

Forward-looking breakeven cattle feeding conditions in futures markets

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Abstract

This study uses cointegration analysis and a vector error correction model to determine the long-run cointegrating equation among feeder cattle, corn, and live cattle futures prices. Assuming that the cointegrating equation is reflective of breakeven conditions in cattle feeding, disturbances from the equation are defined as expected profit in cattle feeding. I find that the cointegrating equation coefficient estimates match reasonably well to expected values based on futures contract specifications. The expected profit is positively correlated with cattle feeder placement decisions. Findings indicate futures markets related to cattle feeding behave in a manner consistent with breakeven conditions.

KEYWORDS

cointegration, economics, feeder cattle, futures contract

JEL CLASSIFICATION

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1 | INTRODUCTION

Conventional cattle feeding in the US involves purchasing light-weight animals (i.e., feeder cattle), feeding them corn-dominant rations in a dry feedlot for several months, and selling the animals (i.e., fed or live cattle) at an appropriate weight. Beginning weight, feed ration composition, time in the feedlot, and ending weight vary but the vast majority of US beef is produced using this general process. To estimate potential profit, cattle feeders must forecast, among other things, the live cattle sale price at the end of the feeding period and the total cost of corn needed. These two quantities are

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the major determinants of how much cattle feeders are willing to pay for feeder cattle. As a result, the current price of feeder cattle, the future price of corn, and the future price of live cattle should be related based on supply and demand for each commodity. Futures contracts for feeder cattle, corn, and live cattle are used by cattle feeders (and other users) to hedge against unfavorable price movements and are traded by speculators hoping to profit from trading based on their understanding of the markets. If these three derivatives are appropriately connected to the underlying physical commodities, their prices should reflect market expectations regarding cattle feeding. Further, if markets related to cattle feeding are efficient, fully reflecting available information (Fama 1970; Malkiel 2003), current feeder cattle price, future corn price, and future live cattle price should exhibit long-run breakeven conditions.

The purpose of this study is to test whether feeder cattle, corn, and live cattle futures prices are related in a manner that is consistent with economic theory (i.e., cattle feeding is a breakeven venture over the long run) and practices in the cattle feeding industry. I perform cointegration analyses, including a vector error correction model (VECM), to estimate the long-run equilibrium relationship between feeder cattle, corn, and live cattle futures prices and short-run adjustments to disturbances in that relationship. Assuming the cointegrating equation represents a long-run breakeven condition (Mallory et al. 2012), I use error terms from the cointegrating equation as indicators of expected economic profit to cattle feeders in the short-run. These VECM errors are then used in a regression analysis of monthly cattle on feed placements to determine if there is a correlation between the implied expected economic profit and cattle feeder placement decisions. Findings indicate that nearby feeder cattle, deferred corn, and deferred live cattle futures prices are cointegrated in a manner consistent with conventional cattle feeding and market efficiency. Nearby feeder cattle and deferred live cattle prices respond to shocks in a way that indicates a stable long-run cointegrating relationship. Disturbances in this cointegrating relationship, defined in this study as short-run economic profit, are positively correlated with cattle feeder decisions to place feeder cattle on feed between June 2005 and December 2024.

