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Sell Now or Later? A Decision-making Model for Feeder Cattle Selling

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Abstract

Given the relatively small industry scale of cow-calf and feedlot operations in New York State to other regions of the country, little is known about differences, if any, in the primary determinants affecting feeder cattle prices in the state. Using a unique dataset on feeder cattle auctions and cattle quality characteristics in New York State over six years, some commonalities in the value of determinants exist; however, differences in key market, lot, and quality parameters suggest opportunities for improved marketing performance by producers. Using the pricing model as a forecasting tool, significant differences in expected profits exist based on the timing of bringing feeders to auction. The results indicate a high potential for producers to increase farm returns by delaying sales of lighter-weight feeder cattle, particularly from fall to spring auction months, given sufficient rates of gain and reasonable feeding costs. An online extension tool is under construction as a decision-making aid for use by producers and for extension educators to include in training curricula for beef producers in the state.

Key words: Feeder cattle, prices, livestock auction, price determinants

Sell Now or Later? A Decision-making Model for Feeder Cattle Selling

Introduction

Sales prices for feeder cattle are a major component of farm profitability for cow-calf operations in New York State (NYS); however, little attention beyond the main cattle producing areas in the United States has focused on management and marketing factors farm operators can implement to improve financial returns (e.g., Schulz et al. 2010; Troxtel & Barham 2007; White et al. 2007; Wang et al. 2001; Dhuyvetter & Schroeder 2000; Lambert et al. 1989; Schroeder et al. 1988). The prior focus is understandable when considering recent beef cow inventories and cows per farm in leading producing states where the research centers, such as Oklahoma (2,129,402, 46), Nebraska (1,890,454, 107), Kansas (1,499,843, 63), and Montana (1,487,789, 145), relative to NYS (109,914, 15) (USDA 2021). Furthermore, over 60% of beef operations in NYS have total herd sizes (cows and calves) less than 50 (USDA 2021).

To the degree that preferences for cattle and lot characteristics by feedlot buyers and regional market structures vary, more refined evidence-based recommendations for local producers can provide opportunities for improved returns (Bailey et al. 1991). In addition, the timing that producers bring their feeders to market can affect net farm returns. Particular to more northern climates like in NYS, seasonal variation in feeder cattle auction prices can be large (i.e., lower in the fall than in the spring), which may provide an opportunity for producers to over-winter feeders once off pasture and sell the following spring.

Expected feed costs and finished cattle prices for cattle feeders (i.e., feedlot operators) are important determinants to current feeder cattle prices. Indeed, Tonsor & Mollohan (2017) find feeder cattle prices have become more responsive to expected corn and finished cattle prices since 2008. It is well understood that feeder cattle prices depend on weight of the animal and generally decrease per hundredweight (cwt) as the animal grows. The price-weight differential (or price slide) is a reflection of the costs to add weight to an animal; i.e., the cost of gain, relative to market prices for finished animals (Zinn et al. 2008). Price differentials among lots of feeder cattle reflect differences in supply and demand of cattle in various weight and grade categories and the demand for and value of the product's characteristics (Brorsen et al. 2001; Anderson & Trapp 2000; Dhuyvetter & Schroeder 2000; Lambert et al. 1989; Buccola 1980;).

A robust literature exists associated with key beef production areas examining feeder cattle pricing relationships with implications for improved management practices, risk considerations, and alternative marketing scenarios. White et al. (2007) find significant risk premiums in Kansas feeder cattle markets implying that producers with known feeder performance characteristics may be better off retaining ownership of them through finishing or marketing them in a way that communicates that information to prospective buyers. Factors such as muscling, frame size, thriftiness, and horn status are within a producer's control and have been shown to affect feeder cattle prices and price-weight relationships (Qian 2014), but are ignored in much of the literature to due to data limitations. Calves in value-added (i.e., preconditioning) programs show price premiums relative to those that are not (Qian 2014; Lalman & Mourer 2014; Mathews 2007; King & Seeger 2004). Preconditioning generally involves a 45-day program to build the health status of the weaned calf prior to sale.

The contributions of this research are two-fold. First, we estimate a price-dependent, risk-responsive input-demand model for feeder cattle based on feeder cattle auction prices at an upstate NY livestock exchange over the course of six years. The data encompass nearly 12,000 lots of feeder cattle over 54 auction dates. The pricing model considers a series of covariates including market conditions, seasonality, and lot and quality characteristics. While consistent in formulation with Dhuyvetter & Schroeder (2000), our approach importantly extends cattle characteristics beyond simply breed and sex to consider preconditioning, frame size, muscling, thriftiness, and the presence of horns.[1] Prices differ not only by weight, but also on feeder cattle quality and market forces that reflect the complex interactions between markets for feed and finished (fed) cattle (Brorsen et al. 2001; Dhuyvetter & Schroeder 2000; Buccola 1980). The pricing model provides for direct calculation of expected market prices for feeder cattle under differing weights, market conditions, and quality characteristics – something necessary as a decision aid when making price forecasts (Schulz et al. 2018).

