What Influences Ability to Hedge Live Cattle?

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Brian K. Coffey, Glynn T. Tonsor, Ted C. Schroeder (Kansas State University)

Hedging Live Cattle

Buyers and sellers of live cattle can use the Chicago Mercantile Exchange (CME) Live Cattle Contract to hedge live cattle cash price risk. Market conditions over the past several years have led some practitioners and analysts to conclude that the CME Live Cattle Contract has become disconnected from cash markets. A predictable relationship between live cattle cash and futures prices (known as basis) is required for any futures contract to be an effective risk management tool. For semi-storable commodities like live cattle, basis is not as straightforward to define as for storable commodities. However, empirical research and practice have shown that basis for live cattle (and other livestock for which CME has contracts) is predictable enough to make the contracts useful for hedging. If the disconnectedness referred to is real and substantial, the concern is that predictability of basis will deteriorate and, with it, ability to hedge using the live cattle contract.

Basis is generally defined as cash price minus nearby futures price. Figure 1 shows weekly basis for Kansas steers sold as negotiated live transactions between June 2004 and June 2016. Basis was calculated as the Agricultural Marketing Service (AMS) weekly price for live negotiated steers, averaged across all grades minus the nearby CME live cattle futures price.[1] A cursory examination of the graph reveals that from 2013 to 2016 hedgers realized pronounced changes in basis. The magnitude of basis increased and seasonal patterns present in 2004 to 2012 did not repeat. Hedgers using historical basis information to predict basis during 2013 to 2016 experienced substantial basis prediction errors. Elevated basis prediction errors translate directly into increased risk around net price received by hedgers.

[1] Nearby is defined as the nearest contract offering. Upon expiration of a contract, the price series rolls over so that the next contract becomes the nearby. As the live cattle contract trades in even months, the nearby contract rolls over approximately every two months.

The purposes of this paper are:

1) give an updated picture of Kansas live cattle basis and how it changed in the past few years, and
2) to summarize recent research findings[2] regarding what factors contributed to the change.

Basis Prediction Errors

We calculated weekly basis prediction errors (BPE) for Kansas live negotiated steers. The first step was to define a method for predicting weekly basis. Basis was defined as AMS weekly price for live negotiated steers, averaged across all grades minus the nearby CME live cattle futures price. We used the common method of taking the average the previous three-years' weekly basis levels to predict weekly basis in any given year. For example, the expected basis in calendar week 14 of 2010 would be the simple average of basis levels in calendar week 14 in years 2007, 2008, and 2009. The next step was to subtract observed basis in a given week from the predicted basis of that week. By this calculation BPE can be positive, negative, or zero. A positive BPE means that basis was stronger than predicted. Put another way, cash prices ended higher relative to futures prices than they were, on average, in a certain calendar week over the past three years. Conversely, a negative BPE means basis was weaker than predicted.

The analysis used cash and futures price data since the implementation of Livestock Mandatory Price Reporting (LMR) in 2001. The time period was narrowed further because we used regional level transaction type data, which have only been reported since 2004. That means basis predictions are only available from 2007 forward, as the predictions are based on a three-year moving average. The time period in question contains relatively large changes in price levels. To control for inflation and effects of price levels on hedging effectiveness, we converted basis to percentage terms. Specifically, basis is defined as Kansas Live Steer price divided by nearby Live Cattle Futures price multiplied by 100. In words, basis is cash price as a percentage of nearby futures. A comparison of predicted and observed Kansas basis is presented in Figure 2. BPE is simply the distance between the two lines. The closer the lines, the better the basis prediction is performing.

[2] This paper is based on the article: Coffey, B.K., G.T. Tonsor, and T.C. Schroeder. Impacts of Changes in Market Fundamentals and Price Momentum on Hedging Live Cattle. *Journal of Agricultural and Resource Economics,* 43(1):18-33. Available at: http://www.waeaonline.org/UserFiles/file/JAREJanuary20182Coffey18-33.pdf

Figure 2 shows that predicting three-year calendar week average generally captures the seasonal patterns of basis. As one would expect, the prediction method performs worse during extreme moves in the market. For example, in early 2010 basis was notably stronger than predicted. Conversely, basis was much weaker than predicted in late 2012 and early 2013. The year 2014 was a difficult year in which to hedge using the historical average basis as a prediction. Basis levels remained strong compared to the prediction throughout the year. In this environment, short hedgers would miss their predicted net price received but the BPE would be in their favor. That is, net price received would be higher than predicted. In 2015, the opposite scenario occurred.

