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Market Signals in Value-Based Pricing Premiums and Discounts

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There is concern in the beef industry that present marketing practices may be impeding the transmission of economic signals from consumers to producers. Presently, fed cattle may be sold on a show list, pen-by-pen, or on an individual head basis, and may be priced using live weight, dressed weight, or grid or formula pricing. Market signals are more likely to reach producers if cattle are priced individually. Current value-based pricing issues are discussed. Three grid pricing systems are evaluated over six marketing dates using data from 5,520 head of fed cattle. Each of the grids do send the anticipated pricing signals in that marbling and leanness are rewarded. However, the magnitudes of the price signals vary over time and across grids.

Key words: fed cattle marketing, grid pricing, value-based marketing

Introduction

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

Recent research on fed cattle marketing and pricing issues has focused on two main areas of concern: (*a*) the method of price determination, and (*b*) the individual price negotiations which lead to price discovery. In response to producer concerns about a concentrated packing industry, packers' large captive supplies, and a possibly noncompetitive marketing environment, the U.S. Department of Agriculture's (USDA's) Grain

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Inspection, Packers and Stockyards Administration (GIPSA) commissioned a study of the red meat packing industry. A number of different research scientists and universities were involved in this study. Williams et al. analyzed packer procurement and pricing methods to determine the impact on the general price level for fed cattle. Ward, Koontz, and Schroeder evaluated short-run impacts on fed cattle prices, and Barkley and Schroeder evaluated long-run impacts of captive supplies. The effect of concentration on the general price level for fed cattle was investigated by Kambhampaty et al. A thorough review and synthesis of the literature on meatpacker competitiveness and fed cattle pricing was conducted by Azzam and Anderson.

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

The general thrust of this study is to extend the work of Schroeder et al. and of Fausti, Feuz, and Wagner on value-based pricing in the beef industry. Specific objectives are: (*a*) to briefly review current value-based marketing efforts to identify those practices that enhance pricing efficiency and those practices that do not enhance pricing efficiency, and (*b*) to determine the economic signals being sent to producers who are selling on alternative value-based "grid" pricing systems. Three different value-based pricing systems (i.e., pricing grids) are evaluated over six different marketing dates.

Value-Based Marketing

In response to declining demand and loss of market share, the National Cattlemen's Association (NCA) conducted a study on the need for value-based pricing of fed cattle. The NCA's Value-Based Marketing Task Force concluded that the present system of pricing the majority of fed cattle on an average price basis does not send adequate market signals to producers to encourage them to improve the quality and consistency of the beef they are producing. Yet, many large feedlots still sell the entire show list (several pens of market-ready cattle) at one price. This practice most likely reduces marketing costs, but is detrimental to pricing accuracy. Cattle feeders have long complained that most fed cattle are bought at an average price for an assumed average quality. This is certainly the case if the entire show list is sold at the same price. However, research has shown that at least some value differences are reflected in transaction prices for individual pens of cattle (Jones et al.; Ward, Koontz, and Schroeder). Jones et al. found that differences in live weight prices reflected about 25% of the value differences at the wholesale level.

Several efforts have been made to move toward value-based marketing and pricing. Among them are exclusive marketing agreements, strategic alliances, and formula or grid pricing arrangements. What are the differences between a grid, a formula, and an alliance?

Table 1 presents a representation of a basic pricing grid. There is a base or par price for the grid, and premiums/discounts are added/subtracted to this base for various

Table 1. An Example Grid Pricing System (carcass $/cwt)

Quality Grade	Yield Grade				
	1	2	3	4	5
Prime	8.00	7.00	6.00	-14.00	-19.00
Upper ⅔ Choice	3.00	2.00	1.00		
Choice	2.00	1.00	Base Price	-20.00	-25.00
Select	-5.00	-6.00	-7.00	-27.00	-32.00
Standard	-20.00	-21.00	-22.00	-27.00	-32.00
Dark Cutters, Stags, etc.	-20.00				
Greater than 950 lbs.	-25.00				
Less than 550 lbs.	-25.00				

carcass grade classifications. Premiums and discounts may change weekly, based on supply-and-demand conditions, or may be fixed for some period of time. If the grid is a "packer grid," the premiums and discounts will generally change. However, some of the grids associated with specific breed alliances have fixed premiums and discounts. Over time, the premiums for yield grade 1 and 2 carcasses, the upper Choice and Prime premium over Choice, the Standard discount compared to Select carcasses, and the discounts for light or heavy carcasses have remained quite stable or fixed on many grids. In contrast, the Choice-Select spread and the yield grade 4 discount are more variable with many grids, and are dependent upon market conditions (Schroeder). From a producer perspective, grids with fixed premiums and discounts provide consistent targets for which cattle can be managed and marketed. However, grids with variable premiums and discounts may be more responsive to box beef demand and perhaps consumer demand as well.