Our second contribution applies forecasting from the pricing model to a seasonal delta profit model to inform producer decision making on optimal timing for feeder sales, conditional on information available as animals come off pasture and expected feeding costs for over-wintering. The concept is similar to that proposed by Wang et al. (2001) who consider future cash sales as well as alternative hedging strategies (through the use of put and call options). In times of expected high prices the following spring (May), they find the cash sales strategy as optimal (Wang et al. 2001). Given that we use our pricing model to forecast current and future feeder prices conditional on market and feeder cattle characteristics, we follow an alternative approach. The delta profit model outputs the expected profit gain (or loss) of selling the feeder cattle the following spring relative to the near term fall, explicitly accounting for price slides. Applying the model to our historical auction data, we find that 55% of the cattle sold in the fall were expected to bring in more profit per head at that time if sold the following spring.

We continue with a summary of the conceptual framework and the empirical pricing and seasonal profit models. The data are then described and empirical results presented. We close with some implications of our results and directions for future research.

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[1] Frame size, muscling, and thriftiness correspond to value-determining characteristics of feeder cattle established by USDA's Agricultural Marketing Service (USDA 2000).

Pricing Model

Following Dhuyvetter & Schroeder (2000), a risk-averse cattle feeder (i.e., buyers of feeder cattle that feed to finishing) maximizes expected utility following equation (1):

(1) $\max \mathrm{E}[U(\pi)] = \mathrm{E}[U(p_L q_L - p_F q_F - p_C q_C - Z)]$,

where $U(\pi)$ represent the cattle feeders utility function, p_L and q_L are the finished (fed) cattle price and quantity, p_F and q_F are the feeder cattle price and quantity, p_C and q_C are the price and quantity of corn fed over the feeding period, and Z represents other costs. Maximizing (1) with respect to q_F and solving for p_F yields the buyer's input demand function for feeder cattle. Since forthcoming corn and fed cattle prices are unknown at the time of feeder purchase, we use futures prices, p_C^* and p_L^*, as reasonable proxies for expected prices, with second moments σ_C and σ_L, respectively. Accordingly, the risk-responsive input demand can be specified in price-dependent form as:

(2) $p_F = f(p_L^*, q_F, p_C^*, \sigma_L, \sigma_C, Z)$

Aggregating individual input demands for feeder cattle to an industry level and allowing for different production functions by weight and cattle characteristics gives the empirical input demand model for feeder cattle as:

(3) $$PF_{it} = \beta_0 + \beta_{LCF}LCF_{it} + \beta_{CF}CF_{it} + \beta_{MAR}Margin_{t-1} + \beta_{LCF}\sigma_{LCF_t} + \beta_{CF}\sigma_{CF_t} + \beta_{WT}WT_i + \beta_{WT2}WT_i^2 + \beta_L LOTSIZE_i + \beta_{L2}LOTSIZE_i^2 + \beta_S Sex_i + \beta_{SW}Sex_i WT_i + \beta_P PreCon_i + \beta_{PW}PreCon_i WT_i + \beta_M Muscle_i + \beta_{MW}Muscle_i WT_i + \beta_F Frame_i + \beta_{FW}Frame_i WT_i + \beta_T Thrifty_i + \beta_{TW}Thrifty_i WT_i + \beta_H Horns_i + \beta_{HW}Horns_i WT_i + \beta_C COLOR_C + \beta_M MONTH_M + \beta_Y Year_Y + \varepsilon_{it},$$

where PF_{it} is the feeder cattle price for lot i in time t, LCF_{it} is the live (finished) cattle futures contract price corresponding to the month feeder cattle in lot i are expected to be sold as finished,[2] CF_{it} is the average of corn futures contract prices relevant over the feeding period for feeder cattle in lot i,[3] $Margin_{t-1}$ is a computed 21-week cattle feeding margin for fed cattle marketed the previous week,[4] and σ_{LCF}, and σ_{CF} are coefficients of variation of daily live cattle and corn futures prices for the previous 21 weeks.[5] In terms of lot characteristics, WT_i is the average weight of feeder cattle in lot i and $LOTSIZE_i$ is the number of head in lot i, both included in level and quadratic forms to allow for nonlinear price response (Dhuyvetter & Schroeder 2000). Dummy variables are included for animal sex (*Sex* = steers (default), heifers, bulls, or stags), preconditioning status (*PreCon* = yes or no (default)), muscling level (*Muscle* = light, medium (default), or heavy), frame size (*Frame* = large, medium (default), or small), thriftiness (*Thrifty* = thrifty (default), unthrifty), the presence of horns (*Horns* = yes or no (default)), and cattle color (*Color* = black (default), red, Hereford, brown, white, other, and mixed).[6] Finally, monthly dummy variables account for seasonality factors based on auction month (*Month* = March, April, May, September, October, November, or December (default)), while year dummy variables account for other year fixed effects not otherwise accounted for ($Year_i$ = 2011 (default) through 2017).

