Characteristics influencing the price of fed cattle sold on the Fed Cattle Exchange online platform

by

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Abstract

With the decline in negotiated trade in the live cattle cash market, feedyards and packers are looking for new ways to increase cash trade. An online, fed cattle auction was created to increase transparency as well as increase the cash trade. Hedonic models have been used heavily to study feeder cattle and the value placed on their characteristics. There is little hedonic modeling done on live cattle and the value of their characteristics. The Fed Cattle Exchange is a new online platform, therefore, no research has been done on it. The objective of this research is to use hedonic modeling to determine the value packers place on characteristics of each lot of fed cattle sold. These characteristics include, weight, number of head, sex, days on feed, location, yield grade, quality grade, delivery time period, and use of a beta-agonist. This research found that use of a beta agonist, location, days on feed, number of head, weight, delivery time frame as well as inclusion of a Select percentage were all statistically important to the price paid. Results will benefit feedyards by informing the sellers on what buyers find the most desirable. This will help with both feedyard procurement practices as well as feedyard management practices.

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Chapter 1 - Introduction

In recent years, the fed cattle market, also referred to as the live cattle market, has seen a large drop in the cash market, negotiated trade and an increase in the use of contracts and formula pricing (Schroeder and Ward, 2000). According to the United States Department of Agriculture, Agricultural Marketing Service (USDA – AMS), there has been a 12 percent drop between 2010 and 2013 in the use of cash trade in the fed cattle market. It has since increased slightly. The decrease in cash trade has led to worries in formula trade. If there is a low volume traded through the negotiated market, which is used for base prices in formula trade, the price for the formula market could be unrepresentative (Schroeder and Ward, 2000). This has put a spotlight on the importance of price discovery and what strategies would be the most effective in increasing price discovery. According to Thomsen and Foote (1952), the definition of price discovery is arriving at transactional prices for a given quality and quantity of a commodity at a given time and place.

There has been discussion in the cattle industry regarding how to increase price discovery. Ten different strategies came out of these discussions. Some strategies include, policy and legislative changes, different types of compensation for use of the cash market, tradable permits or certificates and finally new market reporting and trading technology (Koontz, 2015). The idea of policy and legislative change is not welcomed by most of the industry. Employing market-makers and privatizing the collection and reporting of prices, were strategies that would include some sort of compensation for the use of fed cattle price data. Tradable permits or certificates would force a certain amount of cash trade that could be traded between different feedyards and packers. The Fed Cattle Exchange (FCE) was created in regards to the last strategy mentioned, a new market reporting and trading technology. This trading platform is an attempt at

increasing price discovery in the fed cattle market. The FCE uses an online platform to connect any feedyard that wants to list their lot on the Exchange with any packer throughout the United States, large or small. The Fed Cattle Exchange will be discussed in great detail throughout this thesis.

The objective of this thesis is to review how the Fed Cattle Exchange came about as well as determine if the characteristics of each lot of cattle effects the price the lot sells at. A closer look at the data from the FCE will give more insight on what is driving the price differences between each listed lot. With this information, feedyards will be better informed on how to market their cattle through the Fed Cattle Exchange. Interviews were conducted with several industry participants. These included feedyards, packers as well as employees of the Fed Cattle Exchange. A hedonic model will be used to analyze the data that is collected from the Fed Cattle Exchange website as well as from the Fed Cattle Exchange directly. There has been extensive use of hedonic models in the cattle industry. However, because the FCE is a relatively young trading platform, there is very little research on the Fed Cattle Exchange itself.

Organization of Thesis

This thesis will be split up in 7 chapters. Chapter 2 goes into an assessment of the fed cattle industry and the way the market is structured. It also includes a history of the Fed Cattle Exchange, as well as some industry opinions on the FCE. Chapter 3 reviews past literature on fed cattle and hedonic models. Chapter 4 includes materials and methods. This chapter digs into the data collected from the Fed Cattle Exchange. Chapter 5 talks about the different pricing models that will be used to analyze the data. Chapter 6 will go into the results and discuss the effects of the outcomes of the three models. The final chapter is the conclusion and limitations of this study.

Chapter 2 - Evolution of Fed Cattle Exchange

Cattle Transaction Types

There are several ways a seller, the feedyard owner, can trade cattle with a packer. These include forward contracts, grid pricing, negotiated trade, and the most common one, formula pricing. Forward contracting is done with an agreement between a feedyard and a packer 14 days or more prior to the sale date (Koontz, 2013). The seller and packer do not contribute to price discovery with this contract and do not participate in the cash market. An article by Emmett Elam (1992), claims that forward contracting has no effect on the price of the cash market, whether it be positive or negative. Elam says that forward contracting decreases packer demand but also decreases feedyard supply, therefor, cancelling out the effects of not participating in the cash market. Grid pricing uses a grid that pays more for a higher quality carcass and less for a lower quality carcass. Grid pricing typically falls under formula pricing. Formula pricing, the most used pricing method, pays a premium to cattle that have a more desirable carcass. The premiums and discounts are determined by the cattle's yield grade and quality grade. According to Tatum (2007), yield grades are an estimation of the relative amount of lean, edible meat from a carcass. There are 5 yield grades, 1 through 5, where 1 is the leanest and 5 is the fattest. Quality grades represent the expected eating quality of the carcass, which is depicted by Figure 2-1 and is determined by maturity, and marbling. There are several quality grades, but the ones mentioned in this study are, starting from highest eating quality, Prime, Choice, and Select.

Figure 2-1. USDA Beef Quality Grade Chart

Relationship Between Marbling, Maturity and Carcass Quality Grade[1]

Degrees of Marbling	Maturity[2]				
	A[3]	B	C	D	E
Slightly Abundant	PRIME				
Moderate			COMMERCIAL	COMMERCIAL	
Modest	CHOICE				
Small					
Slight	SELECT		UTILITY	UTILITY	
Traces					
Practically Devoid	STANDARD			CUTTER	

[1]Assumes that firmness of lean is comparably developed with the degrees of marbling and that the carcass is not a "dark cutter."

[2]Maturity increases from left to right (A through E).

[3]The A maturity portion of the Figure is the only portion applicable to bullock carcasses.

Source: USDA-AMS

According to two grid examples used in a study by McDonald and Schroeder (2003), a Select yield grade 3 is the base price and a premium or discount is applied otherwise. A calf with a quality grade of Prime and a yield grade of 2 is going to be paid a premium for the carcass. A calf with a quality grade of Select with a yield grade of 4 will be given a discounted price. The base price typically comes from the live cattle cash price and the discounts and premiums are predetermined. Negotiated trade occurs when feedyards and packers negotiate on a price for cattle. This is an act of price discovery. Many other types of trade depend on this negotiated price for price discovery. The price set from the bid ask process between packers and feedyards is then used as the base price for formula trade.

The last type of trade is done with formula pricing. Formula pricing has increased nationally (Figure A-1). There are many benefits to using formula pricing. To name a few, easier cattle and feedlot management, predictable volumes, and lower costs for both feedyards and packers (Koontz, 2013).

Industry Conditions

Until recent years, fed cattle were traded primarily by cash, creating ample price discovery. The cash market requires buyers and sellers to go back and forth with prices using a bid ask process, until they can settle on a number that they can agree is the value of the cattle. "Negotiated implies that there is price discovery effort and work conducted" (Koontz, 2015, p. 3). Nationally, until about 2010, negotiated trade was between 40% and 60% of total cattle market trades. This meant there was plenty of price discovery going on. Negotiated markets can be risky and require sellers to be constantly monitoring the fed cattle market. This can take up time in an already busy day, as well as creates stress. For this reason, more and more sellers made use of formula trading strategies. However, the lack of price discovery could push the beef market into a situation much like the chicken and egg markets. There cannot be a futures market without a cash market.

Now, according to the USDA – AMS (Figure A-1), around 30% of live cattle are traded through negotiated trade, around 10% are traded through forward contracts, around 5% are negotiated grid and around 55% are traded through formula trades. As seen in Figure A-2, Texas, Oklahoma, and New Mexico, a key region in the cattle market, have next to zero negotiated trade happening. Texas is the top state for cattle sold for slaughter, with 5.5 million head. This upward trend of formula pricing begins in 2010 and never comes back down (Figure A-1). This could be

due to larger feedyard capacities in Texas. Using formula trade eliminates the hassle of having to run a large feedyard, and also having to stay well versed on the market. Sellers do not have to try to make an educated guess as to where the market is headed. They are able to rely on other feedyards negotiated prices to set their formula prices. However, with such key areas trading very little to no cash, price discovery becomes more and more important. According to Kay (2013), the use of a beta agonist in feedlots is partially at fault for the switch from negotiated trade. Kay states that the states where a beta-agonist is used have not seen as drastic a decline as the states that do, such as Texas. The use of a beta-agonist leaves a small window for feedyards to sell their cattle. This means that feedyards want to have their pens sold prior to the sale date to ensure a spot at the packer and not have to hold cattle if they cannot find a buyer.

With the dwindling use of negotiated trade, a question of the sustainability of the fed cattle market arises. Is Texas falling below five percent negotiated trade, and Colorado nearing five percent negotiated trade too thin? Can the high, negotiated trade happening in Nebraska be enough for the national fed cattle market? To answer the question of how thin is too thin, Koontz (2015), applied the Chebyshev inequality to the fed cattle market.

Koontz pulled data from five USDA AMS regions. In his research, using the Chebyshev formula, Koontz found that below 5% trade would be considered too thin. However, 10% negotiated trade is ideal for any market. Koontz conducted industry interviews that indicated that packers would be comfortable with 1-2% negotiated trade.

As indicated in many research papers and interviews, formula pricing is beneficial for both feedyards and packers. “These operations could routinely construct $25 per head values associated with formula marketing. The $25 per head amount was a repeated and conservative figure” (Koontz, 2015, p. 10). A key player for the Fed Cattle Exchange sells most of their cattle

on a grid. In an interview, it was indicated that the seller's grid sales made around $1.60 over the base price

As Steve Williams, JBS' head of procurement put it in an interview, "There are higher highs and lower lows in a shorter period of time." These out front exchanges allow for less price discovery and more volatility in the market. To put this into perspective, Williams explains the market this way, "If packers needed 100,000 head of cattle, they would trade with sellers up to 5 days a week. The price would remain less volatile because of the high amount of price discovery. Now that there are more contracts, most cattle are traded out front. Packers still need 100,000 head of cattle, but 80,000 are already a contracted kill. If there are 15,000 head in the cash market, the price is going to swing much higher because the packers are going to be bidding competitively." The price of cattle futures will increase. This is due to a market shortage. Demand for cattle is higher than what feedyards can or will supply. "The next week, packers still need that 100,000 head of cattle, again 80,000 of them are contracted out ahead. However, feedyards have 25,000 head to trade on the cash market this week. Packers do not need the extra supply, so their bids are going to be less competitive." This effectively lowers the price of cattle for that week because supply is greater than quantity demanded.

