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The 'New' Live Cattle Futures Contract: Basis Issues

Rob Murphy and Keith Boris*

Practical issues for Live Cattle basis calculation are explored. Significant differences were found when cash volume weights and mean futures prices were used in basis calculations rather than equal weighting and settlement futures prices. Using settlement futures prices rather than mean futures prices is probably acceptable for studies considering basis over a long period. Changes to the Live Cattle contract in June 1995 have caused the basis to become more negative. Day-to-day variability in the basis has changed little under the new contract specifications, but month-to-month variability has been reduced significantly.

Introduction

Basis, which is the relationship between cash and futures prices for a commodity, is critical to the price risk management function performed by futures markets. Commercial interests that want to use futures to protect against unfavorable price movements will find greater success in futures markets where the basis is highly predictable. Thus, in order to attract the commercial hedging interest that is vital to the success of a futures contract, exchanges often focus on designing contracts that will provide the most predictable basis possible.

Non-storable commodities, such as livestock, present special problems in contract design that directly impact the basis. In storable commodities, storage arbitrage puts limits on futures price movements that is not present in non-storables (Kolb). Consequently, the cash-futures relationship has the potential to be more erratic in non-storable products. Also, physical delivery of live animals can be high cost and involve considerable risk which may contribute to basis variability.

The Live Cattle contract traded at the Chicago Mercantile Exchange (CME) recently underwent changes in its specifications and delivery provisions that had a profound effect on the basis. One of the primary goals of the CME in making these changes was to improve basis stability for commercial users of the contract.

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Live Cattle Specification Changes

From its inception in November 1964 until June of 1995, delivery on the Live Cattle contract was completed by transferring a load of live animals from seller to buyer at a delivery point stockyard. USDA personnel served as third-party evaluators to ensure that the delivered cattle met the contract specifications. While this method of delivery worked well early on, by the early 1990s the stockyard delivery system was headed toward obsolescence. Many factors contributed to the demise of stockyard delivery, but among most important were the shift to direct trade in the cash market (thus bypassing the stockyard) and the increasing importance of accurately measuring the carcass quality of the delivered cattle.

Buyers who took delivery of live animals at the stockyard often complained that, when the delivered cattle were subsequently slaughtered, the animals fell far short of the quality promised by the contract specifications. These situations served to highlight the difficulties in judging the carcass quality by examining the live animal. As a solution to this inequity, the CME amended the contract, beginning with the June 1995 expiration, to give the buyer the option of having the cattle delivered to a packing plant and the final settlement based on actual carcass results (a "carcass-graded delivery"). Inclusion of this buyer's option, which changed the method of delivery for the first time in the history of the contract, was the first of two major changes implemented in June 1995.

The second important change was a lowering of quality requirements of the contract. Prior to June 1995, the par deliverable load was 100% Choice steers. Beginning with June 1995, a par deliverable load was 55% Choice, 45% Select grade steers. Deviations from the par Choice-Select mix were compensated with an adjustment to the final settlement that came from the daily Choice-Select boxed beef spread reported by USDA. This change greatly expanded the pool of deliverable cattle by making any combination of quality grades eligible for carcass-graded delivery.

While the new specifications used a market-based adjustment for the Choice and Select grades, USDA-reported premiums and discounts did not exist for other quality grades (Prime, Standard, etc.) and other economically important carcass characteristics. Lacking a market source for these adjustments, the CME set the adjustments for non-par attributes at some fixed dollar amount or a fixed percentage of the settlement price. Table 1 lists the non-par adjustments included in the contract specifications beginning with the June 1995 expiration.

The adjustments for the non-conforming cattle (sub-Select, YG4, YG5, over- and underweight carcasses) were intentionally set large so that delivery on the futures contract would not be an economically attractive means of disposing of these undesirable animals. With these relatively large discounts in place, the Exchange assumed no rational seller would deliver these types of cattle. After the first several contract expirations under these provisions however, it became

apparent that sellers delivering cattle were not able to identify (and thus exclude) all non-conforming cattle. This led to significant discounts on delivered cattle which in turn caused the futures contract to trade at a premium to the average cash market price.[1]

These contract changes led to a basis shift that was not anticipated by many in the industry. Cattle producers who did not understand the ramifications of the specification changes were quick to assert that the Live Cattle contract was malfunctioning and that the basis and become so variable that the contract was not viable as a risk management tool. This study provides some of the first quantitative results with respect to the Live Cattle basis under the new specifications. In the remainder of this paper, the terminology "old contract" is used to refer to the contract rules in effect prior to June 1995 and "new contract" refers to expirations since June 1995, inclusive.