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[2] Contracts used are the fifth, fourth and third distant contracts for feeder cattle weighing 300–499, 500–699 and 700–900 pounds, respectively, on the day prior to the feeder cattle sale date.
[3] The corn futures price is a simple average of all contracts relevant over the feeding period from the day prior to the feeder cattle auction date. For example, the corn price for 300-499 pound feeder cattle is the average of the nearby through fifth distant contracts.
[4] *Margin* represents the most recent, lagged, cattle-feeding margin and is incorporated since recent actual profit has been shown to significantly affect feeder cattle prices (Dhuyvetter and Schroeder 2000). It is defined as the nearby live cattle futures price ($/cwt) times 12 cwt (expected finished cattle weight) minus the nearby feeder cattle futures price ($/cwt) 21 weeks prior times 7.5 cwt (average starting feeder weight) minus the average nearby corn futures price ($/bushel) over the preceding 21 weeks times 56.4 bushels (amount of corn consumed during feeding period).
[5] Standard deviations are converted to coefficients of variation by dividing by their respective means. Doing so allows for ease of interpretation since the two parameters originate from different units (i.e., cwt and bushel).
[6] Color is a more refined usage that can distinguish by breed (e.g., *Herford*) and sub-breed (*Black* or *Red* Angus), where appropriate. Black (angus) is by far the most common in NY, with *Brown* (generally Limousin) and *White* (generally Charolais) relatively uncommon (each compose about 2% of our sample)

Weight (*WT*) interaction terms accommodate for differences in production functions and price slides for alternative feeder cattle characteristics. Since *LCF* and *CF*, are already specified for specific feeder cattle weights, weight interaction terms are omitted.[7] The prior feeding margin computed using futures prices for a 750 pound feedert (*Margin*) and monthly dummy variables (*Month*) were also limited to their levels (no interaction effects). These model simplifications vary from Qian (2014) and Dhuyvetter & Schroeder (2000), although robustness checks (not shown) to their inclusion show little impact on marginal effects and price slide behavior for the key variables of interest.[8]

Delta Profit Model

The empirical pricing model is utilized to forecast prices (*PF*) and per head sales (*PF*WT*) based on specific cattle characteristics and time of the year. In NYS, most feeder cattle are marketed in the fall (high supply) and, expectedly, receive lower prices for animals of similar weight class and quality than in the spring (low supply). Depending on expected prices in the fall relative to the following spring, it may be profit enhancing to over-winter feeders and sell them the following spring.[9] Understanding expected profit changes (Δ*Profit*) requires articulation of expected current (fall) and future (spring) sales prices (including price-weight slide behavior), over-winter feeding costs, and production performance (i.e., rate of gain), or:

(4) $\Delta Profit = \mathrm{E}[SF_S] - \mathrm{E}[SF_F] - C_{FS}$,

[7] Dhuyvetter & Schroeder (2000) include weight interaction terms for live cattle and corn futures, as well as their coefficients of variation. While all were statistically significant (in part due the large sample size, N = 46,081), they found no economically important differential impacts on feeder cattle prices across weight for the coefficients of variation terms.

[8] Schulz et al. (2018) and Dhuyvetter & Schroeder (2000) include weight interaction terms for the prior margin variable and monthly (October, July, April) dummy variables. Differences in price slides for prior margins two standard deviations above and below the mean margin are modest. Similarly, modest differences existed between that October (fall) and April (spring) price slides. The summer month (July) showed more variation. There are no summer feeder sales in NYS.

[9] For the purposes of our model and consistent with our data, we define spring as containing the months of March, April and May, while fall includes the months for contains September through December.

where E[SF_F] represents expected sales of selling in the nearby fall auction, E[SF_S] is the same for selling in the following spring, and C_{FS} represents feeding costs between the fall and spring sales dates. Defining each sales component we have:

(5) $\Delta Profit = (PF_F WT_F) - PF_S(WT_F + rDAY) - C_{FS}$,

where PF_F and PF_S represent estimated feeder cattle prices in the current fall and following spring, respectively, using equation (3). WT_F is the current (fall) feeder cattle weight, while WT_S is computed by adding r (the rate of gain per day) times the number of days (DAY) on feed between sales dates. The rate of gain will vary depending on starting weight and farm feeding performance. For our purposes, we assume an average rate of gain of two pounds per day and a 6-month feeding period (180 days). Feeding costs between fall and spring (CF_S) are:

(6) $C_{FS} = (P_C Q_C + P_H Q_H)DAY + FC$,

where P_C and P_H are prices of corn and hay, respectively, over the feeding period, Q_C and Q_H are the respective quantities consumed per day, and FC are fixed costs. We assume that feeders consume a daily quantity of corn and hay equivalent to 1.41% of their weight (Taylor 2007). Given their strong historical correlation P_H is assumed to have a positive proportional relationship with P_C, where P_C follows CF as defined above for the nearby corn futures contract and a P_H is taken from USDA (2019).[10] All feed inputs are assumed purchased at the beginning of the fall. Since feeder cattle weight is increasing during the feeding period, we use the estimated average weight ($\overline{WT}$) to calculate corn and hay feed input quantities. Fixed costs relate to facility and management costs (e.g., utilities, repairs, maintenance) during the feeding period

