Location and Distance Effects on Western Calf and Yearling Prices

by

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Abstract

Some long-standing concerns regarding cattle markets in the western United States are addressed in this study using twelve years of data from video auction sales across the West. Western ranchers receive lower prices for cattle relative to prices received by ranchers in the Midwest. We show that the price received by ranchers in western states includes a discount fixed per mile from a central market in the Midwest. That implies a competitive, FOB pricing structure may be operating in cattle markets, however different distance discounts in calf and yearling market segments, plus the presence of additional regional price discounts in western states, indicate conditions typical of an integrated market in which buyers favor sellers in the Midwest over those in the West. The average amount of location and distance discounts are both reported for multiple market regions. Some implications of those results are drawn concerning the market structure of the western cattle market and its local components.

LOCATION AND DISTANCE EFFECTS ON WESTERN CALF AND YEARLING PRICES

Cattle producers in the western United States are increasingly concerned about the long-term viability of their industry because recent market developments have revealed a pattern of price discounts that disadvantages ranchers located outside of the Midwest. For example, a study conducted in 2004-05 showed that feeder cattle prices were discounted by increasing amounts in markets located farther west, relative to Midwestern prices (Blank et al.). That study was made possible by the development of national cattle auctions conducted using satellite video sales methods. Video auctions operate much like a traditional auction, but have a much larger pool of potential buyers from across the country. As a result, cattle sale prices observed in video auctions are often more indicative of "national" prices than are local cash sale prices (Bailey, Peterson, and Brorsen). Cattle in video auctions are located at ranches across most producing states, so the data enable researchers to analyze sales made at the same time by producers at different locations. Thus, only the recent appearance of such data has shown the cattle industry the scale of spatial price discounting. Ranchers in the West have been alarmed by evidence of spatial discounting because they think it may be indicative of differences in competitiveness between cattle producers in the Midwest versus the West.

This paper contributes to the literature in several important ways. To begin, the analysis was conducted using a unique data set that includes five types of variables not available to researchers earlier. Those unique variables include specially designed regional market dummies, a precise distance variable, a "number of buyers" variable, forward contracting dummies, and several value-added production and marketing variables. The unique data enable this study to do at least two things not done in previous cattle market research. First, we conduct price analyses

over time, space, and product form (calves versus yearlings) simultaneously. Second, we are able to test hypotheses and draw implications about theoretical issues such as the general competitive structure and specific market functions made possible by satellite auctions.

BACKGROUND

The cattle market in the United States is evolving, thus causing changes to the list of factors which influence cattle prices. The evolution has been occurring for decades and is well-documented (e.g., MacDonald and McBride). In general, the evolution is causing concentration in the cattle feeding and meat processing industries (Ward 2002; Morrison Paul 1999, 2000) which is altering the relative market positions of cattle producers in different regions of the country, putting producers in the West at a perceived disadvantage to their competitors located in the Midwest (e.g., Andersen et al.). The primary reason for this price discounting practice is generally understood to be related to the Midwestern location of most feedlot, slaughter, and packing facilities. This means ranchers in western states are essentially paying for shipping calves to these facilities in the Midwest in the form of discounted prices. The cost of that transportation is believed to be the basis for price discounts offered in Western markets compared to prices offered in markets located closer to the Midwestern meat processing industry (Goodwin and Schroeder; Clary, Dietrich, and Farris). These results are alarming for cattle ranchers in the West because, with the cost of transportation increasing rapidly, there is reason to expect cattle price discounts to increase over time in western markets. However, western ranchers are even more concerned about the possibility that recent changes in the cattle market structure are causing buyers to favor suppliers located closer to the Midwestern processing industries.

In economic terms, the presence of price discounts raises important hypotheses. First, if the "distance" discounts approximate actual costs of shipping feeder cattle to the Midwest, pricing resembles FOB ("free on board") pricing, a system consistent with a competitive market structure. Second, if there are additional price discounts in some regional markets after accounting for distance effects of transportation costs, those additional "location" discounts could indicate imperfect market conditions brought about by the evolving structure of the cattle industry. For example, the presence of location discounts would be consistent with a possible imbalance in the market power of cattle buyers and sellers that has led to price discrimination (as noted by Crespi, Xia, and Jones for fed cattle) which, in turn, could cause cattle producers in some western regions to leave the industry entirely, further concentrating the U.S. cattle industry.

The presence of both distance (FOB) and location discounts is possible because positive FOB results may reflect on the competitiveness of the cattle transportation industry more than on the cattle market itself. Beilock, Garrod, and Miklius showed that within a single commodity market, transportation costs are similar across customers due to the competitive nature of the trucking industry. Therefore, a commodity market that is truly imperfect in its pricing behavior can still include a competitive, FOB-type discount per mile for transportation costs.

Both location and distance price discounts reflect aspects of a spatial market. The geographic structure of the cattle industry is important in understanding the pricing observed within that industry. As Schroeder found, "spatial price relationships among beef packing plants have important implications in defining geographic live cattle markets" (p. 359, 361). He found that markets are integrated, but less so over longer distances implying a "... distance-decay in strength of spatial price linkages" (p. 361). He also noted that "... plants in Nebraska were price leaders and were a source of significant evolving price information" (p. 361). This explains why,

in Tomek's study of steers, "... prices on the Omaha market are used as a norm ..." meaning that "Omaha is, in effect, treated as a proxy for the national market" (p. 436). These results suggest using Omaha, Nebraska as a base for defining spatial markets in the West and for measuring the distance of those markets from the "national" beef packing sector (i.e., buyers of live cattle). We do so in this analysis.

