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Assessing the Impact of the COVID-19 Pandemic on Feeder Cattle Prices in Northeast Texas

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ABSTRACT

Even though the COVID pandemic has affected many industries, beef continues to be a prominent commodity in the United States. This study quantifies how COVID has affected feeder cattle prices in Northeast Texas for the period of 2019-2021. Preconditioned cattle sales are one stage from farm to fork within the beef industry that serves as a solid component for the longevity of the beef industry. Preconditioned cattle seem to be a less-risky and better-suited market to some feedlots, which can also bring a competitive nature in the auction ring dependent upon characteristics such as breed, weight, and gender. This study found preconditioned feeder cattle price differences among various COVID stages at NETBIO auctions in Northeast Texas.

KEYWORDS: Coronavirus; COVID; feeder cattle; NETBIO; Northeast Texas; preconditioned cattle; prices; SSLA

INTRODUCTION

Many industries were severely impacted by the 2019 Coronavirus disease pandemic, commonly referred to as COVID (Balagtas and Cooper 2021). The threat of contracting the virus combined with stay-at-home mandates put a strain on everyday tasks and businesses around the world. However, the food industry, and within it the beef industry, along with many other industries endured. Feedlots and packing houses were forced to conform to pandemic guidelines and restrictions. Although there were some setbacks caused by COVID, the food industry persisted in order to meet the consumers' demand. Griffith and Martinez (2020b) reported many uncertainties attributed to the pandemic pertaining to feeder cattle prices and found downward trends in cattle sales early in 2020.

Cattle and beef production are top commodities across the country (Trupo 2021). According to the United States Department of Agriculture – Foreign Agriculture Service (USDA-FAS 2021) and Trupo (2021), the United States is the world's largest beef producer and ranks second in imports and third in exports. The United States experienced a steady increasing trend of beef exports from 2016 to 2019. However, beef experienced a 6% export decrease from the year 2019-2020 on account of trade barriers and export restrictions due to the pandemic (Trupo 2021). Many consumers often choose beef over other meat varieties. The beef industry is commonly split into two sectors, cow-calf operations and feedlot operations, with preconditioned sales being the merging point of the two sectors.

Preconditioned feeder cattle sales. In Northeast Texas, a preconditioned calf sale known as Northeast Texas Beef Improvement Organization (NETBIO) is utilized by many farms and ranches within the area as well as numerous counties throughout Texas and several other southern states. NETBIO holds numerous calf sales each year for producers to market their cattle to larger feedlot operations. The sale is designed specifically to appeal to serve feedlots. NETBIO closes the communication gap between feedlots and local producers, and opens the door to premium price efforts for the producers simply because the feedlots can purchase more from a quantity perspective which entices them to pay the price. The cattle are weighed and classified by color, sex, and breed upon arrival. After they are classified, they are assigned to lots with other cattle that have the same or similar attributes. This allows the lots to have anywhere from one to 100 head depending upon total weight of the lot. Each lot has a description that summarizes the type of cattle that accompanies the lot. For example, the term "Exotic" is used to reference breeds of cattle such as Limousine, Simmental, and Charolais. "Okie" is used to reference Hereford, Angus, and Red Angus Breeds (NETBIO 2021). Numbers are also used to indicate Brahman-influenced cattle. Lastly, the term "feeder" is used on some lots to express the weight of 650 pounds or higher (NETBIO 2021). Another appealing aspect of these

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cattle is the requirements that must be met in order for them to be eligible for the sale, also known as pre-conditioned. The cattle must undergo a series of vaccines for black leg, respiratory viruses, worms, and any other bacteria. The cattle also require a booster 30 days prior to the sale as part of the system. Bull calves must also be castrated and fully recovered by the sale date. Lastly, the cattle must be dehorned and display a NETBIO ear tag in the left ear. Adding these management practices to the cattle develops credence to the buyer's view (Williams et al. 2012). The visible practices like dehorning and castration are seen; however, to ensure that other requirements such as vaccination and weaning protocols are met, the NETBIO provides a veterinary verification form to be complete. In considering the pandemic with many companies' enforcing regulations on face-to-face interaction, NETBIO also offers an online bidding system. This helps to alleviate some of the pressure to promote buyer participation. Upon completion of the sale, these cattle are shipped to feedlots across the Midwest and central United States to serve packing houses. Preconditioning these cattle for the sale increases the added value. Cattle sales and livestock auctions, including preconditioned cattle sales, have endured market uncertainties in times of COVID.

Purpose of the study. The purpose of the study is to assess the impact of the COVID-19 pandemic on feeder cattle prices in Northeast Texas. The general objectives of this study are to determine how the COVID-19 pandemic affected preconditioned cattle sales through the NETBIO program, and to analyze the effect of the COVID-19 pandemic on sale prices. The study helps producers to assess the impact of the COVID-19 pandemic locally, and to gain a better understanding of the impact of similar situations in the future. The specific objectives of the study are to identify and to relate literature on price analysis of preconditioned feeder cattle sales at auctions and to discuss price differentials attributed to feeder cattle characteristics.

