Feedlot vs. Pasture Impacts on Feeder Cattle Prices

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Introduction and Background

Over the past several years, livestock markets have adjusted to higher and more volatile feed prices. While many factors have contributed to these changes, a significant increase in the use of corn for ethanol production, coupled with highly unpredictable weather patterns are largely to blame.

Although the impact has been felt across all livestock sectors, the beef sector is unique in that it is much less integrated and much less contract oriented than the pork and poultry. A typical beef animal will pass through several stages of production during its life including cow-calf, backgrounding or stockering, finishing, and processing. This segmented system means that significant markets exist at multiple levels of the beef system and the impact of grain prices can be examined at multiple stages. Of specific importance to the southern region, feeder cattle markets are heavily impacted by corn prices as it is the main cost for the feedlot sector. Numerous studies have found a negative relationship to exist between corn and feeder cattle prices. This analysis adds to the existing literature on feeder cattle and corn price relationships by employing a breakeven approach and incorporating a seasonal component to corn price effects.

Literature Review

Corn prices have been long established to have a negative relationship with feeder cattle prices. Increases in corn price are generally associated with decreases in feeder cattle prices when other factors are held constant (Burdine, Maynard, and Halich, 2014;

Bulut and Lawrence, 2007; Anderson and Trapp, 2000; Buccola, 1980). However, there has been considerable differences in the magnitude of these effects across many studies that were published at various times suggesting that further exploration of this relationship is well warranted. Further research is also necessitated by the fact that much of this body of literature was developed in the pre-Ethanol era when corn prices were much lower and less volatile.

At the same time, seasonality has also been established as a significant factor affecting the prices of feeder cattle (Burdine, Maynard, and Halich, 2014; Shulz et al, 2000; Dhuyvetter and Schroeder, 2000). Winter is typically associated with lower feeder cattle prices and spring and summer are usually associated with higher feeder cattle prices. While most feeder cattle pricing studies have incorporated both corn price and seasonal effects, past work has failed to integrate these two factors. This work incorporates an important dynamic that has been ignored, or avoided, in previous studies. Corn price and seasonality are examined dynamically in an effort to access feeder cattle response to changes in corn price at different times of the year.

This work contributes to the existing literature on feeder cattle prices in two primary ways. First, it takes a broad look at feeder cattle pricing factors with a unique dataset that covers a wide range of corn prices and macro-economic conditions from 2005 to 2012. This dataset will be further discussed in the following section. Second, it examines the interaction between corn price and price seasonality in a way that estimates corn price affects for spring, summer, and fall/winter.

Data and Research Methodology

The data set used in this study was obtained from a large cattle marketing firm in Kentucky. Data was made available to researchers from their pre-conditioned feeder cattle sales at their largest location from November 2005 to December 2012. The number of sales held varied from year-to-year, but 5-7 were generally held annually. Calves in these sales were co-mingled into like sizes and breed types. Thus they were multi-owner groups. All calves met minimum requirements including being weaned a minimum of 45 days, receiving two rounds of shots, being dehorned and healed, and all calves were required to be bunk and trough broke. Further, a guarantee was in place that no heifers were bred and no males were in-tact.

These data were supplemented with corn and feeder cattle futures prices from the CMEGroup© and databased by the Livestock Marketing Information Center. The combined dataset consisted of a total of 55,948 head of cattle and covered a wide range of feeder cattle and corn price levels, weights, and lot sizes.

The statistical model approach used with this analysis is a bit different than the typical approach used for estimating cattle prices. The typical approach would generically be something like:

Cattle Price = Function (weight, cattle type, lot size, corn price, live cattle futures price)

There are a number of potential problems with this approach that we identified. First, the weight variable attempts to solely estimate the price slide (as cattle get heavier they are generally worth less per pound). Often, weight is modeled by including both a

linear and squared weight variable (Zimmerman et al., 2012; Williams et al., 2012; Bulut and Lawrence, 2007). Part of this price slide is due to the way cattle prices are measured: they are sold per hundred weight, and not by the total dollar figure per animal. I.E., the larger animal is worth more on a per animal basis, but less on a per hundredweight basis. However, this price slide should not be constant. It will change based on overall market conditions as well as based on feed costs. When the cattle market gets stronger, the price slide effect will increase. When feed costs increase, the price slide effect will decrease. However, the standard approach has a difficult time controlling for these two effects, and as a result, estimates a price slide for the average feed cost and market conditions present in a particular dataset.

