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

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ABSTRACT

This study estimates how COVID has affected feeder cattle prices in Northeast Texas for the period 2019-2021. The study examines preconditioned cattle, which seem to be a less-risky and better-suiting market to some feedlots. The study evaluates two models, a separate means ANOVA model and a multiple regression model, and uses sales auction data for the months of September from the North East Texas Beef Improvement Organization at the Sulphur Springs Livestock Auction in Sulphur Springs, Texas. A total of 447 lots encompassing 14,941 heads were analyzed to determine the effects of COVID-19 on feeder cattle prices. The study found price differences in preconditioned feeder cattle among various COVID stages. The September 2021 and the September 2020 auction prices were higher and statistically different from the September 2019 auction by $10.28/cwt and $7.09/cwt respectively, regardless of weight, average, and sex. In addition, several interaction variables as well as variables such as average weight, heifers, and year were statistically significant. This study assists feeder cattle producers, beef organizations, ranchers, and feedlots in the area in assessing the impact of the COVID-19 pandemic.

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 (USDA-FAS, 2021). The United States experienced a steady increasing trend of beef exports from 2016-2019, however they experienced a 6% export decrease from the year 2019-2020, on count of trade barriers and export restrictions due to the pandemic (Troup, 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 North East 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 also opens the door to premium price efforts for the producers, simply because the feedlots are able to 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 1 to 100 heads 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 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 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 buyers 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 help to alleviate

some of the pressure to promote buyer participation. Upon completion of the sale, these cattle are shipped to feedlots all across the Midwest and central United States to serve packing houses. Preconditioning theses cattle for the sale inhibits added value. Cattle sales and livestock auctions, including preconditioned cattle sales, have endured market uncertainties in times of COVID.

LITERATURE REVIEW

Since the pandemic started, there has been limited research on how COVID has impacted commodities. Balagtas and Coopers (2021) discuss some key points that have been discovered in regards to effects of COVID-19 on livestock markets. First, there was a direct spike in grocery sales during the first few weeks of the pandemics arrival. Simultaneously, restaurant and travel spending took a complete 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 the sparse labor availability in the packing of live animals. This also left “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) model a relationship between retail meat prices, livestock prices, and marketing margin. That is,

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

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

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) $Pcasht = \beta_0 + \beta_1 Lot_t + \beta_2 Sex_t + \beta_3 WT_t + \beta_4 Breed_t + \beta_5 JanuaryFutures + \beta_6 MarchFutures + \beta_7 AprilFutures + \beta_8 MayFutures + \beta_9 AugustFutures + \beta_{10} SeptemberFutures + \beta_{11} OctoberFutures + \beta_{12} NovemberFutures + \beta_{13} Lot^2_t + \beta_{14} WT^2_t + u_t.$

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 statistical significant. A unit gain in weight established a slight discount, heifers also were discounted when compared to steers, and lastly 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 purging their cattle in preparation for the season change.

Augustin et al. (2021) study 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) $Basis_{it} = \beta_0 + \beta_1 Lot_{it} + \beta_2 Lot_{it}^2 + \beta_3 Weight_{it} + \beta_4 Weight_{it}^2 + \beta_5 Heifer_{it} + \beta_6 Bull_{it} + \beta_7 February + \beta_8 March + \beta_9 April + \beta_{10} May + \beta_{11} June + \beta_{12} July + \beta_{13} August + \beta_{14} September + \beta_{15} October + \beta_{16} November + \beta_{17} December + \varepsilon_t.$

Equations 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.

University of Tennessee in conjunction with their 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 producer's decisions 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 with 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 earrings. However, conditions such as the Coronavirus and the pandemic brought a wealth of unknown to producers and made future plans to sell difficult to make, 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 have to be continuously grown and must enter the supply chain (Griffith and Martinez, 2020a). Similarly, the NETBIO calves considered in this study have a goal ahead 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 5 years leading into and including the pandemic. In 2020 a downward trend leading into the pandemic.