[10] Specifically, we take U.S. average prices received for hay ($\overline{P_H}$ = \$135/ton) and corn ($\overline{P_C}$ = \$3.75/bushel) for February 2019 (USDA 2019), convert them to common units (\$/pound), and compute their ratio ($\overline{PR}$), where $\overline{PR} = \overline{P_H}/\overline{P_C}$.Then, for each observation, P_C follows from CF and $P_H = P_c\overline{PR}$.

and are assumed constant at \$33.93 for a six-month feeding period (Taylor 2007). With some algebra, the delta profit equation can be expressed as:

(7) $\Delta Profit = (PF_S - PF_F)WT_F + (rPF_S DAY) - 0.0141(P_C + P_H)\overline{WT}DAY - 33.93.$

If $\Delta Profit > 0$, the expected net returns in the spring (6 months later) is greater than the expected net returns in the current fall, implying over-wintering feeders is a preferred strategy based on current (fall) information. A minimum level of $\Delta Profit > 0$ may be established based on producer preferences. Variables that differ directly in the price forecasting of PF_F and PF_S include *WT* (via *r* and *DAY*) and *Month* (via fall or spring sale) while other cattle characteristics (e.g., preconditioning, muscling, thriftiness, frame size) are left constant.

Data

Our analysis is based on transaction-level feeder cattle auction prices at the Finger Lakes Livestock Exchange in Canandaigua, NY during the spring (March through May) and fall (September through December) seasons from October 2011 through April 2017. The data includes transactions from 11,926 lots of cattle (3,565 in spring and 8,163 in fall) encompassing 35,703 head (10,588 in spring and 25,115 in fall) over 54 auction dates.

During the auction, the final price, number of animals, average weight, preconditioning status, sex, color, and the presence of horns are recorded for each lot. In addition, cattle are professionally evaluated for frame size, muscling, and thriftiness. Consistent with the literature, dairy breeds are excluded from the estimation sample, as well as lots with average feeder weights less than 300 pounds or more than 900 pounds. The former bound is considered a minimum for successful feedlot transition performance (i.e., a significant price penalty occurs at auction for lower-weight animals), while the latter bound constrains lots to only those for which over-wintering is feasible. The final dataset includes 9,255 observations.

Table 1 provides descriptive statistics of our estimation sample. Feeder cattle prices averaged about $142/cwt, but with considerable variation spanning $20 to $345. Figure 1 depicts average auction prices by weight range compared to the nearby feeder cattle futures contract price. As expected, auction prices move similarly to the futures price (reflecting aggregate supply and demand conditions), with a relatively constant negative basis (local price – futures price) indicating comparable supply and demand conditions locally. Basis expansion is evident, however, during 2014 and 2015. Similarly, corn and live cattle futures prices spanned relatively large ranges over the six years of data collection, with corn prices about double in variation (CV) relative to live cattle futures (Table 1).

[Table 1 here] [Figure 1 here]

The average feeder weighed about 550 pounds (Table 1). While lots ranged from one to 61 head, there was a substantial number of smaller lots resulting in an average lot size of under three. Nearly 90% of lots contained five head or less. Most animals were without horns (dehorned or polled), thrifty, medium muscled, and carried a large frame size. More animals were preconditioned than not, but not by much (53%). Steers and heifers were evenly split encompassing over 80% of all animals at auction. Black animals (generally Angus) were by far the most common at auction (nearly 63%). As expected, considerably more lots were sold in the fall months (70%) relative to the spring (30%).

Empirical Results – Pricing Model

Equation (3) is estimated with ordinary least squares (OLS) with clustered standard errors by auction date. Parameter estimates are reported in Table 2. An R-squared value of 0.748 suggests the model does well in explaining the variation in feeder cattle prices. For ease of exposition, given the large number of quadratic and weight-interaction terms, marginal effects (categorical variables) and elasticities (numerical variables) are also shown and discussed (Table 3).

[Table 2 here]   [Table 3 here]

Market Characteristics

As expected, live cattle futures (corn futures) is positively (negatively) associated with feeder cattle prices. The elasticities in Table 3 further indicate that feeder cattle prices are considerably more responsive to changes in live cattle prices (1.669) than corn prices (-0.246). The association of volatility (CV) in corn and live cattle futures to feeder prices are positive, but relatively small, and statistically different from zero for only the CV for corn futures (0.063, Table 3). Using auction data from Kansas for 1987 through 1996, Dhuyvetter and Schroeder (2000) find negative CV relationships; however, Schulz et al. (2018) using Wisconsin auction data from 2000 through 2017 find positive relationships and with an order of magnitude higher than ours. Qian (2014) found stronger positive effects than ours with an earlier sample of the NYS data (2011 through 2013). Changes in global markets over time and regional differences in feeding and finishing markets likely contributes to these differences. Prior feeding margins show a statistically significant, albeit small negative association with current feeder cattle prices (-0.003, Table 3). The result is consistent with an elasticity based on Schulz et al. (2018) (-0.018) and nearly identical to that computed from Dhuyvetter & Schroeder (2000) (-0.004).[11]

Lot Characteristics

Prior research confirms the presence on nonlinear (quadratic) relationships between feeder cattle prices and lot size and animal weight (eg., Schulz et al. 2018; Dhuyvetter & Schroeder 2000; Lambert et al. 1989; Schroeder et al. 1988; Faminow & Gum 1986). As introduced above, price slides on weight are confirmed whereby a one percent increase in feeder cattle weight is associated with a 0.356% decrease in price (Table 3). Notably, the quadratic weight parameter is

[11] Schulz et al. (2018) and Dhuyvetter & Schroeder interact the prior feeding margin with weight (positive and significant) and weight squared (negative and significant). The elasticities reported here are computed by the authors based on the reported regression results and average weight per head.

not significantly different from zero (Table 2) suggesting that the price-weight slide, holding all else constant, is linear.