History of the Fed Cattle Exchange

According to an article posted on Drovers (2016, p.1) "Producers, industry groups (NCBA) and commodity traders have attempted to solve the problem through various measures, including: shortening trade hours, placing seasonal discounts for futures at a single delivery location and addressing high frequency trading With this drop off in the use of the cash market, it became apparent that something needed to be done". In December of 2015, a few cattlemen including Jordan Levi and Ed Greiman, started a conversation with the Chicago Mercantile

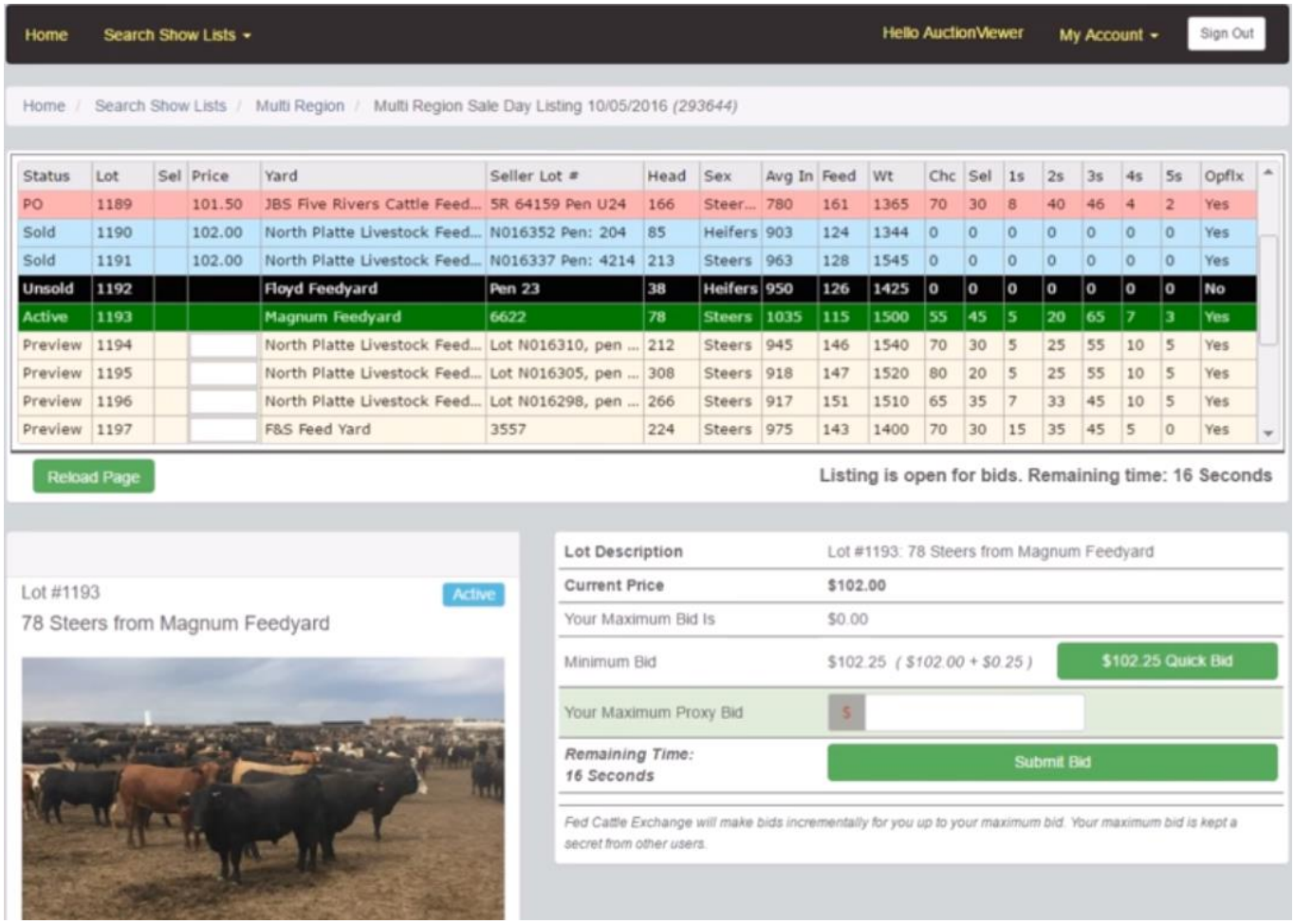
Exchange (CME) about what needed to be done. The CME believed that one issue was the volatility in the market was due to futures trading only on Fridays, sending very few signals to the market during the week. According to Jordan Levi, another issue was an excess supply of cattle in the northern states. This meant that Iowa cattle were being trucked at a discounted price from Iowa down to Kansas. The price with the discount set the market. Kansas cattle were bought at the discounted price even though they did not require the added transportation cost.

The conclusion the group came up with was that there was a need for a transparent, cost effective platform that traded during trading hours, on a different day than Friday. With this new trading platform in mind, Greiman met with several large packers in Kansas City who agreed to support the idea. He also spoke with 10 large feedyards that agreed to put one pen a week on the Fed Cattle Exchange. Superior Livestock agreed to take on the Fed Cattle Exchange, having a similar platform for feeder cattle themselves. The Fed Cattle Exchange, headquartered in Oklahoma City, Oklahoma, began working towards a few goals. According to Levi, those goals were to regionalize trade, limit volatility by giving more cash data points, increase trade during the week, facilitate trade while the market is open, and to increase transparency in the fed cattle market. This online platform allowed feedyards to be able to sell to a much larger market than before.

As of April 1, 2016, the Fed Cattle Exchange's first terms and conditions were posted. According to Fedcattleexchange.com, all cattle were to be sold on a live basis, FOB. Shrink, the amount of weight the cattle lose between the feedyard and the plant, would be calculated on an individual lot basis equivalent to industry practice. Buyers must be registered and in good standing with the Packers and with the Grain Inspection, Packers and Stockyards Administration. Buyers can be terminated if they no longer meet the criteria to buy. The Exchange must approve

buyers. To put a lot in the sale, the seller is charged a fee of $1.00/head. This is a brokerage fee that is collected by the Fed Cattle Exchange. Only sellers that have lots on the current sale, and packers can view the sale. This protects the identity of feedyards and how much they are selling their cattle for. However, the Exchange can make the sale public for exposure. This can only be done after notifying users that the sale will be open to all viewers. Sale lots must be posted to the Fed Cattle Exchange by noon on Monday, the week of the sale. Packers typically send their buyers to look at these lots before the sale starts on Wednesday. The sale begins at 10:00 am Central Time on Wednesdays. A clause allows the FCE to split the sale into regions if necessary. This means that a region like Iowa and Minnesota would begin at 10:00 am, Nebraska would begin at 10:30 am, Kansas at 11:00 am, and so on. The online platform is a basic interface.

Figure 2-2. Fed Cattle Exchange Screenshot



Before the sale, FCE puts up a sale day dashboard. The dashboard lists the lots that are for sale with several characteristics, as seen in Figure 2-2.

Table 2-1. Fed Cattle Exchange Variable Description

Variable	Description
Status	If lot is sold, unsold, or PO'd
Lot	Number of lot i
Price	Price is the price the lot is sold for. Price remains blank if lot is unsold
Yard	Name of the feedyard selling Lot i
Seller Lot #	Name and number of the pen in the feedyard where the lot of cattle is located
Head	Number of head in Lot i
Sex	Pen contains either steers, heifers, or mixed lots
Avg In	Average weight of cattle upon entering feedyard
Feed	Days on feed
Wt	Average weight of cattle in lot at sale
Chc	Percentage of lot that will grade Choice
Sel	Percentage of lot that will grade Select
Dressed	Percentage of weight that will be part of the carcass
1s,2s,3s,4s,5s	Percentage of lot that will have a yield grade of 1,2,3,4, or 5
Optflx/BetaAg	If feedyard used a beta-agonist on cattle in Lot i

These headings change several times over the course of this research. The auction uses a horse race style closing. Once the lot reaches below 15 seconds left to bid, another bid will restart the clock to 15 seconds. Giving buyers adequate time to decide if it is plausible for them

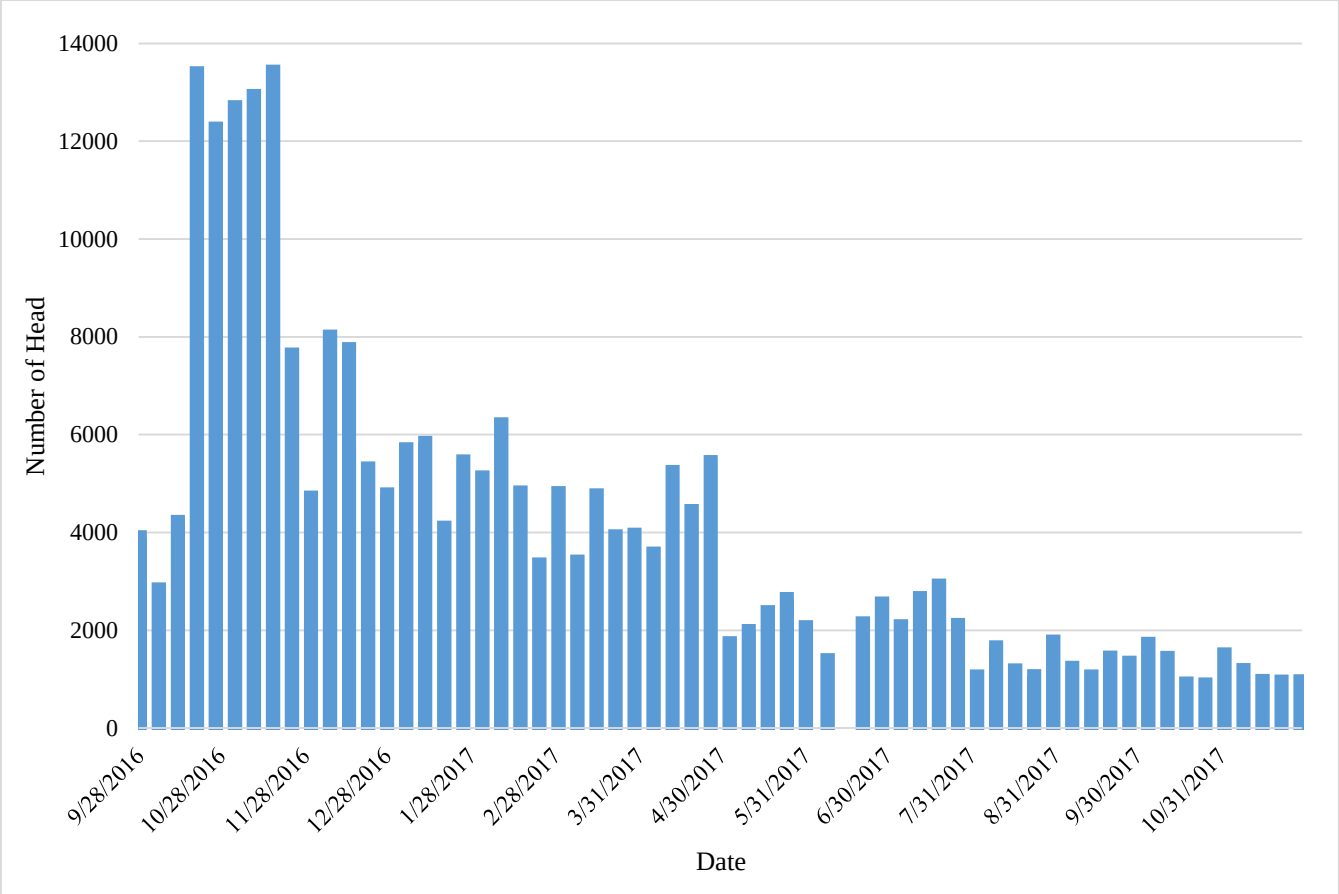
to bid again. Once bidding closes, the seller still has the option to pull out (PO) for a fee of $10.00/head if the price the lot sold for is not sufficient. This fee is paid to the winning bidder. After the conclusion of the sale, payment is not done thru the Fed Cattle Exchange. It is up to the buyer and seller to settle.

Fed Cattle Exchange has made several changes to the terms and conditions since the sale started in April of 2016. To PO, sellers now have to pay $1.00/head instead of $10.00/head. Feedyards see the $1.00/head PO as just a cost of doing business. However, packers believe it allows seller to play games with the packers. It makes it too easy for feedyards to put a pen in the sale without any intention of actually selling. Another change is that the sale can now be viewed by anyone who logs onto the website. This allows feedyards and packers that are not participating in the sale to be able to see what other feedyards are selling at. This is potentially a deterrent for feedyards to put their lots on The FCE. As of August 30th, 2017, cattle were offered both in a live weight offering and a dressed weight offering. FCE indicates which lots are being sold as dressed offerings with a ribbon at the top of the sale that say "Lots X through X will be sold dressed, FOB feedyard". Typically, in the beef industry dressed lots are not sold FOB feedyard. They are sold delivered. The Fed Cattle Exchange also did not enforce having to provide a picture of the pen of cattle.

With a large industry backing, the Fed Cattle Exchange began trading on May 25th, 2016 (Figure A-2) with 2,003 head in the sale. A few weeks after, the Exchange took a short break to work out some technical issues due to the high traffic on the website during the sales. The sales started back up on September 14th, 2016 with 1,500 head listed By September 28th, there were nearly 3,000 head listed, with nearly 84% of the lots selling. As of October 5th, 2016, the USDA AMS reports included the results of the weekly Fed Cattle Exchange sale (Fed Cattle Exchange,

2016). The sale remained between 1,500 and 4,500 head for a few weeks. As seen in Figure 2-3,On October 19th, 2016 the sale shot up to 13,396 head in the sale.

Figure 2-3. Number of Head Offered Through Fed Cattle Exchange per Week



For the next four weeks, the number of head in the sale remained above 12,000. On November 16th, the sale peaked with 13,428 total head listed with 94% selling. The next week, November 23rd, 2016, the sale dropped to nearly half as many listings, with 7,644 head for sale. Listings continued to drop the next week with 4,718 head. In the next few weeks, the sale rebounded to above 8,000 head one more time. After the middle of December, the sale never reaches above 7,000 head again. By July 5th, 2017, the sale had lost its initial following. The head count remains below 3,000 for the remainder of this study. On August 30th, 2017 the sale listed dressed offerings. All four lots listed as dressed were sold. Cattle in northern states typically sell

as dressed. This could have been done to appeal to more packers in different regions. After the first week of dressed weight sales, only one more lot posted as a dressed offering sold. During the period this research covers, there were no dressed listings after September 13th, 2017. In an interview with industry packers it was stated that packers typically do not pay freight for dressed cattle. The FCE listed their dressed cattle as FOB, meaning that the packers would have to pay the freight on the cattle bought off of the online platform. Dressing percentages also differ between different regions and companies.

