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Grid Pricing: An Empirical Investigation of Market Signal Clarity

by

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Abstract

The ability of the grid marketing system for fed cattle to provide an efficient price transmission mechanism is investigated. Nerlove's (1958) adaptive expectations approach is adopted to model the relationship between grid premiums (discounts) and the weekly relative supply of carcass quality attributes. Linear regression techniques are used to estimate Nerlove's supply response function. Granger Causality tests are conducted to investigate the relationship between grid premiums (discounts) and the relative supply of carcass quality attributes. Regression estimates and the Granger Causality tests provide empirical support for the 2005 National Beef Quality Audit call for clearer market signals.

Key words: grid pricing, price transmission, carcass quality, supply response function

JEL Codes: Q11, D40

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Grid Pricing: An Empirical Investigation of Market Signal Clarity

Introduction

The commercial introduction of grid pricing as a marketing alternative for fed cattle started in the mid-1990s. The objective of this pricing mechanism is to discover carcass value consistent with the philosophy of a value based marketing system (Cross and Savell 1994). An important advantage of selling on a grid for producers is detailed carcass data on animals marketed. The general consensus among beef industry marketing experts is that the combination of carcass quality information and premiums should motivate producers to improve carcass quality and reduce carcass quality variability over time.

The issue of inconsistent beef carcass quality was formally investigated by the beef industry's Value Based Marketing Taskforce (VBMTF) 1990. Selling cattle by the pen, at an average price, was linked to beef quality issues in that report (Cross and Savell 1994). The 2005 National Beef Quality Audit (2005 NBQA), conducted by the National Cattlemen's Beef Association (NCBA), indicates the industry is still struggling with the quality and marketing issues highlighted in the 1990 VBMTF report. The 2005 NBQA report provides a list of recurring issues that continue to confront the industry: a) excess fat production, b) inconsistent meat quality, c) the need for clearer market signals, and d) inconsistent carcass quality.

The survey findings presented in 2005 NBQA report indicates that additional research is needed on the price transmission mechanism for fed cattle. The grid marketing channel has become an important marketing alternative for fed cattle producers. The capacity of the grid pricing system to transmit consistent carcass quality

price signals through the fed cattle marketing channel is germane to the market signal clarity issue raised in the NBQA report.

The research question addressed here is: To determine if there is evidence of a lack of market signal clarity in the grid price transmission mechanism. Economic price theory states that the price and quantity of any scarce good are related. The approach we have adopted to answer this question is based on the adaptive price expectations work of Nerlove (1958). We formalize the relationship between a grid premium (discount) and the weekly proportional slaughter volume (relative supply) of the associated carcass quality attribute by adopting an adaptive expectations single commodity market model.

Empirical testing of hypothesized relationships employs Granger Causality and the empirical estimation of Nerlove's supply response function. Thus, the clarity issue is addressed by evaluating 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., the relative supply of the carcass attribute).

The Impetus for Grid Pricing

The competitive position of beef within the red meat industry has struggled for decades. As a consequence, beef demand experienced a sharp decline from 1979 to 1998, recovered moderately, and then continued its decline beginning in 2005 (Mintert 2009). The literature on beef marketing issues (e.g., Fausti, Feuz, and Wagner 1998) has suggested that the decline in beef demand is primarily a consequence of: a) price competition from poultry and pork, b) changing consumer preference for meat products, and c) inconsistent production quality of beef cattle.

A proposed solution to declining demand discussed in the literature is for the beef industry to embrace the concept of value based marketing. The VBMTF provided recommendations for transforming the beef production and marketing systems in accordance with value based marketing principles. Eight consensus points addressing weaknesses along the entire beef supply chain were outlined in the NCBA document: WAR ON FAT (VBMTF, 1990). Specifically, reform of the fed cattle marketing system was recommended in consensus point 7: "Fed cattle should be valued on an individual carcass basis rather than an average price basis." The economic issues associated with average pricing of slaughter cattle have been widely discussed in the academic literature (e.g., Feuz, Fausti, and Wagner 1993).