Data Issues for Live Cattle Basis

The primary reason for interest in the basis is risk management. Basis variability is often used to evaluate the usefulness of a futures contract in this respect (Kenyon, et. al.; Rich and Leuthold; Leuthold). Frequently, basis is calculated and inferences are made with little forethought as to the appropriate price data that should be used to do the best job of measuring a contract's utility for price risk management. This section considers some issues surrounding data selection for cattle basis variability studies. The constraints imposed by real-life data availability for use in calculating Live Cattle basis are also discussed.

Among cattle industry participants, basis (cash price minus futures price) is often referred to in a macro sense. They talk about "the basis" as though it were a single universal number. In reality, basis is more of a micro concept with each hedged animal having a specific basis. However, to make a basis study useful to commercial futures participants, it is important to analyze the basis in the larger sense. This entails aggregating the micro-level basis information to a single basis observation. A reasonable method of estimating the aggregate basis would be to calculate the basis for every unit of the cash product transacted on a given day and then estimate the aggregate basis from this information. The expected value of all of the individual basis observations should be the best estimator in this situation. This can be represented as:

$$\text{Daily Basis} = E[CP_i - FP_i] \qquad (1)$$

where CP_i is the cash price of the ith animal and FP_i is the futures price quoted at the time the ith animal was sold. Of course, this estimate of the daily basis can be expressed as:

[1] Theoretically, the futures price should move to a level where the owners of cattle are indifferent between selling cattle in the cash market or delivering them against the futures. If futures delivery means the seller will incur price discounts, then the base futures price will rise to a level where the expected net price from a futures delivery equals the expected net cash price.

$$\text{Daily Basis} = E[CP_i] - E[FP_i]. \quad (2)$$

Thus, subtracting the mean futures price from the mean cash market price on a given day will provide an acceptable aggregate estimate of the basis for a particular day.

What may be more important to hedgers than the basis on a particular day, is the basis over some larger time period corresponding with the expiration of the futures contract. This is especially relevant for fed cattle where there may be a two or three week window when the cattle would be expected to be ready for sale in the cash market. In deciding whether or not to place a hedge, a user must form a target price for the product being hedged. If the user has a good idea of what the basis in the ending period will be, he or she can form an accurate target price.

The Live Cattle contract has a tender period that spans the last 10 to 15 business days of the contract's life in which a seller may tender a certificate notifying the buyer of his intent to deliver cattle at that day's settlement price. During the tender period, arbitrage may be conducted between the cash and futures markets and this fosters an economic relationship between futures and cash prices that does not exist outside of the tender period. Thus the basis for a particular month (e.g., June basis, December basis) refers to the estimate of basis during that contract's tender period. In line with the above discussion, an appropriate estimator of the monthly basis would be

$$\text{Monthly Basis} = E[\text{Daily Basis}] \quad (3)$$

where the expectation is taken over all of the days in the tender period.

The results so far are not surprising; the best daily estimate of "the basis" is the mean basis level over all the cash cattle sold that day and the best monthly estimate of "the basis" is the mean basis level over all of the cash cattle sold during the tender period.

(a) Cash Prices

Researchers do not have access to all of the individual cash prices for which cattle sold during a particular day. Approximately 20 percent of U.S. fed cattle are considered "captive"—that is they are either packer-fed or sold under forward contract or for a price derived from a formula that is not public information (USDA). These prices are unavailable for use in determining the average daily cash price.

The USDA does report prices for direct transactions in various regions of the country. USDA obtains these prices from voluntary reporting of transactions by producers and/or packers. These prices are aggregated into "weighted averages"; i.e., each individual price is weighted by the number of head sold at that price. The most comprehensive aggregate cash price reported by USDA is the daily average price from its *5-Area Weighted Average Report*. Prices are reported

for both live and dressed weight transactions. Approximately 37% of all fed cattle transactions are based on dressed weight (USDA).