Explaining the Errors in Basis Prediction

We used statistical modeling techniques that accounted for the time series aspects of the data to determine the relationships between BPE and various market factors.[3] Table 1 lists the names of all variables included along with a definition of each. The first three variables have the Δ symbol. This indicates they are measured as a change. Specifically, these variables are the observed value in a given calendar week minus the average of same measure in the same calendar week over the past three years. We defined the variables this way to match the calculation of BPE. We propose that if market conditions in given year are similar to conditions in the years upon which basis prediction is based, BPE should be small in magnitude. If the current year's market conditions diverge from the three-year average, this movement will likely result in increased hedging risk. The change variables included were *ΔAllHead, ΔNegHead, ΔWeight, and ΔWage. ΔAllHead* is the change in the total number of steers and heifers marketed in all five LMR major reporting regions.[4] *ΔAllHead* represents a shift in aggregate supply of slaughter cattle. *ΔNegHead* is specific to Kansas and the change in percentage of all slaughter steers and heifers which were sold on a negotiated basis. *ΔNegHead* measures the relative thinness of the negotiated market in Kansas. This measure is included because of the concern that decreased negotiation in the live cattle market may have reduced the connection between cash and futures prices. Changing marketing weights of cattle also impact basis. This is accounted for by including *ΔWeight* in the analysis. The last change variable is *ΔWage* and is included as a measure of changing delivery costs. Conversations with industry participants confirmed that transporting live cattle by truck often involves relatively short hauls. Therefore, the majority of transportation costs

[3] Empirical details are available upon request from the authors.
[4] The five major LMR reporting regions are Colorado (CO), Iowa/Minnesota (IA), Kansas (KS), Nebraska (NE), and Texas/Oklahoma/New Mexico (TX).

arise from trucking companies covering fixed costs of operating the truck and cost of the driver's time to be present for loading and unloading. With this in mind, we chose the average hourly earnings of employees in the Trade, Transportation and Utilities Industry, as reported by the Bureau of Labor Statistics. This wage approximates wages paid to truck drivers, which are a major component of delivery costs. Finally, two variables were analyzed based on their levels and not changes. These were *CornRatio* and *K*. *CornRatio* can be directly interpreted as the bushels of corn equal to one hundredweight of live cattle in terms of total value. This ratio is a proxy for the marginal benefit feeders receive from adding a pound to live cattle before slaughter. *K* is a measure of price momentum and is bound between 0 and 100.[5] *K* is included to capture the effects of market trends on ability to hedge. Table 2 contains descriptive statistics for all explanatory variables and BPE.

Results

We used the results from the statistical estimation mentioned earlier to simulate the impact of the volatility of each variable on BPE. This approach was chosen because it allows a reasonable comparison between all the variables. For example, a shift in *ΔAllHead* is measured in thousand head of live cattle and a shift in *ΔNegShare* is measured in percent. Comparing a one-unit change in each variable is not meaningful. On the other hand, we can determine the volatility of each variable based on historical data and compare the impact that a shift equal to one standard deviation of each variable would have on BPE.

Table 3 shows our predictions of the impact volatility in the variables analyzed has on net price received by a short hedger. The results are reported in terms of effect on net price received in dollars per hundredweight and in terms of total effect assuming a hedge position of one CME Live Cattle Contract. Since BPE was converted to percentage, a futures price level must be assumed to make these calculations. We calculate the impacts at a price representing an average level for the time period ($110/cwt) and a higher level ($135/cwt).[6]

The direction of the impact of each variable on BPE is important. A positive effect indicates that a positive shift in a given variable causes BPE to be more positive, which means observed basis is

[5] See Appendix for more details.
[6] $135/cwt is approximately the average plus one standard deviation of the nearby CME Live Cattle Futures Contract for the time period considered.

stronger than expected. In this case, a short hedger's net price received is higher than planned. Those variables with negative effects on BPE have the opposite interpretation. In general, more negotiated cattle marketings and higher *CornRatio* (i.e., lower cost of gain) are associated with more favorable hedging conditions for short hedgers. The impact of an increase in *ΔAllHead* is also positive, but small. The relationship between BPE and *ΔAllHead* was not statistically significant.