1.1 | Previous literature

Past research into market efficiency of live cattle futures prices has focused on how live cattle futures incorporate information (Garcia et al. 1988) and respond to severe market shocks (Jin et al. 2008). The use of cointegration analysis in livestock futures markets has often focused on relationships of individual futures contracts to their respective underlying cash markets (Mathews et al. 2015; Oellermann and Farris 1985) or on the relationship between different cash markets for live cattle (Coffey et al. 2019; Goodwin and Schroeder 1991; Pendell and Schroeder 2006). There is other research which, like this study, simultaneously considers feeder cattle, corn, and live cattle futures. This includes work devoted to the inter-commodity feeding spread referred to colloquially as the “cattle crush” (Mefford 2022; Vélez 2006). The cattle crush allows a trader to mimic cattle feeding returns (or their opposite) using concurrent futures positions in feeder cattle, corn, and live cattle, and can be employed by hedgers or speculators. Tonsor and Schroeder (2011) used the cattle crush (or feeding margin) concept to forecast feeder cattle prices. Other examples include research that uses some combination of feeder cattle, corn, and live cattle futures prices to define hedgeable profit from feeding (Kastens and Schroeder 1994) or expected returns to feeding (Koontz et al. 1985) and test whether those measures are related to cattle feeder placement decisions. Defining a cattle crush trade, hedgeable profit, or expected returns requires imposing assumptions regarding placement weight, feed conversion, and finish weight. This study takes a different approach and, rather than impose production assumptions, estimates implied production relationship between nearby feeder cattle, deferred corn, and deferred live cattle futures prices using cointegration analysis and a VECM. This involves establishing a conceptual relationship between nearby feeder cattle, deferred

corn, and deferred live cattle futures prices and treating that relationship as breakeven relationship (Mallory et al. 2012).

1.2 | Breakeven analysis in cattle feeding

Cattle feeders must make the decision to place feeder cattle in feedlots (or not) based on the current feeder cattle price, the expected price of corn, the expected price of fed cattle at slaughter, and the cost of gain (J. D. Anderson and Trapp 2000). The decision of how much to pay for feeder cattle might be framed in several ways, one of which is breakeven analysis (Anderson and Trapp 2000). Equation (1) shows a simplified version of a breakeven equation:

$$BEP_{FC} Weight_{FC} = EP_{LC} Weight_{LC} - EP_C Bushels_C - Other\ Costs.$$
 (1)

$Weight_{FC}$ and $Weight_{LC}$ are live weights of feeder cattle and live cattle measured in hundred-weight. EP_C is expected price of corn in dollars per bushel, and EP_{LC} is expected price of live cattle in dollars per hundredweight. $Bushels_C$ is the bushels of corn needed to feed one animal such that its weight increases from $Weight_{FC}$ to $Weight_{LC}$. $Bushels$ is dependent on the animal's ability to convert dry matter feed into body weight. $Other\ Costs$ represents non-animal and non-corn costs associated with cattle feeding and would include yardage, death loss, veterinary expenses, and other items. A cattle feeder analyzing the potential purchase of feeder cattle would use placement weight, target finish weight, and performance assumptions to estimate $Bushels_C$ (Anderson and Trapp 2000). An example is shown in Table 1.¹ Then, the decision maker would use forecasts for EP_{LC} and EP_C to complete the right-hand side of the equation. The value for BEP_{FC} that balances Equation (1) would be the breakeven purchase price for feeder cattle purchase price and would, therefore, be the maximum price the cattle feeder would pay for the feeder cattle. Several factors could change the values calculated in Table 1 and breakeven price will differ across feeding operations. However, if markets for feeder cattle, corn, and live cattle are efficient, bidding and offering of feeder cattle

TABLE 1 Estimating bushels of corn required for a target live weight gain.

Live Weight Gain
$Weight_{LC} = 14\text{ cwt}$
$Weight_{FC} = 8\text{ cwt}$
$Live\ Weight\ Gain = 14\text{ cwt} - 8\text{ cwt} = 6\text{ cwt}$
Corn Required
Feed Conversion = 6
Total Dry Matter Required = $6 \times 6\text{ cwt} = 36\text{ cwt}$
Percent Corn Ration = 75%
Total Corn Needed = $0.75 \times 36\text{ cwt} = 27\text{ cwt}$
$Bushels_C = 27\text{ cwt} \times 100 \div 56 = 48\text{ bu}$

Note: Feeder cattle and live cattle weights are round numbers that lie within current futures contract specifications. A bushel of corn weighs 56 pounds.

¹The assumed value of dry matter feed conversion determines the feed needed. Anderson and Trapp (2000) used 7. (Anderson et al. 2026) show that Kansas feedlot close-out data from 1995 to 2024 reflect a mean conversion of 6.10 for steers and 6.36 for heifers. I use 6 in the Table 1 example.

should cause their price to converge on BEP_{FC} ² subject to differences in animal weight, performance, and feedlot-specific costs.