Industry Outlook on the Fed Cattle Exchange

With the smaller numbers coming across the FCE platform, a few questions come to mind. How many head of cattle need to be traded weekly for the Fed Cattle Exchange to be sustainable? Where did the large numbers from the beginning go? What is the Fed Cattle Exchange doing to increase numbers? To answer a few of these questions, interviews were conducted with several industry participants. These include packers, feedyards, as well as individuals that started the Fed Cattle Exchange. These interviews do not represent the entire cattle industries opinion of the Fed Cattle Exchange.

When Fed Cattle Exchange was started in 2016, feedyards as a whole were excited about the sale. It would spark cash trade and increase exposure for feedyards. Like the rest of the industry, the excitement waned as offerings and sales began to fall. The longevity of the sale began to come into question. An interview with Troy Stowater, who still consigns cattle to the sale, revealed that although the FCE has failed to bring about active cash trade at the time of the sale, it does stimulate active trade at the conclusion of the sale. Stowater believes that if all the sale does is trigger the market, then that is okay. Feedyards as a whole would like to see an increase in participation from the packer.

As a whole, packers believe that the exchange is a positive move towards an increase in price discovery. The packers interviewed participated, whether that be bidding or watching the sale, in the Fed Cattle Exchange since the day it began. Packers believe that the FCE allowed buyers to pay for value, meaning there was a price spread between higher quality and lower quality cattle. One packer emphasized that a volatile market is difficult to sell cattle in. It is hard to establish a price through a bid and sell process while the market is moving. The ability to have the CME website pulled up, while the market is moving a lot, next to the sale bring emotions into the equation. Packers believe that FCE seems to work better when the market is stable. After looking into this further, this theory is not proven by the data used in this study. As seen in Figures 2-4 and 2-5, there is very little correlation between percentage of lots sold on week X and the dollar difference from week X, which is determined by finding the difference between the Wednesday and Monday futures and the Wednesday and Tuesday futures. This determines how much the market is moving prior to the sale. Packers also believe that the biggest price differences come from differences in quality and yield grade, dressing percentage as well as days on feed. Buyers mentioned the decrease in PO price had an effect on the sale. Feedyards with much less incentive to sell began to put lots on FCE. As seen in Figure A-3, the percentage of PO'd lots increased dramatically immediately following the PO price decrease. This became frustrating to packers and eventually led to a decrease in packers bidding on lots.

Figure 2-4. XY Scatter Plot Showing Volatility in the Market versus the Percentage of Lots Sold on FCE Per Week

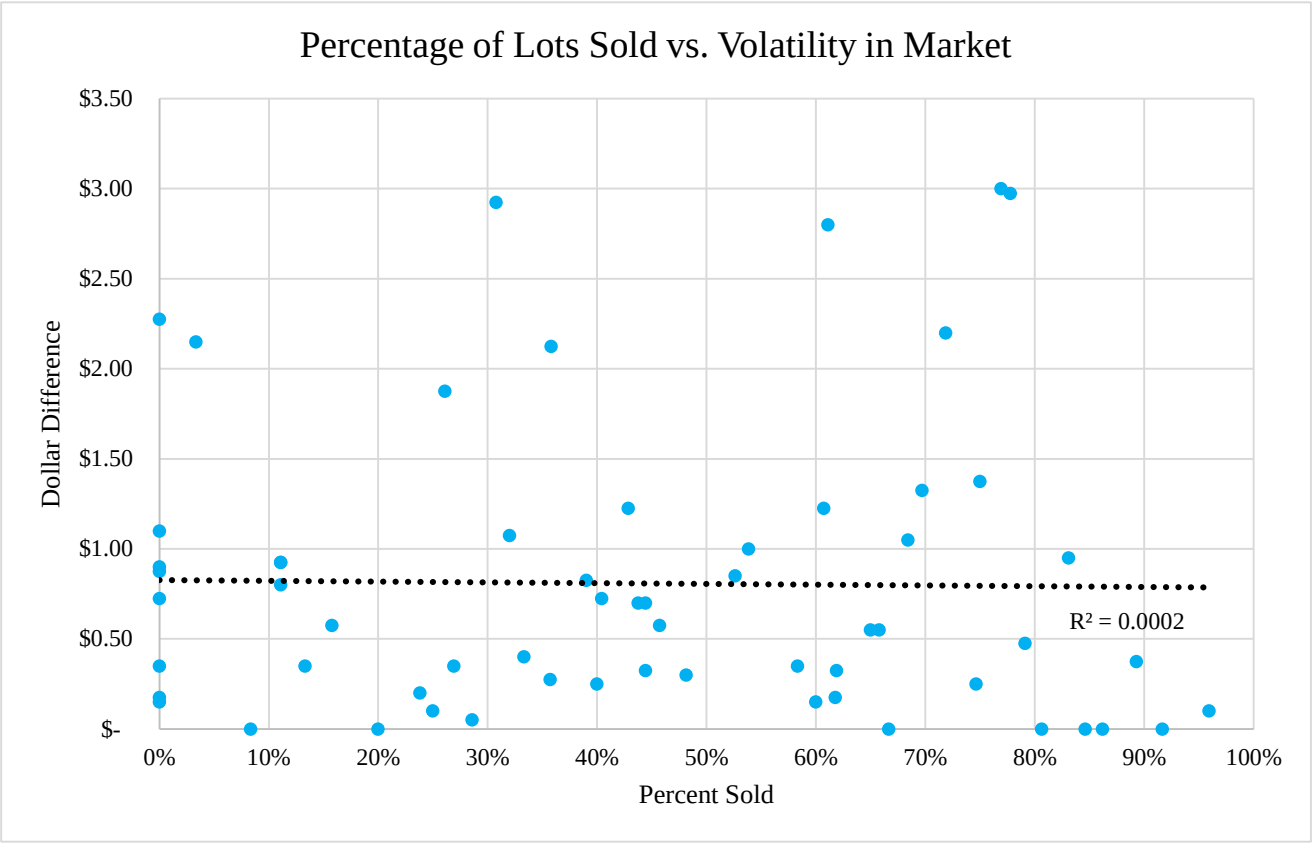


Figure 2-5. Line Graph Showing Volatility in the Market versus Percentage of Lots Sold

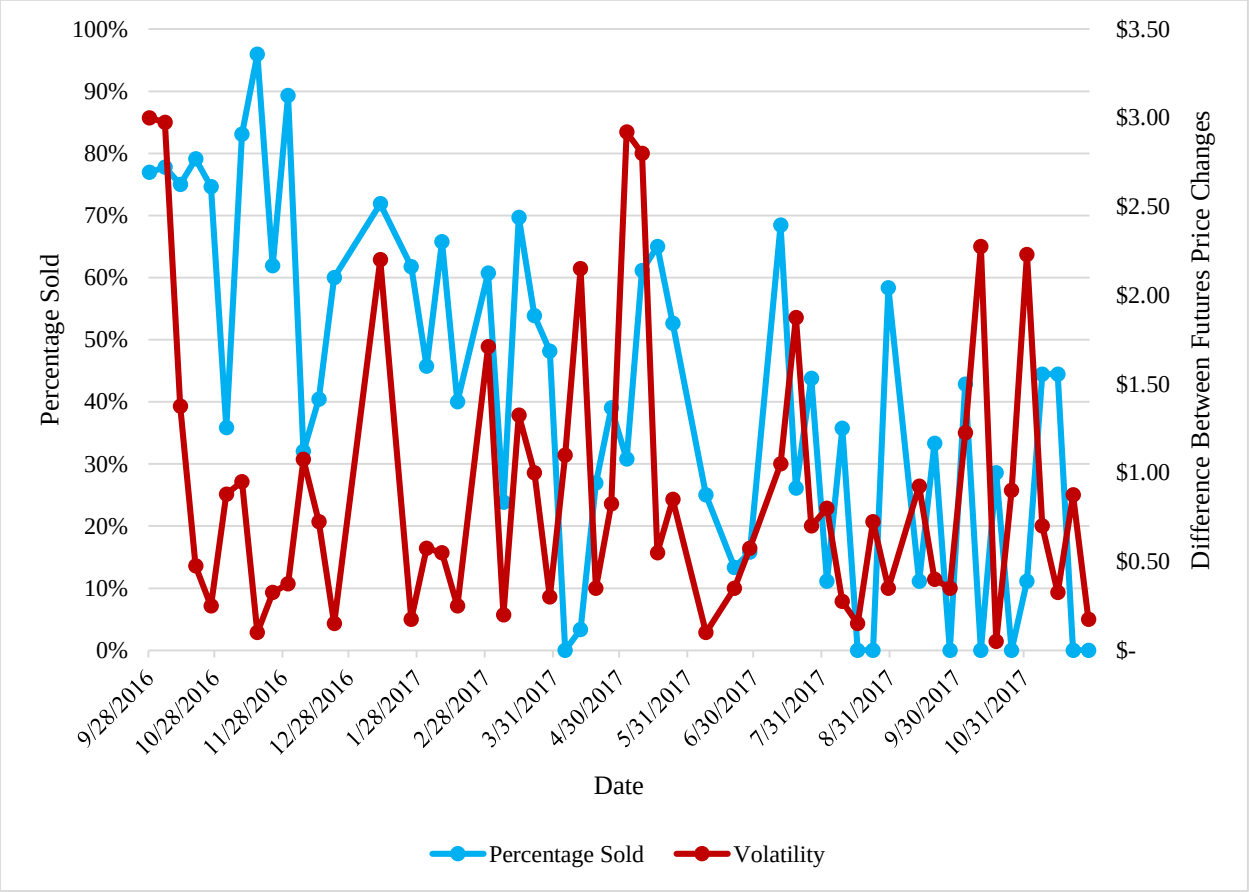


Figure 2-4 contains points with $3.00 difference between the two days and a 77 percent sold and a $0.35 change between the two days prior to the sale and a sale rate of 13 percent. Figure 2-5 uses a different type of chart to again, show that there is little to no correlation between the volatility in the market and the percentage of lots that are sold on FCE.

There was not a consensus from all packers on if 1,000 head is sustainable for the FCE long term. However, there was agreement that trade does need to increase. Packers believe that when the price for sellers to PO dropped from $10/head to $1/head, it became harder to buy. This drop in the PO fee allowed buyers to test the waters with no intention of actually selling. Packers believe that trade will not increase until sellers begin to sell again. One major packer believes that the anonymity of feedyards is also a factor in the decline of sellers. In the beginning of the

sale, only sellers who had a lot listed on the sale could see other lots for sale. Now, anyone who logs onto the Fed Cattle Exchange website during the sale can see who is selling and at what price they are asking and selling at. If one feedyard can make enough by selling fifty cents below the market, there is the potential for other feedyards to bully them for selling lower than the rest of the market. As far as the smaller numbers in the sale as of late, one packer believes that in the beginning of the sale, feedyards had higher number of uncontracted cattle. Once the cattle that were not contracted were sold, feedyards had to honor their contracts. Feedyards essentially ran out of cattle that were available to be put on the cash market.

Next for Fed Cattle Exchange

What is the Fed Cattle Exchange going to do next? With numbers continuing to fall, it is necessary to ask what is going to change. In an interview, Levi said that there were three options for the Fed Cattle Exchange. One, the trading platform does not change and dies. Two, Superior Livestock is going to have to make changes to the Exchange. Lastly, Superior could sell the FCE to a Cooperative that will resurrect the online auction platform. Levi does believe that it has helped condition the market to trade in the middle of the week as opposed to just on a Friday.

There are no reps in the field that are promoting the FCE sale. FCE could use reps, like Superior, that are out weekly reminding feedyards to use the online platform. Prior to Greiman leaving, he was acting as a rep. Feedyards and packers were contacted and reminded to participate weekly. However, FCE is small and is not out to make money off the sale. Ultimately, this limits their ability to promote and advertise for the sale.

Many industry participants agree that the level the FCE is at now, less than 1,000 head per sale, is not sustainable. However, they do not believe that the record high levels of over 13,000 head per sale is necessary either. There seems to be a consensus that offering around

5,000 head per week would be sustainable as well as an effective price discovery tool. It has been mentioned several times that a feedyard selling with a formula receives a higher price per head. Levi's answer to this was, "Over what?" If there is not price discovery, and no negotiated trade, then there is a question as to how formula pricing will work.