The second report from the Griffith and Martinez (2020b) delves into the feeder cattle prices and their affects 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 time in light of the spring grasses that are rich and nutritious and helping enhance the calves growth and development. These producers will prefer to market these cattle in the fall before weather conditions turn undesirable. Although there is some fluctuation in prices between the season because of the operating factors and influx of participation of the seasonality. 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 dive in prices in the early month 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 sixteen 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) $CPH\ price = B_0 + B_1\ Lot\ Size + B_2\ Lot\ Size^2 + B_3\ Weight + B_4\ Live\ Futures + B_5\ Corn\ Futures + B_6\ Diesel\ Price + B_7\ Heifer + V_8\ Season + V_9\ Cattle\ Sort + B_{10}\ Time.$

Results revealed that most of the variable 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, muscling was not proven statistically significant from the model. 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 the country of China where many patients began to experience a shortness of breath and fever (CDC, 2022). The World Health Organizations 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, President Donald Trump announced a nationwide emergency declaration (CDC, 2022). It was not but just a day or two until the whole country 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 this 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%, which had not been seen 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 being produced and began being 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 amongst available vaccines. The first quarter of 2021 still inhibited 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, mask were required in most public areas, and schools returned to in person instruction the previous fall with new regulatory standards. Although cases still 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 sixteen 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 were able to overcome. The vaccines helped to slow the spread and obtained a grasp on the virus as a whole. 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 travel ban in order 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 sought 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 due to the fact that 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 deltas arrival.

MATERIALS AND METHODS

The NETBIO sale takes place 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) that each lot sold for. 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 latest year of COVID considered in the 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 resources, like hay are present.

A COVID variable is included in the ANOVA model to represent various stages regarding COVID and the timing of sales. The 2019 sales data is assigned a 0 to the COVID variable to indicate that COVID had not yet arrived. Sales data from 2020 is assigned a 1 to the COVID variable to show that COVID was in the first year of initialization and that minimal information was known about different variants. Lastly, 2021 sales data is assigned a 2 to the COVID variable to demonstrate the vast number of cases happening as well as the several known variants of COVID.

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

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) $P_{casht} = \beta_0 + \beta_1 Avg + \beta_2 Heifers_t + \beta_3 Y20 + \beta_4 Y21 + u_t$.

The variable *Avg* represents the average weight of the cattle in the lot. Different from Augustin et al. (2021) and Bankole et al. (2017), average weight better suited this study as it accounted for each head individually and alleviated multicollinearity in the variables *TotalWeight* and $TotalWeight^2$. 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's are the population parameters.

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 head were auctioned in the September 2019 sale, 5047 head were

auctioned in the September 2020 sale, and lastly 5,269 head 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.

September 2019					
Variable	N	Mean	Std Dev	Minimum	Maximum
WGT (lbs.)	4625	28618.86	13505.70	583.00	59398.00
AVG (lbs.)	4625	583.37	120.02	227.00	1103.00
Price ($/cwt)	4625	135.80	13.37	40.00	180.00
September 2020					
Variable	N	Mean	Std Dev	Minimum	Maximum
WGT (lbs.)	5047	31900.19	14867.42	652.00	69597.00
AVG (lbs.)	5047	593.75	124.33	249.00	1105.00
Price ($/cwt)	5047	135.61	12.59	50.00	208.00
September 2021					
Variable	N	Mean	Std Dev	Minimum	Maximum
WGT (lbs.)	5269	32146.74	19501.37	358.00	101100.00
AVG (lbs.)	5269	614.40	149.32	231.00	1063.00
Price ($/cwt)	5269	144.44	14.31	60.00	206.00
Overall					
Variable	N	Mean	Std Dev	Minimum	Maximum
WGT (lbs.)	14941	30971.40	16361.61	358.00	101100.00
AVG (lbs.)	14941	597.82	133.07	227.00	1105.00
Price ($/cwt)	14941	138.78	14.09	40.00	208.00