The magnitude of effects of volatility in economic variables on BPE differs markedly across economic variables. The most pronounced is *CornRatio*. A one standard deviation shift in *CornRatio* can change the outcome of a Live Cattle Contract short hedge position by $649, assuming a futures price of $115/cwt. Price momentum, as measured by *K*, is also important. Upward volatility of K by one standard deviation results in a net revenue from a single contract short hedge of $218 less than expected (again, assuming a futures price of $115/cwt). Put another way, as the distance between futures price in a given week and the lowest low observed in the past 14 weeks approaches the trading range for that time (the highest high minus the lowest low), short hedgers fare worse.

Increased weights of negotiated fed cattle, compared to the previous three-year- average, reduces net price received by short hedgers. This is no surprise as fluctuations in weight of negotiated cattle could make those cattle differ from the average weight specified by the CME Live Cattle Contract and, therefore, cause basis to change relative to historical levels. Volatility of delivery cost (as measured by *ΔWage*) has the second largest impact on BPE of all variables examined. As delivery costs increase, BPE becomes more negative. This translates into short hedgers receiving lower net prices than predicted.

Though not reported in the tables, we also found that there is no inherent bias in any CME Live Cattle Futures contract months when hedging Kansas steers. Put another way, hedgers could execute equally effective hedges utilizing any of the six available contracts. This says nothing regarding how well any contract performs, but simply that all available contracts perform equally well for hedging live cattle price risk from a basis prediction perspective.

Conclusions and Discussion

The findings from this study reiterate the existing knowledge that many factors are associated with live cattle basis and ability to effectively hedge live cattle. Changes in the live cattle market, such as fewer negotiated cattle being sold and increasing weights, alter ability to predict basis. Volatility in cost of gain impacts BPE more than any other variable we analyzed. Market trends are also important and volatility in delivery costs substantially alters hedging risk.

These findings are limited by the time period and scope of the study and should be understood as such. However, the findings offer some practical wisdom for hedgers. First, delivery costs matter a great deal, compared to other variables. We approximated delivery costs using wages of workers in the Trade, Transportation and Utilities Industry. Macroeconomic conditions largely determine these costs. If there are other opportunities for trucks and drivers, their time becomes more valuable and the cost of delivery will increase. For a cattle feeder, understanding this relationship can be helpful in understanding why local basis is harder to predict in some periods than others. Further, results show that periods where a larger proportion of cattle are being negotiated coincide with stronger basis and a more positive BPE. This relationship should be interpreted with a clear understanding of the methods used in this study. Specifically, our statistical models are not designed to identify causality. In other words, it is impossible, based on our analysis alone, to say which of these factors leads the other. For example, a strong basis might give feeders incentive to sell more cattle via cash negotiation. On the other hand, increased negotiated marketings could be indicative of market conditions that strengthen local basis. In this paper, we report the statistical relationship as an interesting finding and leave the analysis of the causal relationship to future research. Lastly, short hedgers can expect to fare worse when futures price has a strong upward trend relative to the recent trading range. This implies that when futures prices are rapidly trending upward, they may outpace cash prices and basis weakens, relative to historic levels.

We present this study as one method of identifying why hedging live cattle works better in some time periods than others. The findings supply practitioners with information that can help them better understand the dynamics of hedging risk. Additionally, the study is valuable to guide researchers examining the effectiveness of hedging with the CME Live Cattle contract by highlighting the complex and changing factors that affect ability of producers to use the contract to hedge.