A second problem deals with the seasonal nature of price slides related to feed costs. The feed cost typically measured is corn price, which is the main ingredient in feedlot rations. However, in the spring a large percentage of lightweight calves (generally under 650 lbs) bought at this time are put onto pastures rather than sent to feedlots. These calves would not be expected to be as responsive to the price of corn. During the fall/winter conversely, these lightweight calves would generally be sold to feedlots and put on a corn-based diet. At this time these calves would actually be expected to be more responsive to the price of corn compared to heavier weight cattle. This is because they will be on feed for a longer period of time and will thus require more corn to finish. The typical approach however, is to estimate the responsiveness of corn through one variable without a seasonal interaction. Again, this will force the estimate for corn to show an average response across seasons and range of feed prices.

Because it is difficult to model the effect that the overall cattle market has on price slide using the conventional approach, a breakeven-base approach was taken. To make the breakeven-base approach tractable, a base weight was needed (a proxy for the final sale weight). The most obvious weight to use was 750 lbs as this is the average weight of cattle specified for CME© Feeder Cattle Futures. Thus these futures prices were used as an independent variable.

The breakeven price was calculated by forcing a difference of zero between the breakeven price multiplied by the purchase weight and deferred feeder futures price multiplied by 750 lbs. Thus this would be the purchase price that would give us zero profit if there were not costs to bring the animal to 750 lbs. It can be viewed as the starting point for determining a bid price.

The costs/margins needed to take an animal to 750 lbs were then estimated in the analysis. These would essentially be subtracted from the breakeven price in determining a bid price for the cattle. To do this, the weight difference was taken between 750 lbs and the purchase weight. For example, for a 500 lb animal this would be 250 lbs. or 2.5 hundred weight. For an 850 lb animal, this would be -100 lbs, or -1.0 hundred weight. The way to interpret this last case is that it will be costs avoided by buying at 850 lbs compared to 750 lbs. The mathematics works the exact same however.

For corn cost, the number of bushels needed to reach 750 lbs was estimated using standard feed conversion ratios for various weight animals, accounting for heifer efficiency when applicable. This bushel estimate was then multiplied by the deferred futures price of corn using the contract that would be halfway through the feeding period. The resulting figure was then interacted by three seasonal periods: spring, summer, and

fall/winter. Using this overall method, a separate parameter estimate for corn price effects could be estimated for each of the three seasons. The expected parameter estimates would be -1.0 if a $1 increase in corn costs had a $1 decrease in sale price (overall price and not hundred weight). If the absolute value of the parameter estimate was less than 1.0, than a $1 increase in corn costs would have less than a $1 decrease in the overall sale price. I.E., a parameter estimate of -.5 would imply that a $1 increase in corn costs has a $.50 decrease in overall sale price (overall price and not hundred weight).

Costs other than feed also needed to be estimated. The intercept term could potentially pick up part of this cost, but it would only be that portion of the cost that would be the same on a per hundredweight basis for all sized cattle. The obvious type of cost that would fit into this category was trucking which would theoretically be the same. However, most costs are probably different on a per hundredweight basis such as mineral, vet/medicine, and interest. These were estimated as an "Other Costs" variable as a function of each pound added to reach 750 lbs. This variable was interacted by steers and heifers to allow for cost differences between the two.

A considerable amount of time was spent a priori to determine a functional fit to best estimate lot size effects. Generally, as lot size increases, sale price also increases. It is generally thought to be non-linear, with small lot sizes having the largest responses from a 1-unit change and large lot sizes having almost no responses from a 1-unit change. The standard approach is to use a lot size and lot size squared term (Burdine et al., 2014; Bulut and Lawrence, 2007; Dhuyvetter and Schroeder, 2000). However, from previous experience this seemed to result in too little response from a 1-unit change on small lot

sizes, and negative response from a 1-unit change on the really large lot sizes (i.e. price decreased beyond some lot size). An alternative approach used by Zimmerman et al. (2012) used only natural log of lot size. The functional fit that was deemed to have the best potential to correct for previous problems was with a Ln transformation of lot size, and also using a squared version of this transformation in the estimation.

There were five types of cattle breed classifications in the sales: *black, smokes, charx, blackx, and mix*. Binomial variables were included for each of these with the exception of *black* so all results can be interpreted relative to the *black* classification. A "small" frame classification was also present in the data and could represent any breed and this was represented by another binomial variable.