Ranchers in the West have long sought to counter the perceived location and distance price discounts by applying management practices that add value to cattle. However, not all ranchers use these methods (Gillespie, Kim, and Paudel). Ward et al. found that many factors influence the decision to adopt "value-added" production in cow-calf operations and, as expected, producers' perception of profitability – in the form of a price premium received – is a key factor in that decision (Bulut and Lawrence). Cattle markets signal what they value by offering a price premium for animals that possess desired characteristics (Mintert et al.; Schroeder et al.; Faminow and Gum; Jones et al.; Parcell et al.). As a result, ranchers have developed many production and marketing programs aimed at producing cattle with characteristics thought to add value. For example, Blank et al. evaluated several value-adding programs and found that most had a positive effect on feeder cattle prices. However, Sy et al. (p. 463) noted that "... different segments of the cattle sector do not value characteristics the same ..." suggesting that "... signals regarding preferences may be noisy." Part of the noise in the signals comes from consumers' valuation of beef attributes (Abidoye et al.). An additional product form consideration arises in the results of Anderson and Trapp who found that calves of differing weights are considered different market segments with differences in their price response to input price changes. Finally, Blank et al.'s results showed that the price premiums received for value-adding factors changed over time, thus indicating the dynamic nature of

western cattle markets. For example, they showed that premiums for feeder cattle produced as "natural" increased over time, while preconditioned calves received smaller premiums over their study period. They also noted that some production and/or marketing programs became less popular and began receiving price discounts (e.g., the practice of implanting calves became less popular as price discounts became more common in the face of growing demand for "natural" beef).

A second part of ranchers' response to changes in the cattle market has been to take advantage of new opportunities made possible by video auctions themselves. In particular, one aspect of these sales that offers ranchers new marketing strategies, compared to traditional auctions, is the ability to forward contract. A generation ago feeder cattle auctions were "cash" sales with the animals displayed for buyers at the sale yard before being immediately loaded onto trucks (Faminow and Gum). The development of satellite video auctions has created the option for buyers and sellers alike to make transactions that do not require delivery of the animals for several months, although "immediate" deliveries are still possible. Although this has long been possible in fed cattle markets (Elam), it is a relatively new option for feeder cattle markets which has not been evaluated. Such a marketing strategy may have significant effects on prices received by western ranchers. For example, Ward (1988) argued that any structural changes that increase the number of buyers in cattle markets will increase the price received by sellers.

In summary, there are clearly spatial, product form, and temporal factors influencing the pricing of western cattle. Each of these factors must be addressed to enable an evaluation of the competitiveness of western cattle markets.

METHODOLOGY

Our study included data across time, space, and product forms. This enabled us to see changing trends in the dynamic cattle market in the West and to compare and contrast two market segments. We analyzed both calves and yearlings because previous studies have indicated that these two cattle market segments will have unique prices (Marsh; Garoian, Mjelde, and Conner). We focused on price differences in these markets across locations and were able to estimate average transport-based price discounts and regional location discounts as well as individual value-added program premiums received by ranchers. We conducted this research to broaden the literature beyond calf sales to include yearling sales and found that western cattle markets are indeed dynamic, as evidenced by several changes in the management practices being applied by ranchers and by changes in the pricing observed in both calf and yearling cattle markets. Our results have significant implications for cattle ranchers in all western locations.

Hypotheses to be Tested

A list of hypotheses to be tested is presented below in the form of research questions. Results for each question are presented separately later in the paper.

1: Are there distance effects? (1b) Do they approximate transport costs? (1c) if so, are they increasing over time?

2: Are there location effects? (2b) if so, are they a result of market power imbalances? (2c) do these effects indicate that buyers favor suppliers located closer to the Midwest?

3: Are distance and location effects consistent over time?

4: Are there price effects due to the market structure? (4b) is price positively correlated with the number of buyers in a sale? (4c) is a "storage" premium reflected in forward contract prices?

5: Are there differences between market segments (calves and yearlings)? (5b) what are the implications for competitiveness?

Data and Methods

Our data were unique. We used sales information from a major satellite auction operator, Western Video Market, which is operated in a manner typical of video sales operations. They hold auctions broadcast via satellite almost every month of the year.[1] Western Video Market provided us with anonymous information on steers from 4,618 lots of calves and 5,658 lots of yearlings sold in all of their video auctions held during the period 1997 through 2008. All calf lots had a flesh score of medium, a frame score of medium or medium-large, and average weights in the 500-625 pound range. This weight range was used to focus on the price effects of management of calves at weaning. Yearling lots averaged in the 750-925 pound range. No calves or yearlings between 625 and 750 pounds were considered in this study. The number of lots sold per year increased from a low of 154 in 1998 to a high of 542 in 2005 for calves and from 234 in 1997 to a high of 641 in 2005 for yearlings. In total, approximately 637,600 calves and 943,600 yearlings were included in our data. On average, more cattle were sold each year over the study period. Cattle from split loads, Holstein breed, or of Mexican origin were not considered in this study.

Our rich data set enabled us to create some new explanatory variables not available to other researchers. First, we developed a distance variable that was expressed as the number of miles from Omaha to the ranch selling the lot of cattle. This was possible because the ranch's location was included in the data available to us. We found the distance by using Google Maps.

Next, our analysis of price differences across locations was simplified by grouping the

[1] Sales catalogs and other information are available on their web site: http://www.wvmcattle.com/.

sales data into several market regions based on the pooling and flow of cattle observed in those locations over recent years (Bailey, Brorsen, and Thomsen). Originally, we used the regions defined by Blank et al. to enable us to compare our results to those in that earlier study. Those regions are shown in Figure 1. Three of the regions (regions 3, 4, and 6) are large, covering entire states. Blank et al. divided the far-west into six smaller regions to enable detailed analysis of local markets. We combined the six western-most regions (5, 10, 15, 20, 25, and 55 on the map) into a single, large region called "all other" to simplify our spatial analysis. Region 6, which includes Omaha, was used as the base for comparison with other regions by using dummy variables for all locations other than those in Region 6.

Another variable unique to our study is the "number of buyers" we were able to calculate from the data. It is the number of different people listed as having purchased at least one lot of cattle in a specific sale. For calves, this number ranged from a low of one in the March 1999 sale to 105 in the August 2005 sale. For yearlings, the low was two buyers in March 2002 and the high was 59 in July 2007.

The sale data also reported the date of expected delivery for each lot. By comparing that to the date of the sale, we were able to derive a series of "forward contracting" dummy variables. Most deliveries were set for four months or less from the sale date, therefore we used four dummy variables: "forward contracting one month", "... two months", "... three months", and "...four or more months", with the basis for comparison being cash sales (which were lots delivered the same month as the sale).