Prototype pricing mechanisms that expanded carcass premiums and discounts beyond the traditional "Grade & Yield" individual carcass pricing system began to appear in the early 1990s (Feuz, Fausti, and Wagner 1993). Today, these type of individual carcass quality based pricing mechanisms are generally referred to as a "grid pricing" mechanisms. Consensus point 7 and the increase in the market share of grid sales (Muth et al. 2007) indicates that the beef industry has recognized the need for a pricing mechanism that engenders transparency, and allows the market to differentiate between desirable and undesirable beef carcass traits.

Public Reporting of Grid Premium and Discount Price Signals

Weekly published grid premium and discount reports (National Carcass Premiums and Discounts for Slaughter Steers and Heifers) are provided to the public by the USDA's Agricultural Marketing Service (AMS). The AMS began publishing grid price reports in October 1996. The report reflects an additive grid pricing mechanism.

The AMS designed the weekly reporting mechanism to reflect industry standards. The price data collected on grid sales of fed cattle include: a) heavy and light weight carcass discounts, b) yield-grade and quality-grade premiums and discounts, and c) discounts for carcass defects, such as injection lesions, dark cutters, etc. (Fausti, Feuz, and Wagner, 1998).

From 1996 to 2001, the beef packing industry provided grid premium and discount weekly data on voluntarily basis. The U.S. Congress passed the Livestock Mandatory Reporting Act (MPR) in 1999, and this act was implemented in April, 2001. MPR regulations require firms in the meat packing industry to report grid premium and discount transaction information to the AMS on a weekly basis.[1]

The Economics of Grid Pricing

The grid pricing literature includes numerous comparison studies using carcass data to evaluate the profitability of selling cattle on a grid versus average pricing mechanisms (e.g., Anderson and Zeuli 2001, Fausti and Qasmi 2002, McDonald and Schroeder 2003, Johnson and Ward 2005 and 2006). The general conclusion that can be drawn from this literature is that relative profit (revenue) levels depend on the level of carcass quality when fed cattle are sold on a grid. However, grid pricing incurs higher profit (revenue) variability relative to average pricing regardless of carcass quality.

The literature has also explored the issue of whether grid premium signals are robust enough to persuade producers to sell on a grid. Fausti, Feuz, and Wagner (1998) contend that seller risk aversion may act as a barrier to adoption. Johnson and Ward (2005) report that grid pricing mechanisms are sending the correct signal, but they indicate that the grid premium signal appears to be too weak to affect a change in overall

product quality. Weak premium incentives may act as a barrier to the adoption of grid pricing because sellers have the ability to sell cattle by the pen at an average price if they perceive that grid premium incentives are less than grid discount risks (Feuz, Fausti, and Wagner 1995; Fausti and Feuz 1995, Anderson and Zeuli 2001). White et al. (2007) demonstrates that producers of feeder cattle may face a market disincentive to retain ownership of feeder cattle and market on a grid due to the pricing structure of fed cattle grids. This particular research finding is disconcerting because it implies that the grid pricing system is not transmitting market signals back to feeder cattle producers.

Finally, Feuz (1999) discusses 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 heterogeneous nature of 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." The market signal clarity issue raised in the NBQA report is consistent with recently reported empirical evidence that grid market share of weekly slaughter has increased significantly since the late 1990s (Schroeder et al. 2002, Muth et al. 2007), but average quality has not (2005 NBQA).

