Carcass Quality Volume and Grid Pricing: An Investigation of Cause and Effect.

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ABSTRACT

The relationship between publicly reported weekly grid premiums and discounts for specific carcass characteristics and the percentage of those characteristics reflected in total weekly slaughter volume (i.e., proportional slaughter volume) is investigated. Granger Causality and multi-lag VAR models were used to investigate if grid premiums and discounts were efficiently transmitting market signals to producers with respect to carcass quality attributes. The empirical evidence indicates that there is little evidence to suggest that grid prices are providing efficient price signals to buyers and sellers with respect to market valuation of desirable and undesirable beef carcass characteristics.

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Introduction:

Recent studies on the effectiveness of grid pricing of slaughter cattle to transmit market signals on the market value of individual carcass quality characteristics from the packer to the fed cattle producer suggest that grid pricing has fallen short of industry expectations (e.g. Johnson and Ward 2005, 2006). Johnson and Ward report that carcass quality characteristics only explain 30 to 40 percent of individual carcass value. Furthermore, they report that grid yield and grade discounts associated with carcass characteristics explain the majority of that 30 to 40 percent variability in per-head revenue.

Findings from the 2005 National Beef Quality Audit (NCBA 2006), indicate that the industry is still struggling with the same quality and marketing issues that plagued the industry in the 1980s (Value Based Marketing Task Force 1990). The 2005 NBQA highlighted the following recurring issues still confronting the industry: a) excess fat production, b) inconsistent meat quality, c) the need for clearer market signals, and d) inconsistent carcass quality. The 2005 NBQA findings also suggest that annual changes in average carcass quality have stagnated since the late 1990s. In addition, a recent study released by Certified Angus Beef ^{TM}, Corah and McCully (2006) report that the percentage of heifers and steers grading prime or choice declined from 58% to 54% and 48% to 44%, respectively. Their findings are based on data collected from 1999 to 2005 on approximately 19.8 million carcasses.

The introduction of grid pricing in the mid-1990s, as a pricing mechanism consistent with the philosophy of a value based marketing system, has not alleviated

these problems facing the beef industry. It is apparent that additional research is needed on the ability of the grid pricing system to transmit consistent carcass quality price signals through the fed cattle marketing channel. Our objective is to investigate the relationship between publically reported weekly grid premiums and discounts for specific carcass characteristics and the percentage of those characteristics reflected in total weekly slaughter volume (i.e., proportional slaughter volume).

Literature Review

The phrase "value based marketing" generally refers to a marketing system that establishes the true market value of a product, based on product characteristics. The Beef Industry's perceived need for a value based marketing system for slaughter cattle was articulated in the final report (War on Fat) issued by the Value Based Marketing Taskforce (1990). The beef industry's motivation for embracing the concept of value based marketing was driven by a desire to improve beef's competitive position in the red meat industry and reverse the dramatic decline in beef demand from 1979 to 1998.[1]

The Value Based Marketing Task Force provided recommendations for transforming the beef production and marketing system based on value based marketing principles. These recommendations were conveyed through an outline containing eight consensus points for industry action along the entire beef supply chain. Consensus point 7 focused on the fed cattle market and recommended that "Fed cattle should be valued on an individual carcass basis rather than an average price basis."

The Task Force indentified the traditional practice of selling pens of fed cattle at an average price as a weakness in the beef supply chain and an impediment to the development of a value based marketing system for beef. This conclusion has been

supported in the economics literature (e.g. Feuz, Fausti, and Wagner 1993). Average pricing of fed cattle refers to the traditional industry practice of selling cattle by the pen at an average price per hundred weight.

Average pricing generates pricing inefficiency because above-average and below-average cattle in a pen receive the same price per cwt. Average pricing distorts the transmission of market information to producers about the true market value of carcass attributes. This distortion contributes to production inefficiencies that result in inconsistent product quality, failure to provide consumers with beef products having a level of quality they demand, and excess fat production. Thus, average pricing distorts market signals and poses "… a barrier to the transmission of consumer preferences for a particular type of beef product to the fed cattle producer…." (Fausti, Feuz, and Wagner 1998, p.74). Therefore, a key industry objective for a value based pricing mechanism is the provision of efficient price signals to buyers and sellers with respect to market valuation of desirable and undesirable beef carcass characteristics.