Sales totals by breed from the corresponding September auction are reported in Table 2. Some of the breeds recorded as N/A, which means that no animals represented that breed for that sale. Brahman, Crossbred, Feeder, Okie, Other, and Red Angus, all show an upward trend between the three sales. While Black, Brangus, Charolais, 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 pandemics initiation at the September 2020 auction, and lastly averaged $887.44/head nearly two years after the pandemic existence at the September 2021 auction.[1] Figure 1 illustrates feeder cattle prices (cwt/$) by breed by year from the NETBIO September sales at SSLA.

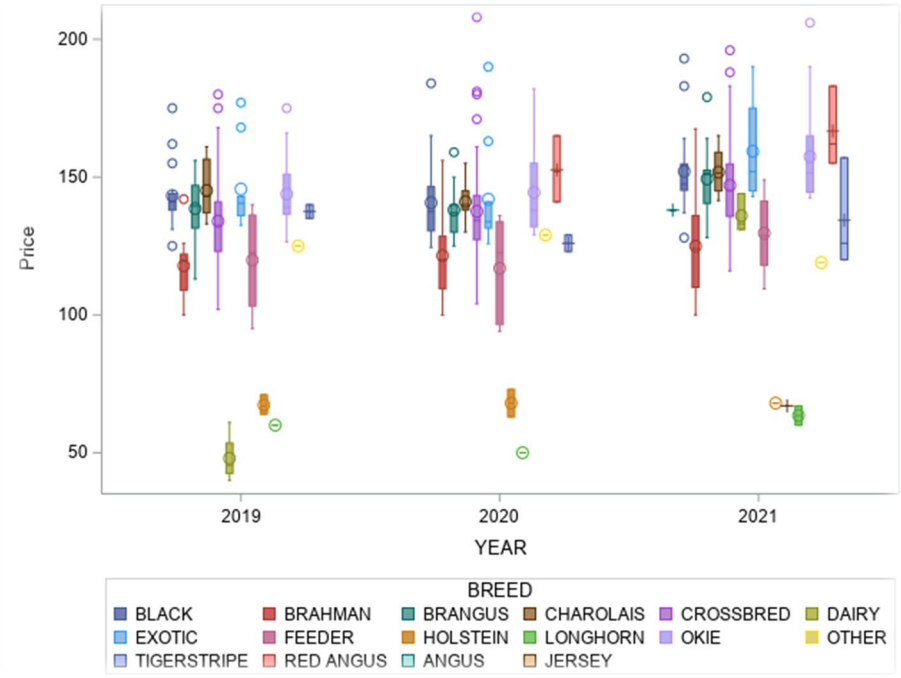

Figure 1. Box Plots of Feeder Cattle Prices from the NETBIO September Sale by Breed per Year at SSLA

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

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 has a p-value less than 0.01 (Table 3), which suggest that the null hypothesis of equality of mean prices across the COVID sates is rejected. That is, there is enough statistical evidence to conclude that at least one of the means from the COVID stages (0, 1, and 2) is statistically different from the others. 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.

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	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.

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 suggest 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.

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

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 suggest 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 suggest 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 suggest that in the September 2020 auction, prices were on average $7.09/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.

CONCLUSION AND DISCUSSION

The COVID pandemic has 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 reveal 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 organization, 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 just 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' decisions making process. Future research may study the relationship between input availability and feeder cattle prices in times of COVID.

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REFERENCES

Augustin J, Lopez J, Leiva E, Bakhtavoryan R. 2021. A case study of cattle prices in Nicaragua. J of Appl Bus and Econ 23(4): 120-138. Internet site: https://articlegateway.com/index.php/JABE/article/view/4470/4249. Last accessed May 18, 2022.