LITERATURE REVIEW

Since the pandemic started, there has been limited research on how COVID-19 has impacted commodities. Balagtas and Coopers (2021) discuss some key points that have been discovered regarding the effects of COVID-19 on livestock markets. First, there was a direct spike in grocery sales during the first few weeks of the pandemic's impact on the American population. Simultaneously, restaurant and travel spending took a sharp downward dive at the exact same time since a national emergency was proclaimed and everyone was advised to stay home. More than just grocery trends, Balagtas and Coopers (2021) delve into looking into commodities that were imprinted by the virus. Although the virus brought many challenges, the meat industry was supported by the president as he ordered that the meatpacking plants remain in production through the Defense Production Act (Telford et al. 2020). In the early stages of the pandemic, the wholesale value of beef and pork had increased while the gross farm value of beef and pork stayed constant. This was due to the shutdowns and regulatory measures of employee exposure that led to the sparse labor availability in the packing of live animals. This also resulted in "decreases in the supply of prepared meat to enter the wholesale and retail markets" (Balagtas and Cooper 2021). While a demand increase is expected to bring increases in prices, the consumer price index (CPI) for meat alone rose 9%, which is larger than any other commodity (Balagtas and Cooper 2021). Balagtas and Coopers (2021) modeled a relationship between retail meat prices, livestock prices, and marketing margin. That is,

$$(1) \quad P_{meat} = P_{livestock} + M,$$

where P_{meat} represents the retail price of meat, $P_{\text{livestock}}$ is the price of livestock, and M is the marketing margin (Balagtas and Cooper 2021). With meat packers incurring additional costs to inhibit virus contraction and providing safety measures, prices are expected to increase even more. Likewise, this study will model cattle characteristics relationship to price. Overall, Balagtas and Coopers (2021) brings to light the unnoticed "upsets" to the meat and livestock industry that arose from the COVID-19 pandemic.

Similarly, Hardin and Saghaian (2014) present a model that is kindred to this study and focuses on the seasonality of feeder cattle. Hardin and Saghaian (2014) used the following model:

$$(2) \quad CPH\ price = B_0 + B_1\ Lot\ Size + B_2\ Lot\ Size^2 + B_3\ Weight + B_4\ Live\ Futures + B_5\ Corn\ Futures + B_6\ Diesel\ Price + B_7\ Heifer + V_8\ Season + V_9\ Cattle\ Sort + B_{10}\ Time,$$

where CPH represents the Certified Preconditioned Health program. Similar to Hardin and Saghaian (2014), this study examines factors such as lot size, weight, and gender to derive the price; and both studies use least squares regression to compute the results.

Bankole et al. (2017) examine data from NETBIO sales for the period 2010-2013. The study focuses on the attributes that significantly "added the most value" (Bankole et al. 2017), including how the futures market prices explain variations in preconditioned feeder cattle cash prices. Bankole et al. (2017) utilize the following model:

(3) $$Pcash_t = \beta_0 + \beta_1\, Lot\ Size_t + \beta_2\, Sex_t + \beta_3\, Weight_t + \beta_4\, Breed_t + \beta_5\, JanuaryFutures + \beta_6\, MarchFutures + \beta_7\, AprilFutures + \beta_8\, MayFutures + \beta_9\, AugustFutures + \beta_{10}\, SeptemberFutures + \beta_{11}\, OctoberFutures + \beta_{12}\, NovemberFutures + \beta_{13}\, Lot\ Size^2_t + \beta_{14}\, Weight^2_t + u_t,$$

where $Pcash_t$ is the cattle cash price ($/cwt) for a specific lot at time t.

Equation 3 is similar to the model used in the present study with the exclusion of the futures variables. Bankole et al. (2017) found that weight, sex, lot size, breed, and futures price were all statistically significant. A unit increase in weight established a slight discount, heifers were discounted when compared to steers, and English or Okie breeds collected premiums over crossbred cattle (Bankole et al. 2017). Futures price and cash price had a positive association while the October futures contract inhibited a push in cash prices. October is a pivotal time of the year where producers are selling their cattle in preparation for the season change.