The Task Force's recommendation to sale fed cattle on an individual carcass basis has encouraged the development of value based pricing mechanisms for fed cattle. These pricing mechanisms are classified as "grid pricing" systems. The typical grid pricing mechanism determines the market value of an individual beef carcass based on yield grade, quality grade, and carcass weight. The U.S. beef packing industry began developing prototype grid pricing systems in the early 1990s. These prototype systems expanded carcass premiums and discounts beyond the traditional "Grade & Yield" individual carcass pricing system. One example of a prototype appearing in the literature is the Excel Corporation's Muscle Scoring System (Feuz, Fausti, and Wagner 1993).

The introduction of grid pricing has provided the market with a pricing mechanism that is designed to overcome inefficiencies associated with selling cattle by the pen (live-weight or dressed-weight) at an average price per hundred cwt. However, Feuz (1999) discussed the practice of large packing firms adjusting their grid premium and discount schedules based on plant averages. The implication is that grid premiums and discounts not only vary across firms but can also vary across plants within a firm. The variation across grid pricing mechanisms within the industry may be contributing to the reported finding in the 2005 NBQA that the fed cattle marketing system is still not providing "clear market signals."

In October 1996, the USDA Agricultural Marketing Service (AMS) began publishing weekly grid premium and discount price reports: National Carcass Premiums and Discounts for Slaughter Steers and Heifers (USDA-AMS). The AMS designed the structure of the weekly report to mirror the premium and discount structure of an additive pricing grid consistent with industry standards (Fausti, Feuz, and Wagner, 1998). These reports provided the market with weekly industry averages based on information voluntarily provided by the packing industry. The AMS weekly survey collects information on: a) yield-grade and quality-grade premiums and discounts, b) heavy and light weight carcass discounts, and c) discounts for carcass defects, such as injection lesions, dark cutters, etc. (Fausti, Feuz, and Wagner, 1998). In April of 2001, the Livestock Mandatory Price Reporting Act went into effect. As a result of this new legislation, firms in the meat packing industry are required to report all grid premium and discount information to the AMS on a weekly basis.

Theory:

A feedlot firm purchases feeder cattle based on perceived physical characteristics and genetic quality. Carcass quality varies as much within breed as across breeds. The firm expends resources to select feeder cattle that will produce the highest average carcass quality possible given market conditions. However, the quality of feeder cattle also vary due to seasonal patterns, pasture conditions, and cow herd management practices irrespective of genetic background. In addition, market conditions, primarily feed costs in conjunction with finished cattle prices also affect the firm's decision concerning carcass endpoint quality. Firm's weigh the marginal benefit of attaining a specific level of average carcass quality against the marginal cost associated with current market prices for fed cattle, feed input, and carcass quality attributes. Profit maximization requires the firm to select a carcass quality endpoint based on the profit maximizing principle of marginal revenue equals marginal cost.

Assuming profit maximizing behavior of producers, four competing theories are proposed to explain the market relationship between grid premiums and discounts and the weekly proportional slaughter volume of carcass attributes associated with those prices. The four scenarios are; a) competitive market forces simultaneously determine price and quantity, b) competitive market forces transmit consistent price signals that provide carcass quality incentives and disincentives that affect producer production behavior, c) noncompetitive forces are affecting market price determination process, and d) grid premiums and discounts are at insufficient levels and have no affect on producer behavior.

Within a competitive market framework, buyers and sellers of fed cattle have no influence over market prices. Ideally, fed cattle producers should target carcass quality attributes based on grid premiums and discounts being paid. Assume the market mechanism provides consistent market signals to producers with respect to desirable and undesirable carcass attributes based on market supply and demand conditions for those attributes. As a consequence, a long-run relationship between grid premiums and discounts and carcass quality attributes of cattle slaughtered should exist.

Given this behavioral structure, weekly equilibrium price and quantity are simultaneously determined by exogenous variables affecting supply and demand conditions in the market as discussed above in scenario "a."

