Estimating the Effects of Factors Influencing Grid Pricing Revenue

Ted C. Schroeder
Professor, Department of Agricultural Economics
Kansas State University
219 Waters Hall
Manhattan, KS 66506-4011
Phone: 785-532-4488
E-Mail: TSHCROED@AGECON.KSU.EDU

Brian K. Coffey
Graduate Research Assistant, Department of Agricultural Economics
Kansas State University
332-A Waters Hall
Manhattan, KS 66506-4011
Phone: 785-532-4438
E-Mail: BCOFFEY@AGECON.KSU.EDU

Gary W. Brester
Professor, Department of Agricultural Economics and Economics
Montana State University
PO Box 172920
Bozeman, MT 59717-2920
E-Mail: gbrester@montana.edu

Selected Paper, WAEA Annual Meetings
July 2002, Long Beach, CA

Abstract: Beef carcasses, carcass premiums, carcass discounts, and grain prices are simulated. Random carcasses are priced according to random sets of market conditions defining a distribution of total and net revenues. Sensitivity analysis is performed to determine the total effect on revenue and net revenue of managing any of the interrelated carcass traits.

Keywords: grid pricing, risk, simulation

Introduction

Consumer demand for beef has obviously declined dramatically over the past few decades (Purcell). Numerous factors have contributed to this decline. These include the relatively high price of beef compared to other meat substitutes (Schroeder, Mintert, and Brester) as well as consumer dissatisfaction regarding issues such as consistency, convenience, and health concerns (Lamb and Beshear). Many livestock analysts suggest that the beef industry can combat this decline by being more consumer driven and sending market signals to producers that encourage producing uniform, quality beef. This involves altering the method by which fed cattle are marketed from a traditional system that concentrates on average live weight[1] to a value-based system that rewards individual carcasses for desirable traits and penalizes them for unfavorable traits. In general this system is commonly referred to as grid pricing, in reference to a grid of premiums and discounts that a packer uses to reward or penalize a base carcass price, based on traits such as quality grade, yield grade, and carcass weight. Usually, a carcass will receive penalties for receiving a quality grade below choice, having a carcass weight outside the 600 to 900 pound range, or receiving a yield grade of more than 3. On the other hand a carcass receiving a quality grade of Prime or a yield grade below 3 will usually receive a premium.[2] Grid pricing should, over time encourage producers to provide consistent quality fed cattle and eventually make them better off for doing so.

The beef industry is historically reluctant to change and changing in regard to the issue of value-based marketing has been no exception. Even though grid pricing systems have been in place for around twenty years, less than half the fed cattle in the United States are marketed on a grid (GIPSA). However, this percentage has been increasing, indicating an increasing awareness

[1] A pen of cattle is often sold based on the average live weight of the pen. This ignores individual animal characteristics.

[2] Pricing grids vary across individual packers and are often adjusted according a particular market niche, such as lean beef.

to quality issues regarding beef. There is also an increasing need for economic research that identifies the benefits and limitations of value-based marketing as well as seeking to highlight why producers are slow to adopt this marketing strategy. This is evident in the recent research that has addressed these very issues (e.g., Fausti, Feuz, and Wagner). One common element referred to in such studies is the variability of revenue (or net revenue) when marketing fed cattle in a grid pricing environment (Anderson and Zeuli, Schroeder and Graff). This risk and the inability of producers to fully identify and comprehend it is likely a large obstacle to the adoption of grid pricing by more beef producers. This study will attempt to model the variability of expected revenue when marketing cattle on a grid.

In general, this study will provide a representation of the distribution of expected revenues a producer will likely face when deciding whether to market fed cattle on a grid. This will aid in the decision-making process of producers by clarifying the marketing risk associated with grid pricing of fed cattle. This distribution of expected revenue will obviously be somewhat specific to the data used to parameterize it. However, the distribution will offer much information that should be applicable across many categories of producers. Furthermore, sensitivity analysis will be used to address this specificity as well as meeting the specific goal of this study, which is to identify the effects of the variability of specific carcass traits on variability of carcass revenue.

To achieve the aforementioned goals, a brief review of past research in the area of value-based marketing of fed cattle is needed. This review will be presented in the following section. Then the methods involved in simulating expected revenue offered along with a description of the data used in this study. Following this, the results of the simulation and subsequent sensitivity analysis will be presented with conclusions following.