Augustin et al. (2021) is a study of trends in the Nicaraguan cattle industry. A hedonic model is utilized to analyze price differentials from futures feeder cattle prices derived from the Chicago Mercantile Exchange as well as supplemental data of cattle auctions in Nicaragua for the period 2017-2018 (Augustin et al. 2021). His model was:

(4) $$Pcash_{it} = \beta_0 + \beta_1\, Lot\ Size_{it} + \beta_2\, Lot\ Size_{it}^2 + \beta_3\, Weight_{it} + \beta_4\, Weight_{it}^2 + \beta_5\, Heifer_{it} + \beta_6\, Bull_{it} + \beta_7\, February + \beta_8\, March + \beta_9\, April + \beta_{10}\, May + \beta_{11}\, June + \beta_{12}\, July + \beta_{13}\, August + \beta_{14}\, September + \beta_{15}\, October + \beta_{16}\, November + \beta_{17}\, December + \beta_{18}\, JanuaryFutures + \beta_{19}\, MarchFutures + \beta_{20}\, AprilFutures + \beta_{21}\, MayFutures + \beta_{22}\, AugustFutures + \beta_{23}\, SeptemberFutures + \beta_{24}\, OctoberFutures + \beta_{25}\, NovemberFutures + \varepsilon_t.$$

Equation 4 encompasses many similar components to Bankole et al. (2017) as well as the present study. Similar to previously discussed studies, Augustin et al. (2021) also identifies factors that influence price differences. Both Augustin et al. (2021) and Bankole et al. (2017) indicate that characteristics such as weight, lot size, and sex of the cattle at the auction are statistically significant in explaining changes in price. Augustin et al. (2021) and this study both have the common objective of helping producers understand the factors that influence cattle prices at auction, which may be of assistance in future operational decision making.

The University of Tennessee, in conjunction with the Tennessee Extension Service, produced two reports by Griffith and Martinez (2020a; 2020b). The first report extensively discusses the marketing factors that are taken into consideration when producers are making plans to sale the cattle. There are many components or external factors that influence a producer's decision to sell. For example, harsh weather conditions such as rain, sleet, or snow make maneuvering as well as loading and unloading the cattle to and from the sale barn difficult. The report from the University of Tennessee claims that factors such as these are "short-lived," and producers are typically able to bounce back within a few weeks (Griffith and Martinez 2020a). Weather does bring a small decrease in prices, but the market is quick to overcome and retain its earnings. However, conditions such as the Coronavirus and the pandemic brought a wealth of unknown to producers and made future plans to sell difficult, as the depressed market prices did not have an end in sight. The report explains that cattle are "perishable products" in the sense that they are continuously grown and enter into the supply chain (Griffith and Martinez 2020a). Similarly, the NETBIO calves considered in this study have a goal to meet the industry's needs. With the unknown of price deflects brought on by the pandemic, producers are willing to ensure the highest of profits by marketing their cattle through precondition sales like NETBIO, in hopes of receiving a higher premium. The report exemplifies total head counts of cattle sold in the auctions of Tennessee during the last five years leading into and including the pandemic. In general, the pandemic led to a downward trend in number of heads sold in 2020.

The second report from Griffith and Martinez (2020b) delve into the feeder cattle prices and their effects from COVID. An interesting point covered in this report is the seasonality of the cattle market. They explain the intricacy of the seasonal planning that is used in most cattle operations. Most cattle producers calve in the late winter and early spring in expectation of the spring grasses that are rich and nutritious and thus, enhance the calves' growth and development. These producers will prefer to market these cattle in the fall before weather conditions turn undesirable. Although there are price fluctuations in between the season attributed to operating factors and number of market participants. To be more specific, prices fall slightly in the fall because of the heavy supply and the prices will rise in the spring when market participation is lower (Griffith and Martinez 2020b). In addition, Griffith and Martinez

(2020b) show a decrease in prices in the early months of 2020 for 500-600 pound and 700–800-pound steers that are substantially lower than any other point in the time period considered.

Williams et al. (2012) conducted a study that determined the price differentials of value-added feeder cattle at various auctions in Oklahoma. The study examines a program that is similar to NETBIO and has the same preconditioning requirements known as Oklahoma Quality Beef Network (OQBN). The OQBN also facilitates regular feeder cattle sales that do not require preconditioning. This study considers the impact of preconditioning and investigates factors that affect price differentials. Williams et al. (2012) collected data at 16 feeder cattle auctions across seven different sale barns over the course of three months for a total of 2,973 lots. Eight of the sales acquired some OQBN preconditioned sales, six were a combination of OQBN preconditioned and regular feeder calves, and two were strictly OQBN preconditioned certified auctions. The study analyzes the price and variable influence of each. The variables included color or breed, presence of horns, use of vaccinations, OQBN Certified, gender, fleshing condition, muscling, and uniformity. Williams et al. (2012) uses the following hedonic model to evaluate each lot and the presence of each variable:

$$(5) \quad \textit{CPH price} = B_0 + B_1\, \textit{Lot Size} + B_2\, \textit{Lot Size}^2 + B_3\, \textit{Weight} + B_4\, \textit{Live Futures} + B_5\, \textit{Corn Futures} + B_6\, \textit{Diesel Price} + B_7\, \textit{Heifer} + V_8\, \textit{Season} + V_9\, \textit{Cattle Sort} + B_{10}\, \textit{Time}.$$

