Price Asymmetry in Spatial Fed Cattle Markets

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Price asymmetry in spatial fed cattle markets is investigated for three large markets (Texas Panhandle, Nebraska, and Colorado) and one small market (Utah). Little support is found for the notion that equilibrium prices for fed cattle are asymmetric between locations. However, adjustments to price increases and price decreases occur at different speeds.

Key words: asymmetric prices, fed cattle, spatial markets.

An issue examined in recent research is whether short-run cash price adjustments are asymmetric in the sense that responses to price increases are different than responses to price decreases. This research has centered on whether price adjustments between levels of a marketing channel are asymmetric (Kinnucan and Forker; Boyd and Brorsen; R. Ward). No research has examined the case of spatial cash price adjustments. Spatial price adjustments in cattle markets might be asymmetric for several reasons including asymmetric adjustment costs, asymmetric information, market concentration, and asymmetric price reporting. Our purpose was to determine whether short-run cash price adjustments of spatial fed cattle markets are asymmetric. Like past research on this issue, we tested for the existence of asymmetry. We did not directly test hypotheses about the reasons for any observed asymmetry.

The procedure used to test asymmetry is to regress price changes in one market on both the positive and negative price changes in another market. This provides a measure of the relative influence of price changes (both positive and negative) in one location on another market location. Two statistical tests are conducted to determine if (*a*) the total effect of positive price changes and negative price changes are equal and (*b*) if the speed of adjustment to positive and negative price changes is the same.

Factors Affecting Price Adjustments

Even though the empirical analysis used here cannot formally test which of several possible factors is the cause of any asymmetry, it is important to establish theoretical reasons to expect spatial price adjustments for fed cattle to be asymmetric.[1] Four possible causes of asymmetry discussed are (*a*) asymmetric adjustment costs, (*b*) market concentration, (*c*) asymmetric information, and (*d*) asymmetric price reporting.

Buyers (packers) and sellers (feedlot operators) in fed cattle markets likely have different adjustment costs. Meat packers invest substantial capital in buildings and equipment. Also, many meat packers are required by labor contracts to provide a minimum number of hours for employees. This makes labor basi-

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[1] We do not base our theoretical arguments on either the spatial pricing theory of Greenhut, Norman, and Hang or the perfect market integration idea advocated by Ravallion. Both sets of research share some common ideas with this paper. However, neither spatial pricing theory nor perfect market integration theory really apply to the problem we address. For example, spatial pricing theory is not based on the adjustment of market prices in different locations as is investigated here but rather the reaction of individual firms to changes in competitors' prices. Also, perfect market integration requires very restrictive assumptions that do not hold for this dataset. These assumptions include (*a*) homogeneous products in the various locations, (*b*) the true model is exactly specified, and (*c*) the prices are measured without error.

cally a fixed cost (McCullough). Fixed costs are large enough that packers are willing to reduce margins significantly in the short run to keep plants operating by increasing prices for cattle to maintain volume (C. Ward 1987). A packer could adjust output by changing line speed or increasing overtime or an additional work shift either could be started or shut down, but all these alternatives are costly.

Feedlots can adjust output by increasing or reducing marketings in the very short run. When prices decline, feedlot operators must establish some expectation of short-run price trends and judge if delaying cattle sales will increase revenues. This also must be based on many other factors including the condition of cattle ready to be sold (grade, homogeneity, etc.), contract requirements, feedlot capacity, and cash-flow requirements.

Once fed cattle reach a desirable grade, the feedlot operator has approximately two weeks to decide when to sell the cattle and still maintain quality (Stenquist). Most cattle are purchased on a liveweight basis and priced on estimates of lot quality (average pricing) (C. Ward 1987). This may allow feedlot operators more latitude in selling decisions and may increase their incentive to withhold cattle from the market should prices fall.

Based on these differences in adjustment costs, feedlot operators may behave differently than packers when prices are either rising or falling. For example, packers may raise bids quickly to compete with packers in other regions but lower bids more slowly in order to maintain volume. The costs of adjustment likely do not vary by location, so if asymmetric adjustment costs were the cause of asymmetry, all locations would be expected to respond similarly.

R. Ward and Kinnucan and Forker suggest market power might explain findings of asymmetric price adjustments. Scherer argues price inflexibility may exist in industries characterized by nonprice competition, high market concentration ratios, and large advertising expenditures. For example, asymmetry could result if firms perceive a kinked demand curve. The kink in the demand curve can result when individual firms believe that no competitor will match a price increase, whereas all firms would match a price cut. The opposite is also possible when the individual firm believes that all its competitors would match a price increase, but none would match a price cut. Cattle markets do not have large advertising expenditures nor do they have much nonprice competition, but they are concentrated on a regional basis [Quail et al.; U.S. Department of Agriculture, Packers and Stockyards Administration (USDA, P&SA); C. Ward 1982], and thus price responses might be asymmetric due to market power.