For many grids, the par quality standard is a USDA Choice, yield grade 3, 550–950 pound carcass. In interviews with feeders and packers, Schroeder et al. found that several base prices were being used: specific market-reported prices, plant average prices, boxed beef cutout prices, futures market prices, and negotiated prices. If the base price is not a negotiated, discovered price, then the base price is some formula of another price. Generally, formula prices do not add to price discovery, are not reportable, and in the case of plant average prices are detrimental to true value-based pricing.

Plant-adjusted base prices are adjusted on a plant-by-plant basis in response to the type of cattle being slaughtered at that plant. Plant average dressing percentages are used to adjust live base prices to carcass equivalent prices. Base prices are frequently adjusted for the percentage of cattle grading Choice or higher at the plant, and yield grades also may be used in arriving at the base price. Data from the plant's prior weekly kill, or the average of the prior three to four weeks slaughter, are used to establish baselines for yield, quality grade, and other specifications. Plant averages have important implications for the value of specific pens of cattle and for the efficiency of the market in general.

Feuz has shown how changing plant averages impact the base price for a grid, and ultimately the net price received from the grid. A disadvantage of base prices tied to plant averages is that the "true value" of a pen of cattle is now relative to the plant average, and not based absolutely on the quality of the pen. From a market efficiency point of view, there are different market signals being sent to producers for producing a similar product. This creates an inefficiency in the marketplace, and will likely impede the efforts of the beef industry to improve the quality and consistency of its products.

Other formula price agreements may not involve a grid. A fixed premium over the live or dressed market price may be paid if a percentage of the pen or show list is within acceptable standards for the agreement. Generally, these formula agreements are exclusive agreements between individual packers and individual feeders.

Alliances among cow-calf producers, cattle feeders, and beef packers have been formed. Almost all alliances use a grid or formula to establish the fed cattle price. An underlying concept for most alliances is the sharing of information across industry segments. The formation of alliances by those in the industry who desire a more coordinated, consumer-responsive beef industry substantiates the hypothesis that the present cattle marketing system is not transferring adequate information in its price signals.

Methodology

Under the present fed cattle marketing practice of pricing an entire show list of market-ready cattle at one price, profit[1] on an individual pen of cattle can be defined as:

$$(1) \qquad PROFIT_{SHOWLIST} = DRESSED\ PRICE \times DRESSED\ WEIGHT - FEEDING\ COSTS - FEEDER\ PRICE \times FEEDER\ WEIGHT,$$

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

$$(2) \qquad PROFIT_{GRID} = GRID\ PRICE \times DRESSED\ WEIGHT - FEEDING\ COSTS - FEEDER\ PRICE \times FEEDER\ WEIGHT,$$

where the grid (or value-based) price is a function of the carcass characteristics for that pen of cattle. The grid price is also a function of the general market level and would be determined by the same supply-and-demand forces as the average dressed price. In fact, the *GRID PRICE* could be defined as:

[1] Profit here is defined as the more general accounting concept, and would encompass a return to several factors including management and risk.

$$(3) \qquad GRID\ PRICE = DRESSED\ PRICE + PRICE\ PREMIUM/DISCOUNT,$$

where $PRICE\ PREMIUM/DISCOUNT = f(CARCASS\ CHARACTERISTICS)$.

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

$$(4) \qquad PROFIT_{GRID} - PROFIT_{SHOWLIST} = PRICE\ PREMIUM/DISCOUNT \times DRESSED\ WEIGHT.$$

$PROFIT_{GRID} - PROFIT_{SHOWLIST}$ can be defined as the profit differential from selling on a value-based pricing system compared to selling on an average show list dressed price. If dressed weight is moved to the left-hand side of equation (4), then it can be shown that the weight-adjusted profit differential is equal to the *PRICE PREMIUM/DISCOUNT* from the value-based pricing system:

$$(5) \qquad \frac{PROFIT\ DIFFERENTIAL}{DRESSED\ WEIGHT} = PRICE\ PREMIUM/DISCOUNT.$$

Before looking at the market signals that producers receive from value-based price premiums/discounts, it is necessary to discuss a critical assumption of equations (4) and (5). These equations are based on the assumption that only the pricing method has changed. It is assumed that feeding and cattle procurement practices remain constant regardless of fed cattle pricing method. This assumption is likely correct for the short run, i.e., for the first few pens of cattle a producer sells on a value-based pricing system. However, if there are market signals being sent to producers in the form of price premiums or discounts, and if those premiums or discounts can be associated with specific carcass characteristics, and if management decisions can impact those characteristics, then rational producers would be expected to alter feeding and procurement practices to receive greater premiums and smaller discounts. Long-run profit differentials not only would be a function of price premiums and discounts, but also would be dependent upon dressed weights, feeding costs, and feeder costs. Producers who have changed management practices cannot simply compare the value-based revenue (*GRID PRICE* × *DRESSED WEIGHT*) to the average dressed revenue (*DRESSED PRICE* × *DRESSED WEIGHT*) and assume the difference is their change in profit in the long run. Feeding costs and purchased feeder costs also must be examined.