Since both steers and heifers were present in the dataset, steers were chosen as the base. However, unlike the conventional approach used where the estimated price difference between steers and heifers would be the same for 500 lb and 800 lb animals, this approach allows for the difference to expand or contract as weight changes. This occurs because 1) more corn will be required for a heifer to reach the same weight and 2) we allowed for different other costs for steers and heifers (see previous discussion). In summary, models were constructed with a base of black steers of normal (non-small) frame size.

Finally, an additional variable was used based on the observation of one of the researchers (who has bought cattle at these sales for the last six years). A binomial variable was created for cattle that weighed less than 450 lbs (most of these were between 380-420 lbs). These cattle consistently sold for far less than would be expected, which was most likely due to the unique nature of the sale. Cattle in these preconditioned sales

are comingled with cattle from other sellers around certain weight points, typically 400 lbs, 500 lbs, 600 lbs etc. Most cattle that would be weaned at 6-7 months and put through this sale would be expected to weight 500-600 lbs. Thus these really light cattle could easily be viewed as the slowest growers (low genetic potential) from each seller's calves. In a standard-type sale a group of 15 head, 400 lbs steers (from the same seller) would normally be viewed as all being weaned early and not necessarily slow growing. Thus this variable was only used based on the unique nature of the dataset.

A summary of descriptive statistics for key variables can be found in Table 1. With all variables specified as described above, the following model was estimated using SAS Statistical Analysis Software:

1) Sale price = $B_0 + B_1$ *Ln lot size* + B_2 *Ln lot size*^{2} + B_3 *Smoke* + B_4 *Charx* + B_5 *Blackx* + B_6 *Mix* + B_7 *Small* + B_8 *Heifer* + B_9 *Under450lbs* + B_{10} *Breakeven* + B_{11} *Corn-Spring* + B_{12} *Corn-Summer* + B_{13} *Corn-Fall/Winter* + B_{14} *OtherCostSteer* + B_{15} *OtherCostHeifer*

Results

Results suggested that the model was well specified as significant variables were found to be consistent with previous literature. Over 90% of the variation in sale price was explained by the breakeven model specified in equation 1 in the Methodology section. Results from the linear regression can be found in Table 2.

As expected, lot size was found to be a highly significant factor explaining sale price. Since the two variables (Ln and Ln^2 transformation variables of lot size) are added together for the cumulative effect, it is difficult to provide context with parameter estimates individually. However, the combined effects of these two variables are shown in Figure 1. Increasing lot size from 1 to 2 calves increased price by $5 per hundredweight. Increasing lot size from 1 to 5 calves increased price by $11 per hundredweight. In previous analysis, it has been the difference in the lower end of lot sizes that been most difficult to realistically capture using a standard linear plus square of lot size. The overall increase in price going from 1 to the highest level was $21 per hundredweight.

Binomial variables for cattle sorts were largely as expected. *Smokes* (Angus / Charolais cross) brought the highest price per lb, $2.38 more per cwt than black cattle holding everything else constant. Black crossed cattle (*blkx*) and Charolais crossed cattle (*charx*) brought $1.25 and $2.39 per cwt less than black cattle respectively. Cattle that were sorted as *mixed* or *small* brought $6.79 and $10.10 less than blacks respectively.

The binomial variable for very light cattle (under 450 lbs) showed a $29.50 decrease in purchase price holding all other factors constant. Again, due to the nature of sorting the cattle in this specialized sale from multiple farms combined with the requirement to have calves weaned for at least 45 days, our hypothesis was that these cattle were being viewed as having slow growth potential. The significance and magnitude of the *under450* variable provided evidence for this hypothesis. The magnitude was even greater than we had expected.

The variable *Breakeven* was discussed in the methodology section. Note that a $1 increase in *Breakeven* was associated with a $.85 increase in the sale price of preconditioned feeder cattle. If this parameter estimate were statistically equal to one, this would imply that a change in deferred feeder cattle futures was fully reflected in sale prices. This was our original expectation. Thus the results suggest either 1) changes in feeder cattle futures were not completely reflected in sale prices during the time of this study, or 2) the difference in absolute dollar value between the theoretical and calculated estimate for this variable is being used as a proxy for costs and/or margin.

The *OtherCostSteer* and *OtherCostHeifer* variables had parameter estimates of -22.4 and -34.3 respectively. These cost were based on each 100 lbs added to reach 750 lbs, and put on a per hundredweight price. For a 500 lb steer, the following would be the estimated bid reduction due to these other costs:

(2.5 100wt) x (-22.4) / (5 100wt) = -11.2

In other words, these other costs are expected to bring the purchase price down by $11.20 per 100wt.