Results revealed that most of the variables were significant at 5% except for the relation between certification and weight (Williams et al. 2012). As expected, black-hided lots receive a higher price than all other hide colors because of the potential for acceptance in the Certified Angus Beef program, which serves as a commonality and trend across all auctions. The variables' fleshiness, frame, and muscling were not found to be statistically significant. Overall, the study revealed that calves with vaccinations alone receive a premium of $1.44/cwt. Ultimately, cattle that are enrolled and are OQBN certified received a higher price compared to the non-preconditioned cattle (Williams et al. 2012).

COVID Timeline. According to the Center for Disease Control and Prevention (CDC), COVID began to appear in December 2019 in China where many patients began to experience a shortness of breath and fever (CDC 2022). The World Health Organization's China division was then informed of the cases of so called "pneumonia" with unknown causes. By the first couple weeks of 2020, the CDC began to identify the "causative agent" (CDC 2022) that produced the outbreak and began the screening of people who had traveled from Wuhan, China, where the virus was first discovered, to cities with connecting flights. A few of these cities include New York, Los Angeles, and San Francisco. USA Today by Hauck et al. (2020) reports that the first COVID case in the United States was found on January 21, 2020, from a man who recently travel back from Wuhan, China one week before. From here, the next few weeks to a month entailed testing development along with federal organization of research on the virus and its contagiousness (Hauck et al. 2020). On March 13, 2020, then-President Donald Trump announced a nationwide emergency declaration (CDC 2022). It was just a day or two until the United States was on a shutdown or commonly referred to as the stay-at-home mandate. At this point, many people were uncertain about the near future and the everyday functions of society. The mask order was also enforced at that time. As time progressed, cases of COVID began to increase hitting a record 100,000 by the end of May (CDC 2022). In addition, unemployment rate rose to 14.7%, the highest since the great depression (CDC 2022). Trials and research regarding vaccines cases continue to increase along with the death toll reaching 200,000 by the end of September 2020 (CDC 2022). By the end of year 2020, the vaccines were in production and administered under certain qualifications. Before January 1, 2021, over a million vaccines had been administered (CDC 2022). Additionally, congress passed a COVID relief act that would provide an allowance of $600 per individual (CDC 2022). Shortly afterwards with more popularity and acceptance towards the vaccine, there began to be a shortage of available vaccines. The first quarter of 2021 still involved many regulations and COVID practices; however, some operations began to return to a new normal. For instance, events were held outside or in spaces that could accommodate social distancing, masks were required in most public areas, and schools returned to in-person instruction the previous fall with new regulatory standards. Although cases continued to rise, normalcy was still able to evolve as more and more people were receiving the vaccine to combat the widespread. By the middle of the year and early summer, the Delta variant was profound. By the end of summer 2021, vaccines were ready and approved for all adults and people above 16 years of age (CDC 2022). As the year 2021 came to an end, COVID was still very much around; however, society was used to its existence and was able to overcome. The vaccines helped to slow the spread and obtained a grasp on the virus. The study from the Annals of Palliative Medicine by Lu et al. (2021) analyzed all aspects of the pandemic and was categorized into three phases. The first phase "intensive attention on Wuhan" (Lu et al. 2021) is centered around the initializing of the virus and the implementation of preventive actions

such as the lockdown and the travel ban to "delay the growth of the epidemic" (Lu et al. 2021). The second phase was described as "internal stability but a threat from abroad" (Lu et al. 2021), which focused specifically on isolating the threat of contraction from abroad with strict quarantine protocols. The last phase "prevention and control of imported goods and the economic recovery" (Lu et al. 2021) assessed the control from an economic standpoint.

COVID Variants. Over the course of the pandemic, many variants of the virus were discovered and continue to be researched over. Yale Medicine article by Katella (2022) reports on each variant and describes their known arrival time as well as their severity and contagiousness. The first variant described is Omicron and B.A.2 which is known as the sub variant to Omicron (Katella 2022). According to Katella (2022), Omicron was developed around the later end of 2021. Omicron also was one of the more transmissible variants as cases tended to "skyrocket" (Katella 2022) and produce a few thousand cases per day. Katella (2022) also reports that because its placement and attachment of cells, it allows it to be more infectious; however, even though it is thought to be very contagious, it is also "appears to be less severe" (Katella 2022) than other variants. Delta is the next variant that Katella (2022) discusses; they report that Delta was first identified around the end of 2020 and caused "more than twice" as many more infections along with a surge in hospitalizations. The report also notes that the severity of the variant may be because many had been unvaccinated around the time of know existence. Another strain of the Delta variant is also reported as Delta AY.4.2. While the report states that data regarding this variant is "limited" (Katella 2022), it is still as much if not more contagious and rigorous as Delta. The next variant discussed from the Yale Medicine (2022) report is Beta, which was first endured at the end of 2020 from South Africa. Katella (2022) explains that while Beta was "about 50% more contagious, it also may have led to more hospitalizations and deaths." Lastly, the Alpha variant is described to have appeared in November of 2020 and is believed as the most contagious, accounting for 66% of cases of the COVID strains until the delta's arrival.