This analysis makes use of the daily *5-Area* weighted average price for steers sold on a live basis since this is what most closely corresponds to the futures contract specification. Using this data as an estimate of $E[CP_i]$ has some limitations. If the reported trades are systematically different from the unreported trades, then the daily *5-Area* price will be different from $E[CP_i]$ in (2) above.

There is a distinct possibility that many of the above average cattle, sold for better than average prices, are not reported to USDA, thus imparting a downward bias in the *5-Area* estimate of $E[CP_i]$. This occurs because many of the formula cattle use as their base price the weekly USDA average price for the state or region. Packers many pay more for above average cattle on the condition that the seller not report the trade. The seller benefits from the higher price and the packer benefits by having a lower base price for the formula cattle bought during the same week. In addition, sales of cattle that are part of a marketing program or in some way use value-based pricing (e.g., price adjusted according to a "grid" of premiums and discounts) do not generally get included in the 5-Area weighted average price. Typically, only better quality cattle are sold in value-based systems (CattleFax). Cattle sold on dressed weight could differ systematically from those sold on a live basis. Most dressed weight sales occur in the northern cattle feeding regions and there may be quality differences between these cattle and those in other regions of the country. In general, it would seem likely that the *5-Area* live steer price underestimates the true $E[CP_i]$.

For the monthly basis calculations, the expectation in (3) requires that each daily basis observation be weighted by the number of cash market transactions that occurred on the corresponding date. This is especially important for a commodity such as live cattle where cash market trading is sporadic. In recent times, a large percentage of the cash market trade for a given week occurs on one day, often within a one or two hour time period. It is intuitive that the basis observed on a day when 100,000 cash cattle were transacted should receive more weight in the monthly basis calculation than the basis observed when only 100 head are reported sold in the cash market.

Table 2 gives the monthly basis calculations since June 1995 calculated two ways. In the first method, the daily bases are weighted by the corresponding cash market volume; this is consistent with (3) above. In the second method, the daily bases are given equal weight; this methodology is common in most basis studies and also in industry practice. Table 2 indicates that when the monthly basis is cash volume weighted the mean basis level tends to be less negative. In four of the contract months, using cash volume weighting produced a mean basis value that was significantly different from the equal weight approach ($P < 0.10$). The standard deviations of the daily bases were generally smaller (but not statistically significant) than when the cash volume weights were used.

(b) Futures Prices

Futures prices represent the other important component of the basis calculation. Most research uses the daily settlement price as the futures price in basis calculations primarily because this data is relatively easy to obtain. It is unclear, however, if the daily settlement price is a good estimate of $E[FP_i]$. Often, futures will trade within a range most of the day only to move well outside of that range as the market close approaches. A few frantic trades on the close can cause the settlement price to be unrepresentative of the price at which most trading occurred during the day.

A better estimate of $E[FP_i]$ might be the mean futures price. The CME retains information on the number of contracts that traded at each specific price during a trading session for all listed contracts. This is listed daily in the *Sales by Price* report. From this information, a density function for the daily price can be constructed and the mean easily calculated. In order to study the effect of using the settlement price as a proxy for $E[FP_i]$, the mean futures price was calculated from the *Sales by Price* information for the nearby Live Cattle contract from May 1995 through February 1997.

Table 3 gives the difference between the mean futures price and the settlement futures price during the tender period for all of the 11 contracts that have expired since June 1995. On average, over all contracts, there appears to be little difference between the mean futures price and the settlement price. The absolute value of the difference is \$0.20/cwt., on average, and the maximum absolute difference observed during this time period was \$2.06/cwt. This suggests the mean futures price can be quite different from the settlement price, but on average the frequency and magnitude of the positive differences is equal to those of the negative differences. This table also reports the actual differences for the last three days of trading in each contract. Differences between the two measures appear to get larger nearer to the end of trading with the last trading day having an average absolute difference of \$0.46/cwt., which is almost one-third of the daily price limit for Live Cattle.