Other information available for each of the lots included characteristics of the animals, details about each sales contract, and supply and demand variables. Regression analysis of fixed-effects models enabled us to estimate the effects on the sales price of not only distance and

location, but also many other variables that commonly influence cattle prices. The hedonic price equation was defined simply as

(1) $$P = f(D, L, C, M, S/D)$$

where

D = the distance in miles from Omaha to the ranch selling the lot of cattle,

L = the location of the ranch in terms of its regional market (a dummy variable),

C = physical characteristics of the cattle in the lot (including value-added attributes),

M = marketing factors of the lot (including sale and delivery month, etc.), and

S/D = supply and demand factors.

The values for *C* and *M* are unique to each lot sold. *C* variables include breed, number of head in the lot, average weight, the variability of the cattle in the lot, and nine value-added programs. *M* variables include month of the year the lot is sold, month the lot is to be delivered, and the number of months the sale is forward contracted. *S/D* includes national supply and demand proxy variables: the number of buyers participating in the auction, total number of feeder cattle in the national inventory at the time of the sale, and a yearly trend. Regional supply variables (lots sold in the region by month and year, total head sold in the region by month and year) were also included to help assure that the regional dummy variable, *L*, is a residual containing only unique aspects of the local market that might reflect bargaining position imbalances.

GENERAL RESULTS ON DISTANCE EFFECTS

Equation 1 was estimated separately for calves and for yearlings using all the data over the 1997-2008 period. The final results of both regressions are presented in Table 1. Earlier regressions included other variables that proved to be insignificant and were dropped.

Calf Market Results

The distance variable ("miles from Omaha") in the calf price equation had a coefficient (per 100 miles) of -0.4458 which was statistically significant at the 99% confidence level indicating the average price received by ranchers is discounted about a half-cent per hundredweight for each mile the calves are away from Omaha at the time of sale. To test the hypothesis that the estimated distance effects are an approximation of actual transport costs, one of the authors contacted local ranchers that sell their cattle out-of-state and inquired about trucking costs. One rancher provided a number of observations on the actual costs incurred from different starting and delivery points, each of which were generally consistent with the regression coefficient (Sarmento).

In total, these regression and anecdotal results indicate that a FOB-type pricing system may be operating in the western cattle industry and that the price received by ranchers for their calves is discounted by the cost per hundredweight-mile of trucking their livestock to Omaha. The fact that the significant distance effects were estimated using data from across the western United States indicates that cattle trucking prices are geographically uniform and are set competitively. This indicates, in turn, that transportation costs are not the source of any price discrimination that may exist in local markets for calves.

Yearling Market Results

The distance variable in the yearling price equation had a coefficient of -0.1732 which was significant at the 99% confidence level. These results are very different to those found for calves, thus indicating the average price discount received by ranchers is *not* an accurate estimate

of transportation costs, otherwise nearly identical discounts per mile (i.e., regression coefficients) would have been found for the two cattle market segments. This result for yearlings supports the conclusion above that cattle trucking prices appear to be set competitively, but raises the point that price differentiation observed between product forms implies that factors beyond transport costs are at work in spatial cattle markets.

Overall, the fact that significant distance effects were found in both feeder cattle market segments studied here indicates that the spatial markets for each segment are integrated. Given that the distance variable is a measure of miles from Omaha for each seller's ranch, the statistical significance of the *D* variables reflects the physical market in which cattle flow from West to East.

GENERAL RESULTS ON LOCATION EFFECTS

Table 1 shows the results for location effects over the entire 1997-2008 period for both calves and yearlings. The location variable is a 0-1 dummy for each region except 6. Region 6 is used as the base of comparison because it includes Nebraska and nearby locations available in the data set. Simply stated, what these results show is that location effects were present in all regions after accounting for the effects on prices from the other factors listed, including the distance variable.

Calf Market Results

The location variable had a negative coefficient (indicating a price discount) for each of the three regions, and the result was statistically significant in all regions. Of particular note are the results for Regions 4 and 3, the two large regions directly west of Region 6. The location

effect for Region 4 shows an average discount of $2.38/cwt relative to the average price received for calf sales in Region 6, which includes the large cattle feeding and packing sector in Nebraska. The discount in Region 3, which is west of Region 4, is $5.24/cwt. This result means that location effects may increase the farther west a ranch is from Omaha, just as do total transportation costs. However, the $4.14 result for Region "all other", which is farther west than Region 3, shows what Schroeder called "distance-decay" in the price relationship.[2] This implies that "location effects" might include transaction costs incurred by cattle buyers (e.g., search costs, higher death rates and/or weight losses for calves in transit, more variability in delivery times, etc.) that they pass on to sellers in the form of a discounted price compared to prices offered to nearby (Region 6) sellers.

Yearling Market Results

The location variable was significant for all three of the regional markets for yearlings. Also, the scale of the coefficients for Regions 4 and 3 were generally similar to the results for calves, with yearling discounts of $1.33/cwt and $5.02/cwt, respectively. Again the discount for Region 4 was smaller than that for Region 3. This implies that similar location effects may be at work in local calf and yearlings markets. Additionally, the result for yearlings in region "all other" ($5.09) is the highest of the three and, thus, consistent with the "higher to the west" conjecture.

In summary, when viewing the map in Figure 1, it is apparent that the regional location results for both calves and yearlings are generally consistent with the conjecture that average

[2] This result is understandable because the cattle market in the far West is not part of a "closed set", meaning that not all feeder cattle in region "all other" move to feedlots and packing plants in Region 6. There are a few feedlots in California and some cattle are transported southeast to processing facilities in Oklahoma and elsewhere. Thus, part of the distance-decay in the price relationships is due to leakage in the physical flow of cattle from the West to the Midwest.

price discounts will be larger the farther away the seller is from the Midwest. The regional discounts were somewhat similar in amount for yearlings and calves, and the same geographic pattern exists. All of these results are consistent with hypothesis 2c, that buyers favor suppliers located closer to the Midwest. Such a spatial bias is easily understood as one means of reducing uncertainties and transaction costs for buyers. It also implies that there is an imbalance in the competitive position of cattle producers in the West compared to producers in the Midwest.