Concentration levels in the meat packing industry are high on a regional basis. For example, the 1982 four-firm concentration ratio (CR_4) for fed cattle slaughter in the Texas North Plains was 98.7%, Southwest Kansas 96.1%, Eastern Nebraska-Northwest Iowa 75.1%, and Central Iowa 100% (C. Ward 1982). Packer concentration in smaller markets is also high (e.g., Colorado 96.5%, Idaho 95.8%, Minnesota 96.7%, and Utah 99.2%) (USDA, P&SA).

While the number of feedlots in the United States has decreased markedly during the past 20 years, the remaining or entering feedlots have increased dramatically in size [U.S. Department of Agriculture, Statistical Reporting Service (USDA, SRS)]. This implies concentration levels in cattle feeding also have increased. However, few experts believe individual feedlot operators or groups of feedlot operators have any market power on a local or regional basis (Davis). This implies that market power, if it exists, would be on the buyers' side.

Economists such as Akerlof have long recognized the market inefficiencies that can be introduced due to asymmetric information. The U.S. Department of Agriculture provides considerable public cattle market information (e.g., number of cattle on feed, marketings, prices, etc.). Other private sources are available to firms, or firms can collect market information internally. Costs associated with gathering both public and private information include subscription fees, telephone and computer charges, salaries, etc.[2]

Firms will likely invest in information (from public and/or private sources) to the point where the "cost of search is equated to its expected marginal return" (Stigler, p. 175). When market participants handle large volumes of cattle, the average cost per head for information decreases. Economies of size may

[2] Some market information that may be valuable in buying and selling decisions include current prices, transportation costs, market shares of buyers and sellers, current and projected near-term marketings, slaughter weights, wholesale orders, and other information related to supply and demand and market environment.

play an important role in price discovery and adjustment if a combination of public and private information is superior (more timely and accurate) to public information alone, and/or some firms are more efficient in analyzing available information. This asymmetric information could cause asymmetric price adjustments.

Finally, there is the possibility that it is just the reported prices that are asymmetric. A spokesman for a large buyer of broilers once observed that "USDA market reporters may not report discounted cash loads as quickly as a higher priced load when the market is going up" (Hayenga, p. 48).

Data

Data for this study were weekly quotes from June 23, 1979, to April 16, 1986, for choice fed steers grades 2–4 between 1,100 and 1,300 pounds liveweight. The locations considered included Amarillo (Texas Panhandle), Omaha (Nebraska), Colorado and Utah. These data were for direct sales except for the Omaha terminal market. The data were collected from the Western Livestock Marketing Information Project (1986), the Utah Department of Agriculture, and U.S. Department of Agriculture (USDA) *Livestock, Meat and Wool Market News.*

These locations were selected based on their relative importance to the price discovery process for fed cattle. Nebraska and the Texas Panhandle represent major markets for fed cattle with large weekly volumes. Colorado is also a relatively large market but smaller than Nebraska and the Texas Panhandle. Utah is a small and isolated fed cattle market with a high packer concentration (CR_4 of nearly 100%). These markets represent a cross section of the types of markets in which fed cattle are traded.[3]

Methods

Test for Asymmetric Prices

Weekly data were selected based on the availability of official price quotes from USDA. While price adjustments may take place in shorter time periods, in a previous study we still found leads and lags among prices in these locations using weekly data. The Texas Panhandle was identified as the leading market for fed cattle prices between 1978 and 1983, and we hypothesized that market volume and packer and feedlot concentration on a regional basis affected the price discovery process for fed cattle (Bailey and Brorsen 1985).

We conducted the same causality tests on the data used in this study. The basic relationships between the markets were the same with the Texas Panhandle leading the market. Consequently, the asymmetry tests were conducted by regressing price changes in the other three markets on Texas Panhandle price changes.

Price differences between central market locations generally have been smaller than transportation costs (trucking and shrink) (Bailey and Brorsen 1986). Price differences exceeding transportation costs between locations are occasionally observed but usually exist for only short periods of time. Factors other than transportation costs may affect these adjustments. However, transportation costs appear to operate as an imperfect upper bound for price differences between locations. Consequently, transportation costs serve as a proxy for influences besides cattle prices that impact the magnitude of price adjustments but do not influence the speed of adjustment. A more complete model would include weekly market concentration levels, live marketings, wholesale sales, supply and demand of transportation services, production density, and marginal processing costs. Unfortunately, these data are not publicly available on a weekly basis. Consequently, we relied on the price and transportation cost information to include these implicit relationships.