Chapter 3 - Review of Literature

The Fed Cattle Exchange began in 2016, so it is a relatively new trading platform. There has been very little research published on the Fed Cattle Exchange. However, there have been many studies using hedonic modeling in fed cattle and feeder cattle, as well as extensive research using hedonic modeling in livestock as well as agriculture in general.

The objective of this chapter is to review literature that are relevant to this study, not to rehash every hedonic model done on fed and feeder cattle. These include papers involving hedonic modeling as well as economic theory behind the fed cattle market. This chapter will go into studies that delve into hedonic modeling, the fed cattle market as well as video auction feeder cattle markets.

Waugh's (1928) research was the first to look at how the quality of a product effects the price consumers are willing to pay, without using a survey. Waugh looks at how price of vegetables are effected by the characteristics of the vegetables. It is stated that a study that looks at the premiums quality products bring, helps farmers determine if it makes sense to invest more in their business to attain that higher quality. Waugh found that cucumbers are discounted when under 8 inches and that price increases at a decreasing rate when buyers look at the diameter of the cucumber. Waugh also cautions blindly following the quality grade of a product. When looking at the "No. 1" asparagus, consumers seemed to decide what they actually considered a "No. 1" vegetable. At the time this study was published, very little research had been done on including quality characteristics in a pricing model.

Lance Zimmermann's (2010) thesis titled Factors Influencing the Price of Value-Added Calves at Superior Livestock Auction (SLA), on what is influencing the price of feeder cattle on the Superior Livestock Auctions video auction. This research is closely related to the research

being done for this thesis due to the platforms the cattle are auctioned through. Both will benefit the beef industry as well as academia by analyzing what characteristics effect the price of fed and feeder cattle and how to quantify the effect. The SLA offers video auctions, internet auctions and, private-treaty internet listings. Zimmermann's research focuses on video auctions. Video auctions provide a unique market for cattle. The sellers have access to a much larger market than they would selling at an auction barn or to regional feedyards. Zimmermann used a hedonic model that includes variables such as weight, number of head, use of different vaccinations, implant use, breed, as well as feeder and corn futures contract prices. The research was able to look at trends in the data over several years as well as seasonality. Among the many characteristics found important for heifers and steers were weight, region of origin, days to delivery, and number of head in each lot sold. While similar in many ways, there are a few major difference between these theses. The first is the type of cattle. Zimmermann looks at feeder cattle, while this thesis focuses on fed cattle. Another major difference is the type of platform. This thesis focuses on a strictly online auction while Zimmermann's focuses on a video auction. The last, and perhaps biggest, difference is how the sale is promoted. SLA has paid representatives that promote the sale to its sellers, cow calf operations and buyers, feedyards. SLA is the parent company for the Fed Cattle Exchange; however the SLA reps are not paid to market the FCE sale. Therefore, there is less reason for the representatives to promote the sale.

Menzie et al., (1972) uses a weight squared variable in a study on feeder cattle. The inclusion of a squared variable looks into the linearity of price and weight. Faminow and Gum (1986), Dhuyvetter and Schroeder (1999) as well as Zimmermann (2010), look at the effects of including a weight squared and lot size squared variable. The inclusion of these variables estimates the non-linearity between price and lot size as well as price and weight (Zimmerman,

2010). Dhuyvetter and Schroeder find that lot size premiums are at their highest between 200-250 head. All of the above research looked at the premiums and discounts of lot size and weight for feeder cattle.

Research by Coatney, Menkhaus, and Schmitz (1996), Feeder Cattle Price Determinants: An Hedonic System of Equations Approach, used a hedonic model approach to look at which characteristics of feeder cattle had the greatest effect on price. This study parallels this thesis in many ways. This research looks at the physical characteristics of the cattle, seller characteristics, as well as the inclusion of video markets. Superior Livestock Satellite Video Auction, the parent company to the Fed Cattle Exchange, provided the data used in this study. This allowed cattle to be viewed throughout the United States. Buyers were also able to view information on the lots prior to the sale date. The model included live, and feeder futures prices and excluded lots that did not sell. The results conclude that weight, proportion of lot that is heifers, certain breeds, flesh variance and frame variance have an impact on price. With the Fed Cattle Exchange data, weight is also expected to have an effect on price. The FCE data however, does not contain all of the same data that is present in Coatney, Menkhaus, and Schmitz study.

Williams, Raper, DeVuyst, Peel, and McKinney (2012) also looked into the price differentials of feeder cattle. Their research was focused around cattle in Oklahoma specifically. The model used was based around Schroeder et al., (1988), with basis as the dependent variable. Location is a random effect. Williams et al., (2012) found that characteristics such hide color, weight and sex have an effect on the price received for cattle. This study talks about the use of video auction data versus a traditional sale barn auction. It is suspected that video auction cattle are not representative of the whole. Technological and marketing capabilities of the seller,

quality of cattle, and lot size were pointed out as being significantly different for traditional and video auctions.

Mitchell and Peel (2016), venture into an area that has not been heavily researched. The study used a log-log hedonic model to look at how bred-cow characteristics effects the bred-cow price. Characteristics like, price, weight, quality, location, and average reported price were used in the model. It was found that an increase in quality, weight, and location of cattle, lead to an increase in price received for the cow.

Bailey, Peterson, and Brorsen (1991), did a comparison on the price cattle sold on a video auction for and the price cattle sold for at a regional market. The study used data from the Superior Livestock Auction and regional sale information from Oklahoma City, Greeley, and Dodge City. Bailey, Peterson and Brorsen hypothesized that video auctions bring a higher price due to an increase in information and lower costs such as transportation and commission fees. Cattle are also shipped fewer times when sold through a video auction. This could mean fewer veterinary costs and sick cattle. The research included testing if there was a statistical difference between SLA and the regional sales as well as the characteristic differences between SLA and Dodge City. The study concluded that SLA received a higher price than OKC, Greeley, and Dodge City. As stated in the research, revenue was between $6.65/head and $23.52/head more for a 700 pound calf. It is concluded that video auctions are likely going to take cattle from regional auctions. This study shows that there is value in selling cattle through a video auction versus selling cattle through a regional sale. However, this study looks at feeder cattle. For fed cattle, there are fewer buyers and sellers for the cattle. This study was also able to use significantly more lots to analyze.

There are many studies using hedonic models to look at the characteristics of cattle and how each affects the price received. Many have looked at feeder cattle, fewer have looked into fed cattle. The Fed Cattle Exchange is the first online fed cattle sale. This study will be the first to use hedonic modeling to look at how certain characteristics affect the price received for fed cattle sold online through cash trade.

Chapter 4 - Materials and Methods

Descriptive Statistics

The Data used for this thesis comes from the Fed Cattle Exchange website as well as directly from the Fed Cattle Exchange office and the Livestock Marketing Information Center (LMIC). The majority of the information was pulled from Excel sheets provided on the FCE website as well as from the live sales held each Wednesday. Individual bid prices and select videos of the sale were provided by the FCE office in Oklahoma City. No bidder information was available. Data ranges from September 29th, 2016 to November 29th, 2017. Because the FCE platform is relatively new, there is not a long time series of data to analyze. For example, there is not enough data to create a variable to test seasonality of the FCE volumes or prices. The average weekly live cattle futures prices as well as daily live cattle futures prices are pulled from spreadsheets provided by LMIC.

The data is not always consistent due to changes in formatting on the FCE website and what sellers were asked for; therefore, data are missing for select weeks. Overall, 17 lots were omitted from the research. The omitted lots were Holstein lots, Mexican cattle lots, Longhorn lots, or sold as dressed. There were not enough of these lots sold to add value to the study. If these lots were not omitted, they would skew the data. The final data set consists of 1,497 lots, all of which are either, sold, unsold or pulled out (PO). The multinomial probit explains the sold data. Some lots do not have all of the information entered. Numbers will vary between descriptive statistics due to this. The following sections discuss in detail descriptive statistics presented in the tables below. Data used in models consists of sold and PO'd data.

The Fed Cattle Exchange includes several physical characteristics of lots offered for sale including: sex, weight in, weight out, dressing percentage, yield grade, and quality grade. The

market variables provided from FCE include: state the lot is located in, delivery time, head, beta-agonist presence, and sale date.

Table 4-1. Average Lot Size, Days on Feed, Weight, Weekly Fed Cattel Futures, and Price

Variable	*Mean*	*Std Dev*	*Minimum*	*Maximum*
Lot Size	160.08535	81.34819	29	648
Days on Feed	165.851035	70.6969242	73	395
Weight	1377.31	101.317522	1100	1612
Average Weekly Live Cattle Futures Price	113.356148	8.6117553	96.6949997	132.8899994
	113.695129	10.288921	97.75	140.25

The mean lot size is 160 head with the smallest lot at 29 head and the largest at 648 head. The average days on feed for the cattle sold through the FCE is 166 days. Weight ranges from 1100 pounds to 1612 pounds with the average at 1377 pounds. The highest average weekly live cattle futures price during this study was $132.89/cwt and the lowest was $96.69/cwt. The average was $113.36/cwt. The highest price through Fed Cattle Exchange during the duration of this study was $140.25/cwt and the lowest was $97.75/cwt with an average of $113.69/cwt.

The Fed Cattle Exchange offered dressed cattle in the latter half of 2017. As indicated in Table 4-2, very few lots actually sold dressed. As mentioned in chapter 2, dressed lots were offered as FOB. This is not standard in the beef industry and may have led to some confusion. Feedyards wanted higher prices than the packers were willing to offer because packers still had to add in the cost of transportation. Less than 1 percent of sale offerings were dressed. Dressed lots were omitted from the data.

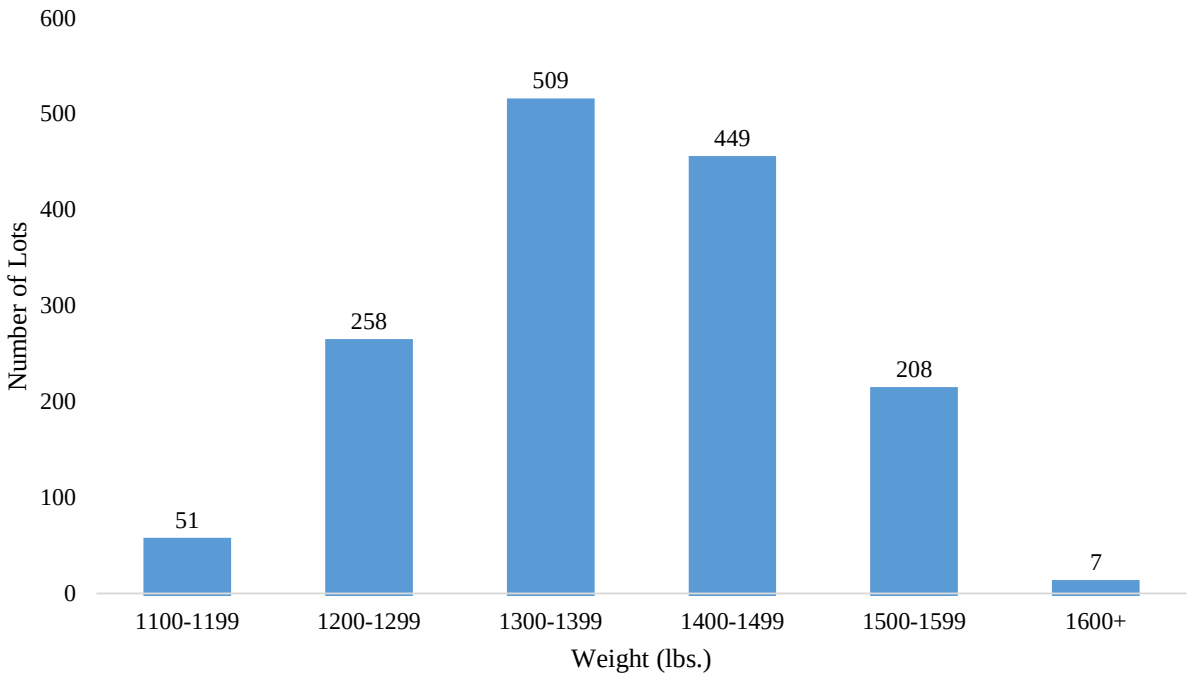
Table 4-2. Cattle Offered As Dressed or Live

Offered As	*Frequency*	*Percent*
Dressed	8	0.53
Live	1497	99.47

Lot Weight

Average in weight per lot ranges from 140 pounds to 1337 pounds. The average out weight, weight at time lot is offered, ranges from 1100 pounds to 1612 pounds. Mean weight is 1377.35 pounds with a standard deviation of 101.43 pounds. Figure 4-1 graphs the average weights per lot. According to Lacy, Knight, and Mckissick (2017), packers are willing to pay more for a 1300 pound calf than one that is fed out to 1400 pounds. Also, medium framed cattle typically bring a premium over larger framed cattle. A heavier lot is expected to bring a premium until the lot reached a certain maximum weight. (Mitchell, 2016).