Grid pricing mechanisms are hypothesized to be the incentive mechanism within a wider value based marketing initiative that has been ongoing in the beef industry since the early 1990s (Fausti, Feuz, and Wagner, 1998). The literature on grid pricing suggests that the grid market share of cattle slaughter has increased since the late 1990s (Schroeder et al. 2002, Taylor et al. 2007). It is the general view that as more cattle are sold on a grid, a larger proportion of producers will adjust production practices to meet carcass quality standards according to the price signals transmitted by grid pricing mechanisms. This view is consistent with scenario "b."

Scenario "c" states that past proportional slaughter volume levels for a particular carcass quality attribute affect its respective current price. Typically, economic theory equates the market condition of market quantity determining market price as being symptomatic of non competitive market forces affecting market outcomes.

Scenario “d” suggests that the level of a particular grid premium or discount is not sufficient to affect producer production behavior. This implies the marginal benefit of improving a particular carcass quality attribute is less than the marginal cost of changing production practices.

Formally, we hypothesize that the introduction of grid pricing for the purpose of changing production behavior over time can be empirically tested by estimating the Granger Causal relationship between weekly grid premiums and discounts (P_i) and proportional slaughter volume reflecting those carcass attributes (Q_i). We propose the following interpretation for the possible Granger Causality outcomes between P_i and Q_i within a time series context for scenarios a thru d:

a) if a particular grid price is responding to only general market clearing signals that reflect supply and demand conditions, then we would expect Bidirectional Granger Causality, i.e., a simultaneous feedback system between Pi to Q_i,

b) if a grid premium or discount is affecting the average quality of a particular carcass attribute then Unidirectional Granger Causality from P_i to Q_i,

c) if average quality of a particular carcass attribute is affecting its respective grid premium or discount then Unidirectional Granger Causality from P_i to Q_i,

d) If no Granger Causal relationship is found between P_i and Q_i, then the grid pricing mechanism is not providing any relevant market information associated with market demand and supply conditions for a particular carcass attribute.

Data:

Data was obtained from the Agricultural Marketing Services, an agency within the United States Department of Agriculture. The data collected is for the post Mandatory Livestock Price Reporting period: July 23, 2001 to July 7, 2008.

Grid premium and discount data was collected on national slaughter cattle grid premium and discount prices for two quality grade price categories (Prime and Choice/ Select Discount), and three yield grade categories (Yg1.0-2.0, Yg4.0-5.0, and Yg5). These data were collected from a weekly AMS publication (USDA-AMS: the National Carcass Premiums and Discounts for Slaughter Steers and Heifers weekly report).

The slaughter volume data was collected from the National Steer & Heifer Estimated Grading Percent Report (AMS NW_LS196) published weekly by the USDA-AMS. The AMS NW_LS196 report provides information on the breakdown of quality and yield grade percentages for weekly national cattle slaughter for the respective carcass quality characteristics associated with grid premium and discount data.

Empirical Methodology and Results:

The concept of causality within a time series framework was introduced by Granger (1969). Granger's empirical methodology is based on the idea that a "Granger Causal Relationship" exist if past values of x_t can be used to better predict current values of y_t. If this is true, then this relationship is expressed as x_t "Granger Causes" y_t.

There are several caveats associated with degree of statistical robustness when using Granger's empirical technique: a) for bilateral causality both random variables must be stationary, b) the selection of lag length for the sampling period, and c) relevant

variables which influence both x_t and y_t may be the source of the causal relationship between x_t and y_t. [2]

Our focus is on the relationship of a weekly price of a beef carcass trait and the proportion of that trait as a percentage of weekly slaughter volume. However we are not sure about the direction of Granger Causality. Toward that end, we use the following VAR (n) model:

1. $y_{1t} = \sum_{i=1}^{2}\sum_{j=1}^{n}\left(B_{ij}Y_{i,t-j}\right) + e_{1t}$

2. $y_{2t} = \sum_{i=1}^{2}\sum_{j=1}^{n}\left(C_{ij}Y_{i,t-j}\right) + e_{2t}$

The null hypothesis of y_{2t} does not Granger cause y_{1t} can be specified as

3. $H_0^1\colon\ B_{21} = \ B_{22} = \cdots = B_{2j} = 0,$

and the null hypothesis of y_{1t} does not Granger cause y_{2t} can be specified as