Determining BEP_{FC} requires a decision maker to have an expectation for future live cattle (EP_{LC}) and corn (EP_C) prices and prices of deferred futures contracts are a common source of commodity price forecasts (Colino and Irwin 2010; Schnake et al. 2012; Tomek 1997). If commodity futures markets accurately reflect available market information, the breakeven condition in Equation (1) should be observable among relevant commodity futures prices. Since the cattle feeding process takes place over several months, the approximate feeding period length must be defined to identify relevant futures prices. Feeding periods vary but 150 to 180 days is a realistic representative time on feed. Feeder cattle futures have eight calendar options: January, March, April, May, August, September, October, and November. Live cattle futures have an option in each even-numbered month. Therefore, the nearby feeder cattle contract is matched with a live cattle contract that is at least 6 months deferred and a corn futures price during the feeding period. Table 2 shows which commodity futures contracts were used to create a continuous series of feeder cattle, live cattle, and corn prices that reflect the timing of feeder cattle placement decisions.³ Prices in Equation (1) can be replaced with the futures price series shown in Table 2 as follows:

$$Weight_{FC}FUT_{FC} = Weight_{LC}FUT_{LC} - Bushels_CFUT_C - Other\ Costs. \quad (2)$$

Equation (2) represents a conceptual relationship between the three futures price series. *Other Costs* cannot be known or estimated at the aggregate level but is left in the equation to emphasize the importance of non-animal and non-corn factors in the breakeven relationship.

TABLE 2 Futures contracts used to define implied cattle feeding breakeven conditions.

Current month	Futures contracts for each commodity		
	Feeder cattle (FUT_{FC})	Corn (FUT_C)*	Live cattle (FUT_{LC})
January	JAN	MAR, MAY	AUG
February	MAR	MAY, JUL	AUG
March	MAR	JUL, SEP	OCT
April	APR	JUL, SEP	OCT
May	MAY	JUL, SEP	DEC
June	AUG	SEP, DEC	DEC
July	AUG	SEP, DEC	FEB
August	AUG	SEP, DEC	FEB
September	SEP	DEC, MAR	APR
October	OCT	DEC, MAR	APR
November	NOV	DEC, MAR	JUN
December	JAN	MAR, MAY	JUN

*Corn price is defined as the average of the two relevant contract months.

²This is based on the assumption that long-run economic profit in a competitive sector will approach zero and, even if that steady state equilibrium is not realized, market forces are always moving prices in that direction. This need not imply that accounting profit for all firms is zero. Additionally, some firms might have competitive advantages that allow them to obtain inputs at lower costs than competitors and, thus, extract rent from the market.

³As noted by a reviewer, the rollover from one futures contract to another can introduce non-market volatility into the series (and its first differences).

Equation (2) reflects the ability to simulate a gross cattle feeding margin via futures positions. Specifically, simulating a gross feeding margin requires simultaneous long positions in feeder cattle, short positions in deferred live cattle, and short positions in deferred corn. This strategy, known as the “cattle crush,” requires traders to determine ratios needed to represent a realistic number of animals and bushels of corn (Mefford 2022; Tonsor and Schroeder 2011; Vélez 2006).⁴ In this study, the relationship between the three price series is the focus, and therefore, it is not necessary to impose, in advance, a ratio of the three contracts needed to build a feeding margin position.

2 | DATA AND METHODS

Using the scheme in Table 2, continuous series of weekly CMEGroup feeder cattle, live cattle, and corn futures prices was assembled from June 2005 to December 2024 (Livestock Marketing Information Center 2025). This time period was chosen based on the consistency of contract specifications. The August 2005 feeder cattle contract narrowed par weights from 600 to 899 pounds to 650–899 pounds. There was one other major weight specification change in the feeder cattle contract when, beginning with the November 2016 contract, par weight range changed to 700–899 pounds. Due to this shift, I consider June 2005 to October 2016 and November 2016 to December 2024 separately. Table 3 reports summary statistics of the three continuous futures price series and monthly cattle on feed placement data.