DISTANCE AND LOCATION RESULTS OVER TIME

As noted earlier, there is reason to think the distance discounts will be fixed per mile at any particular point in time, but may increase over time due to increasing transportation costs, thus enabling us to reject hypothesis 3. Therefore, we evaluated the distance and location price discounts by year to see if they changed over time. The results for calf prices are in Table 2 and yearling results are in Table 3. All variables listed in Table 1 were included in the annual models estimated separately for calves and yearlings, although all of those results are not reported here. In both tables, the columns are arranged from left to right in the order of the regions' locations from west to east so as to make it easier to see whether the discounts followed the expected pattern of increasing from east to west.

Calf Results Over Time

As shown in Table 2, there were indeed differences in the average distance and location effects from one year to the next in the 12 sets of regression results. Those differences across time imply that factors beyond transportation costs and differences in relative supply and demand in each location influenced calf prices. However, a much more complex story appears

in the results. In general, the mixed results in terms of the statistical significance of the distance and location effects from year to year raised the hypothesis that the *D* and *L* effects may be interactive in that the regional price discounts (i.e., the *L* effects) may overcome the FOB pricing (i.e., distance effects) in some years, and vice versa.

It is impossible to test this new hypothesis directly if we are unable to separate the two effects econometrically, so we took an indirect approach to see if *D* and *L* effects are interactive and, thus, jointly determine spatial discounts over time. We selected a typical location in each region and calculated its total spatial discount for each year. Those specific locations and their distance from Omaha were Casper, Wyoming -- 623 miles (Region 4); Elko, Nevada -- 1,158 miles (Region 3); and Redding, California -- 1,642 miles (far West "all other" region). We computed the spatial discount for each location as the sum of the regional dummy plus the distance coefficient times the mileage between the location and Omaha. We did this for each year for both calves and yearlings, and then we plotted the total discounts on a graph and fit a linear trend line through them. Figure 2 shows the results for calves in Casper, Wyoming (in Region 4) as an example.

The trend line estimates for the three locations were

$y = -0.4802x + 957.83$ ($R^2 = 0.7616$) for Casper,

$y = -0.6209x + 1{,}235.4$ ($R^2 = 0.5374$) for Elko, and

$y = -0.4717x + 935.83$ ($R^2 = 0.3790$) for Redding.

These results show that the trend line usually explains half or more of the annual variation in the spatial discount, and the coefficient on the trend line can be interpreted as the average annual increase in $/cwt in the discount. This supports the hypothesis that the *D* and *L* effects are interactive. Also, as indicated in Figure 2 (and the figures for the two other regional locations,

not shown here), the trend line is downward-sloping meaning that total spatial discounts were increasing over time, consistent with hypothesis 1c.

There remains a pattern of increasing discount amounts in the location coefficients moving from east to west (right to left in Table 2) for nearly every year over the 1997-2008 period. Region 3 has a larger discount than Region 4 in every year except 2002 and 2004 when the discounts in Region 3 were not significant. Region "all other" also has larger discounts (when significant) than those received in Region 4, although many annual results for "all other" are smaller than the discounts for Region 3. Therefore, the conjecture that "transaction costs" unique to a local market are part of the location effects appears to be consistent with the results for calves across the study period. In summary, the calf results in Table 2 appear to show the emergence of transportation costs as a regular component of the cattle pricing system operating in western states.

Yearling Results Over Time

The temporal results for yearlings presented in Table 3 appear very similar to those for calves, including the interactive nature of the distance and location effects. In all 12 of the years covered by the data there are significant distance or location effects, or both!

We repeated our indirect approach to see if *D* and *L* effects are interactive for yearlings. We used the same location in each region and calculated its total spatial discount for each year. The trend line estimates for the three locations were

$y = -0.3225x + 643.05$ ($R^2 = 0.6686$) for Casper,

$y = -0.5849x + 1{,}164.5$ ($R^2 = 0.7548$) for Elko, and

$y = -0.738x + 1{,}469.6$ ($R^2 = 0.7934$) for Redding.

These results show that the trend line explains more than two-thirds of the annual variation in the spatial discount. This supports the hypothesis that the D and L effects are interactive. Again, the negative coefficient for each of the three trend lines means that total spatial discounts for yearlings were increasing over time.

The pattern of location discounts increasing from east to west generally remains in the annual yearling results. This again raises the idea that buyers seem to prefer markets that are closer to the Midwest.

VIDEO MARKET STRUCTURE EFFECTS

The structure of satellite video auctions, especially the way in which they are conducted, is expected to have some effects on prices observed. In particular, there are two effects tested in this study. First, it is expected that a satellite sale can attract more participants that are spatially dispersed than traditional auctions and that the more successful a sale is in increasing the number of buyers participating, the higher the average price received by sellers. Results of tests of this idea, expressed as hypothesis 4b, are presented in the next subsection. Then, results for hypothesis 4c are presented. It is expected that a satellite sale's disconnection between sale date and delivery date will have some effect on prices. In particular, the idea that forward prices will reflect a reward to sellers for providing "storage" services is tested.

Number of Buyers

The hypothesis that price is positively correlated with the number of buyers in a sale is an old one, but one that has not been tested before. Therefore, our results in Table 1 showing that the variable is significant for both calves and yearlings are important. It is also important to note

that the "number of buyers squared" variable is also significant in each market segment. This means that sellers are rewarded with higher prices when buyer participation in small sales increases, but the amount of the reward shrinks as buyer numbers increase. Finally, the average price effect observed in our data varies between calf (coefficient of $0.0471/cwt) and yearling ($0.1478) market segments. It is likely that the buyer effect is influenced by the different number of head being traded in the two segments, as well as the different buyers involved (i.e., stocker operations or feedlots versus feedlots looking to stay full of animals needing smaller weight gains).