Figure 4-1. Average Lot Weight



Source: Author's Own Work

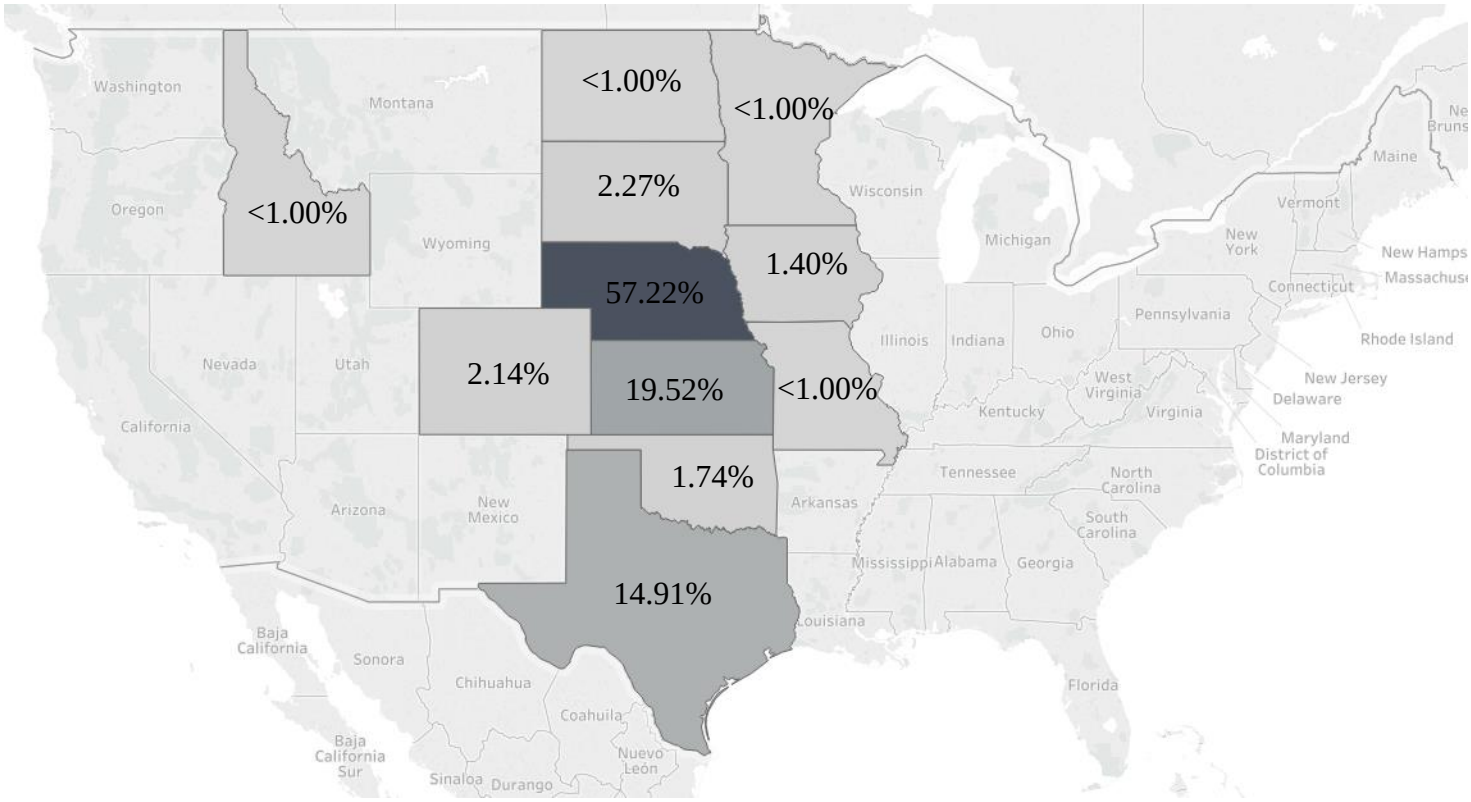
Sale Lot Location

Table 4-3 indicates where lots offered through FCE were located. Over 57 percent of lots were located in Nebraska. Kansas and Texas had the next largest offerings with 20 and 15 percent of lots respectively. The remaining 8 percent of lots were offered from Colorado, Iowa, Idaho, Minnesota, Missouri, North Dakota, Oklahoma and South Dakota. Fed cattle marketings data was collected from USDA. Using the same states as the FCE, percentages of marketings in each state was calculated. This lets us look at national data relative to FCE data. The base state is Nebraska due to the high concentration of listings, as seen in Figure 4-2. Assuming equal quality of cattle, the high concentration of cattle in Nebraska means that the price of cattle in the area would likely be lower. This means that a state like Texas and Oklahoma would get a premium for cattle. States like South Dakota and Iowa have a lower concentration of packers then Nebraska. Therefore, they would likely receive a lower price than Nebraska because of transportation costs. Since there are several different states, each state will have a different effect on price.

Table 4-3. Seller Location

State	*Frequency*	*Percent*	*USDA Fed Cattle Marketings Percentage*
CO	32	2.14	9
IA	21	1.40	6
KS	292	19.52	24
NE	856	57.22	27
OK	26	1.74	3
SD	34	2.27	3
TX	223	14.91	25
Other	12	0.80	4

Figure 4-2. Frequency of Seller Location



Darker states indicate a higher frequency of sold lots

Use of a Beta-Agonist

Feedyards can use a beta agonist, a feed additive, which increases muscle in livestock by allowing protein synthesis to occur more rapidly (Chichester, 2013). There has been some debate about the use of beta agonists in food animals. None of the packers in the United States accept cattle that have been given Zilmax. There is concern whether beta agonist affected the mobility of animals. Optaflexx, another beta agonist, is still used in feedyards today. Beta agonists have increased meat production 1.5-2% (Chichester, 2013). As seen in Table 4-4, nearly 62 percent of the 1521 lots, were administered a beta agonist. One main reason a feedyard would choose to not use a beta agonist would be that the lot is going to be marketed as natural. Use of a beta-agonist

is expected to have a negative effect on price. Use of a beta-agonist increases weight but also decreases quality of the cattle.

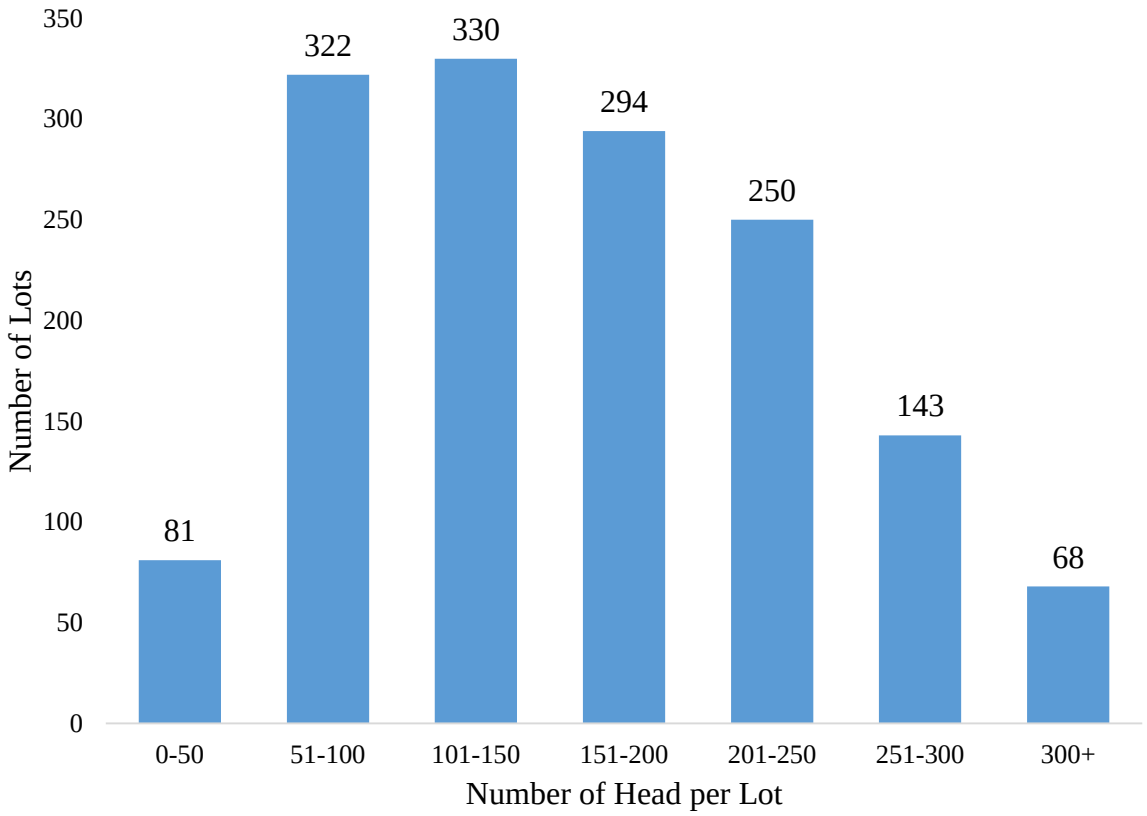
Table 4-4. Use of a Beta Agonist for Cattle in Each Lot

Beta Agonist	*Frequency*	*Percent*
No	572	38.21
Yes	925	61.7

Lot Size

The average lot size is 160 head. Lot size ranges from 29 head to 648 head. The distribution of lot size is seen in Figure 4-3. Lot size is expected to have a positive effect on price. As the head per lot increases, premiums increase at a decreasing rate (Zimmerman, 2010). Small lots do not fill a semi-truck load to capacity. This means that the shipping price per calf increases. Larger lots have been found to have a higher price because packers of reduced transaction costs as well as ease of scheduling for slaughter (Muth et al., 2007)

Figure 4-3. Number of Head per Lot Offered



Source: Author's Own Work

Quality Grade

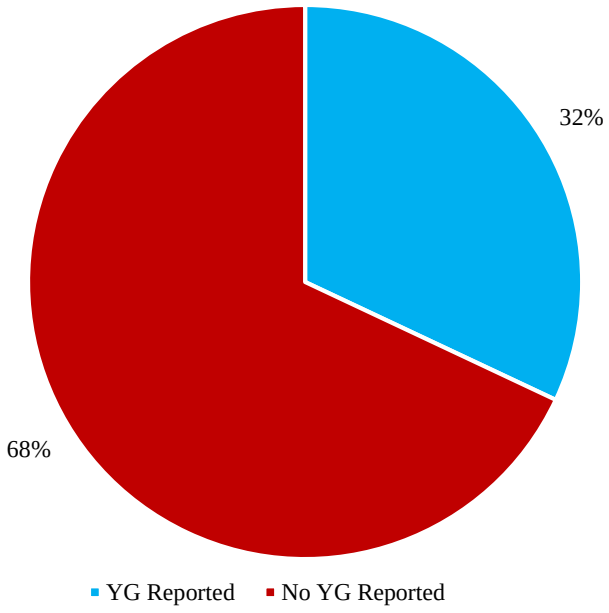
Half of the sellers reported an estimated quality grade distribution for the lot. Quality grades reporting options were Choice, chc, and Select, sel. This indicated what the seller thinks the percentage of cattle in their lot are Choice or Select. Some sellers opted to not record an expected quality grade. Inclusion of a quality grade is expected to have a positive effect on price. The base quality grade used in the model is Select. Sellers are not required to include a quality grade. Therefore, sellers that include the information are likely to have higher quality cattle. A

quality grade of Choice is also expected to have a positive effect on price. Cattle that grade Choice are higher quality and can later be sold for a higher price when sold as boxed beef.

Yield Grade

As illustrate in Figure 4-4, 68 percent of sellers did not report a yield grade. Yield grade reporting options were 1,2,3,4, and 5. Sellers could put in a percentage as discussed earlier in this thesis, a yield grade of 1 is the leanest cut, while a yield grade of 5 is the fattest cut. A lower yield grade is going to be offered a premium. Since the base yield grade used is yield grades 4 and 5, yield grades included in the model should have a positive impact on price. The yield grade data were filled out in various ways by the sellers. Some sellers recorded yield grades that equal 100 percent. Other sellers had percentages that equaled around 94 percent or 102 percent. Other sellers reported the number of cattle in the lot that would be placed in each yield grade. For the purpose of this study, these numbers were adjusted to equal 100 percent by dividing each by the sum if they added to something other than 100.