The variables estimating corn price effects by season were the primary variables of interest. A $1 increase in the corn costs to take an animal from its sale weight to 750 lbs (or avoided costs if over 750 lbs) was associated with a $0.70 decrease in overall sale price (not per cwt) in the spring, $0.82 in the summer, and $0.89 in the fall. Thus corn is indeed having less impact in the spring when a portion of the animals are being put onto pastures rather than feedlots. Although this finding should seem obvious, it has never

been found or tested in studies we reviewed. We hypothesize this is because of the previous model paradigm used in these type of studies.

The *heifer* binomial variable showed a $7.45 reduction in purchase price. However, care should be taken in interpreting the overall difference in heifer price compared to steers. The only case that the overall price difference would be $7.45 is at 750 lbs. At any other weight corn costs and other costs would change this differential. For example, look at the case comparing 500 lb steers and heifers assuming $5/bu corn. The following are the estimated reductions in purchase price due to the various factors:

Corn	$3.29/100wt (assuming the fall/winter .89 est.)
Other costs	$5.95/100wt
Intercept Shifter	$7.45/100wt
Total Reduction	$16.69/100wt

The conventional approach used to estimate feeder cattle prices would only have the intercept shifter and would estimate the same price differential in both the 500 lb and 750 lb situations.

Conclusions and Implications

There is strong theoretical underpinning for the seasonality on corn price's impact on calf prices. When corn sold for $2/bu it was quite possible that feedlots were competitive bidders for calves during the spring. But with $4-7/bu corn, feedlots have a much harder time bidding on calves that could be placed on relatively cheap pasture. As a result, the effect that corn price has on calves should have diminished during the spring. During the fall and winter, there are much fewer opportunities to place these animals on

pasture, and accordingly, the effect that corn price has on calves should not change much during this season.

Although the results supported our basic hypothesis, we were expecting to see higher magnitudes between the spring and fall/winter corn response estimates compared to the actual results of -.89 fall/winter and -.70 spring. We hypothesize that part of this reason is that these specialized sales were originally established to provide a source of healthy, weaned calves for direct placement to feedlots. As a consequence, the sorting process generally results in lot sizes too large for typical small-scale stocker operators (pasture). Therefore, these stocker operators are less likely to place cattle out of these pre-conditioned sales then they would through regular stockyard sales where lot sizes are typically smaller. This is particularly true for the black cattle that made up 72% of the dataset.

Secondly, this analysis enhances our understanding of how price slide is affected by key variables. While most previous studies have suggested a static price-slide, our results reveal a more dynamic price-slide relationship that changes with the overall feeder cattle market, corn price, and grass-effect. Moreover, as the example in the results section demonstrates, the steer-heifer price differential changes dramatically based on weight. It should not be a constant value across weights as other studies have modeled.

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Table 1: Descriptive Statistics of Key Variables

Variable	Mean	SD	High	Low
Sale price	$110.82	$19.45	$212.00	$50.00
Weight	621.74	110.46	1064	314
Corn Futures	$4.30	$1.50	$7.81	$7.81
Steer	0.579	0.494	1	0
Heifer	0.421	0.494	1	0
Black	0.722	0.448	1	0
Smoke	0.127	0.333	1	0
Charx	0.108	0.310	1	0
Blackx	0.030	0.170	1	0
Mix	0.009	0.092	1	0
Small	0.005	0.069	1	0

Table 2: Regression Results Price Model

Variable	Parameter Estimate	Standard Error
Intercept	-5.084	0.260
Ln lot size	8.270	0.102
Ln lot size^2	-0.791	0.014
Smoke	2.375	0.086
Charx	-2.393	0.094
Blackx	-1.252	0.164
Mix	-6.787	0.269
Small	-10.098	0.363
Heifer	-7.451	0.073
Under450lbs	-29.492	5.439
Breakeven	0.846	0.001
Corn-Spring	-0.704	0.006
Corn-Summer	-0.821	0.005
Corn-Fall/Winter	-0.887	0.005
OtherCostSteer	-22.449	0.232
OtherCostHeifer	-34.293	0.258

R^2: 92.2%
F Value: 44,004

All variables were significant at the 99% level

Figure 1: Lot Size Effects Estimated from Model