What short-run market signals are conveyed in the price premiums/discounts of a value-based pricing system? Most value-based pricing systems rely on USDA quality and yield grades to differentiate premiums and discounts. Frequently, discounts are applied to "out cattle," e.g., too light or too heavy carcass weights, hard bones, and dark cutters. This is illustrated in the example grid in table 1. If producers only received the net grid price as information, this would be of limited value in making management decisions. Most value-based pricing systems will supply the producer with pen average carcass data. For an additional fee, producers can receive individual carcass data.

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

Research has shown that consumers want a consistent, tender, palatable cut of beef with minimal outside fat cover (Smith et al.). Consumers want quality lean meat. Therefore, if the marketing system were functioning efficiently, production of fat should be penalized; higher yielding, heavier muscled cattle should receive a price premium; and cattle with a more tender, palatable carcass should also receive a premium. At the individual animal level, the measure of fat depth should be negatively related to price and be nonlinear as increasing fat becomes increasingly less desirable, and KPH also should be negative. Ribeye area (a measure of muscling) should be positively related to price, and marbling score (a subjective measure of tenderness and palatability) should be positively related to price and may be nonlinear. Nonconforming carcasses also should be negatively related to price. At the pen level, increasing the yield grade[2] number (a subjective measure of fat depth and muscling) from 1 to 5 should be negatively related to price. Higher quality grades (Prime and Choice) should be positively related to price, and lower quality grades (Select and Standard) should be negatively related to price.

Data and Procedures

Detailed carcass data were collected on 85 pens of fed cattle (5,520 head) marketed throughout 1997 from numerous feedlots. Table 2 shows summary statistics of carcass characteristics for these cattle. The 85 pens held cattle for which producers had requested detailed carcass data, and all were slaughtered at the same beef packing plant. Pens ranged in number of head from 20 to 205, and averaged 65 head per pen. The average live weight was just over 1,200 pounds, dressing percentage averaged 62.8%, 61% of the cattle graded Choice or above, and yield grade averaged 2.2. The range in the percentage of the pen grading Choice or above was from 15% to 96%. The cattle appear to be typical of the cattle killed in USDA regions 7–8 (Iowa, Kansas, Missouri, Nebraska, Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming). From October 1995 through September 1998, cattle slaughtered in these regions averaged 58% Choice or above, 52% were yield graded 1 or 2, and 1.5% were yield graded 4 or 5 (USDA 1998).

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[2] Yield grade is subjectively called by USDA graders as they visually inspect the carcass. The actual yield grade can be determined by the following formula:

$$YIELD\ GRADE = 2.5 + 2.5 * FAT + 0.2 * KPH + 0.0038 * CARCASS\ WEIGHT - 0.32 * RIBEYE\ AREA,$$

where *FAT* is measured in inches, *KPH* is a percentage, *CARCASS WEIGHT* is in pounds, and *RIBEYE AREA* is in square inches.

Table 2. Summary Statistics on the Carcass Characteristics of the 85 Pens and 5,520 Individual Fed Cattle

	85 Pens		5,520 Individual Fed Cattle	
Description	Mean	Std. Dev.	Mean	Std. Dev.
Live Weight (lbs.)	1,203.24	74.91	NA	NA
Dressing Percent (%)	62.81	1.15	NA	NA
Hot Carcass Weight (lbs.)	755.80	49.20	758.41	80.17
Marbling Score[a]	4.32	0.44	4.30	0.90
Percent Choice or Above (%)	60.99	19.01	NA	NA
Yield Grade (1–5)	2.21	0.37	2.23	0.71
Fat Thickness (inches)	0.41	0.11	0.41	0.19
Kidney-Pelvic-Heart (%)	1.95	0.09	1.96	0.20
Ribeye Area (sq. inches)	12.81	0.85	12.74	1.45
Out Cattle (%)	1.85	3.41	NA	NA

[a] Marbling scores are defined as: 1.0–2.9 = Standard, 3.0–3.9 = Select, 4.0–4.9 = Low Choice, 5.0–5.9 = Choice, 6.0–6.9 = High Choice, 7.0–9.9 = Prime.