Figure 4-4. Percentage of Sellers That Reported a Yield Grade



Source: Author's Own Work

Delivery Time Frame

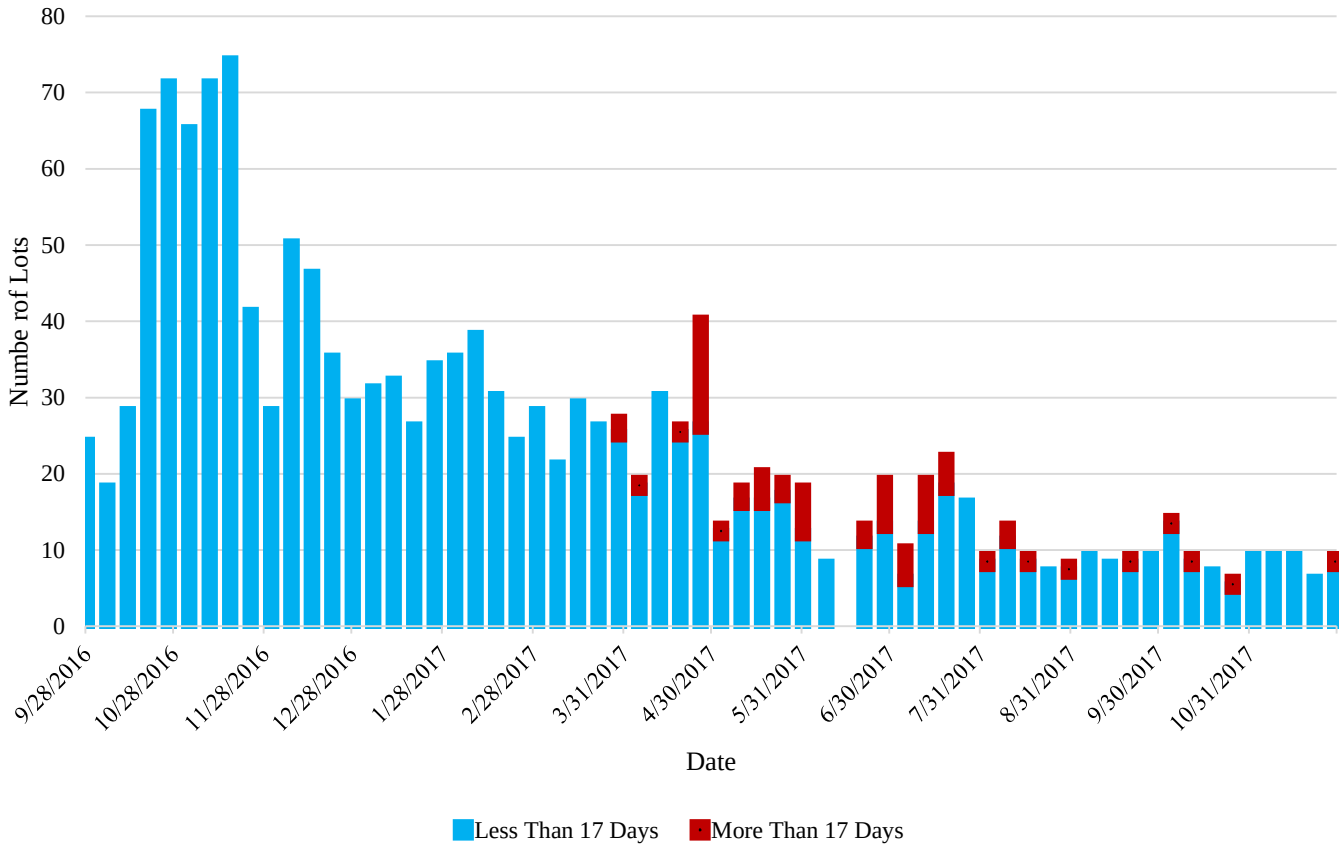
The Fed Cattle Exchange had several options for lot delivery periods, outlined in Table 4-5. The standard delivery time from the feedlot to the packer post-sale in the industry is two weeks. The base for the model is more than two weeks. The sale takes place on a Wednesday, so the seventeen-day time frame would allow feedyards and packers two weeks

Table 4-5. Delivery Time Frame

Variable	*Frequency*	*Percentage*	*Delivery Time Frame Included in Variable*
Less17daydel (Less than 17 days)	1432	95.66%	1-9 days 1-17 days 10-17 days
More17daydel (More than 17 days)	65	4.34%	17-30 days 31-60 days

This means that the shorter delivery time should have a positive influence on price. Packers are going to be more willing to pay a higher price to fill an order for this week because of time constraints. If the delivery time is over 17 days, packers have more time to look for other lots to fill orders. Delivery time of 60 days could potentially put that lot's delivery time with lots on a completely different contract. The Fed Cattle Exchange added a 17-30 day delivery time as well as a 31-60 day delivery time for sellers around the 3/29/2017 sale. Sellers had talked to the FCE about including these longer delivery times so that the FCE could more accurately reflect their current marketing programs. While sellers began to use the longer delivery option, it was not widely used. While the intention could have been to increase the use of the auction with more options, the change could have just moved lots around.

Figure 4-5. Delivery Time Frame



Source: Author's Own Work

Data

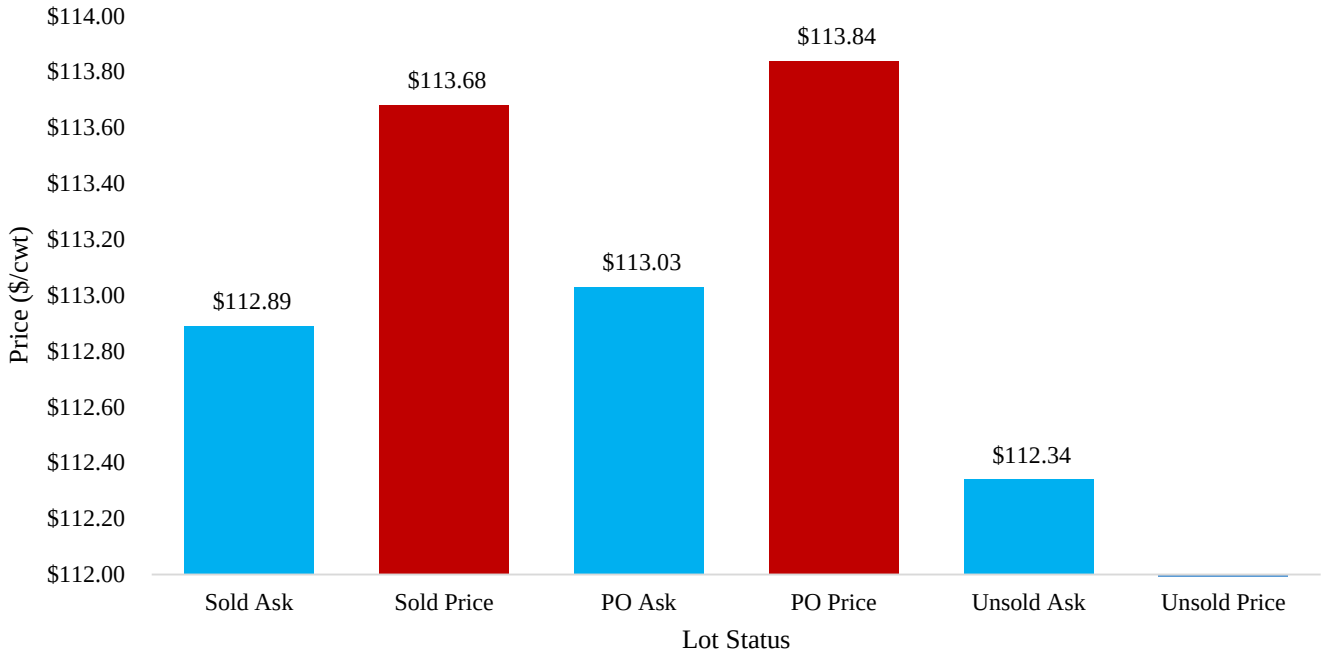
As seen in Table 4-6, over the lifetime of the sale, 814 lots, or nearly 55 percent of lots were sold. 40 percent were unsold and around 5.5 percent were PO'd. As seen in Figure A-3, during the early months of the FCE, PO'd lots were consistently 3 percent or below of the total lots offered. However, the second half of 2017 saw a huge increase in percent of lots PO'd. On September 27th, the PO percentage was as high as 78 percent of the total lots offered. Table 4-7 shows the increase through monthly averages. This would be less unusual if as the amount of total lots decreased, the amount of PO lots remained the same. Therefore, the total percentage would increase. However, as total lots offered decreases, PO lots increase. The Fed Cattle

Exchange originally charged a $10/head PO fee. The first sale of June 2017 was the first sale after the PO fee was changed to $1/head. As seen in Figure A-3, the first sale of June is where the spike in increased PO'd lots occurs. This indicates that sellers are more likely to put a lot in the sale and test the waters because the cost of changing their mind is much lower. This behavior has not gone unnoticed by packers. Packers have noticed that sellers are throwing out prices higher than the market, knowing that they are not going to get a packer bid. This could deter packers from participating. Figure A-4 and figure A-5 show the drastic difference between the PO price change.

Table 4-6. Status of Each Lot at End of Weekly Sale

Status	*Frequency*	*Percent*
PO	82	5.48
Sold	814	54.38
Unsold	601	40.15

Figure 4-6. Price Difference Between Sold, PO'd and Unsold Lots

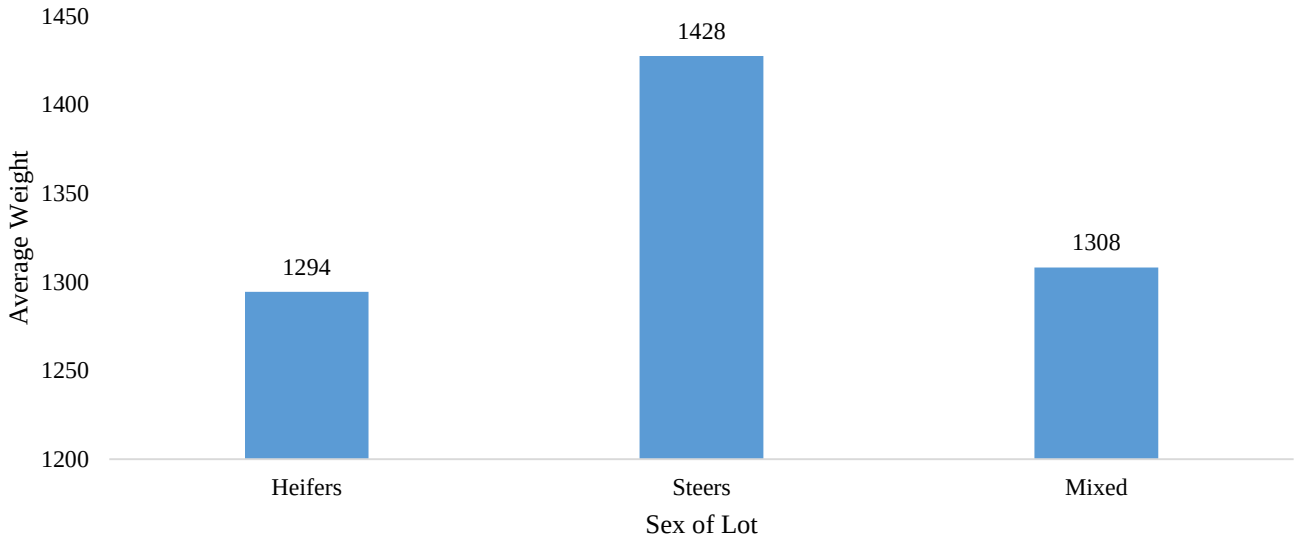


According to Figure 4-6, the PO ask price is the highest ask price at $113.84. The unsold ask price is the lowest price at $112.34. This could mean that prices are lower because packers do not demand as many cattle. The PO price is $0.16 higher that the sold price. This could mean that when prices are higher, sellers are more willing to hold out and not sell.

Table 4-7. PO Percentage of Total Lots Offered

Month of Date	*PO Lots*	*Total Lots*	*Percentage of PO*
Sep-16	2	26	8%
Oct-16	2	184	1%
Nov-16	2	282	1%
Dec-16	2	161	1%
Jan-17	2	123	2%
Feb-17	0	127	0%
Mar-17	3	135	2%
Apr-17	3	116	3%
May-17	3	88	3%
Jun-17	7	42	17%
Jul-17	16	68	24%
Aug-17	8	52	15%
Sep-17	14	39	36%
Oct-17	12	37	32%
Nov-17	8	42	19%

Figure 4-7. Average Weight per Sexed Lot



Source: Author's Own Work

The lots of cattle were offered as steers, heifers or mixed lots. As indicated in Table 4-8, over 54 percent of lots contained only steers, 42 percent of lots were only heifers and under 4 percent of lots had both steers and heifers. Steers can bring a premium over heifers. Heifers carry more fat, therefore they have a lower dressing percentage.