The effect on the calculated monthly basis of using settlement prices instead of mean futures prices is illustrated in Table 4. Using the mean futures price resulted in statistically significant differences in the monthly basis for three contract months ($P < 0.05$). Standard deviations of the daily basis were generally smaller using mean futures prices. The February 1996 tender period is an interesting standout from this sample. In that tender period, the standard deviation of the daily basis was reduced by nearly 68 percent when the basis was calculated using mean futures prices rather than settlement prices ($P < 0.05$).

Basis Differences Under the New Contract

A comparison of basis variability under both the old and new contracts in necessary to clarify the risk management implications of the contract change. The weighted average basis and the standard deviation of the basis during the tender period for each expiration since June 1995 was given in Table 4. Table 5 provides the same information for the 32 expirations immediately preceding June 1995.[2] Several observations can be made. First, the basis has become more negative. The average level of the basis under the old contract was -$0.37/cwt. Under the new contract the average level of the basis has been $-0.77/cwt. However, in the first new contract expiration (June 1995) the basis was abnormally large (and positive). Excluding this outlier puts the average level of the basis under the new contract at $-0.94/cwt.

It is interesting to investigate the cause of this downward shift in the basis. There were two major changes in the contract beginning with June 1995: 1) the par specification was reduced from 100% Choice to 55% Choice and 2) buyers were given the carcass-grading option. The reduction in the quality grade specification would be expected to raise the basis. Since the new contract represents a lower quality animal than the old contract, it should trade at a lower futures price. A lower futures price in basis calculations makes the basis more positive.[3] What occurred, however, is that the basis became more negative. This indicates that the carcass-grading option had more of an impact on the basis than did reducing the quality grade specifications. Since carcass-grading allows for better detection of deviations from the contract specifications (including non-conforming cattle that bring large discounts for the seller), this raises the possibility that under the old contract below-par cattle routinely went undetected.

Variability of the daily basis appears to have increased slightly with the new contract. The average tender period basis standard deviation was $0.48 under the old contract and $0.61 since June 1995 ($P < 0.29$). Variability of the monthly basis has been reduced considerably. The standard deviation of the average monthly basis was $0.83 under the old contract and $0.42 under the new contract, excluding the June 1995 outlier ($P < 0.07$).

The excessive monthly basis variability under the old contract had two likely sources: 1) occasional difficulty in assembling deliverable loads, and 2) uncertainty associated with live-grading. In certain market conditions under the old contract it could be difficult to assemble a significant number of loads that would grade 100% Choice. This could allow occasional market distortions that would cause the futures price to diverge from the economically justified value of

[2] The pre-June 1995 bases were calculated using cash volume weights and settlement futures prices. All comparisons use post-June 1995 bases calculated in the same manner.

[3] This may explain the June 1995 outlier. Market participants, lacking actual experience with the new contract, may have assumed that because the quality grade requirements had been relaxed, that the basis should become more positive.

the underlying. This is no longer a problem with the new contract, as any quality grade mix is allowed in the delivery unit (with adjustments applied for deviations from par).

Accurate estimation of carcass attributes from observation of the live animal is difficult and inexact. Because of this, the buyer in a live-graded delivery under the old system assumed considerable grading risk. This risk is presumably larger than the grading risk assumed by the seller in a carcass-graded delivery because the buyer has no prior information on the cattle. By contrast, the seller is the one who selected the feeder cattle and the feeding regime that were used to produce the finished animal. It stands to reason that the seller should have better information as to how the cattle will grade than a buyer who was assigned delivery from a seller he does not know. The change to carcass-grading essentially shifted the grading risk from the buyer to the seller. Since the grading risk should be smaller for the seller than the buyer, this change should remove uncertainty from the system and reduce the variability of the basis.

Conclusions

Issues involving basis and its calculation are important in determining the usefulness of a futures contract for risk management. Sometimes a contract or its underlying cash market will have unique features that require special considerations in the calculation of basis. Live Cattle is one of those contracts. In this market, the basis can differ significantly between animals in the same pen because of differences in value related to quality factors. Researchers often need consistent methods of aggregating these bases into a single value in order to study the risk management performance of the futures contract.