Augmented Dickey–Fuller test results failed to reject the null hypothesis of non-stationarity for all three price series⁵ and rejected the same null using the first differences. Following price discovery reasoning, nonstationary data are said to be cointegrated if there exists at least one linear combination of the data that is stationary (Engle and Granger 1987; Johansen 1988; Mallory et al. 2012). Results from the Johansen test for cointegration, using a lag of $k = 2$, indicate both time periods have exactly on cointegrating vector.⁶

Given that the data are nonstationary in the levels, stationary in the first differences, and cointegrated, a VECM is appropriate to analyze the relationship between the price series (Enders 1995). The VECM with a trend is represented by:

$$\Delta FUT_{f,t} = \beta_{0,f} + \alpha_f e_{t-1} + \sum_f \beta_f \Delta FUT_{f,t-1} + \beta_{T,f} \Delta t + \varepsilon_{f,t}. \quad (3)$$

The index f represents the futures price series considered and varies across feeder cattle, live cattle, and corn. β_0 is an intercept term, and α_f is the speed of adjustment coefficient for the f th price equation. Errors from the cointegrating equation are represented by e_t . β_f is the parameter for the first lag of the f th price series, $\beta_{T,f}$ is the parameter for a time trend, and $\varepsilon_{t,f}$ is a random disturbance.

If the long-run equilibrium relationship represents breakeven conditions, disturbances in the relationship (e_t) indicate whether the market predicts economic profit or loss from cattle feeding. That is, the expectation is that the long-run equation would exactly balance and profit (e_t) would equal zero. However, there will be short-run disturbances. The *a priori* assumption of this study was that cattle feeder decisions to place feeder cattle in feedlots will be correlated with e_t . There are multiple reasons such a relationship might exist. First, cattle feeders might use futures contracts to hedge a feeding margin, though past research has suggested this is not the case (Kastens and Schroeder 1994). Second, feeders might consult futures market prices to obtain price forecasts to use

⁴A feeder cattle contract is for 50,000 live-weight pounds, which is around 60–65 animals. Live cattle contracts are for 40,000 live-weight pounds, representing approximately 28 to 32 animals. Corn contracts are for 5000 bushels. A trader uses certain parameters, such as those in Table 1, to determine an appropriate ratio of feeder cattle, corn, and live cattle contracts.

⁵(Boyer et al. 2025) also failed to reject the null of a unit root in multiple series of live and dressed basis cash prices of live cattle.

⁶Johansen test results are included in the supplementary appendix.

TABLE 3 Summary statistics of futures price series.

Assumed prices	June 2005 to October 2016	November 2016 to December 2024	June 2005 to December 2024 (Full Sample)
Weekly Futures Price Data			
Nearby Feeder Cattle (FUT_{FC}) (\$/cwt)			
Mean	136.19	168.53	149.67
SD	37.74	41.19	42.32
Min	87.24	114.48	87.24
Max	241.19	260.83	260.83
Deferred Live Cattle (FUT_{LC}) (\$/cwt)			
Mean	112.50	135.45	122.07
SD	22.30	28.70	27.58
Min	79.25	91.83	79.25
Max	165.91	198.61	198.61
Deferred Corn (FUT_C) (\$/bu)			
Mean	4.52	4.63	4.56
SD	1.48	1.14	1.35
Min	1.98	3.17	1.98
Max	8.21	7.86	8.21
N	596	426	1,022
Monthly Cattle on Feed Placements (thousand head)			
Mean	465.29	526.69	502.79
SD	77.39	117.71	108.01
Min	310	315	310
Max	702	874	874
N	137	215	352

Note: Futures price series definitions are shown in Table 2. Placement data are based on monthly USDA NASS Cattle on Feed Reports as archived by Livestock Marketing Information Center (LMIC).

