Regional and Seasonal Differences in Feeder Cattle Basis

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Abstract

The top three cattle-producing states in the United States are Texas, Nebraska, and Kansas. This study analyzes basis differences across these three key states and analyzes basis seasonality over a five-year period from 2013 to 2017. Results show that there are statistically significant differences in the basis across Nebraska, Kansas, and Texas, with each having, respectively, a stronger, an average, and a weaker basis. No seasonal basis pattern is observed in Nebraska; however, both Texas and Kansas exhibit statistically significant basis patterns, which can affect market participant's hedge expectations in those regions.

INTRODUCTION

The U.S. cattle industry is a large and important economic entity. Cattle accounted for 21 percent of the total market for agricultural commodities in the U.S in 2015, with a value of $78.2 billion in cash receipts (National Agricultural Statistics Service et al, 2016). As detailed in a Chicago Mercantile Exchange product bulletin (CME, 2017), a key component of the cattle industry is feeding, which is the process of converting a 600- to 800-pound animal to a finished animal ready for slaughter. Cattle feeding is concentrated in the Great Plains but is also important in parts of the Corn Belt, Southwest, and Pacific Northwest. Cattle feedlots produce high-quality beef that grades USDA Select or higher by feeding grain and other concentrates.

All market participants, including ranchers, stockers, and feeders, face the risk that cattle prices may move adversely. At the feedlot point in cattle marketing, these market participants may use feeder cattle futures to manage price risk. However, these market participants must then bear basis risk. For this study, the feeder cattle basis is defined as the cash price minus the futures price. Understanding the basis is important to firms that use feeder cattle futures to forward price feeder cattle, because changes in the basis change their profits. Firms that currently or potentially trade feeder cattle in various locations are affected by the basis in those different locations. Locational differences in the basis affect decisions regarding the place to buy or sell. Firms that trade feeder cattle at different times during the calendar year are affected by seasonal differences in the basis. Seasonal differences in the basis affect decisions regarding the best time to buy or sell.

The feeder cattle futures contract broadly represents the price of U.S. cattle purchased by feedlots that will likely grade USDA Select or higher and whose intended use of the animals is to feed them for an extended time and then market them for slaughter. The sample of transactions used by CME to calculate the Index — which underlies the futures contract — forces convergence to the weighted average price paid for those cattle across the following states: Colorado, Iowa, Kansas, Missouri, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, and Wyoming.

Texas, Nebraska, and Kansas contribute a total of 65 percent of the feeder cattle market in the U.S., each with over 4 million head (Cook *et al*, 2018). Market participants often refer to these states' prices when hedging locally. While efforts in understanding seasonal differences in cattle basis have been conducted in states such as Nebraska (Brooks *et al*, 2016; and Birch *et al*, 2016), Georgia (Curt *et al*, 2014), and Tennessee (McLemore *et al*, 1990), less work has been conducted around both regional and seasonal basis differences across these key states. Additionally, there has been a swift and substantial increase in the quality of U.S. cattle produced in recent years. The U.S. national average percentage of beef graded as USDA Choice remained static between 50 and 55 percent from 1996 until 2009, when it increased for the first time beyond 60 percent. Figure 1 shows the historical increase in the national Choice grading percentage. Considering this significant increase in quality, and the effects that quality could have on basis relationships, a five-year study period from 2013 through 2017 was selected to more closely represent the quality levels currently being produced.

The purpose of this study is to determine whether the feeder cattle basis differs across these key states and within the calendar year. The feeder cattle basis in Texas, Nebraska, and Kansas is graphed to determine whether regional or seasonal differences are apparent visually. Then, statistical analysis is used to determine whether the visual differences are statistically significant. Finally, based on the results of the statistical differences, various hedge scenarios are considered across place and through time.

CALCULATING BASIS

The cash market for feeder cattle reflects today's supply and demand conditions. Conversely, the futures market is an anticipatory market reflecting expectations of future supply and demand conditions (Lawrence, 2006). Basis relates the local cash market to the futures market for any given commodity and can be obtained by subtracting the future prices from the cash prices. A strong basis refers to a basis value that is more positive or less negative, and a weak basis refers to a basis value that is less positive or more negative.