Kinnucan and Forker used a model similar to the one used here except their model was based on different theoretical arguments and was specified using price levels. Our model, while similar to Kinnucan and Forker's, uses first differences. This model does not have severe first-order autocorrelation like the model with price levels (Boyd and Brorsen).[4]

The selection of a first difference model was

[3] The market area for the Texas Panhandle corresponds to market areas delineated by C. Ward (1982). The Omaha terminal market was not included in C. Ward's study. Colorado and Utah are markets defined within state boundaries based on the information available to the researchers.

[4] Kinnucan and Forker and Boyd and Brorsen found their models had autocorrelated residuals. R. Ward was unable to test for autocorrelation since his data series was not continuous.

based on the Dickey-Fuller (DF) test for unit roots. This test is conducted as follows:

$$\Delta u_t = \phi u_{t-1} + t, \tag{1}$$

where Δu_t is the first difference of a series at time t. Equation (1) is estimated using ordinary least squares, and the test is conducted using a t-statistic for the parameter "ϕ" (Nachane, Nadkarni, and Karnik). A first difference model could not be rejected at the 10% confidence level for all four price series.

Based on the DF test, the specification of our model when prices are allowed to be asymmetric and transportation costs are allowed to vary is

$$PC_{jt} = a_0 + \sum_{k=0}^{K} b_k\, TPP_{t-k} + \sum_{k=0}^{K} c_k\, TPN_{t-k} + TRAN_t + e_t, \tag{2}$$

where PC_{jt} is the price changes for fed cattle in market j (j = Colorado, Nebraska, and Utah) in time period t ($t = 1, \ldots, T$); TPP is the positive price changes in the Texas Panhandle from period $t - k - 1$ to $t - k$ or zero if negative; TPN is the negative price changes in the Texas Panhandle from period $t - k - 1$ to $t - k$ or zero if positive; and $TRAN$ is changes in USDA's Office of Transportation monthly truck fleet costs in cents per mile. Weekly transportation cost values were obtained by linear interpolation.

Akaike's Information Criterion was used to select the value of k in equation (2). A lag of one week for Texas Panhandle price changes was found to be appropriate for all three markets ($k = 1$), showing that these fed cattle markets adjusted to price changes in the Texas Panhandle within one week.

Like Boyd and Brorsen, this study tests two asymmetry hypotheses. The first hypothesis is that the total effect of price increases is equal to that of price decreases $\left(\sum_{k=0}^{K} b_k = \sum_{k=0}^{K} c_k\right)$. The second hypothesis is that the speed of the adjustment is the same for both price increases and price decreases ($b_1 = c_1, \ldots, b_K = c_K$). R. Ward used a distributed lag with only one free parameter, so he could not discern between these two hypotheses. Kinnucan and Forker only tested the first hypothesis, but they did provide some information about the second using a procedure suggested by Rao and Miller (pp. 174–76). The following section reports the parameter estimates of equation (2) together with the associated asymmetry tests.

Results

The results of the asymmetry tests presented in table 1 suggest price increases in the Texas Panhandle have more immediate impact on the other three markets than price decreases. This is true since the coefficients for positive price changes in the current week (TPP_t are larger than the coefficients for negative price changes (TPN_t). The coefficients for all price variables were statistically different than zero. However, the transportation index was not significant in any of the equations. This may indicate that changes in transportation costs were so small relative to changes in actual weekly supply and demand conditions that no statistical relationship was found.

Positive price changes during the current week (TPP_t) have a coefficient statistically larger than one (F-test) for the Colorado market. This indicates an overreaction in this market to price increases in the Texas Panhandle. The lagged positive Texas Panhandle price changes (TPP_{t-1}) are significant in the Colorado and Nebraska equations but have negative coefficients. This indicates that an adjustment is taking place during the second week after a price increase.

Coefficients for the current week's price changes are much larger than for lagged prices for both positive and negative price changes (e.g., the coefficient for TPP_t is larger than the coefficient for TPP_{t-1}) for all three markets. This indicates most of the impact of price changes in the Texas Panhandle is incorporated into price changes in the other markets within one week. This result confirms our finding (Bailey and Brorsen 1985) that fed cattle markets adjust quickly to new price information.

The coefficients for the Utah market [equation (5)] are smaller for the current week adjustments and larger for the lagged week adjustments than the other two markets (Colorado and Nebraska). This would suggest that adjustments in Utah tend to take longer, on average, than in the other markets.