Balagtas J, Cooper J. 2021. The impact of Coronavirus COVID-19 on US meat and livestock markets. Washington, DC: Office of the Chief Economist, United States Department of Agriculture, preliminary working paper. Internet site: https://www.usda.gov/sites/default/files/documents/COVID-impact-livestock-markets.pdf. Last accessed March 26, 2022.

Bankole T, Lopez J, Wahrmund J. 2017. A hedonic analysis of feeder cattle auction prices in Northeast Texas. Selected paper presented at the Southern Agricultural Economics Annual Meeting, Mobile, AL. Internet site: https://ageconsearch.umn.edu/record/252732. Last accessed April 24, 2022.

Centers for Disease Control and Prevention (CDC). 2022 CDC museum COVID-19 timeline. Internet site: https://www.cdc.gov/museum/timeline/COVID19.html. Last accessed August 12, 2021.

Griffith A, Martinez C. 2020a. Tennessee cattle marketing influenced by COVID-19. Extension Report, Department of Agriculture and Resource Economics, University of Tennessee. Internet site: https://ageconsearch.umn.edu/record/303907?ln=en. Last accessed October 14, 2021.

Griffith A, Martinez C. 2020b. Tennessee feeder cattle prices influenced by COVID-19. Extension Report, Department of Agriculture and Resource Economics, University of Tennessee. Internet site: https://ageconsearch.umn.edu/record/303915?ln=en. Last accessed October 17, 2021.

Hardin D, Saghaian S. 2014. Factors that affect seasonality in Kentucky feeder calf prices and how calving dates affect cow-calf enterprise profitability. Selected paper presented at the Southern Agricultural Economics Association, Annual Meeting, Dallas, TX. Internet site: https://ageconsearch.umn.edu/record/162495?ln=en. Last accessed November 11, 2021.

Hauck G, Gelles K, Bravo V, Thorson M. 2020. Five months in: A timeline of how COVID-19 has unfolded in the US. USA Today. Internet site: https://www.usatoday.com/in-depth/news/nation/2020/04/21/coronavirus-updates-how-COVID-19-unfolded-u-s-timeline/2990956001/ Last accessed April 18, 2022.

Katella K. 2022. Omicron, Delta, Alpha, and More: What to know about the Coronavirus variants." Yale Medicine. Internet site: https://www.yalemedicine.org/news/COVID-19-variants-of-concern-omicron. Last accessed February 27, 2022.

Lu W, Huang Y, Gao C, Cai Y, Yang L. 2021. Three phases of COVID-19: Theoretical thinking on epidemic prevention and control. Annals of palliative medicine. Internet site: https://apm.amegroups.com/article/view/75195/html. Last accessed on May 1, 2022.

Northeast Texas Beef Improvement Organization (NETBIO) – Sulphur Springs Livestock Auctions (SSLA). 2021. Internet site: https://sslivestockauctions.com/. Last accessed June 30, 2021.

Telford T, Kindy K, Bogage J. 2020. Trump orders meat plants to stay open in pandemic. The Washington Post. Internet site:

https://www.washingtonpost.com/business/2020/04/28/trump-meat-plants-dpa/. Last accessed August 11, 2022.

Trupo P. 2021. Beef and cattle. United Stated Department of Agriculture (USDA) – Foreign Agriculture Service (FAS). Internet site: http://www.fas.usda.gov/commodities/beef-and-cattle. Last accessed on July 27, 2021.

United States Department of Agriculture (USDA) – Foreign Agricultural Service (FAS). 2021. Beef 2020 export highlights. Internet site: https://www.fas.usda.gov/beef-2020-export-highlights. Last accessed on July 6, 2021.

Williams G, Raper K, DeVuyst E, Peel E, McKinney D. 2012. Determinants of price differentials in Oklahoma value-added feeder cattle auctions. J of Ag and Res Econ 1(37): 114-127. Internet site: https://ageconsearch.umn.edu/record/122309?ln=en. Last accessed December 9, 2022.