Hypothesized Grid Price Transmission Mechanism

Agricultural supply response functions are commonly defined in terms of a lagged production response to a change in market price. The nature of agricultural production lends itself naturally to this supposition because of the time lag between production decisions and harvest (crop or livestock). The literature on lagged agricultural supply response functions is extensive. Comprehensive literature discussions can be found in

Shonkwiler (1982) and Askari and Cummings (1977). Askari and Cummings review the supply response literature with respect to empirical studies on agricultural supply response that have evolved from the seminal work of Nerlove (1958) on the role of *adaptive expectations* in agriculture supply response functions. The production of slaughter cattle is consistent with the concept of a lagged supply response to price changes.[2]

In the case of slaughter cattle, assume a typical feedlot firm purchases feeder cattle based on: a) perceived physical characteristics, b) genetic quality, c) the current price of fed cattle; d) expected input costs, and e) current and expected grid premiums and discounts. The firm expends resources to select feeder cattle that will produce a level of carcass quality at slaughter to maximize profit; given current and expected future market conditions. However, the quality of feeder cattle does 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. Given this market environment, economic theory suggests that firms weigh the expected marginal benefit versus the expected marginal cost associated with attaining a specific level of carcass endpoint quality.

Grid pricing mechanisms are hypothesized to be a type of competitive pricing system that has an intrinsic incentive mechanism that captures the market value of high quality carcass attributes that are not rewarded when cattle are sold by the pen and priced at the pen average. It is assumed that the market value captured by selling on a grid is the incentive that will increase grid market share of total slaughter. As more cattle are sold

on a grid, a larger proportion of firms will have adjusted production practices to meet carcass quality standards according to the price signals transmitted by grid pricing mechanisms. This, in turn, will improve average quality grade and yield grade of cattle marketed. Thus, the *relative supply* of superior quality grade and yield grade carcasses will increase, and the *relative supply* of inferior quality grade and yield grade carcasses will decline as a proportion of total slaughter.

In this setting, the supply of a particular carcass quality attribute in the current marketing period (t) is assumed to be determined by the price of that quality attribute in the previous period (t-1). Nerlove's adaptive expectations supply response model is employed to analyze the relationship between a grid premium (discount) and the corresponding supply response for the production of a specific carcass quality attribute.

The grid price transmission mechanism literature indicates that the supply response for the production of a specific carcass quality attribute to a change in price is determined with a lag. Equation 1 defines a simple linear supply and demand function, respectively. The supply function links quantity supplied (Q_t^s) in period t to Nerlove's expected "normal" market price (P_t^*). Nerlove (p. 231) frames his discussion of P_t^* in terms of "adaptive price expectations." Parameters c and d are the intercept and slope coefficients, respectively. The demand function links quantity demanded (Q_t^d) in period t to market price in period t (P_t). Parameters a and b are the intercept and slope coefficients, respectively.

$$1.\ Q_t^d = a + bP_t$$

$$Q_t^s = c + dP_t^*.$$

Nerlove (pp. 231-232) demonstrates that an agricultural supply response function (Q_t^s) which incorporates an adaptive price expectations mechanism (equation 2):

$$2.\ P_t^* - P_{t-1}^* = \beta[P_{t-1} - P_{t-1}^*],\ 0 < \beta \leq 1,$$

is a function of past price and quantity (equation 3).

$$3.\ Q_t^s = c\beta + d\beta P_{t-1} + (1-\beta)Q_{t-1}^s\ .$$

Following Nerlove's approach, market short-run equilibrium is assumed across all periods: $Q_{t-i}^s = Q_{t-i}^d, \forall\, i \geq 0.$ Substituting the demand function (in equation 1) lagged by one period into the equation 3 provides us with a short-run equilibrium condition for quantity as follows:

$$4.\ Q_t = (c-a)\beta + a + [(d-b)\beta + b]P_{t-1}.$$

Equation 4 demonstrates that equilibrium quantity in period t is a function of price in period t-1. The relationship between quantity and price is determined by the structural coefficients of the supply and demand equations and β, which Nerlove defines as the "coefficient of expectations." Beta reflects the adaptive expectations mechanism. According to Nerlove, producers make production decisions in period t based upon "normal price (P_t^*)". The outcome of producer production decisions is realized in period t+1. As defined by Nerlove, P_t^* is an expected price that reflects the distribution of past prices plus a price prediction error component. Equation 2 demonstrates that P_t^* is equal to the "normal price" in the previous period,(P_{t-1}^*) plus a proportion (β) of the price prediction error in the previous period$[P_{t-1} - P_{t-1}^*]$.