MATERIALS AND METHODS

The NETBIO sale occurs on about nine months of the year at Sulphur Springs Livestock Auction (SSLA). Each lot has corresponding variable characteristics such as breed, total weight of the lot, average weight for each head in that lot, and ultimately the price per hundredweight (cwt) for each lot sold. Data and variable characteristics on the preconditioned cattle were collected for the months of September for the years 2019, 2020, and 2021. The year 2019 is prior to COVID, 2020 is the year COVID started in the United States, and 2021 is the latest year of COVID in this study. Although COVID arose in the early months of 2020, September is a highly desired month to consign cattle for the NETBIO sale. In addition, the fall season is a pivotal time for ranchers to sell cattle. The reason for high volume of participation during the month of September is because of the turning point between seasons. With the change in weather soon approaching during this time, many producers prefer to sell rather than hold the cattle over the winter where threats such as sickness and cost of inputs and limited resources e.g., hay prices and availability.

A COVID categorical variable is included in the ANOVA model to represent various stages regarding COVID. This variable takes the value of 0 in 2019, the year where COVID had not yet arrived; a value of 1 in 2020, initial year of COVID and less known variants; and a value of 2 in 2021, the year following the start of COVID, with more known variants, and higher number of cases.

Models. This study will utilize and compare two models estimated through SAS software version 9.4 to determine the effects of COVID-19 on feeder cattle prices. The first model is the separate means ANOVA model while the second model is a multiple regression model.

ANOVA Model. In the first model, this study uses a one-way ANOVA approach to analyze the mean differences among prices from various stages within COVID pandemic. The model is used to analyze the effect of the COVID pandemic on preconditioned feeder cattle prices. In its simplest form, the separate means ANOVA population model is as follows:

$$(6) \quad Y_{ij} \sim \mu_i + \varepsilon_{ij},$$

where μ_i is the population mean of each group, and ε_{ij} is the population error term that is independent and normally distributed, *i* is the treatment group number indicated by the variable COVID, and *j* is the response number associated to the treatment group. In its simplest form, the sample model is:

(7) $Y_{ij} \sim \bar{y}_i + \hat{\varepsilon}_{ij}$,

where $\bar{y}_i$ is the sample mean of each group, and $\hat{\varepsilon}_{ij}$ is the sample error term that is independent and normally distributed.

Multiple Regression Model. The multiple regression population model is as follows:

(8) $P_{cash_t} = \beta_0 + \beta_1 Avg + \beta_2 Heifers_t + \beta_3 Y20 + \beta_4 Y21 + u_t$,

where $Pcash_t$ is the cattle cash price ($/cwt) for a specific lot at time *t*. The variable *Avg* represents the average weight of the cattle in the lot. The variable *Heifer* is a binary dummy variable that takes the values of 1 if heifers and 0 if steers; therefore, the variable *Steer* is excluded from the model to avoid perfect multicollinearity. The variables *Y20* and *Y21* are binary dummy variables for the years 2020 and 2021, respectively, as they relate to COVID. The variable *Y19*, which would correspond to the year 2019, is the excluded dummy variable from the model to avoid the problem of perfect multicollinearity. The variable *Y19* was excluded to make comparisons to when COVID had not yet initiated and serves as the baseline. Last, u_t denotes the population error term and the β_0, β_1, β_2, β_3, and β_4 are the population parameters that will be estimated. Different from Augustin et al. (2021) and Bankole et al. (2017), the variable average weight (*Avg*) better suited this study as it accounted for each head individually and alleviated multicollinearity in the variables *TotalWeight* and $TotalWeight^2$.

Descriptive Statistics. Sales data from NETBIO at the SSLA was collected for the months of September for the years 2019, 2020, and 2021 representing 447 lots and encompassing 14,941 heads. Steers accounted for 8,220 heads or 55.01%, while heifers represented 6,721 heads or 44.9%. Additionally, 4,625 heads were auctioned in the September 2019 sale, 5047 heads were auctioned in the September 2020 sale, and lastly, 5,269 heads were auctioned at the September 2021 sale. Table 1 provides the summary statistics from the data.