Sporadic trading in the cash market must be reconciled with a futures contract that trades daily in basis calculations. This study finds that calculating basis on a cash volume weighted basis, rather than giving equal weight to all days, can significantly affect the overall basis level, but has little effect on its variability.

Theoretically, the mean futures price is more desirable for basis calculations than the daily settlement price. For Live Cattle, there appears to be no systematic bias in using the settlement price as a proxy for the mean futures but there are frequently large deviations between the two prices. This implies that settlement prices might be acceptable for studies that cover long time periods, but in those instances where the investigator wants to consider the basis level over a shorter time period (e.g., day or week), using mean futures price will provide a better representation of the aggregate basis level.

The failure to use cash volume weighting can combine with short-run distortions caused by using settlement futures prices to cause large inaccuracies in the basis variability measures. This was seen in this study with the February 1996 Live Cattle contract. In that tender period, most of the cash cattle traded on one day each week and, on those days, the settlement futures price

was very different from the mean futures price. When these factors were accounted for, the standard deviation of the estimated basis value was very significantly reduced.

From a basis perspective, the most important of the changes made to the contract in June 1995 was the inclusion of a buyer's option to have the quality of the delivered cattle determined by carcass evaluation. Non-conforming cattle are now routinely detected and large discounts applied. This has caused the futures price to rise relative to the average cash market price; thus the basis has become more negative. Day-to-day variability in the basis was not significantly changed with the new contract, but the month-to-month variability in the average basis level has been reduced significantly. This increased basis stability under the new contract is partly the result of rule changes that allow almost any quality animal to be delivered (with the appropriate premium or discount) which prevents price distortions in the tender period caused by the inability to assemble acceptable loads. Also, carcass-graded delivery has shifted much of the risk for the quality of delivered cattle from the buyer to the seller and this is hypothesized to reduce uncertainty and improve basis stability.

The early evidence presented in this study appears to suggest that the changes made to the Live Cattle contract should improve its usefulness for price risk management. For hedgers to benefit from this improvement, however, they must recognize that the level of the basis has shifted and form their target prices accordingly.

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Table 1. Non-par Adjustments Included in the Live Cattle Contract Beginning with the June 1995 Expiration.

Attribute	Adjustment
Prime	None, Prime considered equal to Choice
Sub-Select quality grades	-25% of the settlement price
Yield Grades 1,2,3	None, all considered par
Yield Grade 4	-$20 per cwt. or -30% of settlement price, whichever is larger
Yield Grade 5	-$30 per cwt. or -40% of settlement price, whichever is larger
Carcasses more than 900 lbs. or less than 600 lbs.	-20% of the settlement price

Table 2. Means and Standard Deviations of the Monthly Basis Calculated Using (a) Daily Bases Weighted by Cash Volume and (b) Daily Bases Given Equal Weight (Tender Period Only).

	Mean Basis		Standard Deviation of Basis	
Contract Month	Weighted by Cash Volume	Equal Weights	Weighted by Cash Volume	Equal Weights
Jun-95	0.96	0.48**	0.50	0.73
Aug-95	-0.41	-0.18	0.67	0.68
Oct-95	-0.93	-1.17	0.70	0.53
Dec-95	-1.14	-1.18	0.24	0.36
Feb-96	-0.50	-1.13**	0.48	0.56
Apr-96	-0.56	-0.64	0.44	0.54
Jun-96	-0.89	-1.34**	0.48	0.76
Aug-96	-1.88	-1.90	0.44	0.46
Oct-96	-1.40	-1.41	1.15	0.91
Dec-96	-0.76	-1.07	1.02	0.96
Feb-97	-0.92	-1.21*	0.52	0.62
Average:	-0.77	-0.98	0.61	0.65

**Means significantly different at 5%
*Means significantly different at 10%.

Table 3. Difference Between the Mean Futures Price and the Settlement Futures Price in the Tender Period (Cash-Volume Weighted, $/cwt.).

