Price determinants of a graded feeder cattle sale

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ABSTRACT

Objective: The objective of this study was to determine how numerous factors, including USDA muscle score, affect auction sale prices for feeder cattle in the US Southeast.

Materials and Methods: Data came from a monthly feeder cattle sale in Tennessee from 2019 to 2021, and a hedonic pricing model was estimated that considered how average lot weight, lot size, sex, breed, weaning management, and corn price influence feeder cattle price.

Results and Discussion: The model shows that average lot weight, total head per lot, corn price, lots with weaned cattle, sex, and breed affected the feeder cattle prices as expected based on the literature. A muscle score of 1 increased the sale price feeder cattle by US$9.51 per hundredweight relative to muscle score 2, which is a key finding of this study.

Implications and Applications: This extends the literature by considering the impact of USDA muscle score on feeder cattle prices for cattle in the Southeastern United States. This paper also builds on the growing literature examining how various factors affect Southeastern feeder cattle prices. Martinez et al. (2021) showed how total lot weight, corn price, average cattle weight, and other factors affect price. Most notably that study was the first to find a positive price effect from a negative “persistently infected with bovine viral diarrhea” test. Furthermore, Garber et al. (2022) found that the Virginia quality assurance certification positively influenced feeder cattle prices.

Beef cattle operations in this region are primarily forage-based cow-calf operations that sell calves at weaning (McBride and Mathews, 2011; Asem-Hiablie et al., 2018). These herds are smaller than those in other regions and have lower-valued cattle (McBride and Mathews, 2011; Asem-Hiablie et al., 2018). Thus, science-based evidence on how to increase cattle producers’ revenue from feeder cattle sales is relevant and meaningful.

The objective of this research was to determine how several factors such as weight, lot size, sex, hide color, weaning management, corn prices, and USDA Agricultural Marketing Service muscle scores influence feeder cattle auction prices in the US Southeast. These results can help guide producers to make management and marketing decisions to add value to their calves.

Key words: auction, feeder cattle, hedonic pricing, value-added marketing

INTRODUCTION

Hedonic pricing models are useful to estimate the influence of characteristics of bulls (Kessler et al., 2017; Boyer et al., 2019; Tang et al., 2020), replacement females (Parcell et al., 1995, 2006; Mitchell et al., 2018; Boyer et al., 2020, 2021), and feeder cattle (Williams et al., 2012; Zimmerman et al., 2012; Martinez et al., 2021; Garber et al., 2022) on auction prices. These analyses provide statistical evidence to demonstrate how different management decisions could affect the sale price of animals, which will be useful for Extension programs.

Although bulls and females are the primary focus of this literature, the limited number of feeder cattle studies focus on cattle from the Western United States (Williams et al., 2012; Zimmerman et al., 2012). A few studies have examined the effects of various characteristics on Southeastern US feeder cattle (Burdine et al., 2014; Parish et al., 2018; Martinez et al., 2021; Garber et al., 2022). Martinez et al. (2021) showed how total lot weight, corn price, average cattle weight, and other factors affect price. Most notably that study was the first to find a positive price effect from a negative “persistently infected with bovine viral diarrhea” test. Furthermore, Garber et al. (2022) found that the Virginia quality assurance certification positively influenced feeder cattle prices.

MATERIALS AND METHODS

Because no human or animal subjects were used, this analysis did not require approval by an Institutional Animal Care and Use Committee or Institutional Review Board.

Data

Data were collected from the East Tennessee Livestock Center feeder cattle sale from 2019 to 2021 at Sweetwater, Tennessee. This sale started in 1962 and hosts a monthly
feeder cattle sale. The requirements for this sale are that calves must have 2 rounds of 4-way vaccines and 7-way blackleg; calves must be wormed and must be weaned for a minimum of 45 d before the sale; and the second round of respiratory vaccines must be a modified-live product given according to label directions. A catalog containing a description for each lot is published 1 wk before the sale date. The description for each lot includes information on number of head, estimated weight per head, USDA feeder calf grades and flesh score, weight, lot size, sex, hide color, and weaning management. These cattle were graded by the same individual over the span of these data. The East Tennessee Livestock Center feeder cattle sale is a public auction with bidders in attendance, on the phone, or online. Additionally, the sale is managed to put similar cattle together in one lot, in hopes of capturing a larger lot premium. Annual monthly sale dates are published.