Additional Resources

Coffey, B.K., G.T. Tonsor, and T.C. Schroeder. Impacts of Changes in Market Fundamentals and Price Momentum on Hedging Live Cattle. *Journal of Agricultural and Resource Economics*, 43(1):18-33.
Available at: http://www.waeaonline.org/UserFiles/file/JAREJanuary20182Coffey18-33.pdf

McElligott, Jeremiah and Glynn T. Tonsor. Fed Cattle Basis: An Updated Overview of Concepts and Applications. K-State Dept. of Agricultural Economics (Publication: AM-GTT-2012.3), March 2012.
Available at: https://www.agmanager.info/sites/default/files/FedCattleBasis.pdf

Mintert, James, Kevin Dhuyvetter, Ernest E. Davis, and Stan Bevers. Understanding and Using Feeder and Slaughter Cattle Basis. Part of the Managing for Today's Cattle Market and Beyond Series, March 2002;
Available at: http://www.agmanager.info/livestock-meat/marketing-extension-bulletins/price-risk/understanding-feeder-and-slaughter-cattle

Sartwelle III, James D. and James Mintert. Hedging Using Livestock Futures. Part of the Managing for Today's Cattle Market and Beyond Series, March 2002;
Available at: http://www.agmanager.info/hedging-using-livestock-futures

Table 1. Variables Included in BPE Analysis

Variable Name	Definition	Units
ΔAllHead	Number of slaughter steers and heifers marketed in a given calendar week minus the average of the same measure in the same calendar week over the past three years.	1,000 head
ΔNegShare	Percentage of Kansas slaughter steers and heifers which were marketed as negotiated, live sales in a given week minus the average of the same measure in the same calendar week over the past three years.	Percent
ΔWeight	The weighted average weight of all Kansas slaughter steers and heifers which were marketed as negotiated, live sales in a given week minus the average of the same measure in the same calendar week over the past three years.	100 pounds
ΔWage	National average of hourly wages for employees in the Trade, Transportation and Utilities Industry, as reported by the Bureau of Labor Statistics in a given week minus the average of the same measure in the same calendar week over the past three years.	Dollars per hour
CornRatio	Cash price of Kansas live steers divided by cash price of corn in Western Kansas	Bushels of corn per hundredweight of live cattle
K	Weekly futures price momentum measure defined as current settlement price minus the lowest low observed in 14 weeks divided by the highest high minus the lowest low in the same time period. See Appendix for more detail.	Percent

Table 2. Descriptive Statistics of Weekly Data from 2004 to 2016

Variable	Units	Mean	StDev	Min	Max	N
BPE	(% Nearby Futures)	0.27	1.91	-5.41	8.24	474
ΔAllHead	(1,000 head)	-3.70	11.01	-31.03	27.65	474
ΔNegShare	(%)	-6.50	9.96	-33.80	22.56	474
ΔWeight	(100 pounds)	0.22	0.30	-0.44	1.22	474
ΔWage	($/hour)	0.73	0.10	0.50	0.91	477
CornRatio	(bushels/cwt)	28.88	10.15	13.44	50.98	630[1]
K	(%)	54.70	33.45	1.61	98.59	635[1]

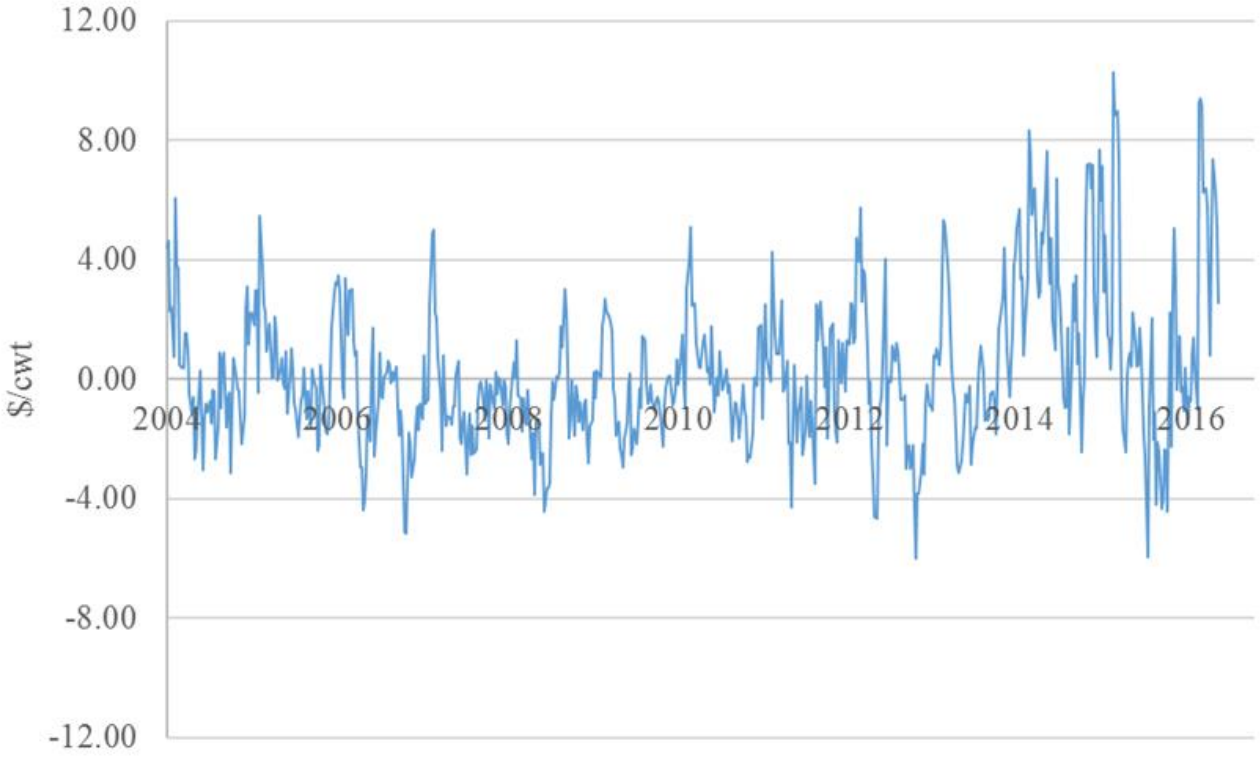
1 CornRatio and K are not change variables, therefore their statistics are reported for the entire time period of 2004 to 2016.