Background

As a means of meeting the changing desires of consumers, the beef industry has, at least to some degree, altered both the production and marketing of its products. The latter has been the topic of a growing body of agricultural economic research. Specifically, numerous studies have examined value-based marketing of fed cattle and compared it to traditional marketing methods, such as average live weight sales (e.g., Feuz, Fausti and Wagner, Feuz, Ward and Lee). As mentioned earlier, a common area of interest in many grid pricing studies is the variability around expected revenues.

It is generally agreed upon in economic literature that grid pricing does increase revenue risk in many instances. As mentioned in footnote one, average pricing ignores individual animal characteristics. Schroeder and Graff state that in these situations, high-quality cattle often subsidize lower-quality cattle. However, when animals are examined individually in a value-based environment, pricing accuracy increases along with price variability (Ward, Feuz, and Schroeder). Explaining this variability in terms of what factors cause or enhance it is a first step in developing better decision-making criteria for livestock producers to evaluate live sale versus value-based carcass sale of their product. Past studies have indicated that grid revenue variability is primarily determined by carcass weight (Greer and Trapp) and that quality and yield grade are relevant but noticeably less important (Feuz, Fausti, and Wagner).

This study will highlight the effects of each of these characteristics on revenue variability using basic sensitivity analysis on simulated carcass data. In the following section the data needed to parameterize such a simulation will be discussed. A brief description of the methodology and computer programming used to complete the simulation will accompany.

Data and Methods

Slaughter data for 2092 carcasses were provided by the Montana Stock Growers Cooperative. The fed cattle were from a few ranches and were marketed across two years in pens of varying sizes. These data included carcass weight, quality grade (Defined numerically in this study as: 0 = Less than Standard 1=Standard, 2=Select, 3=Choice, 4=Prime) [3], and yield grade. These three carcass traits were of particular interest since they are present and critical in almost any grid used to price carcasses. The data were aggregated across time, producers, and sex of the cattle. This was done in the interest of simulating a distribution of carcass traits and resulting expected revenue for any given animal. This is a somewhat different approach than many studies, which opt to simulate and/or analyze practical marketing strategies across time. Descriptive statistics of the data are presented in Table 1. The data were used along with the correlation coefficients in Table 2 to parameterize a simulation of beef carcasses.

The @Risk package, which runs in a Microsoft Excel environment, is an increasingly popular and very powerful simulation tool and was used to conduct the carcass simulation in this study. The Best Fit feature of @Risk was used to define the distributions of yield grade and carcass weight. These were identified as approximately normal and parameterized by their respective means and standard deviations. The simple proportions present of each quality grade in the data defined quality grade as a discreet random variable. For example, in simulations based upon all data, there was a 1.3% chance of selecting Prime, 46.4% chance of selection Choice, 47.8% chance of choosing Select, a 3.9% chance of choosing Standard and 4.5% chance of selecting a grade of less than Standard. With this base of data and the simulation framework, useful experiments analysis can be conducted.

---

[3] Commercial, Cutters, Canners, and Heiferettes were put into the same group defined as less than Stnadard. No Roll carcasses were deemed Standard.

Two simulations were initially performed. The first was parameterized by all data, the second using only the data for carcasses grading Choice or better. This is should offer an example, if somewhat extreme, of the effects of being able to control the percentage of cattle that would receive no penalty for quality grade (i.e., receive a grade of Choice or Prime) on revenue and revenue variability. Quality grade, yield grade and carcass weight were treated as correlated random variables using the statistics in Tables 1 and 2. Introducing the correlations from the carcass data will ensure that realistic carcasses are simulated. , 5000 carcasses were simulated. Descriptive statistics of these carcasses are shown in Table 3 with correlation coefficients of the carcass traits being presented in Table 4. These carcasses were subsequently priced based on the grid in Table 5. This grid is adapted from the *USDA National Weekly Direct Slaughter Cattle Premiums and Discounts* for an arbitrary week (November 26, 2001). These premiums and discounts were added to a base price of $109.02 per cwt. This value was chosen, as it was the weekly average boxed beef cutout value for 750 to 900 pound Choice carcasses, as reported by the USDA for the same date. Base price may vary from one packer to another. However, boxed beef cutout value is used as a base by some packers (Schroeder et. al.) and has been used as such in other grid pricing simulations (e.g., Anderson and Zeuli, Greer and Trapp). These values were held constant across all simulations so as to isolate the effects of the changes in the variability of carcass traits on revenue variability.