Table 1 shows the definition of variables used in this analysis. Table 2 shows the summary statistics of the sale data. The average sale price for the period of study was US$121.99 per hundredweight (cwt). Approximately 16% of the lots were weaned, which producers self-identify. Nearly half the lots (45%) were Angus, and 53% of the lots were steers. Cattle were identified as weaned if they had been weaned for at least 30 d before the sale. The average lot size was 6.71 head, and the average weight was 265 kg per head. About 38% of the lots had a thickness grade (i.e., muscle score) of 2. Muscle thickness grades are defined by the USDA-AMS (2012). Cattle grades range from 1 to 4, with 1 being the thickest and 4 the least thick. Studies have shown that grades of 1 bring a higher price than other thickness scores (Williams et al., 2012; Zimmerman et al., 2012). In this study, only a few lots included cattle graded greater than 2. These observations were deleted from this study, and only grades 1 and 2 were analyzed.

**Estimation**

A hedonic pricing model was estimated to determine the effects of muscle grade, average lot weight, lot size, sex, hide color, weaning management, and corn price on the feeder cattle price in this sale. Because this sale occurred monthly, we also included fixed effects for year and month when the sale occurred. We specify a log-level model by taking the log (ln) of sale price, which corrects for non-

<table>
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<th>Table 1. Definitions of dependent and independent variable analyzed</th>
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<td><strong>Variable</strong></td>
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<td>Price</td>
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<td>Grade</td>
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<td>Average lot weight</td>
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<td>Corn futures price (US$/bushel)</td>
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<th>Table 2. Summary statistics of feeder cattle lots sold from 2019 to 2021 at the East Tennessee Livestock Center (number of lots was 3,250)</th>
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<tbody>
<tr>
<td><strong>Variable</strong></td>
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<tr>
<td>Average price per lot (US$/head)</td>
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<tr>
<td>Grade</td>
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<td>Weaned¹</td>
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<td>Angus²</td>
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<td>Sex³</td>
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<td>Lot size (head)</td>
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<td>Average lot weight</td>
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<td>Corn futures price (US$/bushel)</td>
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¹= 1 if cattle were weaned before sale.
²= 1 if lot was Angus or Angus cross.
³= 1 if lot was steers.
Because feeder cattle were sold in lots, we estimate the model using the lot as an observation. The model is written as follows:

\[
\ln (\text{Price}_{imt}) = \beta_0 + \beta_1 \text{Grade}_{imt} + \beta_2 \text{Weaned}_{imt} + \beta_3 \text{Angus}_{imt} + \beta_4 \text{Steer}_{imt} + \beta_5 \text{Head}_{imt} + \beta_6 \text{Average weight}_{imt} + \beta_7 \text{Corn price}_{imt} + \beta_8 \text{Month}_{imt} + \gamma_{1} \text{January}_{imt} + \gamma_{2} \text{February}_{imt} + \gamma_{3} \text{March}_{imt} + \gamma_{4} \text{April}_{imt} + \gamma_{5} \text{May}_{imt} + \gamma_{6} \text{June}_{imt} + \gamma_{7} \text{July}_{imt} + \gamma_{8} \text{August}_{imt} + \gamma_{9} \text{September}_{imt} + \gamma_{10} \text{October}_{imt} + \delta_{1} \text{Year}_{imt} + \delta_{2} \text{2019}_{imt} + \delta_{3} \text{2021}_{imt} + \varepsilon_{imt},
\]

where \(\text{Price}_{imt}\) is the average price per cwt for cattle sold in lot \(i\) in time \(t\) during sale month \(m\); the \(\text{Grade}_{imt}\) indicator variables equal 1 for lot grade 1 and 0 for lot grade 2; \(\text{Weaned}_{imt}\) is a binary variable equal to 1 when lots were not weaned and 0 otherwise; \(\text{Angus}_{imt}\) is a binary variable for a lot categorized as breeds other than Angus; \(\text{Steer}_{imt}\) is a binary variable equal to 1 for heifer lots and 0 for steer lots; \(\text{Head}_{imt}\) is the total number of head per lot; \(\text{Average weight}_{imt}\) is the average weight per head; \(\text{Corn price}_{imt}\) is the nearby corn futures prices (US$/bushel); \(\text{Month}_{imt}\) is a binary variable for the months the cattle are sold; \(\varepsilon_{imt}\) is a binary variable for the year cattle are sold; \(\varepsilon_{imt} \sim N(0, \sigma^2)\) is the random error term; and \(\beta, \gamma, \text{ and } \delta\) are parameters to be estimated.