Table 3. Estimated Impacts in Dollars per Hundredweight on Net Price Received on with a Short Hedge Associated with a One Standard Deviation Increase in Economic Variables

Nearby Futures Price	Economic Variable	Effect on Net Price Received ($/cwt)	Effect on a One Contract Position ($/cwt)
$115/cwt			
	ΔAllHead	$0.08	$30.16
	ΔNegShare	$0.49	$195.19
	ΔWeight	-$0.27	-$107.80
	ΔWage	-$0.83	-$330.52
	CornRatio	$1.62	$649.08
	K	-$0.55	-$218.57
$135/cwt			
	ΔAllHead	$0.09	$37.01
	ΔNegShare	$0.60	$239.55
	ΔWeight	-$0.33	-$132.30
	ΔWage	-$1.01	-$405.64
	CornRatio	$1.99	$796.60
	K	-$0.67	-$268.24

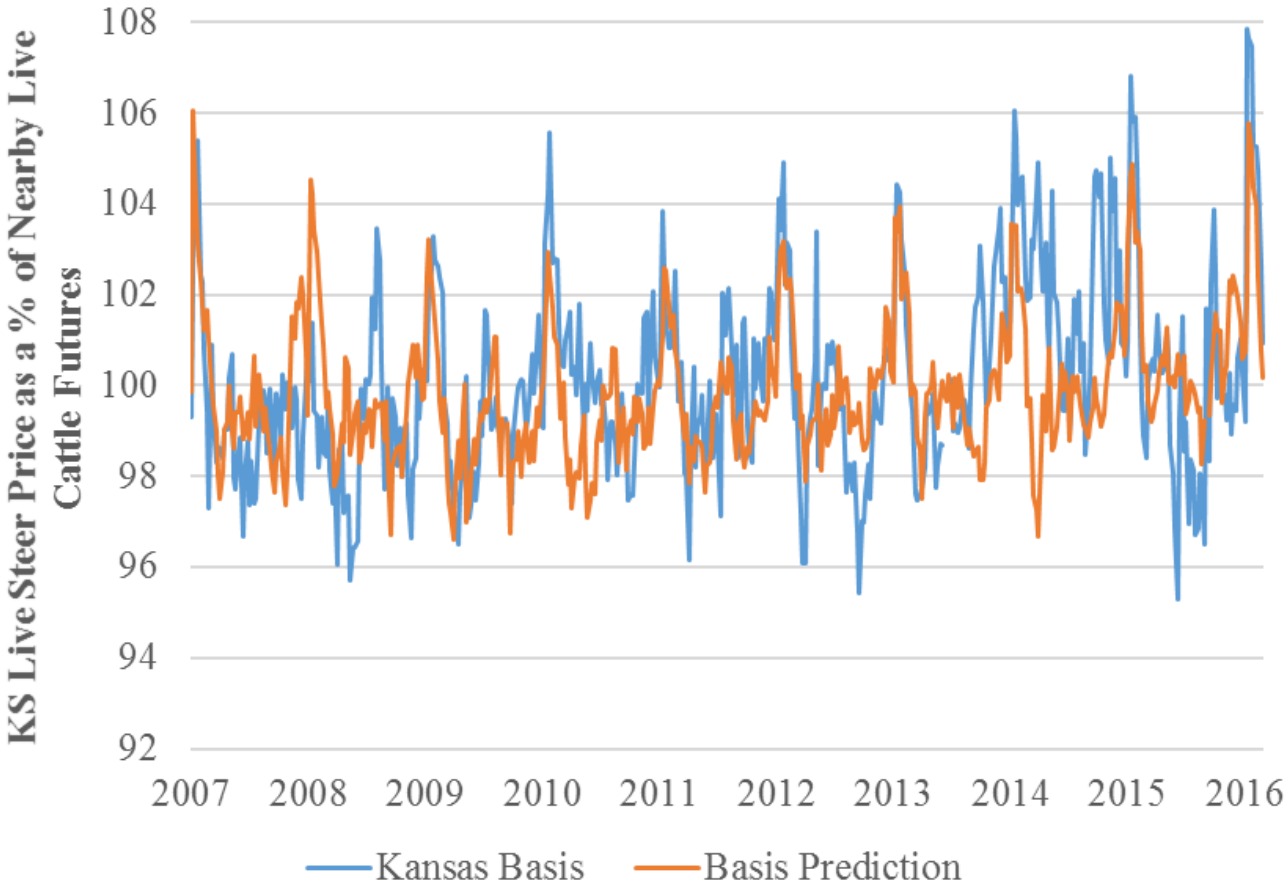
Notes: As explained in the text, results can be interpreted as the change in net revenue due to basis prediction error experienced by a short hedger with a position of one contract. The impacts of changes in all variables, except ΔAllHead, were found to be statistically significant.

Figure 1. Weekly Nearby Basis: Kansas Live Steers – Nearby CME Live Cattle Futures, 2004 to 2016



Sources: Futures prices are CRB Weekly Averages of the Nearby CME Live Cattle Contract, Cash prices taken Livestock Marketing Information Center data based on livestock mandatory price reporting data from USDA-AMS

Figure 2. Observed Weekly Kansas Live Steer Basis vs. Predicted Basis Where Basis is Expressed as Cash as a Percentage of Nearby Live Cattle Futures Price



Notes: Futures prices are CRB Weekly Averages of the Nearby CME Live Cattle Contract, Cash prices taken Livestock Marketing Information Center data based on livestock mandatory price reporting data from USDA-AMS. Basis predictions are made using a three-year moving average of basis observations.