Three more simulations were performed. The purpose of these simulations was used to conduct sensitivity analysis regarding the variability of carcass traits. Each simulation was parameterized by data from all carcasses with one exception. The variability (i.e., standard deviation) of one carcass trait was reduced. In the case of yield grade and carcass weight these standard deviations were simply multiplied by 0.85. The variability of quality grade was reduced by moving the probability of choosing a less than Standard carcass to the probability of choosing either a Select or Choice carcass. This effectively narrows the distribution and has a very similar effect on the standard deviation of quality grade to multiplying by 0.85. Carcasses from these three simulations were then priced as described above.

Results and Discussion

The descriptive statistics of the revenues resulting from the simulated carcasses, in terms of dollars per carcass, are presented in Table 6. The descriptive statistics of the underlying premiums and discounts are shown in Table 7. It is evident that modifying the parameters of the simulation indeed affects both the expected level and variability of revenue. In the case of the Choice or better simulation compared to the simulation based on all carcasses, the differences are very pronounced, as would be expected. Mean revenue per carcass increases by about $39.98 while standard deviation declines by over $5.00 per carcass. It is also important to note the median in this case. It increases by over $40.00 on a per carcass basis. This indicates that a producer would now expect half of the carcass revenues to be above $897.90 compared to $855.98 for the initial case. While this comparison may not be particularly practical, it highlights the potential gains in both expected revenue and risk management from learning to produce high-quality, uniform cattle.

The sensitivity analysis directed at the variability of carcass traits offers further insights into the benefits of producing carcasses of a more predictable quality. Reducing the variability of any of the three given carcass traits positively affects revenue in two ways. The mean level is increased and the variability around the mean decreases. Yield grade produces the least drastic effect on mean and standard deviation of revenue. This is quite understandable considering the grid used in this study. Premiums are given for low (specifically, less than 3) yield grades. Since yield grade is defined as a normal random variable with near 2.5, much of the potential for premiums lies in the left tail of the distribution. Reducing variability will reduce some of this potential for premiums.

The same can be said for quality grade, which offers the greatest increase in mean revenue of the three changes to variability. It is important to note how the variability of quality grade was altered. The potential for Prime carcasses was not at all reduced. Rather potential for discounts due to low quality grades was removed. This is a reasonable procedure since one would expect management efforts to move in the direction of consistently realizing higher quality grades rather than a tighter distribution of quality grades about the mean. However, this makes it difficult to compare the effects of changing quality grade variability to changes variability of other traits in this study.

Reducing the variability of carcass weight resulted in the greatest decrease in variability of revenue. This is very reasonable if, once again, the nature of the grid is considered. No premiums are available for quality grade; rather discounts are present for high or low weights. Therefore tightening the distribution of carcass weights can only reduce downside risk.

Conclusions and Implications for Further Research

Carcasses were simulated in a way that should provide a reasonable picture of expected revenue per carcass for any random animal given the underlying data and relevant premiums and discounts. It is obvious from the simulations and subsequent pricing of the carcasses that the ability of a manager to control the carcass traits of his or her cattle are paramount to managing the revenue risk associated with marketing cattle on a grid. Reducing the variability of quality grade, yield grade, or carcass weight enhances expected revenue and reduces the risk around it. Sensitivity analysis indicates that yield grade is the least important characteristic, in terms of managing revenue risk. Both quality grade and yield grade risk are important to carcass revenue variability. Given the procedure used to alter quality grade, outlined in the previous section, it is likely that further analysis using the data in this study would support existing literature that cites carcass weight as the most important factor influencing revenue variability.

Meaningful research is needed in the area of value-based beef marketing. Specifically, in the area of how management can be used to overcome the obstacles keeping beef producers from adopting this marketing method. While many factors such as subjective carcass grading, packing plant costs that must be passed on either upstream or downstream, and normal volatility of livestock prices are outside the control of these managers; many other important factors are not. If the reductions in variability of revenue or the enhancement of expected revenue from some improvement in the quality of carcasses produced (e.g., consistent carcass weights) can be quantified by economic research, managers can begin to understand how much time and capital should be invested in moving toward these improvements. As noted earlier, much research has already been directed at this area and it will likely continue.

This study represents a basic first step toward aiding producers in these marketing decisions by utilizing existing data to simulate what revenue a random will generate when sold on a grid. Furthermore the variability around this expected value is reasonably defined. Sensitivity analysis indicates that the areas achieving consistent carcass weight and producing Choice carcasses warrant the most attention if it is the goal of a manager to successfully utilized value based marketing.

References

Anderson, J.D. and K.A. Zeuli. "The Revenue Risk of Value Based Pricing for Fed Cattle: A Simulation of Grid Versus Average Pricing." *International Food and Agribusiness Management Review*, forthcoming.