Actual sale price and pricing method are not known for the 85 pens. However, sale prices were computed for three value-based pricing systems and six different marketing dates. The value-based pricing systems used in this analysis were actual grids offered by three different beef packers. One was more representative of a grid that had larger premiums and discounts associated with quality grades, and generally had lower premiums and discounts associated with yield grades. Another grid had higher premiums and discounts associated with yield grades, and had lower premiums and discounts associated with quality grades. Two of the grids used plant average adjusted base prices, which impacted the net price received from the grid. The third grid adjusted the base price for the USDA Choice-Select carcass spread, but did not adjust the base for plant averages.

As this analysis focuses on value-based price premiums or discounts compared to the average dressed price, the general price level was not a concern. However, the six different marketing dates represent time periods when there was a higher/lower percentage of cattle grading Choice and a narrower/wider Choice-Select price spread. This information is displayed in table 3.

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

$$(6) \quad VBP = b_0 + b_1 MARBLING + b_2 MARBLING^2 + b_3 MARBLING^3 + b_4 FAT + b_5 FAT^2 + b_6 RIBEYE + b_7 KPH + b_8 WEIGHT + b_9 OUT + e,$$

Table 3. Prices ($/cwt) and Grading Percentages Used for the Analysis

	Marketing Dates					
Description	2/6/98	2/21/97	6/20/97	12/19/97	10/24/97	12/6/96
Nebraska Dressed Price ($/cwt)	98.47	106.25	105.17	104.84	107.85	114.76
Choice-Select Carcass Spread ($/cwt)	1.15	3.26	5.62	7.85	10.13	15.81
U.S. Carcass % Grading Choice	63.58	52.71	48.75	51.86	45.34	44.44
USDA Regions 7–8 % Grading Choice	61.30	59.68	54.49	57.75	55.63	52.35
USDA Regions 7–8 % Yield Grade 1–2	50.70	55.59	55.54	54.50	49.13	56.42
USDA Regions 7–8 % Yield Grade 4–5	1.56	1.09	1.16	1.00	1.19	1.01

Note: USDA regions 7–8 include the states of Iowa, Kansas, Missouri, Nebraska, Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming.

where *VBP* is the value-based price premium or discount compared to the average dressed market price; *MARBLING* is the USDA-reported degree of marbling for each carcass (coded as 1.00–1.90 = Practically Devoid, 2.00–2.90 = Traces, 3.00–3.90 = Slight, 4.00–4.90 = Small, 5.00–5.90 = Modest, 6.00–6.90 = Moderate, 7.00–7.90 = Slightly Abundant, 8.00–8.90 = Moderately Abundant, and 9.00–9.90 = Abundant; *FAT* is the fat thickness over the 12th rib in inches; *RIBEYE* is the size of the ribeye in square inches; *KPH* is the percentage kidney-pelvic-heart fat; *WEIGHT* is the hot carcass weight; and *OUT* is a dummy variable for all nonconforming carcasses. The minimum marbling scores for each of the USDA quality grades are as follows: Slight^0 for Select, Small^0 for low Choice, and Slightly Abundant^0 for Prime.

Equation (6) was estimated for three grid pricing systems over six marketing dates. Regression parameters were tested for stability across grids and marketing dates.

Results

Results of computing sales of 85 pens of cattle on three different packer grids over six different marketing dates are presented in table 4. Many of the complexities of current value-based pricing systems can be illustrated from this table. Packer grid A is from a regional packer that had a desire to procure cattle which typically graded Choice or higher. The grid had the highest reported premiums for Prime and Upper 2/3 Choice carcasses. The base price for the grid was adjusted for plant averages and was for low-Choice, yield grade 3 carcasses. This base exceeded the other two packer grid bases on all marketing dates. However, on average for the 85 pens of cattle, this grid resulted in the smallest premium or largest discount. Over the six marketing dates, the 85 pens averaged -$0.33 per cwt discount from the average dressed show list price. Given that this packer was interested in above-average quality cattle, this is not surprising. This packer did pay the highest premium on five of the six marketing dates and consistently had the largest discounts for poorer quality cattle that did not fit the packer's grid.

Packer B and packer C are two of the major packers having markets for all types of cattle. Packer B has a plant-adjusted base price that floats between a Choice and Select, and a yield grade 2 and 3 carcass, i.e., there is a premium for Choice and yield grade 2,

Table 4. Grid Premiums/Discounts for Three Value-Based Pricing Systems and Six Time Periods ($/cwt)

