The Effect of Carcass Quality on the Grid versus Dressed Weight Carcass Revenue Differential*

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Abstract:

Our study investigates the fed cattle grid pricing system and its premium and discount incentive mechanism over time. We hypothesize that the influence of an animal's carcass quality attributes on a price grid's incentive mechanism can be revealed by evaluating the effect of carcass quality on an individual animal's grid determined carcass premium or discount. A pooled-cross sectional data set containing carcass information on 604 fed steers evaluated weekly on the USDA-AMS publically reported price grid (National Carcass Premiums and Discounts for Slaughter Steers and Heifers) was constructed for the years 2001 to 2008 (238,000 observations). The empirical evidence suggests that carcass quality attributes prime, select, and heavy weight have been gaining influence with respect to market valuation of individual animal's carcass characteristics.

Introduction:

Published studies in the grid pricing literature have investigated numerous issues involving the economic incentive structure associated with marketing on a grid (see Fausti et al. 2010 for a discussion of this literature). Several of these studies suggest that the grid premium and discount incentive mechanism is biased toward discounts (e.g., Johnson and Ward 2005 and 2006; Fausti and Qasmi 2002). We are interested in how the economic relationship between carcass quality attributes and grid price signals has evolved over time. The innovative aspect of this research is the construction of a weekly pooled time series-cross sectional data set that evaluates the grid incentive mechanism using the animal's assessed premium or discount. This approach was used by Feuz (1999). Feuz' s study was unique because it focused on the animal's levied premium or discount rather than grid value, grid profit or the price differential between a grid and an average price marketing alternative (i.e., selling live or dressed weight by the pen at an average price per cwt.).

We extend the Feuz approach by evaluating a single set of slaughter steers over an extended time period. We hypothesize that the influence of the interaction of an animal's carcass quality attributes and a grid's incentive mechanism can be revealed by evaluating the effect of carcass quality on the premium (discount) an individual animal receives. A pooled time series-cross sectional data set containing carcass information on 604 fed steers evaluated weekly on the USDA-AMS publically reported price grid (National Carcass Premiums and Discounts for Slaughter Steers and Heifers) was constructed for the years 2001 to 2008 (238,000 observations).

Background:

The value based marketing initiative is the beef industry's response to declining beef demand over the last several decades. The goal of this initiative is to improve the overall quality of beef carcasses and improve production efficiency all along the beef supply chain. Grid pricing of fed cattle is a key component in the beef industry's value based marketing initiative. The beef industry identified the practice of selling fed cattle by the pen at an average price as a significant source of the inconsistency in carcass quality and a factor associated with weak beef demand. Conceptually, the opportunity of selling on a grid provides producers of fed cattle an incentive to improve carcass quality because they are rewarded with additional premiums for high quality carcasses. Literature suggests that the incentive of grid premiums may not be strong enough to overcome the financial risk associated with grid discounts to induce a majority of fed cattle producers to sell their cattle on a grid (Johnson and Ward 2005 and 2006).

Data:

The carcass data contains carcass characteristics for 604 slaughter steers collected by the Animal Science Department at SDSU as part of a ranch to rail study (see Table 1). The price data were collected from USDA weekly grid premium and discount reports. The price data were used to simulate individual animal weekly per head revenue for the AMS price grid (USDA report: National Carcass Premiums and Discounts for Slaughter Steers and Heifers). We used an additive premium and discount price grid as suggested by Fausti et al. (1998). We also estimated a per-head dressed weight price for each animal on a weekly basis. The primary data set reflects estimated per head weekly revenues from April 2001 to July 2008 combined with individual animal carcass characteristics (See Table 2). A total of 378 weeks of price data were collected. The data set contains 238,000 observations.

Methods:

A pooled time series regression model is used to investigate the influence of carcass quality characteristics on an individual animal's per head premium or discount relative to the AMS grid base price. We refer to this levied premium or discount as the animal's carcass quality value (QV). We regress QV on carcass quality variables as defined by the AMS grid, monthly dummy variables to account for seasonality, a time trend variable, interaction terms, and the weekly hot carcass dressed weight price.