in breakeven analysis or other approaches to determine a feeder cattle price at which feeding is profitable. Finally, the relationship could exist without a direct connection between feeders and futures markets. Cattle feeders might make decisions based on their own expert opinions and those of other trusted market information sources. If futures market prices reflect an understanding of market fundamentals that is similar to that of cattle feeders and market advisors they consult, cattle feeders' expectation of profit will be correlated with profit implied by relevant futures prices. Regardless of the pathway of connectiveness, the empirical relationship between the implied profit and observed decisions to place cattle on feed can be tested using Equation (4):

$$Placements_t = \gamma_0 + \gamma_1 Placements_{t-1} + \gamma_2 (-e_t) + \gamma_3 (-e_{t-1}) + \sum_{m=1}^{11} \theta_m Month_m + \varepsilon_t. \tag{4}$$

$Placements_t$ is number of cattle weighing 700 to 799 pounds placed on feed in month t , and are monthly values reported in the USDA National Agricultural Statistics Service Cattle on Feed Report (Livestock Marketing Information Center 2025). A variable for lagged placements ($Placements_{t-1}$)⁷ was also included. Placement decisions are based on market conditions but are also limited by biology (i.e., age of available cattle), aggregate cattle supply, and feedlot space. The lagged placements are meant to control for the latter two of these. Kastens and Schroeder (1994) also included lagged placements in their analysis of the relationship between hedgeable and observed profit and feedlot placements. Binary variables for calendar month m are included (θ_m) and $\varepsilon_{t,f}$ is a random error term. Economic profit, as indicated by the long-run equilibrium equation used in VECM estimation (Equation 3) is represented by e_t .⁸ The sign is changed to make interpretation intuitive. The formulation of the cointegrating equation in the VECM model is such that a negative error (i.e., $e_t < 0$) indicates purchasing feeder cattle and feeding them to be slaughtered as live cattle in approximately 6 months is expected to be profitable. On the contrary, if $e_t > 0$, there is an expected loss given current market conditions. USDA NASS cattle on feed placement data are published monthly, and summary statistics for placement numbers are reported in Table 3. As VECM analysis was done using weekly futures prices, e_t was aggregated to monthly averages to align with placement data.

2.1 | VECM results

Johansen normalized parameters from the VECM estimation of the long-run equilibrium relationship are reported in Table 4. Recall that Equation (2) is the theoretical basis for interpreting this long-run relationship. As an example, results from June 2005 to October 2016 indicate that: $FUT_{FC} - 1.938FUT_{LC} + 9.596FUT_C + 35.060 + 0.012TREND = e_t$. Since feeder and live cattle prices are in dollars/cwt. The normalized coefficient on FUT_{LC} price is the ratio of cwt of live cattle to cwt of feeder cattle. This suggests that, on aggregate, live cattle finish weighing 1.9 times as much

TABLE 4 VECM results for long-term equilibrium relationship between feeder cattle, live cattle and corn.

	June 2005 to October 2016	November 2016 to December 2024
Nearby Feeder Cattle (\$/cwt)	1	1
Deferred Live Cattle (\$/cwt)	-1.938** (0.048)	-1.631** (0.048)
Deferred Corn (\$/bu)	9.596** (0.438)	9.749** (0.666)
Trend	0.012	0.009
Constant	35.060	4.563
Number of Observations	596	426

Note: Johansen normalization restrictions imposed.
** $p < 0.01$; * $p < 0.05$.