"Storage" Premium

Cattle are considered to be a non-storable commodity, therefore storage costs cannot be an actual component in their prices across time (Leuthold). However, the production process of cattle makes them "semi-storable" in nature in that delivery dates can be delayed somewhat through production management[3] and, therefore, price relationships can exist across a limited period of time (Naik and Leuthold; Blank). Empirically, a "storage" premium temporal relationship would show up in prices for different delivery dates as a sequence of increasingly higher prices quoted at a single point in time. Essentially, this is what our data show for the four forward sale dummy variables. However, the interpretation of our results varies depending on whether we are estimating the premiums being paid by buyers or the premiums actually received by sellers.

First we consider the buyer premiums. The average premiums being paid by buyers at auctions over the data period are reflected in the coefficients for the four forward contracting

[3] For example, calves can go straight to a feedlot or they can go to a stocker operation that has a much slower rate of gain, hence delaying their ultimate arrival at a slaughter house.

dummy variables in Table 1. For example, the $2.05 per hundredweight premium for one-month forward deliveries indicates that over the data period buyers wanting calves weighing an average of 500-625 pounds offered an extra $2.05 for animals to be delivered in a month compared to what they offered for identical animals available for immediate delivery. For a storable commodity, like grains, that premium would be interpreted as buyers' average offer to pay for the storage service required before the commodity could be delivered to the buyer one month after the sale. For feeder cattle, the premium can be interpreted as buyers' average offer at the time of the sale to pay for the certainty of receiving delivery of the cattle needed in one month. Thus, the "storage" premium is a payment to producers to keep possession of the cattle for one month after the sale, at which time they will average 500-625 pounds as specified in the sales contract.

The forward pricing results in Table 1 are mixed. There appears to be a sequence of higher premiums paid for cattle delivered farther in the future, but the results are much stronger for calves. Highly significant premiums are paid for each of the four forward contract periods, compared to sales made for immediate delivery, in the calf market segment. The amount of the premium increases for sales of one, two, and three months forward, but the premium declines slightly for longer contracts. For yearlings there are significant premiums only for one-month and three-month forward contracts, with the three-month premium being higher. Clearly, most buyers of yearlings (feedlots) want delivery in the short-term.

Next we consider seller premiums. The actual average premiums received by sellers over our data period require more calculations to estimate. The benefits to sellers from forward contracting cannot be interpreted simply by looking at the contract dummy variables because the sale month and the delivery month are different. Thus, for a two-month forward contract lot that

was sold during an auction in May, for example, we need to compare the value of that identical lot as if it had been sold in July for immediate delivery. We did that analysis. Our calculations show the mean premium to each forward contract (one, two, three, and four or more) months forward for both calves and yearlings. All are positive, and for calves especially they are quite high, probably because of the much higher demand for forward contracted calves. Those premiums are

Calves one month forward = $2.8476/cwt,

Calves two months forward = $4.56/cwt,

Calves three months forward = $5.1698/cwt,

Calves four months forward = $5.3951/cwt,

Yearlings one month forward = $0.38506/cwt,

Yearlings two months forward = $0.12603/cwt,

Yearlings three months forward = $1.65997/cwt, and

Yearlings four months forward = $1.52137/cwt.

In summary, the results of this study vary both between market segments and across contracting periods, but they do indicate a "storage" premium is being offered in satellite video auctions and being captured by producers. The different amounts indicate that the premium is probably being generated by supply and demand factors in each market segment. In other words, there appears to be much interest among calf buyers in "locking up" supplies needed for feedlots to keep their future operations running smoothly, hence they offered sellers over $2 per hundredweight to guarantee delivery in the future, whereas that appears to be much less of an issue for buyers of yearlings for feedlots or slaughter houses, hence the lower premium offered in that market segment. The fact that buyers do offer a "storage" premium in these markets is an

important result that should be considered by all feeder cattle producers when deciding how and when to sell their output.

MARKET SEGMENT DIFFERENCES

The last hypothesis tested here is that there are price differences between the calf and yearling market segments. This can easily be accepted when reviewing the results in Table 1. In general, there are at least six types of important differences.

First, it was noted earlier that calves are discounted more per mile, yet their regional results are less spatially consistent than the yearling results. This indicates differences in the nature of interaction between the *D* and *L* variables in each market segment.

Second, the "number of buyers" participating in a particular sale aids yearlings more. This is most likely due to the big difference in the distribution of buyer numbers between the two segments. Calves had a much bigger range across the data period than did yearlings: 1-105 and 2-59, respectively. Given that about 50 percent more yearlings were sold during the auctions in our data, it is clear that an average yearling buyer purchased more animals than did an average calf buyer. This implies calf sales may be more competitive, on average, than are yearling sales.

Third, price premiums for "natural" beef aids yearlings more. Clearly, this indicates natural beef are in greater demand (or in smaller supply) in general, and for yearlings in particular. This market preference may be accommodated by changes in production over time, thus gradually eliminating price premiums as more cattle are marketed as "natural" beef. It is worth noting that a variable for "implants" was included in earlier regressions, but was not significant and dropped. The year-by-year data showed that implants had been important earlier, but declined over time as opposite results were observed for the natural variable. The production

processes for implanted and natural cattle are opposites: cattle following one protocol cannot be labeled as the other. Thus, the pricing results here show that implanted cattle no longer receive premiums while natural beef do receive premiums, indicating a shift in consumer preferences over the data period. The fact that yearlings receive a higher premium than calves, on average, indicates it may be more difficult to maintain the "natural" production protocol over the transition between calf and yearling status.

The next major difference between pricing effects across market segments is that forward sales aid calves more than yearlings. There appears to be a "storage" premium effect for both segments, but calf producers can make significantly more money per hundredweight by selling their output a month or more forward of the planned delivery date. This may be one of the few ways in which the structure of cattle markets favor sellers over buyers. Clearly, buyers are willing to pay a premium to acquire feeder cattle in a manner that enables them to have some control of when they will take possession of the animals. The fact that those premiums are much lower for yearlings indicates that different types of buyers may be involved in the two market segments (e.g., stockers, feedlots or slaughter houses).