The concept of a value based pricing system is theoretically consistent with Nerlove's adaptive expectations hypothesis. Empirical evidence of grid pricing mechanisms being effective conduits for the transmission of price signals to producers

should be revealed in the relationship between weekly market price and quantity across grid carcass quality categories.

Two empirical methods will be used to evaluate the robustness of the grid price transmission mechanism across grid premium and discount categories: a) Linear regression techniques used to estimate Nerlove's supply response function as specified in equation 3 to evaluate changes in the relative supply of carcass attributes in response to changes in grid prices, and b) Granger Causality to evaluate the strength of the relationship between the grid premiums (discounts) and the relative weekly supply of a carcass attribute. These empirical procedures can help us ascertain if the producers are responding to grid premiums (discounts) signals and if the grid premiums (discounts) are conduits to bring the desired changes in cattle carcass quality.

Data:

Data was downloaded from the Livestock Marketing Information Center (LMIC). The LMIC obtained the data from a weekly AMS publication (USDA-AMS: the National Carcass Premiums and Discounts for Slaughter Steers and Heifers weekly report: LM_CT155). The data collected represents the post MPR period starting April 09, 2001 through May 24, 2010 for quality grades (n=477) and through March 31, 2008 for yield grades (n=365).[3] There is empirical evidence that the pre MPR grid premium and discount reports may be bias (Fausti et al. 2008). Accordingly the pre MPR grid premium and discount data were not included in the analysis. Prior to April 2008 packers reported yield grade for 90% of weekly slaughter volume. Beginning in April of 2008 the percentage of weekly slaughter for which packers reported yield grade began to decline. By February 2009 the percentage of slaughter volume for which packers reported yield

grade dropped to 50%. Accordingly the yield grade data after March 31, 2008 were not included in the analysis.

Specifically, grid premium and discount data were collected on national slaughter cattle grid premium and discount prices for the following quality grade categories (prime, choice/select discount, and standard), and two yield grade categories (YG1-2 and YG4-5). We decided to use the absolute value of discount price data to simplify the discussion of empirical results.

Weekly carcass quality steer and heifer slaughter data reflects the percentage of carcasses grading prime, choice, select, standard, YG1-2, and YG4-5. The volume variables are labeled Primev, Choicev, Selectv, Standardv, YG1-2v, and YG4-5v. This LMIC data corresponds to 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.[4] Summary statistics are provided in Table 1.

Empirical Methodology:

Nerlove "Supply Response"

Nerlove's short-run supply response function (eq. 3) assumes quantity supplied in period t is dependent on price and quantity supplied in period t-1. The "Coefficient of Expectations (β)" captures producer reaction to unexpected changes in price; i.e., a deviation from the expected "normal" price. We use linear regression techniques to estimate equation 3 for each grid category discussed above:

$$5. \qquad Q_t^s = \iota + \kappa P_{t-1} + \lambda Q_{t-1}^s + v_t \,.$$

Where $\iota = c\beta, \kappa = d\beta, and\ \lambda = 1 - \beta,$ and the symbol v_t denotes the error term. We employ the Newey-West (1987) estimation procedure to generate a Heteroscedasticity / Autocorrelation (HAC) robust standard error to estimate the regression coefficients.

We assume Q_{t-1}^{s} is a proxy capturing all exogenous factors affecting producer supply response. The adaptive expectations hypothesis suggests that Q_{t-1}^{s} also captures the distribution of past prices $P_{t-j}\ \forall\ j > 1.$ The regression coefficient estimate "λ" will be used to derive an empirical estimate for β. The empirical estimate for β will provide a rough estimate of how quickly producers are adapting their price expectations to unexpected price changes.