⁷Lagged placements are not the variable of interest, but their inclusion is conceptually appropriate as explained in the text. Econometrically, including a lagged dependent variable can lead to inconsistent estimates in some cases.
⁸Using generated regressors can often cause standard errors to be unreliable (Pagan 1984). However, treating the error terms from a regression based on cointegrated data as known data has been shown to be appropriate, and those errors are treated as such in the VECM framework (Engle and Granger 1987; Hamilton 1994). Using the cointegrating equation error terms as regressors should not be an issue.

as when they were placed as feeder cattle for 2005 to 2016. Between 2016 and 2024, the ratio is 1.6. This is comparable to real-world conditions. Using 8 and 14 (see Table 1) to represent cwt of feeder and live cattle, respectively, the ratio would be 1.75. The difference across time periods is also consistent with the change in feeder cattle contract specifications, as the par feeder cattle weight in the more recent time period is heavier, but there was no major change in live cattle weight specifications. The interpretation of the estimated parameter on FUT_C is bushels of corn fed per cwt of feeder cattle placed. Using Table 1 values would result in a value of 6 (48 bushels of corn required divided by 8 cwt of feeder cattle) for this parameter. In both time periods, the estimate is substantially larger than 6, but estimates are similar across periods. Bushels of corn required to finish one fed animal is dependent on several factors, and it is impossible to completely decompose and interpret these parameter estimates but the magnitude of difference between estimates and expected values can be explored. Assuming feeder cattle weight in the time period of 2005 to 2016 was 7.75 cwt (the midpoint of the feeder cattle contract weight specifications), the coefficient on FUT_C implies that 74.4 bushels of corn are needed to finish one animal. Using the same rationale and the new contract weight midpoint of 8 cwt, results for 2016 to 2024 imply the 77.9 bushels of corn are needed. A reviewer suggested that corn price in the model may actually serve as a proxy for the suite of feed ingredients available to cattle feeders (e.g., dried distillers grains, wheat middlings, etc.). In this case, the coefficient is more complex than literal bushels of corn in a breakeven calculation. Finally, assuming breakeven conditions, the constant term would be non-animal and non-corn costs per cwt of feeder cattle placed. For example, between 2016 and 2024, if cattle go on feed at 8 cwt, the constant term suggests a return over feeder cattle and corn cost of \$37 per head. Between 2005 and 2016, using a lighter weight of 7.75 cwt, the constant implies a return over cost of feeder cattle and corn of \$272 per head. Though the magnitude of this difference is extreme, cattle feeders saw much better margins in the time period of 2005 to 2016 than during 2016 to 2024.

Though not the primary focus of the study, the results in Table 4 provide an implied ratio of feeder cattle, live cattle, and corn futures contracts that accurately reflect a feeding margin or “cattle crush” position. Doing so requires an initial assumption of how many cwt of feeder cattle are placed. Using 500 cwt for total weight placed represents 1 feeder cattle futures contract. The estimates from 2016 to 2024 imply that placing 500 cwt of feeder cattle yields 816 cwt of live cattle ($500 \text{ cwt} \times 1.938$). As live cattle futures contracts are specified for 400 cwt of live weight, this is 2.03 contracts worth of live cattle. The estimated total corn needed for 500 cwt of feeder cattle is 4875 bushels ($9.749 \text{ bu/cwt} \times 500 \text{ cwt}$), which is 0.97 corn futures contracts. This implied ratio of 1 feeder cattle contract, 2.03 live cattle contracts, and 0.97 corn contracts. Estimates from the 2005 to 2016 time period suggest a ratio of 1 feeder cattle contract, 2.5 live cattle contracts, and 0.96 corn contracts. In both time periods, the estimated ratios are consistent with the often-used standard of 1 feeder cattle contract, 2 live cattle contracts, and 1 corn contract in building a “cattle crush” position.

The second step of the VECM measure short-term adjustments given shocks to the long-term equilibrium relationship.⁹ Adjustment coefficients are the response of each price series to a disturbance in the long-run equilibrium. In both time periods, feeder cattle and live cattle futures prices exhibit a statistically significant response to equilibrium shocks and corn futures price does not. It is not surprising that corn price does not react to changes in feeding margin, as corn has many sources of demand other than cattle feeding. In both time periods, the adjustment coefficients for feeder cattle and live cattle prices have opposite signs, indicating a stable relationship. The relative magnitudes of the coefficients indicate contributions to the price discovery process.¹⁰ In the 2005 to 2016 time period, the adjustment coefficient on changes in feeder cattle price was -0.063 , compared to 0.058 for live cattle. In the second time period, these coefficients were -0.092 and

⁹Full results of the short-term adjustments are reported in the Supplementary Appendix.