The minimum price is at a steady increase between the three sales (Table 1). In September 2019, the prices ranged from $40/cwt to $180/cwt while in September 2020, feeder cattle prices ranged from $50/cwt to $208/cwt, and in September 2021, the prices ranged from $60/cwt to $206/cwt. The September 2021 sale experienced the highest and the lowest total weight of all the lots among the three sales, as well as auctioned the most head of cattle versus the other two sales.

Table 1. Descriptive Data by Year of the NETBIO September Sales at SSLA.

Variable	N	Mean	Std Dev	Minimum	Maximum
September 2019					
Avg. Weight (lbs.)	4625	583.37	120.02	227.00	1103.00
Price ($/cwt)	4625	135.80	13.37	40.00	180.00
September 2020					
Avg. Weight (lbs.)	5047	593.75	124.33	249.00	1105.00
Price ($/cwt)	5047	135.61	12.59	50.00	208.00
September 2021					
Avg. Weight (lbs.)	5269	614.40	149.32	231.00	1063.00
Price ($/cwt)	5269	144.44	14.31	60.00	206.00
Overall					
Avg. Weight (lbs.)	14941	597.82	133.07	227.00	1105.00
Price ($/cwt)	14941	138.78	14.09	40.00	208.00

Sales totals by breed from the corresponding September auction are reported in Table 2. The abbreviation N/A stands for “not available”, and it means there were no animals of that breed during that sale auction. Brahman, Crossbred, Feeder, Okie, Other, and Red Angus all show an upward trend between the three sales while Black, Brahman, Brangus, Charolais, Crossbred, Exotic Holstein, Longhorn, and Tigerstripe all exhibit a decrease between at least two of the sales.

Table 2. NETBIO September Sales at SSLA Totaled for Each Year by Breed.

	Sales ($)		
	September 2019	September 2020	September 2021
Angus	N/A	N/A	52330.98
Black	472059.98	573633.06	550391.79
Brahman	37155.91	25433.87	108660.25
Brangus	183577.37	211977.45	157051.68
Charolais	203820.85	247477.42	148593.43
Crossbred	1807943.79	1726925.51	2105268.51
Dairy	4840.59	N/A	51491.20
Exotic	242634.74	285644.85	116711.66
Feeder	180137.19	321025.92	584678.06
Holstein	3695.79	3250.19	733.04
Longhorn	470.40	2127.00	1089.27
Jersey	N/A	N/A	856.93
Mixed	N/A	N/A	N/A
Okie	497954.26	602931.64	603520.17
Other	1653.75	1953.06	86585.59
Red Angus	N/A	18988.62	32528.47
Tigerstripe	3424.10	2684.85	9251.95
Total	3639368.72	4024053.44	4609742.98

Note: The abbreviation N/A stands for not available, which means absence of that breed during that sale auction.

RESULTS

The results indicate that cattle prices averaged $792.22/head prior to the pandemic at the September 2019 auction, while they averaged $805.18/head six months post the pandemic's initiation at the September 2020 auction, and lastly averaged $887.44/head nearly two years after the pandemic's existence at the September 2021 auction.[1] Figure 1 illustrates feeder cattle prices ($/cwt) by breed by year from the NETBIO September sales at SSLA.

In general, the most noticeable difference is between the years 2020 and 2021. Dairy breeds including Holstein and Jersey along with Longhorn are typically less desirable for this sale and usually do not compete in pricing with the higher fleshier breeds as illustrated in Figure 1. An ANOVA test was conducted using PROC GLM in SAS software 9.4 version to further assess the impact of the COVID-19 pandemic on Feeder Cattle Prices in Northeast Texas. The results are presented in Table 3.

The *F* tests statistic is 301.99 and has a p-value less than 0.01 (Table 3), which suggests that the null hypothesis of equality of mean prices is rejected. That is, there is enough statistical evidence to conclude a separate means model. Type III sum squares are preferred in testing effects in unbalanced cases because they test a function of underlying parameters that is independent of the number of observations per treatment combination. The variables *Sex*, *Head*, and *Avg* along with interactions of the variables are all statistically significant with a p-value of less than 0.01 (Table 3). The interactions between variables indicate that together the variables have a combined effect on price.

The Tukey test results in Table 4 indicate statistical differences at a 0.05 confidence level among the feeder cattle price means derived from the COVID variable (Table 4). Each of the COVID stages (0, 1, and 2) means comparisons are statistically significant, except for the means between stages 0 and 1. Feeder cattle prices in 2020 are statistically different from 2021. Similarly, feeder cattle prices in 2019 are statistically different from 2021 prices, but 2019 prices were not statistically different from 2020 prices, which suggests that there were larger price variations from 2020 to 2021 than there were from 2019 to 2020. The second column of Table 4 reports the difference in feeder cattle price means among the COVID stages. This column indicates practical significance for the means between the COVID stages (except between 0 and 1), which also suggests that there is statistical significance among the means (except between 0 and 1). To further examine the impact of the COVID-19 pandemic on feeder cattle prices, a multiple regression model was estimated using PROC REG from the SAS software version 9.4. Table 5 reports the results.