The possible difference in market buyer composition between market segments noted above may also explain the observed difference in the seasonality of our results. The results in Table 1 for the "sale month" dummy variables are surprising. Only video sales held in July had a significant effect on the average price received for calves, whereas eight of the 11 sales month dummies were significant for yearlings. This implies different types of buyers (with different preferred delivery schedules) may be involved in acquiring calves versus yearlings.

Finally, the sixth type of difference between the two cattle market segments shows up in the results for the "head sold in region" variable in Table 1: the sign of the coefficient differs

between calves and yearlings. This is a clear signal that the general structure of the market in particular regions differs across market segments.

CONCLUDING COMMENTS

This study shows that ranchers receive lower prices for cattle sold in western states compared to prices received by ranchers in the Midwest. We show that calf and yearling cattle prices west of Omaha include two types of discounts. First, there is a "distance" discount which may partially reflect the transport costs per mile to ship cattle to feedlots in the Midwest. That implies a competitive, FOB pricing structure may be operating in cattle markets. However, the presence of a second "location" price discount indicates that market conditions may differ across many western states. The most likely source of the location effect is a combination of transaction costs incurred by buyers (e.g., search costs) and transport-related costs (e.g., higher death rates when cattle are in transit longer distances, and more uncertainty in delivery schedules). The distance and location effects appear to be interactive, thus making joint estimation of spatial discounts more appropriate for specific points in time.

The presence of discounted prices paid to ranchers in western locations indicates an imbalance in the competitive position of those ranchers compared to their competitors in the Midwest. It is likely that local supplies of calves and yearlings are a major source of this imbalance. For example, feeder cattle buyers (e.g., feed lots in the Midwest) will minimize transaction costs if they are able to purchase all the animals they need within a short distance of their facility, thus buyers will only venture farther west if they need additional cattle. In other words, buyers will prefer to purchase all acceptable cattle in the Midwest before they consider purchasing any cattle from western suppliers. Compounding the problem for western producers,

our results show that the relatively small number of buyers in a particular sale directly affects average prices observed. We show that prices are positively correlated with the number of buyers participating in a sale, which means western producers' prices are directly affected by the number of buyers that venture out of the Midwest in search of additional supplies.

In the future, the existence of distance and location discounts and their amounts will continue to depend upon the cattle market structure. As long as most feedlots and meat processing facilities are located in the Midwest, calves and yearlings raised in western states will be sold at a price discount and shipped east. Ranchers in the West can improve the average price they receive by participating in a number of production and/or marketing programs that receive price premiums, but they have no comparative advantage in most of these programs so the ultimate profitability of these efforts may disappear. On the other hand, there is one way for cattle producers to take advantage of the current market structure: use satellite video auctions to forward contract their output. Calf producers, in particular, received large price premiums for lots sold one month or more before the expected delivery date.

The results of this study have significant implications for the competitiveness of the feeder cattle industry in western states. The general picture which comes out of the video auction sales data is one of a market integrated across time, space and product form. In such a market, buyers will favor sellers located nearest their feedlot, slaughter, and packing facilities and arbitrage will create a pricing system that discounts feeder cattle produced to the west of those processing industries. This will, in turn, keep average revenues lower for ranchers in the West compared to those for ranchers in the Midwest. As a result, western ranchers will be more at risk in periods of rising input costs, such as land values, and may be more likely to exit the industry. This could add to the level of concentration in the cattle industry.