	Marketing Dates					
Description	2/6/98	2/21/97	6/20/97	12/19/97	10/24/97	12/6/96
Nebraska Dressed Price	98.47	106.25	105.17	104.84	107.85	114.76
Grid A Base:	99.47	107.25	106.56	106.80	111.27	120.25
Average Premium/Discount	0.80	-0.14	-0.67	-0.97	-0.40	-0.55
Maximum Premium/Discount	4.61	4.18	4.47	4.94	6.29	8.11
Minimum Premium/Discount	-9.22	-11.13	-12.72	-14.02	-14.47	-17.17
Grid B Base:	98.99	106.77	105.69	105.36	108.37	115.28
Average Premium/Discount	0.99	-0.03	1.36	1.00	1.53	2.37
Maximum Premium/Discount	3.04	2.69	4.09	4.56	5.65	8.43
Minimum Premium/Discount	-5.18	-8.38	-6.82	-8.57	-8.68	-10.30
Grid C Base:	98.47	106.25	105.17	104.84	107.85	114.76
Average Premium/Discount	0.99	1.79	1.03	1.00	1.08	1.13
Maximum Premium/Discount	2.59	3.42	4.15	4.82	5.78	7.79
Minimum Premium/Discount	-4.24	-3.49	-6.23	-7.36	-8.18	-10.68

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

Carcass	GRID A		GRID B		GRID C	
Characteristics[a]	Parameter	Std. Error	Parameter	Std. Error	Parameter	Std. Error
Intercept	-266.85*	1.714	-70.64*	1.077	-113.60*	1.227
Marbling	151.17*^{A}	1.119	34.38*^{C}	0.703	58.12*^{B}	0.801
Marbling Squared	-27.69*^{C}	0.240	-5.11*^{A}	0.151	-9.74*^{B}	0.172
Marbling Cubed	1.68*^{A}	0.017	0.26*^{C}	0.010	0.55*^{B}	0.012
Fat	-0.47^{C}	0.663	1.44*^{B}	0.417	6.40*^{A}	0.475
Fat Squared	-4.09*^{A}	0.671	-8.79*^{B}	0.422	-12.85*^{C}	0.481
Ribeye Area	0.02^{C}	0.026	0.32*^{A}	0.017	0.17*^{B}	0.019
Kidney-Pelvic-Heart	0.58*^{A}	0.178	-0.18^{B}	0.112	0.12^{B}	0.127
Carcass Weight	-0.002*^{A}	0.0005	-0.004*^{A}	0.0003	0.001*^{B}	0.0003
Out Cattle	-16.00*^{A}	0.233	-20.28*^{B}	0.146	-16.58*^{A}	0.167
Adjusted R^2	71.21		66.66		64.09	
No. of Observations	33,120		33,120		33,120	

Notes: An asterisk (*) denotes that the parameter is significantly different from zero at $\alpha = 0.05$. Parameters with different capital letter superscripts in the same row are significantly different across grids at the 0.05 level.

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

and a discount for Select and yield grade 3 compared to the base. Packer C does not adjust the base for plant average, and the base is for a yield grade 3 carcass. The Choice premium and the Select discount relative to the base are fixed proportions of the Choice-Select spread. The grid premium compared to the average dressed show list price over all pens and time periods averaged \$1.20 and \$1.17 per cwt of carcass weight for grid B and grid C, respectively. The differences in the average premium/discount over time between grid B and grid C range from grid C offering an average premium of \$1.82 per cwt above grid B, to grid B offering an average premium of \$1.24 per cwt above grid C.

In summary, marketing the same set of cattle on three different value-based pricing systems (grids) resulted in three different price premiums/discounts. Furthermore, marketing cattle with the same carcass characteristics on the same value-based pricing system over different time periods also resulted in different price premiums/discounts. Finally, it is difficult to draw any conclusion about the superiority or inferiority of any specific value-based pricing system by only evaluating price premiums/discounts, as they change over time and relative to one another.

Price Signals

Results of estimating equation (6) using individual data on 5,520 head across the three grids and over the six marketing dates are presented in table 5. The estimated parameters are the average over the six time periods. To test the stability of these parameter estimates over time, equation (6) was also estimated with dummy variables included for five of the six time periods.[3] Both the intercepts and the slopes on the parameters were tested for stability. These results are shown in table 6.

Marbling has a significant positive but nonlinear impact on the premium/discount received from pricing on a grid compared to pricing a show list at the average dressed price. As seen in table 5, the impact of marbling varies significantly across grids. The impact of marbling is graphically depicted in figure 1. All variables, with the exception of marbling, are held constant at their mean values. The management implication from this estimated impact of marbling on the price premium/discount could well be that it is profitable to feed animals to just reach the Choice grade. Given the flatness of the curves through the mid-Choice and high-Choice grades (marbling score of 5.00–6.90), feeding costs may exceed any additional revenue.

The impact of the Choice-Select price spread and the percentage of cattle grading Choice on the parameter estimates associated with marbling varies by grid (table 6). Grid A is quite stable over time. However, with grids B and C, the slope parameters associated with marbling tend to change over time. It appears the marbling response is impacted more by the grid pricing scheme than by the Choice-Select spread.