Parameter estimates are translated to a sale price change by multiplying the parameter estimates by the average predicted sale price of the feeder cattle (Wooldridge 2013). This transformation shows the marginal effect of a change in the independent variable at the average price.

Heteroscedasticity can be an issue for cattle hedonic pricing models (Kessler et al., 2017; Mitchell et al., 2018). The likelihood ratio test was used to determine whether heteroscedasticity was present from year and month. If heteroscedasticity is found, it is corrected using multiplicative heteroscedasticity in the variance equation (Wooldridge 2013). The model was estimated using maximum likelihood with the MIXED procedure in SAS 9.4 (SAS Institute Inc., 2013).

## RESULTS AND DISCUSSION

Parameter estimates for the hedonic pricing models are shown in Table 3. Heteroscedasticity was found across years and months. Results, therefore, are estimated using multiplicative heteroscedasticity in the variance equation, correcting for unequal variances.
The model shows that several factors that influenced the feeder cattle prices and signs of estimated parameters were as expected based on the literature. Feeder cattle lots that were graded as 1 were found to sell for US$9.51/cwt more than cattle graded as 2. This is consistent with the findings of both Zimmerman et al. (2012) and Williams et al. (2012), but these cattle were sold in the Western United States. Garber et al. (2022), who analyzed cattle sold in Virginia, found that muscle score was significant, but their result was not interpreted, and it was unclear how muscle affected price. Ours is the first study, to our knowledge, showing how muscle score affects feeder cattle sale price in the Southeastern United States.

If the lots were indicated as weaned before the sale, the sale price would be US$5.22/cwt higher than cattle calves fresh off the cow. Garber et al. (2022) found that the Virginia quality assurance program did not have a significant effect on sale price received by producers. This certificate program includes cattle being weaned and vaccinated. Our study found a slightly different result from that of Garber et al. (2022), but the same as that reported by Williams et al. (2012). Angus cattle sold for a higher price (US$4.03/cwt) relative to other breeds, and steers sold for US$17.60/cwt more than heifers. These findings align with other studies (Williams et al., 2012, 2014; Zimmerman et al., 2012; Martinez et al., 2021; Garber et al., 2022).

Our results did produce similar findings to other studies on the relationship between corn price and feeder cattle prices, as well as average lot weight and feeder cattle prices (Williams et al., 2012, 2014; Zimmerman et al., 2012; Martinez et al., 2021; Garber et al., 2022). We found that as average lot weight and corn price increased, the feeder cattle price declined. Like Garber et al. (2022), we found that an increase in the number of head in a lot resulted in a price increase. All months were found to be significant relative to November except October and January. Thus, sale prices were higher in all months relative to November, October, and January. Sale prices were the highest, on average, in August and lowest in December.

**APPLICATIONS**

The objective of this study was to determine how several factors such as body weight, lot size, sex, hide color, weaning management, corn prices, and USDA Agricultural Marketing Service muscle scores influence feeder cattle auction prices. Results for various factors such as breed, average lot weight, head per lot, and corn prices were aligned with the literature. A key finding of this study was measuring the price effects for USDA Agricultural Marketing Service muscle scores on feeder cattle auction prices in the Southeastern United States. Given these findings, Extension educators will have data-driven programs on increasing feeder cattle prices for producers. These values will allow producers to see the effects of price premiums for various management decisions, such as implementing a weaning program, and marketing muscle score on calves. Additionally, marketing cattle through a graded sale is a possible way to add value to calves if graded as 1.

**ACKNOWLEDGMENTS**

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**LITERATURE CITED**


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