A fixed effect model was selected to analyze the data. Allison (2005) provides a general functional form for a fixed effect model and below is our modified version:

1) $QV_{it} = \mu_t + \beta X_{it} + \gamma Z_i + \alpha_i + \delta T_t + \theta S_{jt} + \varphi Z_i T_t + \varepsilon_{it}, were\ i = 1\ to\ 604, j = 1\ to\ 11, and\ t = 1\ to\ 378.$

For our analysis: a) QV_{it} denotes the individual animal's weekly (t) grid determined premium or discount relative to the grid base price (defined in terms of dollars per hundred weight), b) μ_t denotes the intercept that is allowed to vary over time, c) X_{it} denotes the exogenous variable vector for variables that vary across individual animals and over time for each animal (model's interaction terms), d) Z_i denotes the exogenous variable vector for individual animal carcass quality characteristics that vary across animals but do not vary over time (i.e., hot carcass weight, yield and quality grade rankings based on standard USDA grading standards), e) α_i denotes the fixed affect variable that accounts for differences between animals that are stable over time but not accounted for by Z_i, f) T_t denotes the weekly time trend variable, g) S_{jt} denotes the monthly seasonal dummy variable, and h) Z_iT_i denotes interaction terms between time and carcass quality characteristics.

Carcass quality variables were converted into dummy variables. Quality grade categories are prime, choice, select, and standard. Regression estimates reflect parameter estimates relative to choice quality grade. Yield grade variable categories are yield grade less than 2 (YG1), yield grade between 2 and 3 (YG2), and yield grade greater than 4 (YG45). Heavy weight carcass dummy variable reflects a carcass with HCW>950 and light weight carcass dummy variable reflects a carcass with HCW<600.

Interaction terms combing the time trend variable and carcass traits were included to determine if there is a change in the market incentive mechanism with respect to carcass characteristics. We also included the AMS reported Nebraska dressed weight price (HCWP) to determine if a change in the market price for slaughter cattle affected how the market rewards carcass characteristics over time. Fausti and Qasmi (2002) hypothesized that such a relationship may exist even though the HCWP is factored out of the grid price minus dressed weight price differential when the AMS additive grid mechanism is used to estimate grid value.

Results:

The empirical analysis was conducted using SAS version 9.2. The fixed effect model was estimated using SAS's *Restricted Maximum Likelihood* procedure. Regression diagnostics revealed a problem with serial correlation and an AR(1) correction procedure was performed on the covariance matrix to correct the problem. A chi square test was conducted to determine the validity of the AR(1) correction procedure and it strongly supported our decision to correct for serial correlation. We are currently testing for heteroscasdicity. We believe the structure of the data rules out the possibility of a random effect but we have not tested for it. Type 3 Tests of Fixed Effects indicate that seasonality and carcass characteristics do explain differences in QV across individual animals included in the data set.

Summary statistics presented in Table 2 indicate 52% of the 604 carcasses graded choice, 39.7% graded select, 7% graded standard, and 1.3% graded prime. Carcasses receiving a yield grade less than 2 accounted for 17.4% of the sample, 48.3% of the carcasses were determined to be yield grade 2 to 3, 6% received a yield grade greater than 4, 28.3% of grade carcasses were assessed a yield grade of 3 to 4. We estimated per head grid minus dressed weight revenue differential. The differential averaged $2.42 in favor of selling on a grid versus selling by the pen at an average price. The per hundred weight premium/discount variable (QV) averaged -$5.056. The revenue differential and QV were significantly different from zero ($p< 0.001$). A positive revenue differential and a negative QV is the result of the base price used in the grid revenue calculation reflecting the value of a yield grade 3 carcass, grading choice, and weighing between 600 and 950 pounds.

Regression results are presented in Table 3. Monthly seasonal dummy variable parameter estimates indicate that relative to December, QV increases in Jan, Feb, Mar, July, Aug Sep, and declines in Apr, May, and June. Carcass quality parameter estimates indicate that yield and quality grade differences among animals significantly affect an individual animal's QV. The time trend variable is reported as insignificant in Table 3. However, in an early version of the model without interaction terms, it was negative and significant. The introduction of the interaction terms resulted in it becoming insignificant. The empirical implication is that the time trend effect was the result of changes in how the market rewarded or penalized particular characteristics over time. Furthermore, the interaction terms indicate that the quality characteristics of prime and select carcasses and heavy weight carcasses have seen an increase in influence on an individual animal's QV over time. Finally, the parameter estimate for HCWP is positive and significant ($p<0.001$) indicating that while the market price for slaughter cattle is not directly related to QV it does positively influence QV. This finding supports the *Supply Response Hypothesis* proposed by Fausti and Qasmi (2002: p. 31).