Grain Inspection, Packers, and Stockyards Administration (GIPSA). *Packers and Stockyards Report: 189-1995*. 1998 Washington, DC: USDA

Greer, H.C. and J.N. Trapp. "The Impact of Grid Pircing Premiums and Discounts on Individual Animal Values." Selected Paper presented at the Southern Agricultural Economics Association Annual Meeting, Memphis, TN, January 1999.

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

Feuz, D.M. "Economic Implications of Show List, Pen Level , and Individual Animal Pricing of Fed Cattle." *Formula Pricing ad Grid Pricing Fed Cattle: Implications for Price Discovery and Variability*. C.E. Ward, D.M. Feuz, and T.C. Schroeder, eds. Research Bulletin 1-99. Blacksburg, VA: Research Institute for Livestock Pricing: 27-38.

Feuz, D.M., S.W. Fausti, and J.J Wagner. "Analysis of the Efficiency of Four Marketing Methods for Slaughter Cattle." *Agribusiness International Journal*, 9(September 1993): 453-63.

Lamb, R.L. and M. Beshear. "From the Plains to the Plate: Can the Beef Industry Regain Market Share?" Federal Reserve Bank of Kansas City, *Economic Review*, Third Quarter 1998.

Purcell, W.D. "Measures of Changes in Demand for Beef, Pork, and Chicken, 1975-1998." Research Bulletin 3-98, Research Institute on Livestock Pricing, Virginia Tech, Blacksburg, VA, October 1998.

Schroeder, T.C. and J.L. Graff. 2000. "Estimated Value and Increased Pricing Accuracy for Fed Cattle." *Review of Agricultural Economics*, 22(2000): 89-101.

Schroeder, T.C. and J.L. Graff. 1999. "Comparing Live Weight, Dressed Weight, and Grid Pricing: Assesing the Value of Cattle Quality Information." *Formula Pricing ad Grid Pricing Fed Cattle: Implications for Price Discovery and Variability*. C.E. Ward, D.M. Feuz, and T.C. Schroeder, eds. Research Bulletin 1-99. Blacksburg, VA: Research Institute for Livestock Pricing: 17-26.

Schroeder T.C., J. Mintert, G. Brester. "Positioning the Beef Industry for the Future." Kansas: Kansas State University Coop. Extension Service, No. MF-2123, August 1995.

Schroeder, T.C. C.E. Ward, J. Mintert, and D.S. Peel. "Value-Based Pricing of Fed Cattle: Challenges and Research Agenda." *Review of Agricultural Economics*, 20(1998):12-134.

USDA-AMS. *National Weekly Direct Slaughter Cattle Premiums and Discounts.* Des Moines, IA: USDA-AMS, November 26, 2001.

USDA-AMS. *National Weekly Boxed Beef Cutout and Boxed Beef Cuts.* Des Moines, IA: USDA-AMS, November 26, 2001.

Ward, C.E., J.I. Lee. "Short term Variability in Grid Prices for Fed Cattle." *Formula Pricing ad Grid Pricing Fed Cattle: Implications for Price Discovery and Variability*. C.E. Ward, D.M. Feuz, and T.C. Schroeder, eds. Research Bulletin 1-99. Blacksburg, VA: Research Institute for Livestock Pricing: 39-55.

Ward, C.E.. D.M. Feuz, and T.C. Schroeder. *Formula Pricing ad Grid Pricing Fed Cattle: Implications for Price Discovery and Variability*. Research Bulletin 1-99. Blacksburg, VA: Research Institute for Livestock Pricing.

Table 1. Descriptive Statistics of Carcass Data

	Mean	St. Dev	C.V.	Min	Max
Entire Data Set					
Quality Grade[1]	2.450	0.618	25.20%	0.000	4.000
Yield Grade	2.441	0.677	27.71%	-0.055	5.000
Carcass Weight	818.431	73.681	9.00%	482	1053
Choice and Better Carcasses					
Quality Grade[1]	3.025	0.161	5.30%	3.000	4.000
Yield Grade	2.652	0.632	23.85%	1.000	5.000
Carcass Weight	815.751	75.393	9.24%	482	1053

1. Quality grade was defined numerically as: Prime = 4, Choice = 3, Select = 2, Standard = 1, Less than Standard = 0.

Table 2. Correlation Coefficients for Carcass Traits

	Quality Grade	Yield Grade	Carcass Weight
Entire Data Set			
Quality Grade[1]	1		
Yield Grade	0.328	1	
Carcass Weight	-0.001	0.066	1
Choice and Better Carcasses			
Quality Grade[1]	1		
Yield Grade	0.104	1	
Carcass Weight	0.001	0.028	1