Appendix: Explanation of the Price Momentum Measure K

The stochastic oscillator, *K* is a standard price momentum measure used widely in trading futures contracts as a technical indicator. *K* is calculated as:

$$K=\left(\frac{\text{Fut}_{\text{current}}\text{-Lowest Low Fut For the Period}}{\left(\text{Highest High Fut For the Period-Lowest Low Fut For the Period}\right)}\right)\times 100$$

The numerator of *K* equals the current week's average nearby futures price minus the lowest low average nearby futures observed in the past 14 weeks. The denominator is the highest high average nearby futures observed in the last 14 weeks minus the lowest low observed during the same time. *K* is the ratio (bound between 0 and 100) of the distance of the current price from the lowest low to the range in which the contract has recently traded.

There are varying opinions regarding what momentum measures capture. In the context of this study, *K* is a reasonable proxy for market trends beyond those explained by the fundamental measures included in the model. As a technical indicator *K* indicates buying or selling pressure in the futures market and is often used by traders to identify signals to sell or buy a derivative. As *K* (and the three-period moving average *K*) approaches 100, the market is termed more "overbought" by traders, meaning that price level the current period may be too high relative to the recent range of trading for the contract. This is generally interpreted as signal to sell. As *K* approaches zero, a market is said to be "oversold", implying the current period bids are low relative to recent trading range and that one should buy.