4. $H_0^2\colon\ \ C_{11} = \ C_{12} = \cdots = C_{1j} = 0.$

Furthermore, cattle prices and slaughter volume are subject to seasonal variation. Grid premiums and discounts and the associated proportional slaughter volume were deseasonalized by regressing these variables upon seasonal monthly dummy variables. This was done to remove seasonality as a potential source of false causality. Unit root tests for stationary were conducted. The unit root tests indicated that the premium for prime, the discount for YG4-5, and the weekly volume value for YG4-5 were non stationary. The first-difference of these variables was found to be stationary and utilized for the Granger Causality tests. The results for the Granger Causality tests are summarized in the next three tables;

a) Table 1 provides results for a VAR (4) model,

b) Table 2 provides the results for a VAR (12) model, and

c) Table 3 provides the results for a VAR (24) model.

Table 1: VAR (4) Model: Direction of Granger Causality (significance level = 0.10)

y_{1t} % Volume	y_{2t} Price	y_{1t}Granger causes y_{2t} ?	y_{2t}Granger causes y_{1t}?	Exogenous variable
PRIMEV	PRIME	no	no	independent
CHOICEV	SELECT DISC	yes	no	Volume
YG1V	YG1-2	no	no	independent
YG4V	YG4-5	no	no	independent
YG5V	YG5	no	yes	Price

Table 2: VAR (12) Model: Direction of Granger Causality (significance level = 0.10)

y_{1t} % Volume	y_{2t} Price	y_{1t}Granger causes y_{2t} ?	y_{2t}Granger causes y_{1t}?	Exogenous variable
PRIMEV	PRIME	no	no	independent
CHOICEV	SELECT DISC	no	no	independent
YG1V	YG1-2	no	no	independent
YG4V	YG4-5	no	no	independent
YG5V	YG5	yes	yes	simultaneous

+Table 3: VAR (24) Model: Direction of Granger Causality (significance level = 0.10)

y_{1t} % Volume	y_{2t} Price	y_{1t}Granger causes y_{2t} ?	y_{2t}Granger causes y_{1t}?	Exogenous variable
PRIMEV	PRIME	yes	yes	simultaneous
CHOICEV	SELECT DISC	no	no	independent
YG1V	YG1-2	no	yes	Price
YG4V	YG4-5	no	no	independent
YG5V	YG5	yes	yes	simultaneous

Discussion:

Five premium and discount categories were selected for the analysis. Four basic theoretical scenarios were provided according to the four potential empirical outcomes generated by the Granger Causality tests (S= simultaneous, P=price, V=volume, I=independent). The Granger Causality tests were conducted using three different VAR modeling assumptions.

The Granger Causality results are mixed across the three VAR models. Table 4 provides a summary of Granger Causality results across VAR models. The summary suggests that there is little evidence to support theoretical scenarios b&c. The implication is that the grid pricing mechanism, on average, has not provided consistent carcass quality incentive and disincentive signals to producers during the time period of this study. Furthermore, grid price market signals reflecting general market supply and demand conditions for particular carcass attributes appears to be very weak across all categories except for the YG-5 discount. In support of this conclusion, if the levels of significance for the Granger Causality tests are set at the 5% level, then only the YG2 VAR (24) result and the YG5 results for all three VAR models remain significant.

Table 4: Summary of Granger Causality Results Across VAR models

	VAR(4)	VAR(12)	VAR(24)
Prime	I	I	S
Choice/Select Disc	V	I	I
YG2	I	I	P
YG45	I	I	I
YG5	P	S	S

Summary:

The empirical results do suggest that grid premiums and discounts did little to influence producer behavior with respect to modifying production practices to alter carcass characteristics. Once possible explanation for this finding is that producer behavior during this period was influenced by the incentive to produce heavier cattle due to low corn prices and relative high fed cattle prices. Johnson and Ward (2005), among others, have reported in the literature that hot carcass weight is a primary determinate of

carcass revenue. It should be noted that the lack of Granger Causality does not rule out a contemporaneous relationship between P_1 and Q_i.

On a final note, this study is the first in the literature to empirically test if grid prices are providing efficient price signals to buyers and sellers with respect to market valuation of desirable and undesirable beef carcass characteristics. Our study suggests that the NBQA (2006) call for clear market signals is justified.

Footnotes:

1. See (Mintert 2007) for data on trends in beef demand during this period.
2. See Granger and Newbold (1986) for additional discussion.

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