There is a positive correlation of outside fat thickness and marbling (0.35 with this data set), particularly at lower measures of fat thickness. Therefore, one would expect that fat thickness may be positively related to price premiums at low levels of outside

[3] The model was initially estimated with five dummy variables to test for stability of the intercept. All independent variables were multiplied by the five dummy variables, and these interaction terms were also included in the model to allow for the slope coefficients to change in each time period. This process is identical to estimating a separate regression equation for each time period. With the exception of marbling and fat, the coefficients were stable over time, i.e., there were no significant slope changes. Therefore, in the final model, only the coefficients associated with marbling and fat thickness were tested for stability over time.

Table 6. Stability of the Estimated Regression Coefficients over the Six Marketing Dates When Including Dummy Variables for the Choice-Select Price Spreads

Carcass Characteristics[a]	GRID A	GRID B	GRID C
Intercept:	-266.95*	-69.68*	-112.61*
Spread 1	14.76*	4.20	4.78
Spread 2	2.96	1.22	5.47
Spread 4	-2.55	-2.14	-1.79
Spread 5	-4.31	-4.43	-4.31
Spread 6	-10.26	-4.61	-10.05*
Marbling:	153.46*	37.03*	59.38*
Marbling × Spread 1	-2.43	3.44	3.32
Marbling × Spread 2	1.80	-2.28	3.24
Marbling × Spread 4	-1.74	-2.81	-2.50
Marbling × Spread 5	-3.50	-3.47	-3.59
Marbling × Spread 6	-7.87*	-10.81*	-7.97*
Marbling Squared:	-28.60*	-6.22*	-10.34*
Marbling Squared × Spread 1	-0.58	-1.84*	-1.81*
Marbling Squared × Spread 2	-0.96	0.54	-1.76*
Marbling Squared × Spread 4	0.92	1.30*	1.05*
Marbling Squared × Spread 5	1.86*	1.85*	1.88*
Marbling Squared × Spread 6	4.19*	4.77*	4.22*
Marbling Cubed:	1.76*	0.36*	0.60*
Marbling Cubed × Spread 1	0.09	0.17*	0.17*
Marbling Cubed × Spread 2	0.09	-0.04	0.17*
Marbling Cubed × Spread 4	-0.09	-0.12*	-0.10*
Marbling Cubed × Spread 5	-0.18*	-0.18*	-0.18*
Marbling Cubed × Spread 6	-0.40*	-0.44*	-0.40*
Fat:	0.04	2.09*	6.32*
Fat × Spread 1	1.35	1.34	0.66
Fat × Spread 2	0.70	1.00	0.63
Fat × Spread 4	-0.67	-1.89	4.91*
Fat × Spread 5	-1.36	-1.35	-2.02
Fat × Spread 6	-3.06	-3.03*	-3.73*
Fat Squared:	-4.50*	-9.47*	-12.61*
Fat Squared × Spread 1	-1.64	-1.26	-0.44
Fat Squared × Spread 2	-0.68	-0.55	-0.41
Fat Squared × Spread 4	0.62	1.77	-6.40*
Fat Squared × Spread 5	1.26	1.27	2.09
Fat Squared × Spread 6	2.86	2.85*	3.69*
Ribeye Area	0.02	0.32*	0.17*
Kidney-Pelvic-Heart	0.58*	-0.18	0.12
Carcass Weight	-0.002*	-0.004*	0.001*
Out Cattle	-16.00*	-20.28*	-16.58*
Adjusted R^2	74.95	76.98	74.04
No. of Observations	33,120	33,120	33,120

Notes: Spreads 1–6 are dummy variables for the smallest to the largest Choice-Select price spread. An asterisk (*) denotes that the parameter is significantly different from zero at $\alpha = 0.05$.

