. The Select signal is the primary driver of grid price market signal change when quality grade discounts change, and the yield grade 4 signal is the driver when yield grade discounts change. Quality and yield grade discount changes also have a modest impact on average grid values. Overall, changes in the Prime premium and Yield Grade premiums have a limited effect on grid price market signals and average grid prices. The sensitivity analyses findings corroborate the base grid findings that existing grids are more effective at shaping production by penalizing poorer quality carcasses rather than rewarding better quality carcasses. The largest change in average grid values comes from an increase ($10/cwt) in the base price. In addition to $70–$80/head increases in average grid values, weight's signal strengthened as all carcass quality market signals weaken slightly. This result is generally consistent with previous research that found base grid price is an important determinant of fed cattle profit (Langemeier, Schroeder, and Mintert, 1992; Mark, Schroeder, and Jones, 2000; McDonald and Schroeder, 2003). Results from the quality grid and yield grid analyses are consistent with Feuz's (1999a, b) research for pricing individual animals. However, Feuz estimated signals using only a single set of cattle. Both studies found grids transmit market signals from packers to feeders, but that signals vary by grid.

Summary, Implications, and Conclusions

Information conveyed under average pricing (live or dressed weight) related to carcass quality is limited. Value-based marketing via grid pricing is designed to price individual fed cattle on carcass traits, link price and wholesale value, and transmit market signals through the marketing channel to cattle producers/feeders. Grid pricing facilitates the transmission of market signals to producers by incorporating USDA quality and yield grades along with carcass weight into the appraisal of animal value. Market signals generated under grid pricing provide producers with information about the needs of the market and the quality of that particular herd. With market signals and carcass quality information, producers can make management and genetic selection changes to produce carcasses that meet grid specifications, and thereby satisfy market demands and earn higher revenues and profits.

Four diverse sets of carcass data, a two-stage CSD process, and sensitivity analyses are employed to identify the market signals sent by grid pricing and to determine whether market signals change given changes to the grid. Results indicate grid pricing incorporates yield and quality grade information into the valuation of an animal, but weight continues to explain much of the variation in animal value. Weight, which accounts for 96%–100% of the variation in value under average pricing according to previous research, explains 61%–71% of the variation in the value of animals sold on a grid across this study's four data sets. Grid price premiums and discounts therefore account for the remaining 29%–39%. Weight sends a stronger signal to producers, but carcass quality signals suggest grids have more influence on shaping cattle production compared to average pricing. Furthermore, as most of the variation in grid value explained by carcass quality is attributed to quality and yield grades associated with a discount, grids are shaping production by penalizing poorer carcasses rather than rewarding better carcasses.

Sensitivity analyses show that changes in quality and yield grade discounts have a greater impact on the grid price signal. Differences in the Select quality grade and yield grade 4 signals explain most of the grid price signal change. This study's findings support previous research even though this study uses a different methodology, four data sets of cattle, and different grids. Prime premium increases and yield grade premiums have minimal impacts on the grid price signal and average grid values. A higher base price causes a significant increase in average grid values and a stronger weight signal coinciding with weaker carcass quality signals. Additionally, analyses of a quality grid and yield grid reveal that different grids transmit different signals, which coincides with previous research.

When producers feed and market cattle, they must decide whether to sell cattle at an average price or on a grid. Their decision is predicated on several factors, including market conditions (prices, premiums/discounts, etc.) and the quality/condition of their cattle. Each pricing mechanism sends different signals through the marketing channel. Weight is the primary signal sent by average pricing; aside from weight, lower quality and yield grades send the strongest market signals under grid pricing. Therefore, if all cattle are sold on the grid, this pricing mechanism should dissuade producers from selling poorer quality cattle. However, the elimination of poorer quality cattle from the industry will be difficult because producers can sell these cattle at an average price, a pricing mechanism which lacks or has weak carcass quality market signals. Future studies need to identify whether the current structure of grid pricing can motivate producers to sell cattle on a grid and enable grid pricing to become the dominant pricing mechanism.

As reported here, better quality carcass traits send relatively weak signals under grids, and large changes in grid premiums do not have a significant impact on carcass quality signals. Because the current form of grid pricing lacks strong carcass quality signals, the beef industry may find it difficult to achieve its long-run goal of producing carcasses where 70% grade Prime or Choice, 70% attain yield grade 1–2, and 0% are "out" cattle. Consequently, continued evolution of the value-based marketing system can be expected.

A nagging question is whether grid pricing over the last 10 years has been a catalyst for changing cattle quality. It was not the intent of this research to address that issue directly. When viewing the distribution of graded carcasses by quality grade and yield grade over time, one might conclude grid pricing has had little or no effect on carcass quality improvements. Yet, input from some of the largest cattle feeding firms and cow-calf producers indicates that substantive changes have been made by some producers and feeders. Changes in breeding programs and fed cattle purchasing, feeding, and marketing practices have resulted in cattle quality improvements.

Are these conflicting observations? Maybe the positive changes made by a small percentage of producers are overridden because of continued use of average pricing and errors by producers in responding to grid pricing market signals. After all, while our results confirm grid pricing is sending signals back through the marketing channel, those signals may be evident only after appropriate statistical analyses, and may not be obvious in everyday market data. Our results provide support for the argument that grid pricing market signals may enable positive changes to occur in cattle quality; however, concrete evidence that changes have occurred is sparse. Further research to determine how effective grid pricing actually is in improving cattle quality is sorely needed. Economists have conducted considerable research and created an entire body of literature on grid pricing without really addressing a central issue—the efficacy of grid pricing to accomplish its presumed objectives.

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