[1] Average prices ($/head) are computed by multiplying the average price ($/cwt) times the average weight (cwt/head).

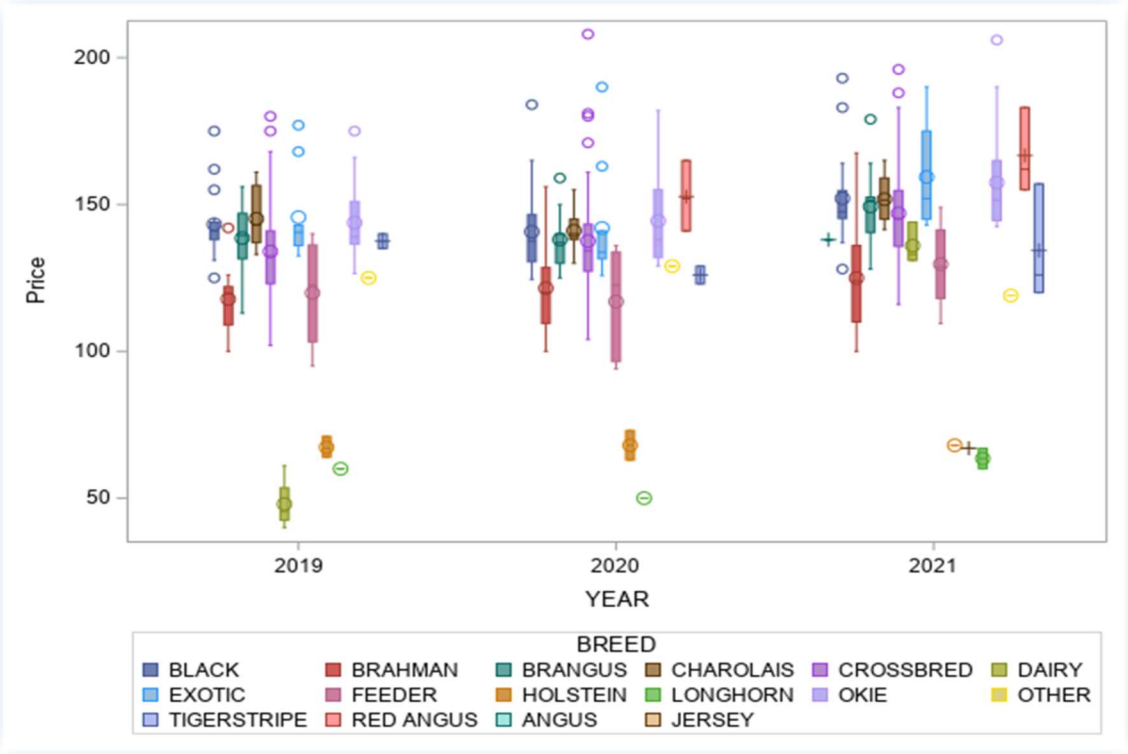

Figure 1. Box Plots of Feeder Cattle Prices from the NETBIO September Sale by Breed per Year at SSLA

From the results of the multiple least-squares regression, it is observed that all of the parameter estimates are statically significant at a 0.01 significance level. The R^2 value of 0.4196 suggests that 41.96% of variation in preconditioned feeder cattle prices is explained by the multiple regression model. The parameter estimate associated with the variable average weight per head (AVG) is statistically significant below the 0.001 level. The parameter estimate suggests that for every pound added to the average weight, price is expected to decrease by $0.05294/cwt, ceteris paribus. The parameter estimate associated with the variable Heifers is significant below 0.01 significance level, indicating that heifers were discounted by $9.59/cwt in comparison to steers prices regardless of weight, average, and year, ceteris paribus. This result is consistent with the literature as steers typically bring a premium over heifers. Statistical significance of the parameter estimates associated with variables *Y20* and *Y21* suggest that preconditioned feeder cattle prices in the years 2020 and 2021 are on average statistically different from the baseline year 2019. The *Y20* variable suggests that in the September 2020 auction, prices were on average $0.71/cwt higher than at the September 2019 auction regardless of weight, average, or sex, ceteris paribus. Similarly, the *Y21* is statistically significant below 0.01, indicating that prices at the September 2021 auction were on average $10.28/cwt higher than at the September 2019 auction regardless of weight, average, or sex, ceteris paribus.

Table 3. SAS Results from ANOVA Test.