Table 4-8. Sex of Cattle in Each lot

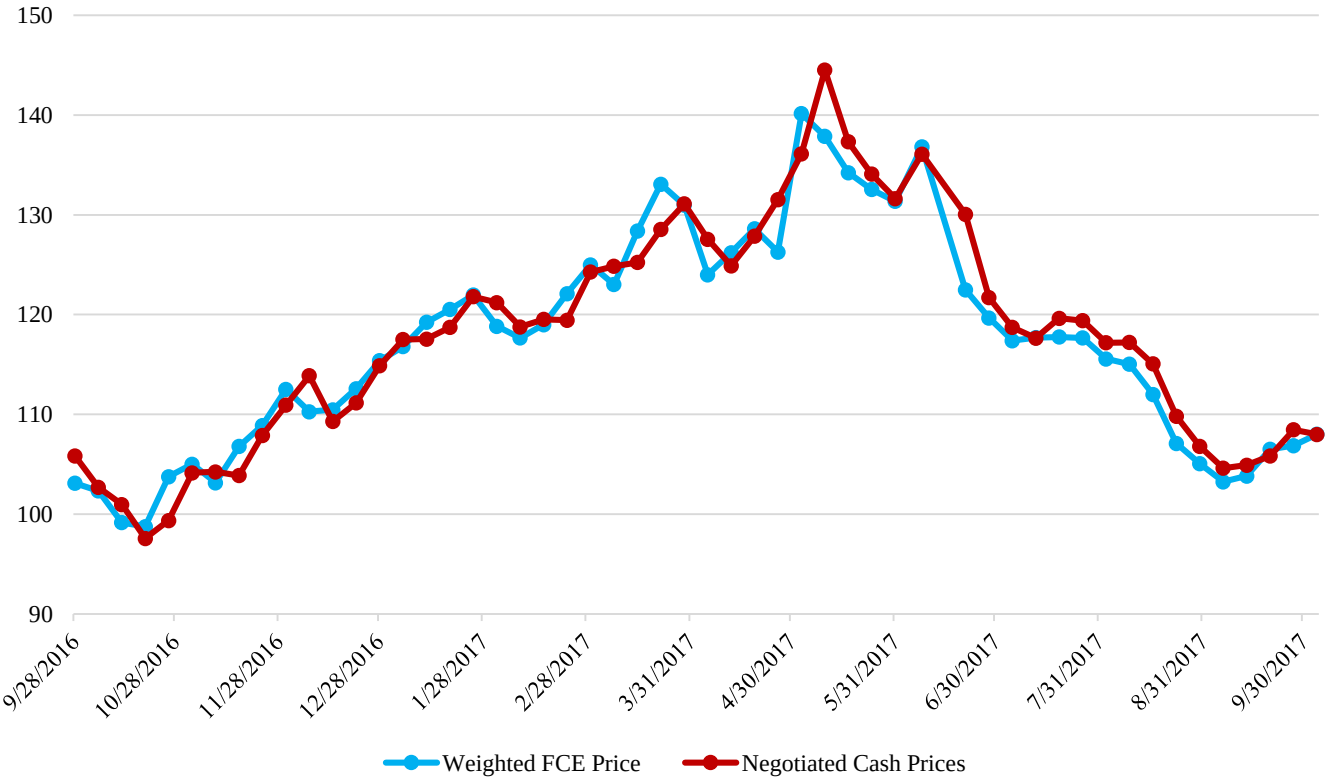
Sex	*Frequency*	*Percent*
Heifers	626	41.82
Mixed	59	3.94
Steers	812	54.24

One distinct difference is the average weight per lot. As seen in Figure 4-7, steer lots average over 100 pounds more than both heifer and mixed lots at 1428 pounds. Heifers average 1294 pounds and mixed 1308 pounds.

Another difference seen in the sexed data is the average sold price per lot, shown in Figure 4-9. Steers average the lowest price at $112.18. This is not expected because heifers have more excess fat than steers, which lowers the dressing percentage. Therefore, heifers typically get a discounted price compared to steers. Looking further into the data reveals why the steer average price is so much lower than both heifer and mixed average prices. As seen in figure 4-10, during the highest volume weeks of the sale, steer lots were a high percentage of total lots. Steer lots were up to 75 percent of the total lots sold. At this time, futures prices were also the lowest point during the duration of the course of this study. Therefore, the average sold steer lot price would be lower.

A major concern from sellers using the FCE platform is the price they are receiving for their cattle. As seen in Figure 4-8, the FCE weighted average price follows the national

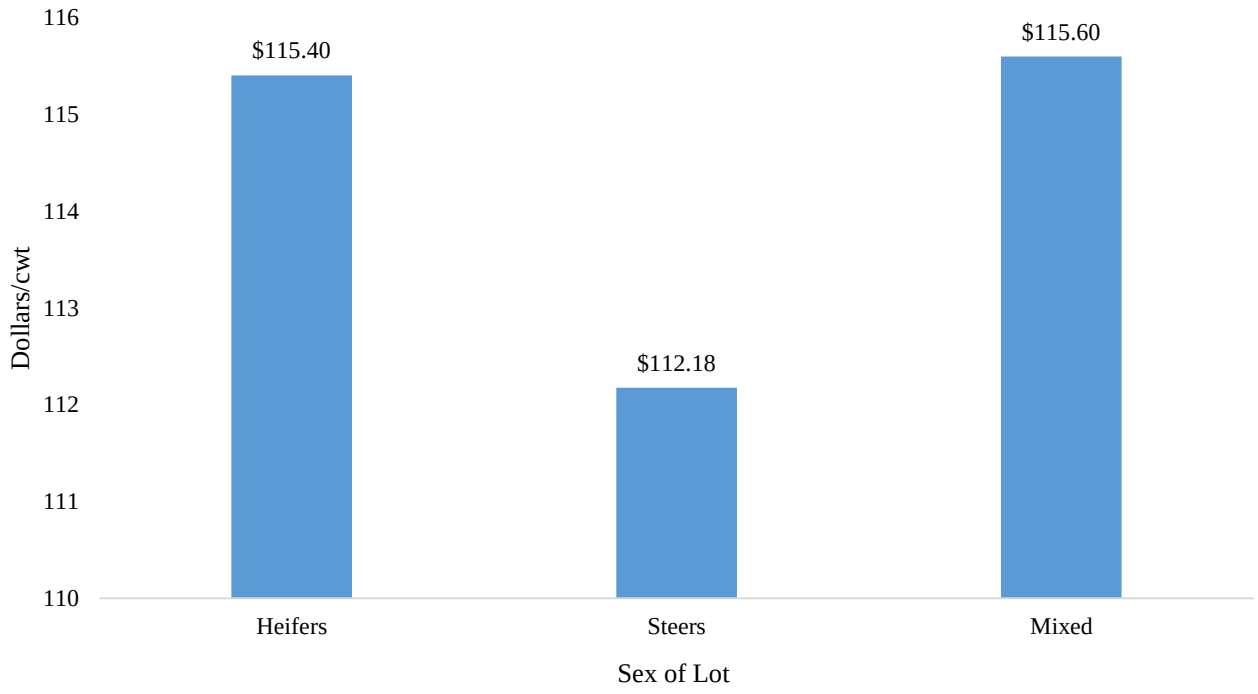
Figure 4-8. Fed Cattle Exchange Price vs. the National Negotiated Cash Price



Source: Author's Own Work negotiated

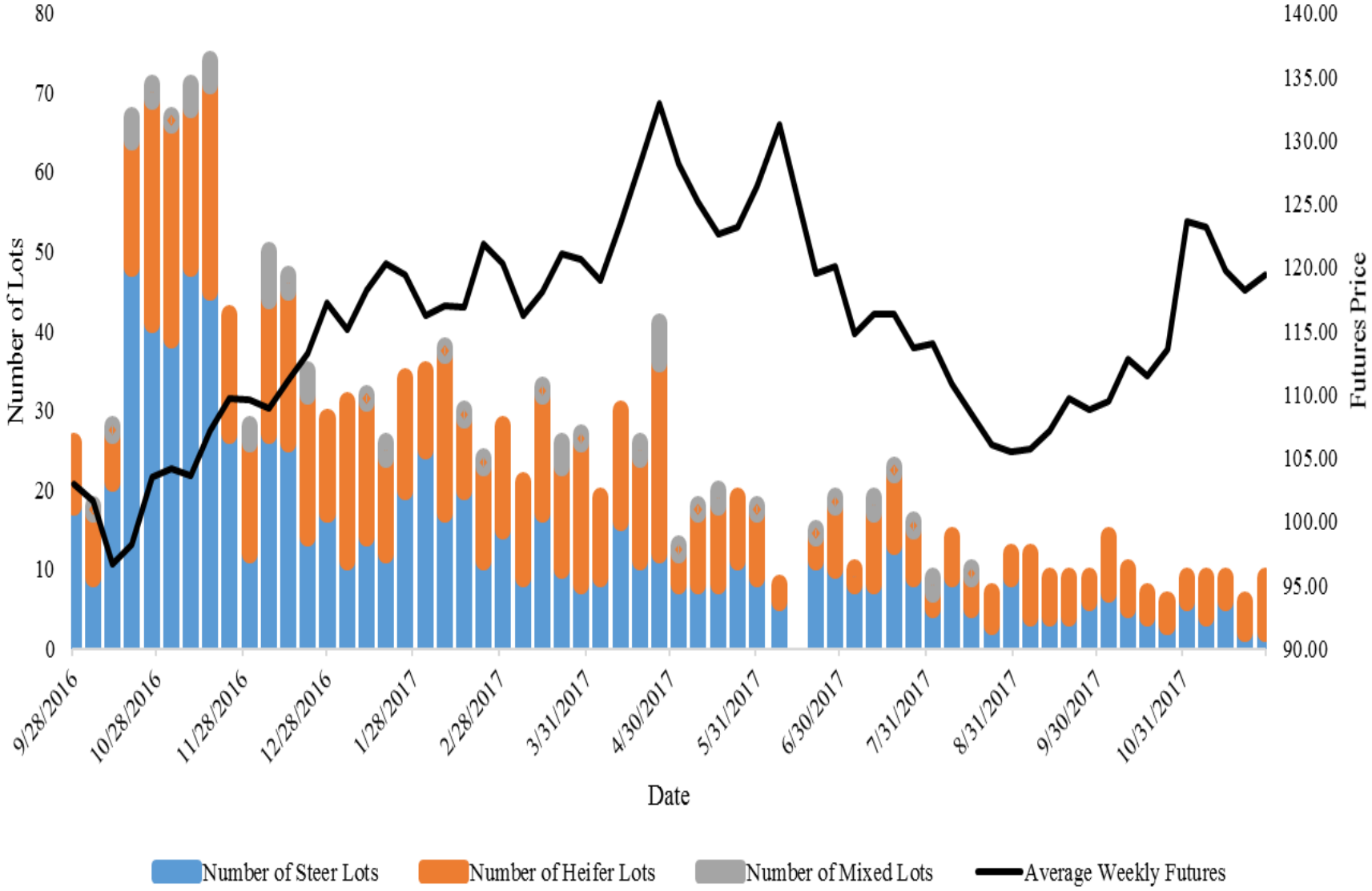
cash price for live cattle (LMIC). Depending on the week, cattle sold on the FCE platform sell for higher than the national cash price. However, the average weighted price on FCE is $116.96/cwt and the average national cash price for the same time period is $117.93/cwt.

Figure 4-9. Average Price per Sexed Sold Lots



Source: Author's Own Work

Figure 4-10. Sex of Sold Lots vs Average Weekly Futures Prices.



Source: Author's Own Work

Chapter 5 - Pricing Model

In this thesis hedonic models are used to evaluate how the characteristics given to Fed Cattle Exchange affect the price of cattle sold on the platform.

The basic pricing model recognizes that the price of cattle will reflect the physical characteristics, such as weight and lot size, as well as market forces, such as sale location. The base model comes from Schroeder et al., (1988) and more recently, Zimmermann (2010), and Mitchell (2016), the model is:

$$Price_{it} = \sum_k V_{ikt} C_{ikt} + \sum_h R_{ht} M_{ht} + \mathcal{E}_t \quad (1)$$

In Equation (1), V represents trait value; C represents the physical characteristics of the lot. The lot number is referenced by i, the date is referenced by t, and the trait of the animal is referenced by k, and market influence is referenced by h. The Input Characteristic Model (Ladd and Martin, 1976) is used for a base. This allows us to look at the demand side of the fed cattle market. As said in Ladd and Martin (1976), a firm in a competitive industry will not affect the price of the market by changing the amount of fed cattle they produce. They can affect the price they receive by changing the quality of the cattle the feedyard produces. In this case the feedyard would focus on the cattle characteristics as well as management practices, i.e. use of a beta-agonist.