The lagged price coefficient estimate "κ" for each grid category represents the influence of last week's premium or discount on the relative supply of a specific carcass quality characteristic for the current week. We do not expect a substantial supply response from feedlot operators to changes in the previous week's premium and discount schedule. However, we do expect that feedlot operators would show some level of sensitivity to recent price information given that we expect marketing decisions to be made using profit maximizing criteria. Thus, we interpret a "k" as capturing a very short-run supply response to a change in weekly grid premiums and discounts.

Granger Causality

The concept of causality within a time series framework was introduced by Granger (1969). Granger's empirical methodology is based on the concept that a "Granger Causal Relationship" exist if past values of p_t can be used to better predict current values of q_t. If this is true, then this relationship is expressed as p_t "Granger Causes" q_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 or cointegrated, b) the selection of the appropriate lag length for the sampling period, and c) relevant variables which influence both p_t and q_t may be the source of the causal relationship between p_t and q_t.[5]

Formally, it is hypothesized that the introduction of grid pricing for the purpose of changing production behavior over time can be empirically tested by estimating the Granger Causality relationship between weekly grid premiums and discounts (p_t) and the relative supply of those carcass attributes (q_t). There are three possible Granger Causality outcomes between p_t and q_t: a) bidirectional causality, b) unidirectional causality, and c) Granger noncausality.

Let us define the weekly price of a specific beef carcass trait as p_t, and weekly relative supply of a carcass trait as q_t. The potential relationship between p_t and q_t is defined in equations 6 and 7. The direction of Granger Causality is not assumed. Toward that end, a VAR (n) model is utilized:

$$6.\ q_t = \sum_{j=1}^{n} B_{qj} q_{t-j} + \sum_{j=1}^{n} B_{pj} p_{t-j} + e_{qt}$$

$$7.\ p_t = \sum_{j=1}^{n} C_{qj} q_{t-j} + \sum_{j=1}^{n} C_{pj} p_{t-j} + e_{pt}$$

The null hypothesis of p_t does not Granger cause q_t can be specified as

$$8.\ H_0^1\colon\ B_{p1} = B_{p2} = \cdots = B_{pn} = 0,$$

and the null hypothesis of q_t does not Granger cause p_t can be specified as

$$9.\ H_0^2\colon\ C_{q1} = C_{q2} = \cdots = C_{qn} = 0.$$

The sensitivity caveat of the Granger test to lag length is addressed by adopting an optimal VAR lag length selection criteria rule that is based on AIC "goodness of fit"

statistic. The adoption of an optimal VAR lag length rule is consistent with the basic economic principle of profit maximization underlying producer supply response to changes in market price. The issue of stationarity is addressed using AIC criteria to select the appropriate lag length for the Augmented Dickey-Fuller Unit Root (ADF) test (Wooldridge 2000: p.581).

Empirical Results:

Supply Response Estimates

The regression estimates for the relative supply response function indicate that producer price expectation response (β) to a price change is very slow. Beta values range from 0.11 for Primev to 0.02 for YG4-5v (Table 2). Nerlove (1956: p. 501) commented on the magnitude of beta that "...the closer is the coefficient of expectation to zero, that is, the greater the tenacity with which farmers cling to their previous expectations…" The estimated β values provide evidence that the cattle producers do cling to their previous expectations with great tenacity.

Nerlove (1956: p. 501) suggests that β can be used to estimate the length of the distribution of past prices necessary before a new price signal will be acted upon to alter the producer's supply response. Assuming a producer has a threshold price ($\hat{P}_t$) above the expected normal price (P_t^*), the producer will alter his/her supply response if and only if he/she sees the ($\hat{P}_t \geq P_t^*$) for certain period of time. The adaptive expectations hypothesis assumes that producers will revise their expected price P_t^* in proportion (β) to the level of their prediction error:$\hat{P}_t - P_t^*$. The length of the adjustment process (n) necessary to fully integrate the threshold price into expected normal price (P_t^*) can be estimated by evaluating the sum of the weights for "n" past prices: $(1-\beta)^{n+1}$.