Our results confirm a positive albeit diminishing impact of lot size on feeder cattle prices (Table 2). When computed at average weight, a one percent increase in lot size is associated with a 0.035 percent increase feeder price. The results also imply an optimal lot size of around 27 head, far less than the average lot size exhibited in our data. However, the magnitude is consistent with Schulz et al. (2014) (44) and Dhuyvetter & Schroeder (2000) (219) for Wisconsin and Kansas, respectively, in the context of average beef farm and feedlot sizes, and associated trucking and related infrastructure.

As expected, steers are preferred to either heifer or bulls, but with differing relationships with animal size (Table 2). For heifers, price discounts are reduced as animal weight increases. The opposite is true for bulls, where heavier bulls are increasingly penalized on price. For example, consider 300 and 700 pound animals. For heifers, the price discounts are $19 and $12 per cwt, respectively (relative to steers). For bulls, the price discounts are $6 and $16 per cwt, respectively. The results are expected, heifers typically have lower daily gains, but as weight becomes higher there are fewer pounds (to finishing) impacted by this lower efficiency (Schulz et al. 2018). Lower meat quality and dressing percentages may also contribute to a price discount. Conversely, lighter weight bulls are more conducive to castration after purchase and reductions in meat quality as a bull matures. Notably, at the average feeder weight (550 pounds), price discounts are comparable, even for stags (Table 3).

Quality Characteristics

Incorporating feeder quality characteristics (within control by the farm operator) is an important contribution of this research relative to the historical literature – accomplished by professionally trained personnel physically on-site during each auction. Accounting for changes in quality values as an animal grows is important for marketing decisions. Some management practices would appear simple and with minimal cost relative to the premium garnered. For example, a 300 pound horned feeder faces a substantial price discount of nearly $20 per cwt (Table 2). Although decreasing with animal weight, the price discount remains over $15 per cwt at the average feeder weight (Table 3). Similarly, preconditioning a 300-pound feeder finds a premium of $7 per cwt but, again, decreasing in weight (Table 2). This makes sense as preconditioning improves initial health conditions of the feeder for transition to a feedlot environment; the older (larger) the animal becomes (post weaning) negative ration transitioning and health effects become less prevalent. At the average feeder weight, the premium is still nearly $6 (Table 3). Finally, management practices promoting heavily muscled, medium to large frame sizes, and thrifty animals all return significant price premiums.

It is worth noting that these quality premiums exist irrespective of color/breed. Put differently, animal color price effects are controlled for separately in the model. While price discounts (relative to black) are modest for red, brown, and white feeders, more sizable discounts exist for Hereford (-$17) and Other (-$25) colors (Table 2). Even preventing lots with mixed colors would negate a $10 per cwt price discount.

Finally, as introduced earlier, seasonal price changes are important to consider, giving rise to the delta profit model application. March and April sales dates, holding all else constant, garner price premiums in excess of $20 per cwt relative to December (Table 2). Relative to the October sales, those premiums are be even larger.

Empirical Results – Delta Profit Model

The delta profit model, equation (7), includes three parts: expected sales of marketing feeders now (fall), expected sales of marketing feeders later (spring), and farm/feeding costs between the two points. Therefore, for a specific lot of cattle at a specific time, the delta profit model informs the timing of feeder sales based on current information at that time. Based on the pricing model (equation (3)), weight and the related price-slide relationships are key factors. However, given quality factors differentiated by (i.e., interacted with) weight, the application of the delta profit model is cattle/lot specific.[12]

We begin by considering a specific example using two observations in the data to illustrate the mechanics. The observation values are shown in Table 4 for two lots labeled 1 and 2. Assuming the decision to sell in the fall has not yet happened (i.e., *PF* is unknown), expected prices and per head sales for the current fall ($E[PF_F]$ and $E[SF_F]$) are estimated with equation (3) based on the weight (*WT*) and other determinants. Next, assuming a rate of gain (*r*) of two and the number of days between the fall (September) and spring (March) auctions is 180, we compute the expected per head feeder weight for the spring ($E[WT_S]$) for each lot. In our example, an additional 360 pounds is added to *WT* for each lot. Then, using equation (3) with expected spring feeder weights for a March auction sale, we estimate expected prices and sales accordingly ($E[PF_S]$ and $E[SF_S]$). The cost of over-wintering the feeders for 180 days follows Equation (6) for each lot ($E[C_{FS}]$). Finally, $\Delta Profit$ for each lot is calculated by Equation (4) or, equivalently, Equation (7). In this case, even though both lots were brought to sale in the September 2012 auction, $\Delta Profit$ is negative for lot 1 (sell now) and positive for lot 2 (sell in March).[13] The different result lies in the magnitudes of the month marginal effects (same for both lots) relative to differences in value based on lot-specific characteristics and feeder weights.