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Figure 1. Market Regions

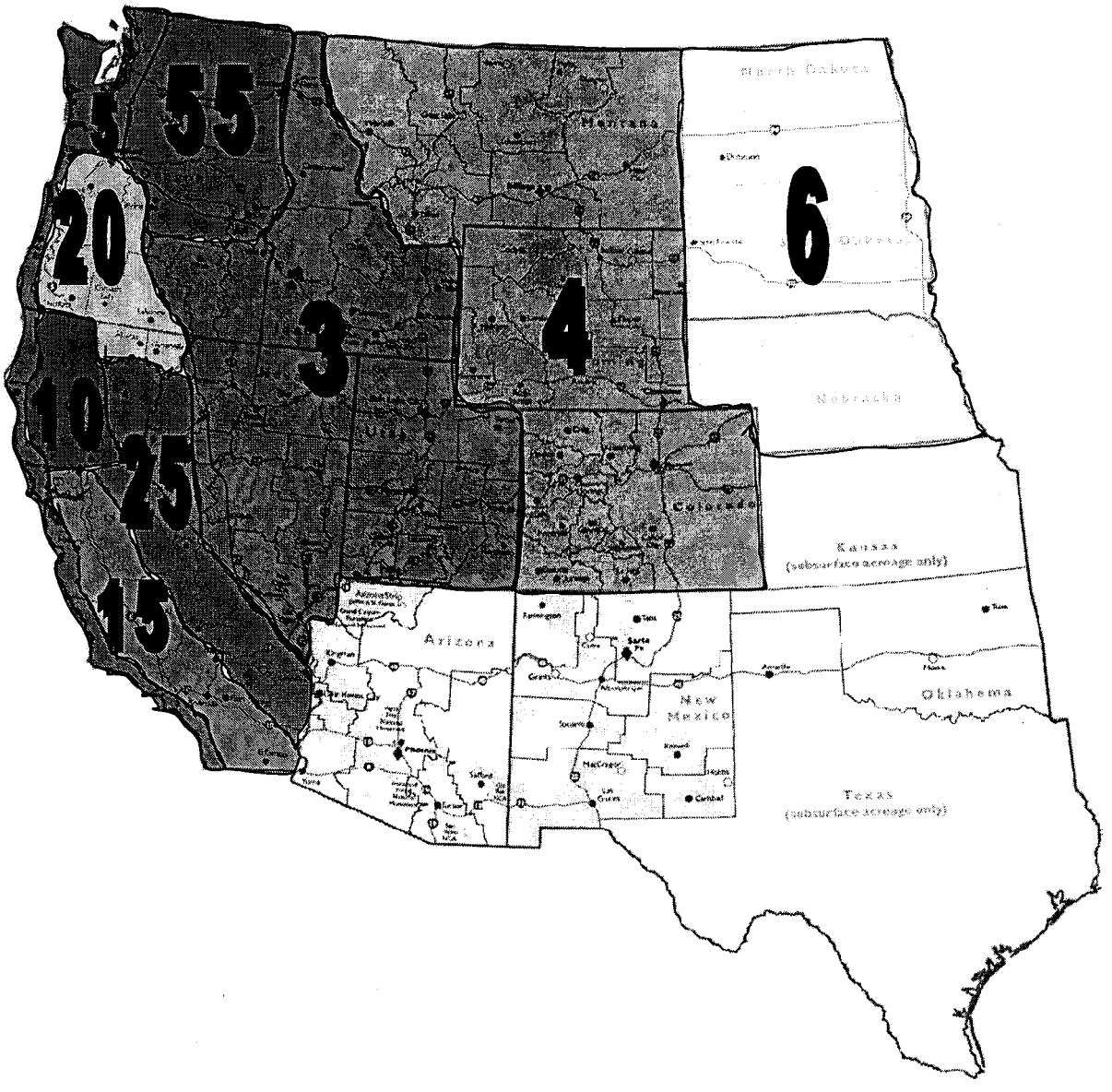

Figure 2. Total Spatial Discounts for Calves in Casper, Wyoming (Region 4)