Following Nerlove, in Table 2, it is assumed that 95% of the prediction error has to be transmitted before a supply response is triggered: $(1-\beta)^{n+1} = 0.05$. Accordingly, the estimated lag length for the transmission of a price signal to trigger a supply response ranges from 25 to 164 weeks (Table 2). These results show that producers are only responsive to a persistent market signals: i.e., the threshold price $\hat{P}_t$ must persevere in the market over long periods. The beef industry's assertion of a lack of market signal clarity seems compatible with producer's requiring persistent market signals over a long period of time before any supply response occurs. In the absence of a persistent signal, producers may perceive the market signal to be vague, and may not alter their production plans until a persistent (clear) market signal is indentified.

In accordance with Nerlove's adaptive expectations hypothesis, the lagged price supply response coefficient "κ" is expected to be positive for premiums and negative for discounts. Empirical results indicate that none of the "κ" coefficients are significant with the correct sign (Table 2). The "κ" coefficient in the Primev regression is significant but has a negative sign, which is contradictory to the Nerlove's adaptive supply response hypothesis. Nerlove's supply response suggests that higher premiums will be associated with a larger relative supply of cattle grading prime. Our estimate indicates that a higher premium level is associated with lower relative supply of prime carcasses. Similarly, the "κ" coefficient for the Standard regression is significant but has positive sign, indicating that larger discounts are associated with increased relatively supply of fed cattle grading Standard. Nerlove's supply response hypothesis suggests that higher discounts will be associated with lower relative supply of cattle grading standard.

A plausible explanation for these contradictory results is that the supply of a particular carcass characteristic is fixed in the very-short run. This implies producers have no production flexibility in the very short-run. Therefore, in the very short-run, the market reacts to increases in quantity supplied with a decline in price. Market demand, in this case, determines the level of the carcass attribute's premium or discount. If our explanation is correct, then this would imply that market demand for the prime and standard carcass attributes is relatively inelastic in the very short-run.

Empirical estimates for "k" in the other four supply response equations find that "k" is statistically insignificant. This implies that for the carcass attributes; choice, select, YG1-2, and YG4-5, feedlot operators production decisions in the very short-run, are not responsive to price. Again, this implies producers have no production flexibility in the very short-run. However, in this case, this would imply that the market response to an increase in the quantity supplied of carcass attributes choice, select, YG1-2, and YG4-5 is very elastic in the very short-run.

The empirical results for producer short run supply response to price suggest that fed cattle producers need market signals that are persistent because they lack production flexibility in the short-run. The market clarity issue raised in the 2005 NBQA report may be due to the lack of persistence in grid price signal levels.

Granger Causality Estimates

Six premium and discount categories were also subjected to Granger Causality tests analysis. ADF unit root tests for stationary were conducted using AIC criteria to select the lag length for the ADF procedure (Table 3). The unit root tests indicated that the volume series for Choicev, Selectv, Standardv, and YG4-5v have unit roots.

Similarly, price series for Prime and YG4-5 also have unit roots. The unit root issue was resolved by taking the first-difference of these non-stationary variables. The Granger Causality tests were conducted to determine if there is a Granger causal relationship between the volume or the first difference of the volume and the price or the first difference of the price. The results for the Granger Causality tests are summarized in Table 4.

Grid pricing was introduced in order to facilitate discovery of carcass value consistent with the philosophy of a value based marketing system (Cross and Savell 1994). As it was pointed out elsewhere, the general consensus among beef industry marketing experts is that the carcass quality information along with premiums and discounts should motivate producers to improve carcass quality and reduce carcass quality variability over time. If the market participants' behavior were consistent with the philosophy of value based marketing system and the beef industry marketing experts' expectations, then we would expect to reject H_0^1 (i.e. p_t does not Granger causes q_t) and accept H_0^2 (i.e. q_t does not Granger causes p_t). In other words, we would expect uni-directional causality i.e. p_t Granger causes q_t. All of the tested series failed to confirm this uni-directional Granger relationship (Table 4). Two quality categories (Prime and Standard) show significant uni-directional causality but in the wrong direction, i.e. q_t Granger causes p_t. The other two quality categories (Choice and Standard) show highly significant bi-directional Granger causality, which implies price impacting the quantity at times, and quantity affecting the price at other times. This bi-directional Granger causality indicates the failure of the market to send consistent price signals.