Daily cash price data for Kansas, Nebraska, and Texas are sourced from the U.S. Department of Agriculture's Agricultural Marketing Services (USDA-AMS). The feeder cattle futures contract, with expirations in January, March, April, May, August, September, October, and November, is a cash settled futures contract based on the CME Feeder Cattle Index. The CME Feeder Cattle Index is based on a sample of transactions of 700- to 899-pound Medium and Large Frame #1 feeder steers and Medium and Large Frame #1–2 feeder steers. The sample consists of all feeder cattle auction, direct trade, video sale, and Internet sale transactions within the 12-state region of Colorado, Iowa, Kansas, Missouri, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, and Wyoming for which the number of head, weighted average price, and weighted average weight are reported by the USDA-AMS.[1]

Basis data are created by subtracting the nearby non-spot feeder cattle futures contract price from each cash price observation (i.e., basis = cash price – futures price). The daily observations are then averaged into monthly observations. The data cover a five-year period from 2013 to 2017.

REGIONAL FEEDER CATTLE BASIS

The Kansas, Nebraska, and Texas feeder cattle bases are graphed in Figure 2. The feeder cattle basis in Nebraska is the strongest; the Texas basis weakest; and the Kansas basis in between. To test whether these visual differences in the feeder cattle basis are statistically significant, the non-parametric Friedman test is used. The Friedman test is appropriate compared to a parametric ANOVA test because the basis observations are not independent; the same futures price is used to calculate the basis across the three states and the cash prices are determined simultaneously.

The Friedman test determines whether the basis observations differ by treatment (three different states) after the effect of the blocking variable (each month of the calendar year) is removed. Given monthly average basis is calculated over five years, the analysis has 60 blocks. The data are organized as follow:

Date	Nebraska	Kansas	Texas
1/1/2013	$B_{1,N}$	$B_{1,K}$	$B_{1,T}$
2/1/2013	$B_{1,N}$	$B_{1,K}$	$B_{1,T}$
.	.	.	.
.	.	.	.
.	.	.	.
12/1/2017	$B_{60,N}$	$B_{60,K}$	$B_{60,T}$

where $B_{i,j}$ represents the observed average monthly feeder cattle basis for observation i (i = 1, 2, ..., 60), in state j (j = N, K, T). The observations in each row from the above matrix are ranked from lowest to highest.

The Friedman test is used to determine whether there are significant differences in the sums of the ranks for each state. Specifically, the test statistic indicates whether the basis in at least one state (column) is significantly different from any other state over the sample period.

The rank sums over the study period are Texas: 180; Nebraska: 113; and Kansas: 67. The calculated Friedman test statistic is 170.26. The null hypothesis is rejected at the 5 percent significance level implying that the feeder cattle basis is different in at least one among the states of Kansas, Nebraska, and Texas.

Multiple comparison analysis applicable to ranked data is available to determine the state or states in which the basis differs. The difference in the rank sums is calculated for each possible pair of states. A test statistic, q, is calculated to test the null hypothesis that the monthly state basis is the same for each possible pair of states. The calculated q test statistic is compared to the studentized range critical value, q, which is dependent upon α (the significance level), ∞ (infinite degrees of freedom), and k (the total number of states (3) being tested). The third column of Table 1 presents the results of the multiple pairwise comparisons made between each state at the 5 percent significance level. The pairwise comparison results indicate that the differences in the basis between the three states are statistically significant with the Nebraska basis being statistically stronger than the basis in both Texas and Kansas; the Kansas basis being statistically stronger than the basis in Texas; and the Texas basis being statistically weaker than the basis in both Nebraska and Kansas. Many factors can be attributed to these differences in regional basis values. Cattle feeders in the northern regions of the U.S. have access to cheaper corn for feeding compared to those in Texas. There are also notable differences in the quality of the cattle typically found in Nebraska compared to Texas. For example, the five-year average (2013–2017) percentage of cattle grading USDA Choice in Nebraska was 70 percent versus 59 percent in Texas. Lastly, weather conditions are very different when comparing Texas to Nebraska, as very hot and dry summers in Texas can affect an animal's ability to put on weight.