The F-test of the hypothesis that the sum of the coefficients for positive and negative Texas Panhandle price changes are equal cannot be rejected for the three markets tested [equations

Table 1. Ordinary Least Squares Estimates for Asymmetric Models of Spatial Fed Cattle Markets, 1978–86[a]

Dependent Variable	Intercept	Independent Variables[b]					R^2	Durbin-Watson Statistic	Sum[c] F-Value	Identical[d] Coefficients F-Value
		TPP_t	TPP_{t-1}	TPN_t	TPN_{t-1}	$TRAN_t$				
Equation:										
(3) Nebraska Price Changes	0.001 (.028)	0.987** (24.63)	−0.163** (−3.92)	0.659** (16.23)	0.191** (4.74)	0.0543 (0.637)	.811	2.19	0.100	20.30**
(4) Colorado Price Changes	0.001 (.019)	1.080** (30.45)	−0.107** (−2.92)	0.898** (24.99)	0.073** (2.05)	0.013 (0.179)	.885	2.68	0.001	7.29**
(5) Utah Price Changes	−0.071 (−0.97)	0.623** (10.69)	0.236** (3.92)	0.452** (7.65)	0.304** (5.18)	0.192 (1.55)	.568	2.13	0.735	1.56

[a] t-values are in parenthesis.
[b] TPP_t = Positive Texas Panhandle Price Changes, TPP_{t-1} = TPP_t lagged one week, TPN_t = Negative Texas Panhandle Price Changes, TPN_{t-1} = TPN_t lagged one week, $TRAN_t$ = Changes in USDA Office of Transportation monthly truck fleet costs (¢/mile).
[c] A test of the null hypothesis that the impact of positive price changes is the same as negative price changes (i.e., $b_0 + b_1 = c_0 + c_1$).
[d] A test of the null hypothesis that the coefficients for the positive and negative variables are identical (e.g., $b_0 = c_0$ and simultaneously $b_1 = c_1$ [see equation (2)].
Note: Single asterisk indicates statistical significance at the .05 to .10 level; double asterisk indicates statistical significance at the .05 level or better.

Table 2. Sums of Coefficients for First Difference Model of Spatial Fed Cattle Markets

Market Location	Sum of Positive Coefficients[a]	Sum of Negative Coefficients[b]
Nebraska	.824	.850
Colorado	.973	.971
Utah	.859	.756

[a] Sum of positive price change coefficients from table 1, i.e., $b_0 + b_1$.
[b] Sum of negative price change coefficients from table 1, i.e., $c_1 + c_2$.

(3)–(5)]. This implies that total impacts of negative and positive price changes in the Texas Panhandle tend to have equal influence on the other markets.

Although negative and positive price changes appear to have equal total effects between the Texas Panhandle and most of the other markets considered, the speed of adjustment is different. The F-tests for identical coefficients for the positive and negative price changes reveal that adjustments to positive price changes tend to be made more quickly (table 1). As mentioned before, there are several possible theoretical reasons to find asymmetry. Since all markets responded similarly, the most likely explanation is asymmetric adjustment costs. Packers may be more aggressive in buying and contracting cattle when prices increase in anticipation of tighter cattle supplies.

Sellers may also sometimes hold cattle off the market when prices decrease. This phenomenon had a major impact on the market during the spring months of 1985 and 1986. During these periods, large numbers of cattle were held in feedlots past their usual marketing weights due to falling prices (Western Livestock Marketing Information Project 1985).

Sellers must make some judgment regarding the longevity of market trends, i.e., they must make current marketing decisions based on current prices, recent price trends, and price expectations. While sellers may have some discretion regarding withholding cattle from the market, buyers are likely more constrained by contract agreements and plant efficiency to continue to produce. Decreasing prices indicate adequate supplies of fed cattle, but prices may drop more slowly if sellers hold cattle off the market.

The sums of the positive ($b_0 + b_1$) and negative ($c_0 + c_1$) price change coefficients found in table 1 were calculated and are presented in

table 2. Taking the total impacts of price increases and decreases together, little evidence was found to suggest that asymmetry exists in the long run between major market locations for fed cattle. Total price adjustments upward and downward are nearly equal. In all markets examined, reaction to price increases was quicker than reaction to price decreases, indicating that different incentives for market participants exist when faced with either price increases or price decreases.

Summary and Conclusions

This study found that spatial price adjustments in fed cattle markets are asymmetric. Positive Texas Panhandle price changes were reacted to faster than negative price changes. The total effects of positive and negative price changes in the price leading market (Texas Panhandle) on the three other cattle markets were not significantly different. The other markets included a large regional market (Nebraska), an intermediate-sized market (Colorado), and a small market (Utah).

Price adjustments to new information appear to be slower in the small Utah market. This may indicate that buyers in the Utah market need not be as aggressive in responding to new price information as their counterparts in the major markets. Lack of competition and also the fact that Utah is a residual market may explain this more even adjustment. However, buyers in Utah also eventually adjust to price information in the other regional markets.

Price adjustments in fed cattle markets are apparently influenced by different incentives for market participants. While overall impacts of positive and negative price changes are equal, more information is needed regarding why the speed of adjustment to price increases is faster than to price decreases. This phenomenon may represent an inefficiency where gains and losses do not equally offset in the short run. However, further investigation is needed to fully explain why prices increase faster than prices decrease.

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