¹⁰When two price series are analyzed in a VECM framework, price discovery weights can be derived from adjustment coefficients (Arnade and Hoffman 2015; Mathews et al. 2015; Plato and Hoffman 2011; Theissen 2002). However, with more than two price series, the process differs and is more complex (Gonzalo and Granger 1995; Plato and Hoffman 2011).

0.073. The price series that has the adjustment coefficient that is smaller in absolute magnitude is contributing more to the price discovery process. Intuitively, the series that moves less in response to a shock is serving as the anchor, providing a reference point toward which the other price series moves more rapidly to restore equilibrium conditions. In both periods, live cattle futures price is contributing more price discovery information, and feeder cattle futures prices exhibit larger responses to disturbances in the breakeven condition. Considering the specifications of the price series (Table 2), this behavior is conceptually appropriate. The live cattle price is an expected price several months deferred. Current decisions made by cattle feeders would likely have little impact on deferred prices. However, cattle feeders can adjust their bids for feeder cattle immediately, and this change in willingness to pay for feeder cattle would be seen in the cash market and, presumably, reflected in the nearby feeder cattle futures price. Live cattle prices also adjust but do so more slowly. This finding is relevant to the concern over the volatility in feeder cattle futures prices (Bina et al. 2022). Specifically, it is economically rational that nearby feeder cattle prices are more volatile than deferred live cattle prices based on the reasoning used in this study, and VECM results empirically indicate that this is the case.

The impact of lagged prices differs across time periods. Between 2005 and 2016, both the lagged price changes of live cattle and corn price were statistically related to feeder cattle price and each had the expected sign. Further, lagged live cattle price changes were statistically related to current live cattle price changes. However, during 2016 to 2024, the lagged price changes were not statistically significant. Several factors could contribute to the change. This time period includes the year 2020, when COVID-19 disruptions altered markets for livestock and meat. During 2023 and 2024, feeder cattle futures prices rallied at a faster rate than live cattle prices, resulting in a spread between the two price series that was quite wide by historical standards. A similar situation existed in 2014 but did not persist as long. Any of these anomalies could have contributed to a change in short-run adjustments to the equilibrium state during 2016 to 2024.

2.2 | Implied breakeven prices and cattle feeder decisions

The coefficient estimates in Table 4 were used to construct a predicted breakeven feeder cattle price. In the period of June 2005 to October 2016, this calculation would be: $BEP_{FC} = 1.938FUT_{LC} - 9.569FUT_C - 35.060 - 0.012TREND$ and for November 2016 to December 2024 breakeven price is: $BEP_{FC} = 1.631FUT_{LC} - 9.749FUT_C - 4.563 - 0.009TREND$. Figures comparing this implied breakeven price for feeder cattle (BEP_{FC}) to observed nearby feeder cattle futures price are available in the supplementary appendix. If the long-run equilibrium relationship is indeed a breakeven condition, the differences between the two series (e_t) indicate whether the market predicts economic profit or loss from cattle feeding. Specifically, time periods on the graph where implied breakeven price is greater than nearby feeder cattle price indicate there is economic profit available from placing feeder cattle and feeding them to be sold as live cattle after a few months.¹¹

To test whether there is an empirical relationship between cattle feeder decisions and the forward-looking implied breakeven condition among feeder cattle, corn, and live cattle futures, Equation (4) was estimated for each of the time periods. Estimation used the Prais–Winsten generalized least squares estimator, due to first-order autocorrelation. Results from the regressions are reported in Table 5. The dependent variable was thousand head of 700 to 799 pound cattle placed in a given month. Errors from the VECM estimation, interpreted as the dollars/cwt difference between projected breakeven price for feeder cattle and the nearby feeder cattle futures price, are statistically significant and positively related to feeder cattle placement decisions during both time periods. A nearby futures price one dollar/cwt below implied breakeven correlated with a 2.995 thousand head

¹¹One could also use this reasoning to see e_t as a signal of whether a speculator should be long or short the cattle crush position.