1. Quality grade was defined numerically as: Prime = 4, Choice = 3, Select = 2, Standard = 1, Less than Standard = 0.

Table 3. Descriptive Statistics of Simulated Carcass Data

	Mean	St. Dev	C.V.	Min	Max
Based Upon Entire Data Set					
Quality Grade[1]	2.450	0.618	25.22%	0.000	4.000
Yield Grade	2.441	0.678	27.76%	-0.054	5.885
Carcass Weight	818.463	73.844	9.02%	516.333	1210.154
Based Upon Choice and Better Carcasses					
Quality Grade[1]	3.027	0.161	5.32%	3.000	4.000
Yield Grade	2.651	0.634	23.91%	0.010	6.138
Carcass Weight	815.786	75.530	9.26%	539.316	1205.954

1. Quality grade was defined numerically as: Prime = 4, Choice = 3, Select = 2, Standard = 1, Less than Standard = 0.

Table 4. Correlation Coefficients of Carcass Traits for Simulated Carcasses Traits

	Quality Grade	Yield Grade	Carcass Weight
Based Upon Entire Data Set			
Quality Grade[1]	1		
Yield Grade	0.294	1	
Carcass Weight	0.001	0.069	1
Based Upon Choice and Better Carcasses			
Quality Grade[1]	1		
Yield Grade	0.034	1	
Carcass Weight	0.015	0.040	1

1. Quality grade was defined numerically as: Prime = 4, Choice = 3, Select = 2, Standard = 1, Less than Standard = 0.

Table 5. Carcass Premium and Discounts (in dollars per cwt)

	Premium/Discount
Quality Grade	
Prime	4.79
Choice	0.00
Select	-8.75
Standard	-17.38
Yield Grade	
1 – 2	2.17
2 - 2.5	1.21
2.5 – 3	0.96
3 - 3.5	-0.08
3.5 – 4	-0.08
4 – 5	-12.42
>5	-18.25
Carcass Weight	
400 – 500 lbs.	-22.27
500 – 550 lbs.	-13.08
550 – 600 lbs.	-2.31
600 – 900 lbs.	0.00
900 – 950 lbs.	-1.25
950 – 1000 lbs.	-9.71
>1000 lbs.	-17.60

Source: *USDA National Weekly Summary of Carcass Premiums and Discounts*, November 26, 2001
Note: Premiums and Discounts were added to a base price taken from the USDA boxed beef cutout value of $109.02 / cwt for the same week.

Table 6. Simulated Carcass Revenues (in Dollars Per Head) Parameterized by Various Combinations of Carcass Data

	Entire Data Set	Choice or Better Carcasses	Reduced QG Variability	Reduced YG Variability	Reduced CW Variability
Mean	852.64	892.51	876.82	857.70	859.48
St. Dev	81.85	76.47	77.58	80.90	73.99
C.V.	9.60%	8.57%	8.85%	9.43%	8.61%
Median	855.98	897.90	880.34	859.99	860.95
Min	558.95	523.95	510.74	527.37	526.69
Max	1038.47	1114.06	1054.27	1133.61	1062.47

Note: QG = Quality Grade, YG = Yield Grade, CW = Carcass Weight

Table 7. Carcass Premiums/Discounts (in Dollars Per cwt) Based Upon Various Combinations of Carcass Data

	Entire Data Set	Choice or Better Carcasses	Reduced QG Variability	Reduced YG Variability	Reduced CW Variability
QG Premium/Discount					
Mean	-4.81	0.12	-2.38	-4.81	-4.81
St. Dev	5.14	0.77	4.00	5.14	5.14
Median	-8.75	0.00	0	-8.75	-8.75
Min	-17.38	0.00	-8.75	-17.38	-17.38
Max	4.79	4.79	4.79	4.79	4.79
YG Premium/Discount					
Mean	1.15	0.91	1.15	1.23	1.15
St. Dev	1.53	1.82	1.53	0.97	1.53
Median	1.21	0.96	1.21	1.21	1.21
Min	-18.25	-18.25	-18.25	-18.25	-18.25
Max	2.17	2.17	2.17	2.17	2.17
CW Premium/Discount					
Mean	-0.54	-0.55	-0.54	-0.54	-0.29
St. Dev	2.22	2.24	2.22	2.22	1.47
Median	0	0	0	0	0
Min	-17.6	-17.6	-17.6	-17.6	-17.6
Max	0	0	0	0	0

Note: QG = Quality Grade, YG = Yield Grade, CW = Carcass Weight