Contract Month	Mean Difference	Mean Absolute Difference	On the Third to Last Trading Day	On the Second to Last Trading Day	On the Last Trading Day
Jun-95	0.00	0.24	0.23	-0.22	-0.29
Aug-95	0.05	0.17	0.00	-0.24	-0.23
Oct-95	-0.07	0.19	-0.05	0.22	-0.64
Dec-95	-0.05	0.17	-0.33	0.21	-0.41
Feb-96	0.13	0.20	0.03	0.02	0.88
Apr-96	0.19	0.25	-0.08	0.05	0.97
Jun-96	-0.08	0.26	0.07	-0.46	-0.29
Aug-96	-0.01	0.24	-0.20	0.35	0.56
Oct-96	0.00	0.17	-0.23	0.01	-0.07
Dec-96	-0.11	0.19	-0.05	0.25	-0.51
Feb-97	-0.10	0.12	-0.25	-0.36	-0.17
Average:	0.00	0.20	-0.08	-0.02	-0.02
Avg. Absolute Difference	0.00	0.20	0.14	0.22	0.46

Table 4. Means and Standard Deviations of the Basis Calculated Using Mean Futures Prices and Settlement Futures Prices During the Tender Period ($/cwt.).

	Mean Daily Basis = Monthly Basis		Standard Deviation of Daily Basis	
Contract Month	Mean Futures	Settle Futures	Mean Futures	Settle Futures
Jun-95	0.81	0.96	0.51	0.50
Aug-95	-0.37	-0.41	0.54	0.67
Oct-95	-0.92	-0.93	0.54	0.70
Dec-95	-1.04	-1.14	0.29	0.24
Feb-96	-0.94	-0.50**	0.14	0.48**
Apr-96	-0.81	-0.56**	0.35	0.44
Jun-96	-0.93	-0.89	0.32	0.48
Aug-96	-1.61	-1.88**	0.34	0.44
Oct-96	-1.50	-1.40	1.03	1.15
Dec-96	-0.72	-0.76	1.13	1.02
Feb-97	-0.85	-0.92	0.43	0.52
Mean Monthly:	-0.81	-0.77	0.51	0.62
(Std Dev. of Monthly)	(0.63)	(0.71)		
Excluding June 95 outlier				
Mean Monthly:	-0.97	-0.94		
(Std Dev. of Monthly)	(0.36)	(0.45)		

**Significant at 5%

*Significant at 10%.

Table 5. Mean Basis and Standard Deviation of the Daily Basis During the Tender Period, February 1990 Through April 1995 Contracts.

Delivery Period	Tender Days	Total Cash Steers Reported During Tender Period	Mean Basis	Standard Deviation of Daily Basis
Feb-90	16	204,640	-0.363	0.366
Apr-90	17	219,918	0.632	0.565
Jun-90	17	341,484	1.434	1.051
Aug-90	17	271,413	-0.449	0.325
Oct-90	18	240,305	-0.241	0.155
Dec-90	17	208,254	0.946	0.637
Feb-91	13	207,553	0.288	0.480
Apr-91	12	220,157	-0.036	0.233
Jun-91	10	170,495	0.107	0.482
Aug-91	15	309,599	-1.600	0.824
Oct-91	14	259,243	-2.815	0.939
Dec-91	9	114,060	-0.740	0.691
Feb-92	9	123,938	-1.042	0.244
Apr-92	13	176,946	-0.314	0.457
Jun-92	12	227,704	0.762	0.247
Aug-92	11	261,769	-0.163	0.189
Oct-92	15	258,940	-0.167	0.280
Dec-92	12	163,343	-0.098	0.639
Feb-93	9	159,578	-0.550	0.290
Apr-93	14	249,249	0.168	0.315
Jun-93	13	265,749	0.716	0.372
Aug-93	12	233,615	-0.156	0.283
Oct-93	15	281,999	-1.123	0.511
Dec-93	12	239,148	-0.643	0.590
Feb-94	10	210,440	-0.976	0.197
Apr-94	15	219,731	-0.678	0.286
Jun-94	14	248,667	-0.019	0.672
Aug-94	13	199,433	-1.546	0.649
Oct-94	11	232,782	-1.438	1.032
Dec-94	14	250,990	-0.427	0.176
Feb-95	11	201,971	-0.880	0.426
Apr-95	9	136,130	-0.557	0.690
Average:	13.09	222,164	-0.374	0.478
Standard Dev.	2.60	49,557	0.827	0.247