In the case of yield grade categories, YG1-2 has a significant uni-directional Granger relationship but in the wrong direction (i.e. q_t Granger causes p_t), as in the case of prime. The empirical analysis for yield grade category YG4-5 failed to find a significant Granger relationship in either direction. The Granger analysis re-enforce the empirical results reported for the grid supply response functions.

The empirical results from Nerlove's supply response as well as Granger Causality analysis indicate that the grid pricing mechanism has not been able to transmit consistent and persistent signals that are necessary to encourage producers to alter production practices. These empirical findings re-enforce the concern raised in the literature that market signals transmitted by grid pricing mechanisms may be too weak to affect widespread change in the production behavior of fed cattle producers.

Concluding Remarks:

The general conclusion gleaned from our empirical findings is: while selling cattle on a grid does affect producer profit revenue and profit levels, it has not provided clear market signals that induce producer supply response to price across carcass quality attribute categories as envisioned by proponents of the value based marketing initiative for the fed cattle market. The lack of empirical evidence of grid premiums and discounts affecting the relative supply of quality grade and yield grade attributes in weekly slaughter volume over the 2001 to 2008 period covered in this study suggests that grid pricing signals to the market has not significantly affected producer supply response behavior. The lack of a supply response by producers suggests that the grid marketing mechanism has fallen short of the goals envisioned by the beef industry's value based

marketing initiative. Our study suggests that the 2005 National Beef Quality Audit (NCBA: 2006) call for clearer market signals is justified.

One possible explanation for the lack of market signal clarity in the grid pricing system is that producer behavior during this period was influenced by the incentive to produce heavier cattle due to low corn prices and relatively high fed cattle prices. This implies that the market incentive targeting weight gain rather than carcass quality dominated the price transmission mechanism. Another explanation is that carcass quality uncertainty may have affected producer production and marketing decisions. Risk aversion is a plausible explanation for the low beta estimates reported. Targeting weight gain rather than carcass quality may have been viewed as the lower risk production and marketing strategy, given that producers have the option of selling slaughter cattle by the pen at an average price. Both of these suppositions are plausible explanations for the weakness in the grid price transmission mechanism empirically documented in this study.

Footnotes:

1. The regulatory authority of the Livestock Mandatory Reporting Act of 1999 expired October 1, 2005 due to a sunset clause. Regulatory authority resumed in July of 2008. For discussion of MPR and the legislative time line see Perry et al. 2006, or Fausti et al. 2007.

2. The empirical literature on agriculture supply response suggests that the adaptive expectations approach has greater explanatory power than other expectation modeling approaches, e.g., rational expectations (Shonkwiler 1982).

3. The AMS stopped reporting the weekly percentage of individual yield grade volumes in February 2009. Therefore, it is no longer possible to look at the relationship between yield grade market share and yield grade premiums and discounts.

4. Note that because yield grade categories YG2–3 and the YG3–4 encompass 73.2% of weekly slaughter volume but provide relatively small premiums or discounts we are essentially calling them par categories during the sample period; therefore these series were not analyzed. The yield grade category YG>5 is very highly correlated with the YG4-5 category, and as a result we only included the YG4-5 category in our analysis.

5. It should be noted that the lack of Granger Causality does not rule out a contemporaneous relationship between p_t and q_t.

6. We employed Spearman Correlation analysis (Newbold 1995) as measure of contemporaneous correlation. Only the yield grade premium pair was found to have a statistically significant correlation coefficient ($r= 0.38$: $P<0.01$). All other correlation coefficients were below $r=0.10$. However, correlation is not a sufficient condition for causality.