SEASONAL FEEDER CATTLE BASIS

This section tests for statistically significant seasonal differences in the feeder cattle basis. Figure 3 suggests visually the possibility of a statistically significant basis pattern for both Kansas and Texas. Again, the Friedman test is used to test whether these visual patterns are statistically significant. Each state is tested separately to determine if the basis differs in at least one month of the calendar year. In these tests, the 12 months of the calendar year are the treatments and the five calendar years are the blocks. The data are organized for each state as follows:

Year	Jan	Feb	Mar	•	•	•	Dec
2013	$B_{1,1}$	$B_{1,2}$	$B_{1,3}$	·	·	·	$B_{1,12}$
2014	$B_{2,1}$	$B_{2,2}$	$B_{2,3}$	·	·	·	$B_{2,12}$
2015	$B_{3,1}$	$B_{3,2}$	$B_{3,3}$	·	·	·	$B_{3,12}$
2016	$B_{4,1}$	$B_{4,2}$	$B_{4,3}$	·	·	·	$B_{4,12}$
2017	$B_{5,1}$	$B_{5,2}$	$B_{5,3}$	·	·	·	$B_{5,12}$

where B_{ij} represents the observed monthly average basis for calendar year i (i = 1, 2, . . ., 5), in month j (j = 1, 2, ...,12). The objective is to determine if the basis in at least one month (column) differs from the basis in the other months.

Friedman test results are significant for both Kansas and Texas, which suggests seasonally significant basis patterns in those states; the Friedman test result is not significant for Nebraska, suggesting no significant seasonal pattern and a result that is consistent with Birch et al's results for Nebraska. This suggests that the rate of change in the local Nebraska cash price is not significantly different to the rate of change in the futures price.

Multiple pairwise comparison results are included in Table 2. In Kansas, the December basis is significantly stronger (i.e., the cash price higher relative to nearby futures) compared to all other months, while the basis in March, April, and May is significantly weaker (i.e., the cash price lower relative to nearby futures) compared to all other months. In Texas, the basis in February, December, and January is significantly stronger than all other months, while the basis in October and November is significantly weaker compared to all other months. Many of the factors that contribute to differences in regional basis also contribute to seasonal differences in the basis. Extreme heat in the south in the summer and the potential for cold and wet in the north in the winter are examples of seasonal factors that can contribute to seasonal basis differences. Placements tend to follow a seasonal pattern as well. For example, over the past five years, Texas placements have tended to peak in the late spring as seen in Figure 4. The lack of a significant seasonal pattern in the Nebraska basis is interesting, which likely is an indication of the high quality of cattle produced in the north. While the price of cattle in Nebraska indeed does vary by season, the basis does not vary significantly; it stays strong throughout the year because the cattle are consistently higher quality than the U.S. average.

Hedgers should keep these historical basis relationships in mind when placing hedges and forming marketing expectations.

CONCLUSION WITH HEDGING EXAMPLES

Feeder cattle are continually produced, but regional and seasonal differences in the basis indicate that hedge results vary based on the location where the hedge is placed and on the time of year. Seasonality of production can only be adjusted up to a point because of the biological nature of cattle. Factors such as weather can play a significant role in the decisions producers make, ultimately affecting price behavior in the market. It also affects a producer's ability to modify production to take advantage of seasonal marketing opportunities. However, to the extent that producers can adjust production, the following hedging results may be expected:

Kansas

The results indicate that the Kansas feeder cattle basis is significantly stronger compared to Texas as shown in Figure 3 and that there is a significant seasonal pattern, with basis stronger than average in December but weaker than average in March, April, and May, as seen in Table 3. Thus, a feeder cattle producer in Kansas who hedges using feeder cattle futures can expect to lock in better prices relative to feeder cattle producers in Texas, ceteris paribus. Because there is a significant seasonal pattern to the Kansas basis, a feeder cattle producer in Kansas marketing cattle in December can reasonably expect better than average hedge results; and while marketing cattle in March, April, and May, can reasonably expect worse than average hedge results.2

Nebraska

The results indicate that the Nebraska feeder cattle basis is significantly stronger compared to Kansas and Texas, as seen in Figure 3, and that there is no significant seasonal pattern, as shown in Table 3. Thus, a feeder cattle producer in Nebraska who hedges using feeder cattle futures can expect to lock in better prices relative to feeder cattle producers in Kansas and Texas, ceteris paribus. Because there is no significant pattern to the Nebraska basis, a feeder cattle producer in Nebraska should be able to expect similar hedge results throughout the calendar year.

Texas

The results indicate that the Texas feeder cattle basis is significantly weaker compared to Kansas and Nebraska, as seen in Table 2, and that there is a significant seasonal pattern, with basis stronger than average in December, January, and February but weaker than average in October and November, as seen in Table 3. Thus, a feeder cattle producer in Texas who hedges using feeder cattle futures can expect to lock in lower prices relative to feeder cattle producers in Kansas and Nebraska, ceteris paribus. Because there is a significant seasonal pattern to the Texas basis, a feeder cattle producer in Texas marketing cattle in December, January, or February can reasonably expect better than average hedge results; and while marketing cattle in October and November can reasonably expect worse than average hedge results.

ENDNOTE

1. Additional details about the cash-settlement process for lean hogs and feeder cattle futures can be found in the CME Rulebook located at cmegroup.com/rulebook/CME/.
2. A worse than average hedge result does not indicate that a hedge is ineffective in this case; only that cash prices are weaker relative to futures prices, so a seller would, on average, lock-in a lower price relative to futures during this time.
3. Treatments with different letters are significantly different.
4. **Texas** results are grouped from *A*– Significantly Strongest Basis, *B*– Strong Basis, *C*– Average Basis, *D*– Weak Basis, and E– Statistically Weakest Basis. **Kansas** results are grouped from *A*– Significantly Strongest Basis, *B*–Average Basis, and *C*– Significantly Weakest Basis. **Nebraska** results showed no significant statistical differences.

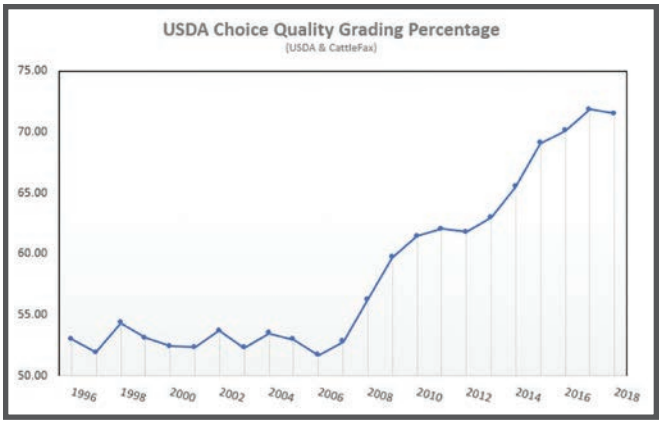

Figure 1. Yearly Average National USDA Choice Grade Percentage (1996–2018)

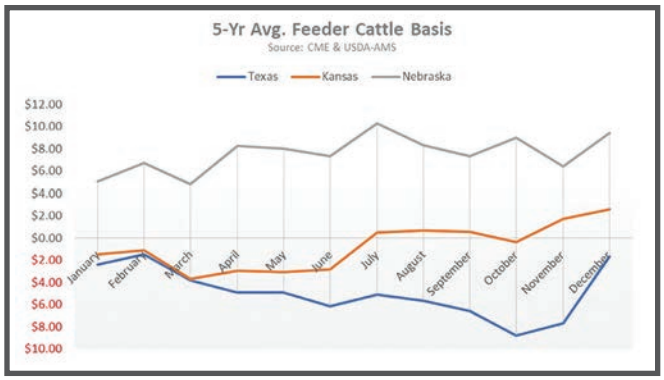

Figure 2. Historical Basis in Texas, Kansas, and Nebraska (2013–17)