[Table 4 here]

[12] The model is easily generalized between any two points in time, consistent within the bounds of the empirical pricing model assumptions and the delta profit model input parameters. Delaying sales of feeders in the fall to the following spring is a key consideration facing cow-calf operators in NYS.

[13] Of course $PF \neq E[PF_F]$, and both fall price forecasts are below actual fall prices realized (both lots were sold in the September 8 auction). While concerning on one level (no model is perfect), it is expected that prediction errors from Equation (3) will be reasonably consistent across fall and spring price predictions, effectively netting out much of the inherent prediction errors to provide confidence in estimation of $\Delta Profit$.

To provide additional context, we apply the delta profit model to all lots of feeders within the data sold during fall months. In this case, over one-half (55%) of the lots sold in the fall were expected at that time to have higher profits ($\Delta Profit > 0$) if they had stockered the feeders for an additional six months and sold them the following spring (Table 5). Applying the model to spring observations suggests that even then 36% of spring observations were expected to increase per head profits by selling six months later (in the fall). Given the positive marginal effects for monthly spring sales, the lower percentage is expected but other positive cattle-weight interaction effects can offset spring month price gains for feeders with particular characteristics.

[Table 5 here]

Using all observations from 300- through 900-pound weights necessarily implies using the pricing model (Equation (3)) for forecasting purposes outside of the range of data from which it was estimated. For example, a 650 pound feeder would be over 1,000 pounds 180 days later ($r = 2$). Accordingly, we restrict the delta profit model to observations with weights no larger than 540 pounds. In this case, the percentage of observations with $\Delta Profit > 0$ increase to 71% and 51% for fall and spring observations, respectively (Table 5). The result heightens the consideration of supplemental feeding of lighter weight feeders prior to bringing to auction. This issue is highlighted in more detail in Table 6, where over 84% of the fall observations with feeder weights between 300 and 400 pounds had $\Delta Profit > 0$ compared to less 20% weighing between 801 and 900 pounds.

[Table 6 here]

Conclusions

Given the relatively small industry scale of cow-calf and feedlot operations in NYS to the primary cattle producing regions of the country, little is known about differences, if any, in the primary determinants for feeder cattle prices in the state. Further, the literature is scant on incorporating key feeder cattle quality characteristics that cattle feeders consider when purchasing feeders at auction. This paper addresses both of these topics. While some commonalities in the value of pricing determinants exist, e.g., live cattle and corn futures prices and prior feeding margins, other market conditions varied in their association with feeder prices (e.g., volatility in futures prices and lot sizes), likely due to differences in local supply and demand conditions and industry scale effects. Furthermore, quality factors play an important role, with many within the control (and adjustment) of producers. The inclusion of six years of auction data for nearly 10,000 lots of cattle provides confidence in the robustness of our results.

Seasonality effects on feeder cattle prices are also different in NYS relative to other regions, likely due to weather/climate conditions and industry scale effects. Accordingly, a delta profit model was constructed using the feeder cattle pricing model as a forecasting tool, with production performance and expected feeding costs, to inform timing of marketing decisions for NYS producers. The results indicate a high potential for producers to increase farm returns by delaying sales of lighter-weight feeder cattle, particularly from the fall to spring auction months, given sufficient rates of gain and reasonable feeding costs for over-wintering. An online extension tool is currently under construction for use by producers as a decision-making aid and for extension educators to include in training curricula for beef producers. Incorporating confidence intervals around delta profit, given the underlying pricing model, is a reasonable extension, through Monte Carlo simulation or similar methods.

The average cow-calf operation in NYS has 15 cows suggesting many are part-time farming operations with additional off-farm income needed to support the farm household. Understanding differences in abilities or skill sets to address value-improving cattle quality characteristics in light of these findings is a needed direction to support industry growth and vitality. NYS is a large dairy state with more retail meat (in aggregate) produced through dairy farming than beef farming. Expanding on this analysis to consider dairy feeders similar to Schulz et al. (2018) is a needed extension to support NYS livestock industries in general, as well as to more comprehensively analyze beef-dairy-meat markets in the state in order to identify complementary and/or competing opportunities for agricultural industry growth. Similar efforts for alternative livestock (sheep, hogs) is worthy of exploration to support other smaller-scale industry enterprises as well.