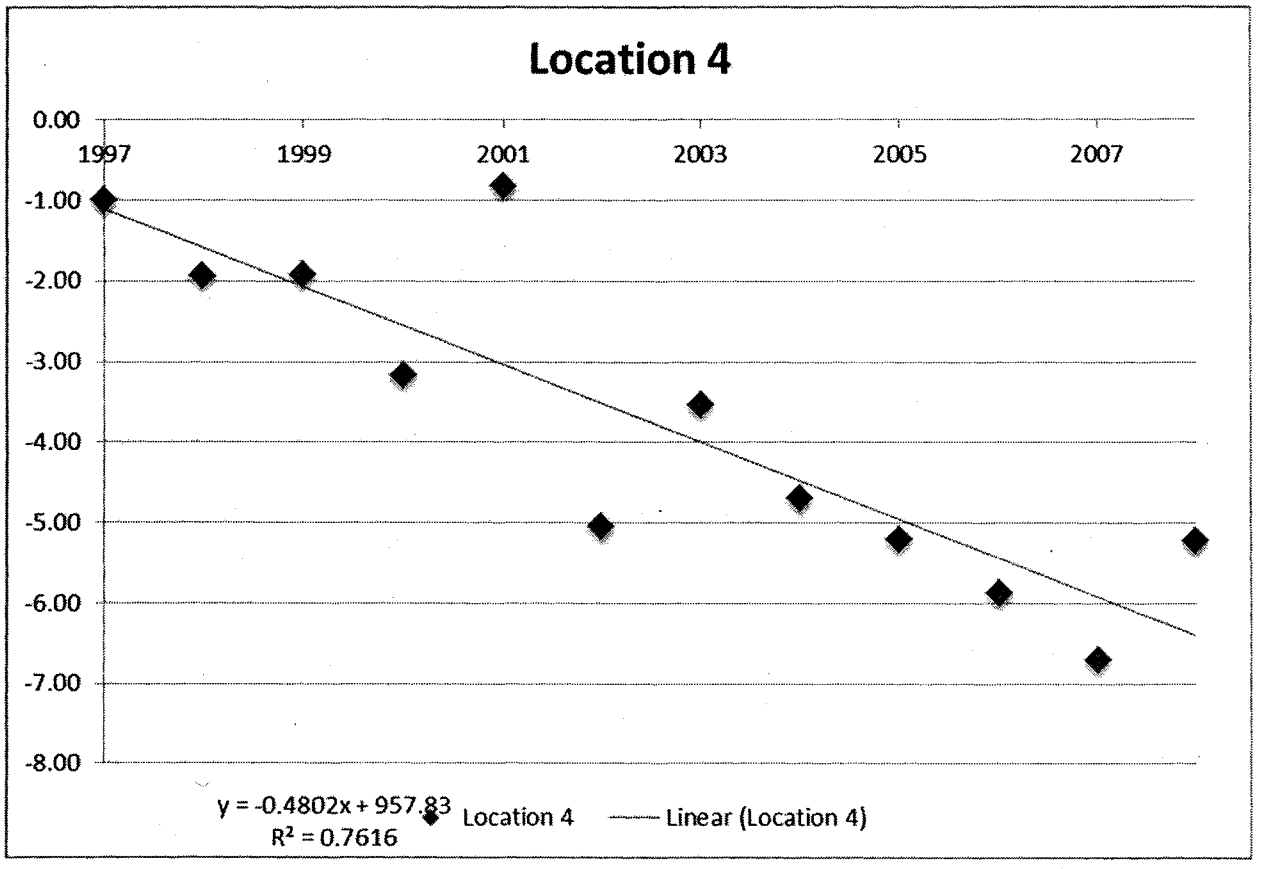

Table 1. Cattle Price Regression Results, 1997-2008

	Calf Prices			Yearling Prices	
Factor	*Coefficient*	*t-statistic*		*Coefficient*	*t-statistic*
	$/cwt			*$/cwt*	
Miles from Omaha (100s)	-0.4458	-8.75**		-0.1732	-3.22**
Location all other (all 6 far-western regions)	-4.1406	-6.81**		-5.0938	-7.63**
Location 3 (SE Ore., Idaho, Utah, E Nev.)	-5.2441	-10.68**		-5.0172	-9.19**
Location 4 (Mont., Wyo., Colo.)	-2.3777	-9.05**		-1.3295	-4.68**
Number of buyers in auction	0.0471	2.49*		0.1478	5.91**
Number of buyers in auction squared	-0.0006	-3.98**		-0.0014	-4.29**
Head sold in region, total by sale month (1000s)	0.2497	7.63**		-0.0958	-6.34**
Head (number of cattle in lot)	0.0088	9.19**		0.0017	4.85**
Weight (average cwt per head)	-40.6111	-5.47**		0.8731	0.21
Weight (average cwt per head) squared	2.7513	4.18**		-0.2653	-1.05
Preconditioned	0.9239	5.07**		NA	
Age and Source Verified	1.7769	5.47**		NA	
Quality Assurance Program	1.3207	4.71**		NA	
Certified Angus Beef (candidates)	1.4807	6.15**		1.4324	6.63**
Natural beef	0.7487	3.26**		2.5927	11.48**
Weaning 1 (calves weaned <30 days)	2.5474	5.54**		NA	
Weaning 2 (calves weaned ≥30 days)	2.8595	11.87**		NA	
Feed 2 (fed on both pasture and hay lots)	NA			-1.0283	-4.92**
Feed 3 (fed on pasture only)	NA			-0.1443	-0.46
One Month Forward sale	2.0485	4.24**		0.6219	3.40**
Two Months Forward sale	2.3980	5.11**		0.3774	1.46
Three Months Forward sale	2.7033	5.78**		0.8772	2.02*
Four or more Months Forward sale	2.0943	4.07**		0.0135	0.02
Sale month: February	1.9537	0.99		-1.2243	-1.41
Sale month: March	3.8573	1.43		-1.9031	-2.64**
Sale month: April	2.4646	1.33		-2.3287	-3.88**
Sale month: May	1.8294	1.73		-0.5432	-0.99
Sale month: June	0.9499	0.81		1.0371	1.76
Sale month: July	1.9407	2.20*		1.8420	3.04**
Sale month: August	1.1027	1.11		1.7849	2.99**
Sale month: September	0.3925	0.45		2.2631	3.92**
Sale month: October	-1.3475	-1.68		2.0346	3.48**
Sale month: November	-0.4714	-0.61		2.6983	4.36**
Sale month: December	-1.2008	-1.49		3.3606	4.93**
Constant	238.3705	11.39**		93.3059	5.30**

Notes: the adjusted R^2 for the calf model is .8923 and for the yearling model is .9106. There are 4,521 observations for the calf model and 5,626 observations for the yearling model. For each model, variability, breed, and year fixed effects were significant. Breeds received price discounts, compared to Angus cattle.

* or ** indicates the t-test is statistically significant at the 95% or 99% confidence level, respectively.

NA = "not appropriate" in this model. For the calf "weaning" dummy variables, the base is calves not weaned prior to sale, "weaning 1" indicates calves weaned less than 30 days, and , "weaning 2" indicates calves weaned 30 days or more. For the yearling "feed" dummy variables, the base is yearlings fed from hay lots only, "feed 2" indicates yearlings fed on both pasture and hay lots, and "feed 3" indicates yearlings fed from pasture only.

Definition: "Natural" beef is certified in an affidavit from the seller.

Table 2. Distance and Regional Price Discounts by Year, Weaned Calves (nominal $/cwt)

	Distance to Omaha	*Region others*	*Region 3*	*Region 4*
1997 n = 171 R^2 = .83	-0.2270	-2.8419	-2.6300	0.4212
1998 n = 154 R^2 = .79	-0.3199 **	-2.9422 *	-3.4747 **	0.0514
1999 n = 218 R^2 = .79	-0.2009	-2.4934	-2.0983	-0.6708
2000 n = 335 R^2 = .75	-0.3643 *	-3.7483 *	-4.1729 **	-0.8900
2001 n = 350 R^2 = .75	-0.1124	-5.3832 **	-4.2665 **	-0.1191
2002 n = 327 R^2 = .78	-0.5694 **	1.0376	-0.0439	-1.5061 **
2003 n = 443 R^2 = .81	-0.2611 **	-2.9371 *	-3.0969 **	-1.9032 **
2004 n = 519 R^2 = .77	-0.2351	-1.3337	-2.6467	-3.2284 **
2005 n = 532 R^2 = .73	-0.2851 *	-5.7521 **	-7.9015 **	-3.4363 **
2006 n = 444 R^2 = .82	-0.4138 **	-4.9726 *	-6.1363 **	-3.2905 **
2007 n = 530 R^2 = .84	-0.6146 **	-4.8726 **	-7.1391 **	-2.8726 **
2008 n = 501 R^2 = .80	-0.4639 **	-2.2097	-4.9253 **	-2.3299 **

Note: regional results show the average differences between the region indicated and Region 6, which was used as the base. These results are not adjusted for inflation.
The coefficients shown are statistically significant only when indicated by * or ** (95% or 99% confidence level, respectively).

Table 3. Distance and Regional Price Discounts by Year, Yearlings (nominal $/cwt)

	Distance to Omaha	*Region others*	*Region 3*	*Region 4*
1997 n = 234 R^2 = .81	-0.1479	-2.6829 *	-2.5278 **	-0.5403
1998 n = 345 R^2 = .90	-0.0667	-4.5813 **	-4.1905 **	-0.5161
1999 n = 373 R^2 = .87	-0.4102 **	-1.2785	-1.1542	-0.1643 *
2000 n = 423 R^2 = .75	-0.2169 **	-1.7415 *	-1.6710 *	-0.3224
2001 n = 455 R^2 = .79	0.0234	-5.2798 **	-4.3454 **	-1.0901 **
2002 n = 446 R^2 = .86	-0.2718 **	-1.5838	-2.1028 *	-0.6773 *
2003 n = 506 R^2 = .95	-0.2646 **	-2.2158 *	-2.2398 *	-0.2307
2004 n = 554 R^2 = .84	-0.4174 *	-3.2412	-3.4664 *	-2.1295 **
2005 n = 620 R^2 = .76	-0.3037 **	-5.9673 **	-6.1659 **	-2.8583 **
2006 n = 568 R^2 = .81	-0.4307 **	-4.8925 **	-4.6162 **	-0.7668
2007 n = 590 R^2 = .87	-0.3164 **	-7.9296 **	-7.0578 **	-2.4082 **
2008 n = 512 R^2 = .93	-0.4157 **	-3.8255 **	-3.4495 **	-0.9133 *

Note: regional results show the average differences between the region indicated and Region 6, which was used as the base. These results are not adjusted for inflation.

The coefficients shown are statistically significant (different than zero) only when indicated by * or ** (95% or 99% confidence level, respectively).