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

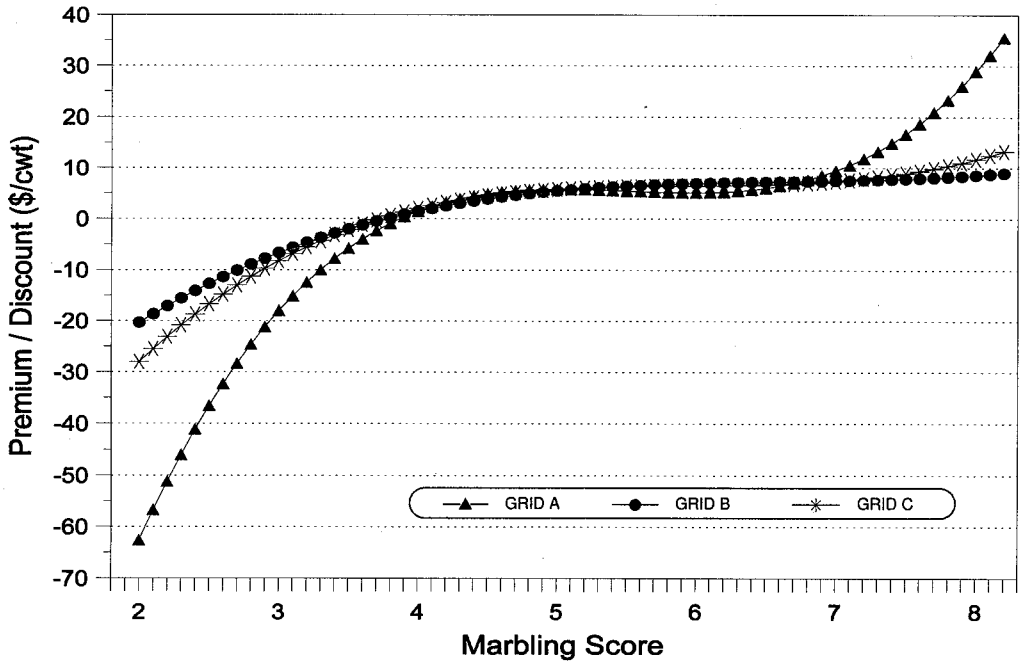

Figure 1. Average impact of marbling on price premiums/discounts for grids A, B, and C

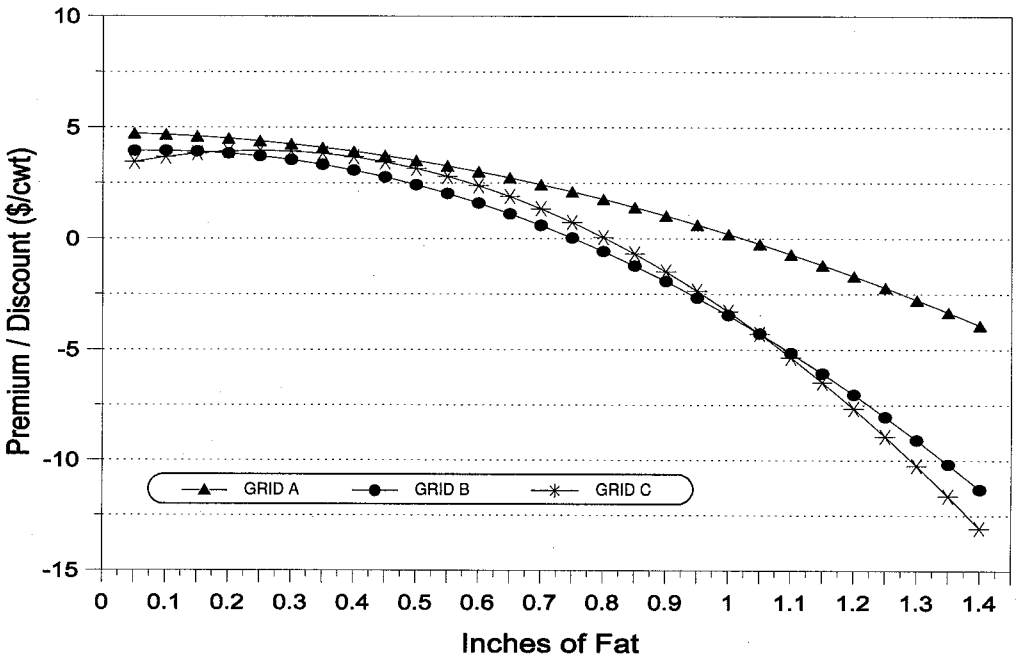

Figure 2. Average impact of fat thickness over the 12th rib on price premiums/discounts for grids A, B, and C

fat thickness, but then become negative with increasing fat thickness. The estimated regression parameters substantiate this hypothesis. As was the case with marbling, the impact of fat thickness on the price premium/discount varies across pricing grids (table 5). The premium/discount associated with varying fat thickness for each of the grids is plotted in figure 2. All other variables are held constant at their mean values, so these fat response curves are based on animals that would quality grade low Choice.

Tests for the stability of the parameter estimates associated with fat thickness over time revealed that they are generally stable (table 6). With grid A, the parameters on fat thickness were stable over the six time periods. However, the parameters were significantly different in one time period with grid B and two time periods with grid C.

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

The adjusted R^2 values ranged from 64.09 to 71.21 for the three different grids for the average model with no dummy variables for the six time periods (table 5). Including the dummy variables increased the adjusted R^2 to a range of 74.04 to 76.98 (table 6).