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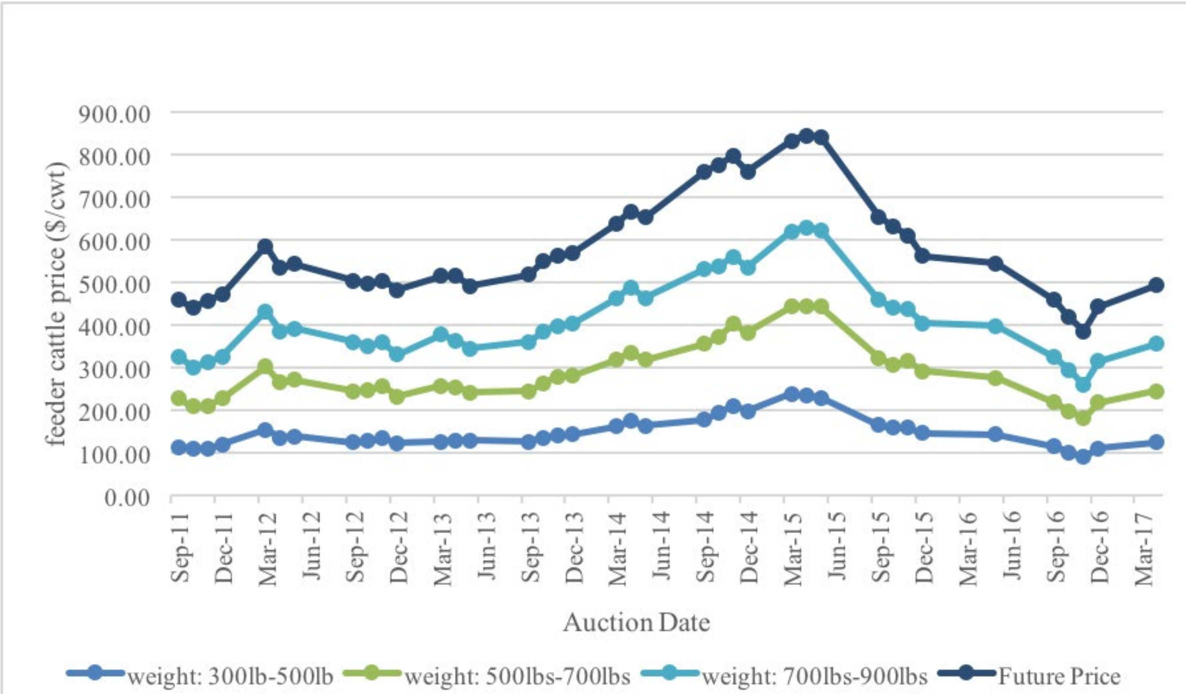

Figure 1. Average NYS auction prices by weight range and nearby futures contract prices for feeder cattle.

Table 1. Descriptive statistics of Finger Lakes Livestock Exchange beef feeder cattle auctions, 2011 - 2017, 300-900 pound average weight per head lots (N = 9,255).

Numerical variables	**Mean**	**Std. Dev.**	**Minimum**	**Maximum**
Feeder cattle price, \$/cwt, *PF*	141.62	39.76	20.00	345.00
Live cattle futures price, \$/cwt, *LCF*	131.84	15.15	92.18	167.15
Corn futures price, \$/bushel, *CF*	4.93	1.30	3.35	7.99
Prior feed margin, \$/head, *Margin*	46.63	189.57	-354.02	345.99
Coefficient of variation *LCF*, σ_{LCF}, %	3.80	1.20	1.50	6.20
Coefficient of variation *CF*, σ_{CF}, %	7.70	4.30	2.60	17.70
Average weight, pounds/head, *WT*	550.41	140.93	300.46	899.00
Lot Size, head/lot, *LOTSIZE*	2.51	2.33	1.00	61.00

Categorical variables	**Percentage**
Preconditioned, *PreCon* – Yes	52.84
Preconditioned, *PreCon* – No (default)	47.16
Muscling, *Muscle* – Light	0.61
Muscling, *Muscle* – Medium (default)	75.73
Muscling, *Muscle* – Light	23.65
Frame size, *Frame* – Large	83.34
Frame size, *Frame* – Medium (default)	15.83
Frame size, *Frame* – Small	0.82
Thriftiness, *Thrifty* – Thrifty (default)	96.23
Thriftiness, *Thrifty* – Unthrifty	3.76
Sex, *Sex* – Steer (default)	40.25
Sex, *Sex* – Heifer	40.30
Sex, *Sex* – Bull	18.95
Sex, *Sex* – Stag	0.50
Horns, *Horns* – Yes	3.01
Horns, *Horns* – No (default)	96.99
Color, *Color* – Black (default)	62.50
Color, *Color* – Red	13.03
Color, *Color* – Herford	12.17
Color, *Color* – Brown	2.32
Color, *Color* – White	2.20
Color, *Color* – Other	4.12
Color, *Color* – Mixed lot	3.66
Month, *Month* – March	8.01
Month, *Month* – April	11.32
Month, *Month* – May	10.79
Month, *Month* – September	11.65
Month, *Month* – October	20.44
Month, *Month* – November	21.55
Month, *Month* - December	16.30
Year, *Year* – 2011	9.83
Year, *Year* – 2012	17.03
Year, *Year* – 2013	19.62
Year, *Year* – 2014	23.00
Year, *Year* – 2015	18.78
Year, *Year* – 2016	9.67
Year, *Year* – 2017	2.13

Note: Auction data encompasses October 2011 through April 2017

Table 2. Regression results for New York feeder cattle price determinants (N = 9,255).