TABLE 5 Cattle on feed placements regression results.

Variable	June 2005 to October 2016	November 2016 to December 2024
Lagged placements	0.779** (0.056)	0.673** (0.082)
VECM long-run equilibrium error	2.995* (1.383)	3.303** (1.191)
Lagged VECM long-run equilibrium error	-2.235 (1.414)	-2.692* (1.210)
Binary month variables		
Feb	-190.335** (22.511)	-150.413** (21.052)
Mar	-85.622** (20.400)	-100.672** (18.178)
Apr	-242.349** (20.442)	-211.689** (18.008)
May	-67.278** (18.828)	-78.444** (16.808)
June	-242.654** (19.451)	-196.478** (18.355)
July	-126.850** (19.178)	-152.736** (18.976)
Aug	-99.668** (18.536)	-101.673** (16.478)
Sept	-123.096** (19.084)	-122.420** (17.422)
Oct	-138.153** (19.869)	-123.934** (17.740)
Nov	-236.278** (20.489)	-167.515** (16.762)
Dec	-149.701** (20.781)	-135.007** (17.422)
Intercept	242.361** (25.496)	275.652** (36.160)
Autocorrelation parameter	-0.28	-0.29
Adjusted R-squared	0.77	0.81
Number of observations	136	98

Note: Estimates are from Prais–Winsten AR(1) regression using Equation (4). Numbers in parentheses are standard errors.

** $p < 0.01$; * $p < 0.05$.

increase in placements during 2005 to 2016 and a 3.303 thousand head increase in placements during 2016 to 2024. This differs from previous similar research, which found no statistical relationship between cattle feeder placement decisions and hedgeable profit (Kastens and Schroeder 1994). The definition of hedgeable profit used by Kastens and Schroeder (1994) is not the same as the breakeven equation used in this study. Their definition was also forward-looking and based on futures market prices but imposed assumptions of feed conversion and gain, as one must do to project feeding profit. In this paper, I did not impose those conditions but estimated intra-commodity relationships via the cointegrating equation (Table 5).

3 | CONCLUSIONS

Cattle feeders in the US purchase feeder cattle to be fed a corn-intensive ration and grown into fed (or live) cattle that are converted into beef. Since the feeding process takes several months (this study assumes an approximate feeding period of 150 to 180 days), the forward-looking decision to purchase feeder cattle and willingness to pay for those cattle are dependent upon expectations of the future price of corn, expected animal performance, and future live cattle price. Breakeven analysis is a common practice among cattle buyers used to determine a maximum willingness to pay for feeder cattle. This study conceptually links breakeven analysis to a combination of nearby feeder cattle futures, deferred corn futures, and deferred live cattle futures and examines whether these futures price series reflect breakeven conditions over time.

Cointegration analysis and VECM results established that there is a single cointegrating vector among the futures price series that is very similar to a breakeven relationship consistent with cattle feeding practices and market efficiency. Further, feeder and live cattle prices respond to market shocks in a stabilizing way to restore the relationship, with nearby feeder cattle prices exhibiting more volatility in response to shocks. Differences between the predicted breakeven price for feeder cattle and the observed nearby feeder cattle futures price (i.e., errors in the VECM cointegrating equation) are interpreted as short-run expected profit or loss from cattle feeding. This expected profit was regressed, along with other appropriate covariates, on feeder cattle placement levels from USDA NASS monthly Cattle on Feed Reports and found to be positively correlated with placements. The stable long-run relationship between nearby feeder cattle and deferred live, combined with the relationship between implied profit from cattle feeding and real-world placement decisions, offers empirical evidence that these futures contracts are behaving in a manner consistent with economic theory.

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CONFLICT OF INTEREST STATEMENT

The author declares no conflicts of interest.

DATA AVAILABILITY STATEMENT

Data are available as supplementary material.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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