A contributing factor to the unexplained error in the model is the error associated with the USDA subjectively determined yield grade. Yield grade was calculated using the equation in footnote 2 and the individual measures of fat thickness, ribeye area, percentage kidney-pelvic-heart fat, and carcass weight. This was then compared to the USDA yield grade of each of the 5,520 carcasses. The USDA yield grade matched the calculated yield grade on only 68.2% of the carcasses. There was an error of one yield grade on 30.8% of the carcasses, and an error of two yield grades on 1% of the carcasses (illustrated graphically in figure 3). Historically, as fed cattle have been sold on a live, dressed, or grade and yield basis, yield grade has not been used to differentiate prices—with the exception of perhaps an estimate of the yield grade 4 and 5 carcasses. However, with more fed cattle being sold on a grid, accurately determining yield grade becomes more critical. This may lead to renewed interest in an objective, instrument grading system.

Summary

There is concern in the beef industry that present marketing practices, particularly average pricing, may be impeding the transmission of economic signals from consumers to producers. If there are not clear economic signals reaching producers, then it is not likely that producers will alter their management practices to produce a product more desirable to consumers. Presently, fed cattle may be sold on a show list (several pens of market-ready cattle), pen-by-pen, or individual head basis, and may be priced using live weight, dressed weight, or grid or formula pricing. Are all these marketing practices equal in transmitting economic signals from consumers to producers?

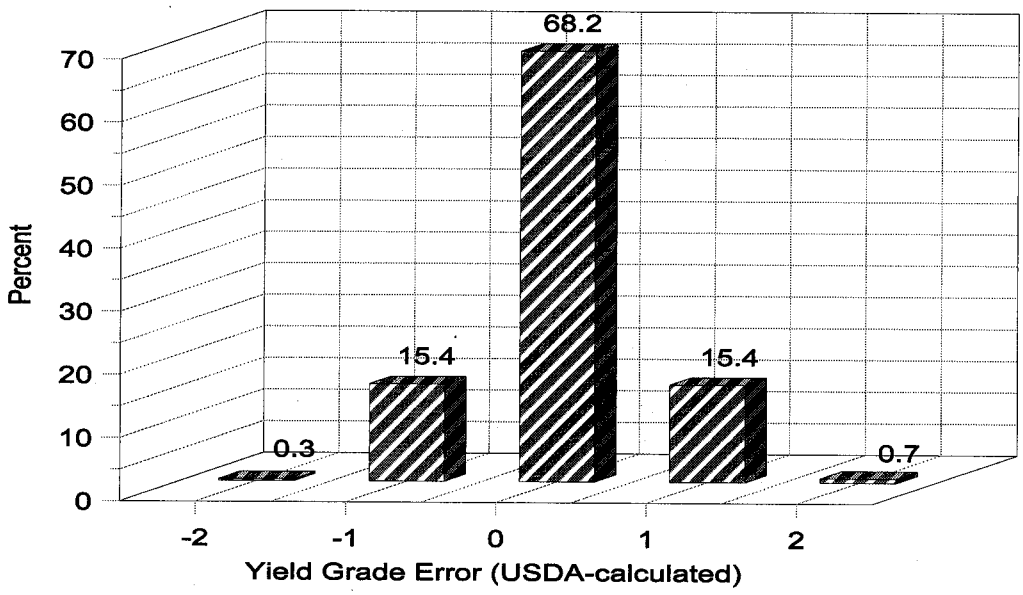

Figure 3. Yield grade error as defined by the calculated yield grade vs. USDA yield grade on 5,520 carcasses

Clearly, market signals are more likely to reach producers if cattle are priced individually. Present grid pricing practices are sending different price signals to producers across grids, and some signals may vary over time. Is one of the grids more efficient at transmitting consumer preferences to producers? This analysis cannot answer that question. However, not all consumers have the same preference, and if different grids are designed with different consumer targets in mind, then it is logical that the grids should send different signals to producers. Producers, then, need to match the type of cattle they are producing to the grid, or the value-based pricing system, that rewards that type of cattle. If this is accomplished, then an increase in efficiency in the beef industry should be realized. However, there are often additional costs to selling on a grid, and producers may incur more costs in sorting cattle to "fit" a grid.

Pricing several pens at one average show list dressed or live weight price does not send any meaningful price signals to producers. This research has shown that at least some price signals are being sent with current grid pricing systems. However, while smooth curves were estimated for the impact of marbling and fat on price premiums/discounts, the reality is that most grids have some substantial price breaks for what might be considered as some arbitrary levels of marbling and leanness. While it could be argued that there is little difference between a Slight^{90} and a Small^{00} marbling score, the present grading system places a heavy economic emphasis on this difference. The same system places no economic emphasis on going from Small^{00} to Small^{90}. Likewise, yield grades of 3.0 and 3.9 on two carcasses would result in the same price, while a yield grade of 4.0 would result in a discount of $100 or more on many grids. Is there a $100 difference in a 3.9 and a 4.0 yield grade? As value-based pricing continues to evolve, there also may be a need to reevaluate the present grading system.

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