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	217	2422248.55	11162.44	301.99	<0.0001
Error	14723	544209.15	36.96		
Corrected Total	14940	2966457.70			

R-Square	Coeff Var	Root MSE	Price Mean
0.8166	4.3808	6.0797	138.7828

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Sex	1	869.09	869.09	23.51	<0.0001
COVID	2	14.85	7.43	0.20	0.8180
Breed*Sex*COVID	14	8753.65	625.26	16.92	<0.0001
Avg	1	6769.27	6769.27	183.14	<0.0001
Avg*Breed	7	13503.50	1929.07	52.19	<0.0001
Avg*Sex	1	278.45	278.45	7.53	0.0061
Avg*Breed*Sex	6	9166.77	1527.80	41.33	<0.0001
Avg*Breed*COVID	14	2489.48	177.82	4.81	<0.0001
Avg*Sex*COVID	2	190.88	95.44	2.58	0.0757
Avg*Breed*Sex*COVID	7	1924.64	274.95	7.44	<0.0001
Head	1	895.44	895.44	24.23	<0.0001
Head*Breed	6	11238.45	1873.08	50.67	<0.0001
Head*Breed*Sex	7	6131.11	875.87	23.70	<0.0001
Head*Breed*COVID	14	6496.03	464.00	12.55	<0.0001
Head*Breed*Sex*COVID	9	9784.85	1087.21	29.41	<0.0001
Avg*Head	1	1080.03	1080.03	29.22	<0.0001
Avg*Head*Breed	8	10961.56	1370.20	37.07	<0.0001
Avg*Head*Breed*Sex	6	2753.57	458.93	12.42	<0.0001
Avg*Head*Breed*COVID	14	3442.59	245.90	6.65	<0.0001
Avg*Head*Sex*COVID	2	321.88	160.94	4.35	0.0129
Avg*Head*Breed*Sex*COVID	8	3637.35	454.67	12.30	<0.0001

Table 4. SAS Results from Tukey Test.

COVID Comparison	Difference Between Means ($/cwt)	Simultaneous 95% Confidence Limits		
2 - 0	8.6448	8.3576	8.9319	***
2 - 1	8.8353	8.5546	9.1159	***
0 - 2	-8.6448	-8.9319	-8.3576	***
0 - 1	0.1905	-0.0996	0.4806	
1 - 2	-8.8353	-9.1159	-8.5546	***
1 - 0	-0.1905	-0.4806	0.0996	

Note: Alpha = 0.05; Error Degrees of Freedom = 14723; Error Mean Square = 36.9632; Critical Value of Studentized Range = 3.31483.

Table 5. SAS Results from Multiple Regression Model.

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	1244754	311188.00	2699.60	<0.0001
Error	14936	1721704	115.27		
Corrected Total	14940	2966458			

Root MSE	10.73648	R-Square	0.4196
Dependent Mean	138.78285	Adj R-Sq	0.4195
Coeff Var	7.73617		

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Variance Inflation
Intercept	1	170.88	0.433	394.83	<0.0001	0.00
Avg	1	-0.05	0.001	-79.49	<0.0001	1.02
Heifers	1	-9.59	0.177	-54.05	<0.0001	1.01
Y20	1	0.71	0.218	3.24	0.0012	1.34
Y21	1	10.28	0.217	47.32	<0.0001	1.40

CONCLUSION AND DISCUSSION

The COVID pandemic impacted the food industry in many ways and has brought on new challenges. The beef industry is built on a solid foundation with a drive to fulfill the consumers' demand. With the high demand for beef not only across the nation but across the world, it is imperative the industry performs at the most effective and efficient level to satisfy the continuously growing demand.

This study examines the economic effect of the COVID pandemic on feeder cattle prices at preconditioned sales in Northeast Texas. The study conducted an ANOVA analysis and estimated a multiple regression model. The ANOVA analysis reveals several interaction variables had a combined effect on feeder cattle prices. There were also statistically significant differences among the feeder cattle price means from the three years analyzed, except for the years 2019 and 2020. The multiple regression model revealed similar results. The parameter estimates corresponding to the variables average weight, heifers, and years were statistically significant. In general, the study found that prices of preconditioned cattle at the NETBIO sale increased in times of COVID. This study assists feeder cattle producers, beef organizations, ranchers, and feedlots in assessing the impact of the COVID-19 pandemic.

Recommendations for Future Research. This study analyzes preconditioned cattle sales, which consists of mostly yearling heifers and steers. In most cases, sale barns all over the state of Texas host a sale every week for cattle of all ages, such as bulls, cows, breeding heifers, and baby calves, in addition to the yearling steers and heifers. Future research could expand to include these cattle in addition to the preconditioned sales like NETBIO. There are also other sales facilities across the state and nation that host their own preconditioned sales; future research might establish a comparison of prices among the differing preconditioned sales. Last, there are many inputs that are involved in raising cattle from feed cost, veterinary supplies, land leases in some cases which may play a role in the producers' decision-making process. Future research may study the relationship between input availability and feeder cattle prices in times of COVID.

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