Variable	Estimate		Std. Err.
Intercept	-24.174	**	9.051
Live cattle futures (LCF)	1.792	***	0.041
Corn futures (CF)	-7.066	***	0.538
Coefficient of variation LCF	90.830		56.161
Coefficient of variation CF	116.870	***	12.172
Prior feeding margin	-0.009	*	0.004
Lot size	2.149	***	0.130
Lot size squared	-0.039	***	0.006
Weight	-0.082	***	0.013
Weight squared	0.000		0.000
Heifer (default = Steer)	-24.408	***	1.942
Heifer*Weight	0.018	***	0.003
Bull (default = Steer)	1.214		2.419
Bull*Weight	-0.024	***	0.004
Stag (default = Steer)	-1.510		18.057
Stag*Weight	-0.025		0.026
Preconditioned (default = Not preconditioned)	8.479	***	1.750
Preconditioned*Weight	-0.005		0.003
Muscling heavy (default = Muscling medium)	93.150	***	15.960
Muscling heavy*Weight	-0.125	***	0.026
Muscling light (default = Muscling medium)	12.396	***	2.053
Muscling light*Weight	-0.042	***	0.004
Frame size large (default = Frame size medium)	-8.705	***	2.384
Frame size large*Weight	0.016	***	0.004
Frame size small (default = Frame size medium)	-24.709	*	9.842
Frame size small*Weight	0.015		0.019
Unthrifty (default = Thrifty)	-61.186	***	4.523
Unthrifty*Weight	0.051	***	0.008
Horns (default = No horns)	-25.182	***	5.001
Horns*Weight	0.018	*	0.009
Red (default = Black)	-4.236	***	0.645
Hereford (default = Black)	-17.678	***	0.667
Brown (default = Black)	-1.584		1.407
White (default = Black)	-3.080	*	1.441
Other (default = Black)	-25.922	***	1.112
Mixed (default = Black)	-9.968	***	1.149
March (default = December)	23.225	***	1.161
April (default = December)	21.222	***	1.121
May (default = December)	10.838	***	1.026
September (default = December)	-4.730	***	1.037
October (default = December)	-8.383	***	0.974
November (default = December)	0.884		0.812

Note: Pricing model estimated with Ordinary Least Squares (OLS) for beef breed lots with average weight of 300 to 900 pounds per head. Model includes year fixed effects (not shown). ***, ** and * represent estimated parameters statistically different from zero at the 99%, 95%, and 90% significance levels, respectively.

Table 3. Elasticities and marginal effects of New York feeder cattle price determinants.

Variable	Elasticity		Std. Err.
Live cattle futures	1.669	***	0.038
Corn futures	-0.246	***	0.019
Live cattle futures CV	0.024		0.015
Corn futures CV	0.063	***	0.007
Prior feeding margin	-0.003	*	0.001
Lot size[a]	0.035	***	0.002
Weight[a]	-0.356	***	0.019
Variable	**Marginal Effect**		**Std. Err.**
Heifer[b]	-14.359	***	0.474
Bull[b]	-12.208	***	0.611
Stag[b]	-15.324	***	4.241
Preconditioned[b]	5.657	***	0.451
Muscling heavy[b]	24.440	***	3.134
Muscling light[b]	-10.635	***	0.594
Frame size large[b]	0.059		0.613
Frame size small[b]	-16.542	***	2.492
Unthrifty[b]	-33.026	***	1.122
Horns[b]	-15.032	***	1.248

Note: Default categories for marginal effects are shown in Table 2. Elasticities and marginal effects computed at sample means. [a] = numerical variable included in level and quadratic form, [b] = categorical variable interacted with weight. Marginal effects for categorical variables not interacted with weight can be read directly from Table 2. ***, ** and * represent estimated parameters statistically different from zero at the 99%, 95%, and 90% significance levels, respectively.

Table 4. Selected observations from feeder cattle auction data and delta profit calculations.

Lot	Date	***PF***	***LCF***	***CF***	***CV LCF***	***CV CF***	***Margin***	***LotSize***
1	9/8/12	$126	$136.13	$7.99	2.1%	13.5%	-$4.07	3
2	9/8/12	$107	$132.48	$7.96	2.1%	13.5%	-$4.07	2

Lot	***WT***	***PreCon***	***Horns***	***Sex***	***Color***	***Frame***	***Muscling***	***Thrifty***
1	535	No	No	Steer	Mixed	Large	Medium	Yes
2	354	No	No	Heifer	Hereford	Large	Medium	Yes

Lot	E[PF_F]	E[SF_F]	E[WT_S]	E[PF_S]	E[SF_S]	E[C_{FS}]	Δ*Profit*
1	$131.27	$703	895	$130.94	$1,172	$557	-$88
2	$106.05	$376	715	$120.00	$857	$423	$58

Table 5. Percentage of observations with ΔProfit > 0, by season

Season	Weight Range	ΔProfit > 0
Fall	300 – 900	55.33%
Spring	300 – 900	36.40%
Fall	300 – 540	70.61%
Spring	300 – 540	50.78%

Table 6. Percentage of fall season observations with ΔProfit > 0, by weight

Weight Range	ΔProfit > 0
300 – 400	84.11%
401 – 500	67.52%
501 – 600	53.75%
601 – 700	37.35%
701 – 800	34.29%
801 – 900	19.85%