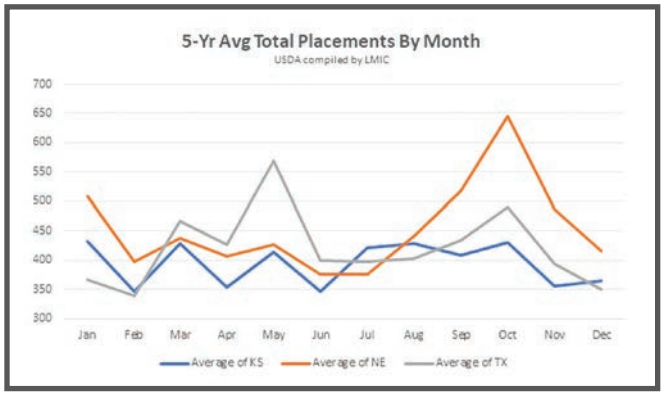

Figure 4. 5-Year Average Placement of Feeder Cattle (2013–17)

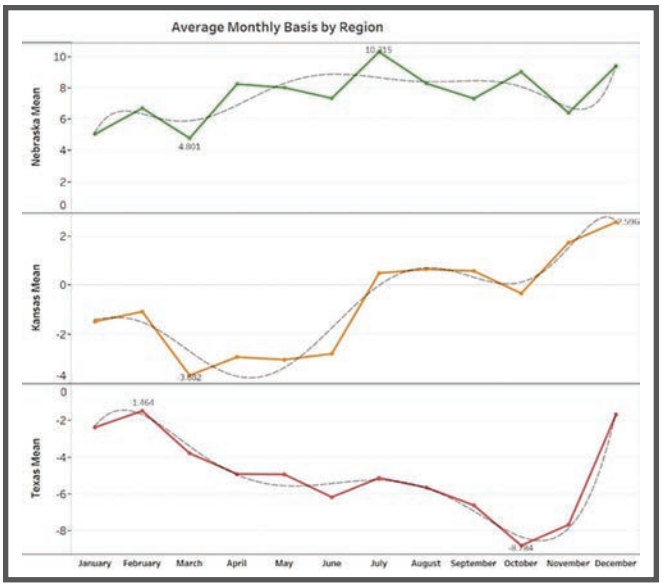

Figure 3. Monthly Average Basis with Smoothing Spline (dotted) by Region

Table 1. Regional Pairwise Comparison Results2, 3

Region	Average Basis	Sum of Ranks	Pairwise q Group
Texas	7.5884	180	A
Nebraska	-0.7687	113	B
Kansas	-4.9487	67	C

Table 2. Seasonal Pairwise comparison results.3, 4

Texas			Kansas			Nebraska		
Month	Average Basis	Group	Month	Average Basis	Group	Month	Average Basis	Group
February	-1.46438	A	December	2.59600	A	January	5.06537	A
December	-1.67200	A	January	-1.48000	B	February	6.72011	A
January	-2.36094	B	February	-1.07400	B	March	4.80117	A
March	-3.76859	C	July	0.50200	B	April	8.26286	A
April	-4.89324	C	August	0.66600	B	May	8.03399	A
May	-4.91887	C	June	-2.80000	B	June	7.35700	A
July	-5.10778	C	September	0.59100	B	July	10.31468	A
August	-5.63595	C	October	-0.32400	B	August	8.30003	A
June	-6.15577	C	November	1.75500	B	September	7.33738	A
September	-6.59602	C	March	-3.68200	C	October	9.03048	A
November	-7.65234	D	April	-2.93400	C	November	6.42638	A
October	-8.78390	E	May	-3.04100	C	December	9.41158	A