Discussion:

The empirical evidence suggests that carcass quality attributes prime, select, and heavy weight have been gaining influence with respect to market valuation of individual animal's carcass characteristics. Also, as previously reported in the literature (e.g., Fausti and Qasmi 2002), there seems to be a very strong seasonal component to the premium/discount structure.

References:

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Table 1: Cattle Quality Characteristics: 604 OBS.

Variable	N	Mean	Std Dev	Minimum	Maximum
HCW	604	742.647	77.662	789.000	1022.000
REA	604	12.542	1.469	8.100	20.300
FT	604	0.431	0.176	0.100	1.100
KPH	604	1.864	0.605	0.500	3.500
Marb	604	492.566	91.495	340.000	830.000
YG	604	2.740	0.751	0.564	5.237
QG	604	2.520	0.064	1.000	4.000

Table 2: Summary Statistics: Grid Data Set

Variable	N	Mean	Std Dev	Minimum	Maximum
dumHYwt>950	228132	0.132	0.114	0.000	1.000
dum1twt<600	228312	0.028	0.165	0.000	1.000
qv	228312	-5.056	7.051	-54.310	15.280
pgrid	228312	131.584	17.503	63.730	196.290
hcwpr	228312	131.314	15.887	97.800	172.460
basepr	228312	136.640	16.840	101.070	185.800
griddiff	228312	2.430	49.819	-259.092	190.634
prime	228312	0.013	0.114	0.000	1.000
choice	228312	0.520	0.500	0.000	1.000
select	228312	0.397	0.489	0.000	1.000
standard	228312	0.070	0.254	0.000	1.000
yg1	228312	0.174	0.379	0.000	1.000
yg2	228312	0.483	0.500	0.000	1.000
yg45	228312	0.060	0.237	0.000	1.000

Table 3: QV REML Fixed Effect Model Estimate

AR(1) = - 0.9685

-2 Res Log Likelihood = 545102.7

DF=1 Chi-Square=609134.8 Pr > ChiSq <.0001

Variable	DF	Estimate	Std Error	t Value	Pr > |t|
Intercept	595	-0.3829	0.1813	-2.11	0.0351
Jan	238K	0.2027	0.0119	16.98	< .0001
Feb	238K	0.3929	0.0161	24.45	< .0001
Mar	238K	0.1483	0.0185	8.03	< .0001
Apr	238K	-0.0900	0.0200	-4.49	< .0001
May	238K	-0.6734	0.0208	-32.35	< .0001
June	238K	-0.4473	0.0211	-21.18	< .0001
July	238K	0.0958	0.0210	4.57	< .0001
Aug	238K	0.1990	0.0201	9.91	< .0001
Sept	238K	0.1010	0.0185	5.46	< .0001
Oct	238K	0.0174	0.0160	1.09	0.2757
Nov	238K	0.0207	0.0119	1.75	0.0808
Time	238K	-0.0001	0.0008	0.13	0.8986
Prime	595	4.7255	0.7762	6.09	< .0001
Select	595	-8.5365	0.2057	-41.50	< .0001
Standard	595	-17.5624	0.3780	-46.46	< .0001
Yg1	595	2.9077	0.2998	9.70	< .0001
Yg2	595	1.4489	0.2198	6.59	< .0001
Yg45	595	-13.4485	0.3981	-33.78	< .0001
dumHYwt	595	-11.4951	0.7740	-14.85	< .0001
dum1twt	595	-6.9686	0.5407	-12.89	< .0001
Hcwpr	238K	0.0026	0.0005	5.61	< .0001
Time*prime	238K	0.0167	0.0034	4.91	< .0001
Time*select	238K	-0.0031	0.0009	-3.39	0 .0007
Time*standard	238K	-0.0024	0.0017	-1.42	0 .1563
Time*Yg1	238K	0.0004	0.0013	0.32	0 .7518
Time*Yg2	238K	-0.0006	0.0010	-0.58	0 .5650
Time*Yg45	238K	-0.0003	0.0017	-0.15	0 .8843
Time*dumHYt	238K	0.0097	0.0034	2.87	0.0041
Time*dum1twt	238K	-0.0004	0.0024	-0.18	0 .8552