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Table 1. Summary Statistics

Variable	No. of Obs.	Mean	Standard Deviation	Minimum	Maximum
Price (Premium/Discount):					
Prime	477	7.979	2.100	3.690	13.950
Choice/Select Discount	477	8.951	4.430	1.220	24.870
Standard	477	17.03	3.086	11.660	31.180
YG1-2	365	2.887	0.299	1.890	4.300
YG4-5	365	13.182	0.947	10.750	16.500
Volume:					
Primev	477	2.872	0.481	1.870	4.270
Choicev	477	54.314	3.451	48.560	65.430
Selectv	477	34.896	2.985	25.540	41.300
Standardv	477	7.918	1.240	4.710	11.590
YG1-2v	365	8.549	1.246	5.970	12.350
YG4-5v	365	6.242	2.550	1.510	11.280

Table 2. Grid Supply Response Estimates

Dependent Variable	No. of Obs.	Coefficient Estimates[1]				Price Formation (Weeks)[2]	R^2
		I	κ	λ	β		
Primev	477	0.370	-0.008*	0.892**	0.108	25	0.825
		(4.07)	(-1.63)	(38.83)			
Choicev	477	1.612	0.008	0.969**	0.031	94	0.926
		(1.77)	(0.80)	(61.67)			
Selectv	477	1.520	0.004	0.955**	0.046	64	0.918
		(2.41)	(0.38)	(49.37)			
Standardv	477	-0.205	0.152*	0.9430**	0.057	50	0.905
		(-0.36)	(3.16)	(44.08)			
YG1-2v	365	0.527	0.026	0.929**	0.071	39	0.877
		(2.55)	(0.32)	(45.29)			
YG4-5v	365	-0.110	0.018	0.982**	0.018	164	0.981
		(-0.45)	(0.84)	(106.6)			

[1]T statistics are provided in parenthesis below coefficient estimate, and a single asterisk (*), and double asterisks (**) denote statistical significance at 0.10, and 0.01 level, respectively.
[2]Estimate for the number of weeks required before 95% of a price signal is transmitted to producers.

Table 3. ADF Unit Root Test Results: Ho=Unit Root[1]

Weekly Price and Volume Proportion Series	Obs.	Tau Statistics	P-Value[2]	AIC Optimal Lag
Price (Premium/Discount):				
Prime	477	-1.92	0.322	12
Choice/Select Discount	477	-3.02	0.034	12
Standard	477	-3.89	0.002	12
YG1-2	365	-4.59	0.001	12
YG4-5	365	-1.51	0.528	12
Volume:				
Primev	477	-4.05	0.001	8
Choicev	477	-1.40	0.584	12
Selectv	477	-3.04	0.032	4
Standardv	477	-2.45	0.128	12
YG1-2v	365	-4.59	0.001	8
YG4-5v	365	-2.18	0.213	4

[1]Statistical analysis was conducted using SAS (Version 9.13: 2007) and RATS (Version 7: 2010). SAS generated P-Values based upon RATS estimated Tau statistics.

[2]Existence of unit root is rejected at $\alpha \leq 0.05$.

Table 4. VAR (Optimal) Model: Direction of Granger Causality (α level = 0.05)[1]

q_t% (Volume)	p_t % (Price)	q_t Granger causes p_t	p_t Granger causes q_t	Granger Causal Variable
Primev	*d*Prime	Yes*	No	Uni-directional
*d*Choicev	C/S Discount	Yes**	Yes**	Bi-directional
*d*Selectv	C/S Discount	Yes**	Yes**	Bi-directional
*d*Standardv	Standard	Yes*	No	Uni-directional
YG1-2v	YG1-2	Yes*	No	Uni-directional
*d*YG4-5v	*d*YG4-5	No	No	Non-Granger Causality

[1]First difference of a variable is denoted by placing a *"d"* at the beginning of the variable label. Statistical analysis was conducted using RATS (Version 7: 2010).
Note: Number of observations=410, a single asterisk (*), and double asterisks (**) denote statistical significance at 0.10 and 0.01 level, respectively.