Empirical Model

The model used in this thesis is based on the more general equation 1. Equation 2 is the hedonic, price-dependent model.

$$Price_l = \beta_0 + \sum_{j=1}^{2} \beta_j Sex_{jl} + \beta_3 BAg_l + \beta_4 Dressed_l + \sum_{s=5}^{10} \beta_s State_{sl} + \beta_{11} Feed_l + \beta_{12} Head_l + \beta_{13} Head^2{}_l + \beta_{14} Wt_l + \beta_{15} Wt^2{}_l + \beta_{16} Chc_l + \beta_{17} Sel_l + \sum_{\alpha=18}^{19} \beta_\alpha YG_{\alpha l} + \sum_{\sigma=20}^{21} \beta_\sigma Delivery_{\sigma l} + \sum_{\theta=22}^{81} \beta_\theta WKDUM_{\theta l} + \mathcal{E}_l \quad (2)$$

Equation 2 includes weekly dummy variables to allow for changes in market fundamentals across auction dates. Equation 3 drops the weekly dummy variables and includes the weekly average nearby live cattle futures price. These two variables are controls but for different reasons. Equation 3 uses the average weekly futures price to look at where the market is. Equation 2 uses weekly dummy variables to find where basis is relative to futures. Equation 4 includes both the average weekly futures and weekly dummy variables. Equation 4 as such allows assessing whether basis varied over time since both futures and dummy variables are included in the model. The average weekly futures price is restricted so that it's coefficient is equal to 1 in the model that includes both futures and monthly dummy variables. This allows us to look strictly at basis.

$$Price_l = \beta_0 + \sum_{j=1}^{2} \beta_j Sex_{jl} + \beta_3 BAg_l + \beta_4 Dressed_l + \sum_{s=5}^{10} \beta_s State_{sl} + \beta_{11} Feed_l + \beta_{12} Head_l + \beta_{13} Head^2{}_l + \beta_{14} Wt_l + \beta_{15} Wt^2{}_l + \beta_{16} Chc_l + \beta_{17} Sel_l + \sum_{\alpha=18}^{19} \beta_\alpha YG_{\alpha l} + \sum_{\sigma=20}^{21} \beta_\sigma Delivery_{\sigma l} + \beta_{22} WklyAvgFtrs_l + \mathcal{E}_l \quad (3)$$

$$Price_l = \beta_0 + \sum_{j=1}^{2} \beta_j Sex_{jl} + \beta_3 BAg_l + \beta_4 Dressed_l + \sum_{s=5}^{10} \beta_s State_{sl} + \beta_{11} Feed_l + \beta_{12} Head_l + \beta_{13} Head^2{}_l + \beta_{14} Wt_l + \beta_{15} Wt^2{}_l + \beta_{16} Chc_l + \beta_{17} Sel_l + \sum_{\alpha=18}^{19} \beta_\alpha YG_{\alpha l} + \sum_{\sigma=20}^{21} \beta_\sigma Delivery_{\sigma l} + \beta_{22} WklyAvgFtrs_l + \sum_{\theta=23}^{82} \beta_\theta WKDUM_{\theta l} + \mathcal{E}_l \quad (4)$$

Table 5-1 has a description of all of the variables in Equation 2, Equation 3, and Equation 4 as well as the expected sign of each variable as discussed in the previous chapter.

Table 5-1**. Model Variable Description**

Variable	***Description***	***Expected Sign***
Price	*Dependent Variable - Price per hundredweight for lot l*	*N/A*
Sex	*Binary Variable - Sex of cattle in lot l* *Steer* *Heifer* *Mixed*	 *Base* *-* *-*
BAg	*Binary Variable - use of beta-agonist by seller on cattle in lot l*	
Dressed	*Binary Variable – inclusion of dressing percentage by seller for lot l*	
State	*Binary Variable - Location of cattle in lot l* *Nebraska* *Colorado* *Iowa* *Kansas* *Oklahoma* *South Dakota* *Texas*	 *Base* *+* *-* *+* *+* *-* *+*
Feed	*Number of days on feed of cattle in lot l*	*+*
Head	*Number of head of cattle in lot l*	*+*
Head²	*Number of head of cattle squared in lot l*	*-*
Wt	*Average weight of cattle in lot l*	*+*

Wt²	*Average weight of cattle squared in lot l*	*-*
Chc	*Binary Variable – inclusion of a Choice variable by seller for lot l*	*+*
Sel	*Binary Variable – inclusion of a Select variable by seller for lot l*	*+*
WklyAvgFtrs	*Average weekly price of fed cattle futures for the week of the sale*	*+*
YG	*Percent yield grade 1-5 for cattle in lot l*	*+*
Delivery	*Binary Variable - Delivery time frame of lot l* *More17daydel* *Less17daydel*	 *Base* *+*
WKDUM	*Week sale of lot l took place*	*N/A*
E	*Error term*	*N/A*

In this analysis of the effects of cattle characteristics on price, days on feed, head, head squared, weight, weight squared and weekly average futures are continuous variables. The parameter estimates, or coefficients, for these variables are reflected in the price paid for the lot. For example, if the coefficient is 0.500, every unit increase would lead to a $0.50 increase in price. A negative coefficient would lead to a decrease in price. The squared terms account for any non-linear relationship between price and weight as well as price and lot size. Several studies including Schroeder et al., (1988), and Zimmerman (2010) have used squared variables in hedonic models to find the non-linear relationship between price and weight and lot size. The remaining variables are dummy variables. This means that if the variable is present in the data, the dummy variable is a one. Otherwise, a zero is returned for the dummy variable. For example, if the lot offered contained heifers from Nebraska that included a percentage Select number, a one would show up for the dummy variables heifer, Select, and Nebraska. The remaining

dummy variables, steer, mixed, Colorado, Iowa, Kansas, Oklahoma, South Dakota, and Texas, would be zeroes.

Chapter 6 - Results and Discussion

Hedonic Models

This chapter reviews the results of the regression models discussed previously in this thesis. Three models are included. The first model looks at the physical characteristics and the marketing characteristics with weekly dummy variables as a control. The second model includes the physical characteristics and marketing characteristics with the average weekly futures price as a control for price variation. The third model includes both weekly dummy variables as well as the average weekly futures price. This allows us to look at the basis for the market. The format of this chapter will be the models, the results of the models and the effects of the variables that were expected. Then the final part of the chapter will be a discussion of the models and the variables in all three models that did not do what was expected.

Model 1 Results

The model was estimated using 854 transaction including sold and PO'd lots. Table 6.1 contains the coefficient estimates, standard errors, and P-values for the hedonic model described earlier. Several of the variables are statistically significant at the P<.0001 and P<0.005 levels. The model has an adjusted R-squared value of 0.9867, meaning that around 99 percent of the price paid for the lots on the Fed Cattle Exchange can be explained by the variables in this model. This R-Squared value may be over fit, meaning that the model does not actually explain 99 percent of the variability in price. The remainder of this chapter will go over the results of the hedonic model as well as a discussion, of this research.

Table 6-1. Weekly Dummy Hedonic Model

Number of Observations Used		854	
Root MSE	1.19038	**Adj R-Sq**	0.9867

Variable	Parameter Estimate	Standard Error	Pr > |t|
Intercept	96.71683	7.02366	<.0001
Sex (Base = Steer)			
heifer	0.22617	0.131	0.0847
mixed	0.24847	0.3017	0.4104
BAg	0.16762	0.10991	0.1277
Dressed	0.18664	0.1907	0.328
State (Base = NE)			
CO	0.06425	0.35388	0.856
IA	-1.35964	0.50692	0.0075
KS	0.72982	0.15249	<.0001
OK	0.62793	0.38215	0.1008
SD	-0.63143	0.33862	0.0626
TX	0.64932	0.16715	0.0001
Feed	0.0056	0.00137	<.0001
Head	0.00674	0.00227	0.0031
hd2	-1.637E-05	0.00000602	0.0067
out_Wt	0.01496	0.01035	0.149
wt2	-5.43E-06	0.00000379	0.152
QGDUMchc	-0.00129	0.00243	0.5945
QGDUMsel	-0.01011	0.00458	0.0274
Yield Grade (Base = YG45)			
YG1	-1.49492	1.16363	0.1993
YG23	0.26405	0.22101	0.2325
Delivery (Base = more17daydel)			
less17daydel	1.75515	0.35443	<.0001
Week (Base = WKDUM53)			
WKDUM1	-7.19518	0.47446	<.0001
WKDUM2	-8.13752	0.48213	<.0001
WKDUM3	-11.1716	0.46232	<.0001
WKDUM4	-11.57163	0.41209	<.0001
WKDUM5	-6.79135	0.40397	<.0001
WKDUM6	-5.24641	0.46232	<.0001
WKDUM7	-7.40641	0.38332	<.0001
WKDUM8	-3.52437	0.37966	<.0001
WKDUM9	-1.26709	0.42397	0.0029
WKDUM10	1.79976	0.42291	<.0001
WKDUM11	-0.11985	0.49783	0.8098
WKDUM12	-0.25935	0.45297	0.5671
WKDUM13	1.92472	0.43614	<.0001

Variable	Parameter Estimate	Standard Error	Pr > |t|
WKDUM14	4.80602	0.42853	<.0001
WKDUM15	6.1692	0.44877	<.0001
WKDUM16	8.49415	0.41828	<.0001
WKDUM17	9.89238	0.43494	<.0001
WKDUM18	10.9821	0.42908	<.0001
WKDUM19	8.13896	0.45925	<.0001
WKDUM20	7.30559	0.42102	<.0001
WKDUM21	8.26002	0.49066	<.0001
WKDUM22	11.39561	0.42984	<.0001
WKDUM23	14.15707	0.44696	<.0001
WKDUM24	12.26515	0.56268	<.0001
WKDUM25	17.00973	0.4387	<.0001
WKDUM26	21.83491	0.47822	<.0001
WKDUM27	19.67924	0.48884	<.0001
WKDUM28	12.94392	1.2427	<.0001
WKDUM29	15.36047	0.76833	<.0001
WKDUM30	17.89715	0.60311	<.0001
WKDUM31	19.7919	0.63432	<.0001
WKDUM32	29.17266	0.68988	<.0001
WKDUM33	27.20302	0.48915	<.0001
WKDUM34	23.66999	0.48277	<.0001
WKDUM35	21.60752	0.52383	<.0001
WKDUM36	20.64381	0.47155	<.0001
WKDUM37	26.10209	0.91771	<.0001
WKDUM38	11.76255	0.7767	<.0001
WKDUM39	8.76585	0.63349	<.0001
WKDUM40	7.78256	0.59726	<.0001
WKDUM41	7.93233	0.4719	<.0001
WKDUM42	7.59043	0.51423	<.0001
WKDUM43	6.7253	0.52265	<.0001
WKDUM44	4.79396	0.65219	<.0001
WKDUM45	4.24007	0.63641	<.0001
WKDUM46	1.41358	1.25714	0.2612
WKDUM47	-3.82582	0.91164	<.0001
WKDUM48	-5.79336	0.68701	<.0001
WKDUM49	-7.82617	1.24299	<.0001
WKDUM50	-7.52435	0.68269	<.0001
WKDUM51	-4.54729	0.59081	<.0001
WKDUM52	-3.9902	0.6301	<.0001
WKDUM54	-0.56516	0.6299	0.3699
WKDUM55	-1.9335	0.6873	0.005
WKDUM56	0.06712	1.24265	0.9569
WKDUM57	8.88007	0.76997	<.0001
WKDUM58	12.75523	0.6323	<.0001
WKDUM59	7.99082	0.63172	<.0001

Effect of Week

The week of the sale has a significant effect on the price per hundredweight for fed cattle. The majority of the weeks are significant at the 1 percent level. This is because prices change significantly over time. Price is going to be affected in a negative or positive manner depending on the week. For instance, Week 24 of the sale has a $12.27 increase in $/cwt as compared to week 53. Whereas week 55 has a $1.93 decrease in $/cwt as compared to week 53. These prices are moving with the fed cattle market. The week variable is in this model to act as a control for omitted variables that occur weekly.

Effect of Sex of Cattle

Heifer and mixed were expected to have a negative effect on the price. The heifer variable was statistically significant at the 10 percent level. A lot of heifers is expected to receive $0.23 more than a lot of steers offered on the same week. Typically a heifer would bring less than a steer. However, as mentioned in the data chapter, steer lots were at a higher percentage when cattle were bringing less money. Therefore, heifers would, on average, bring a higher price than steers. Mixed lots were not significant, with a P-value of 0.41. This means that the price packers paid for a lot of only steers was not different from the price the packer would have paid for a lot of mixed cattle.

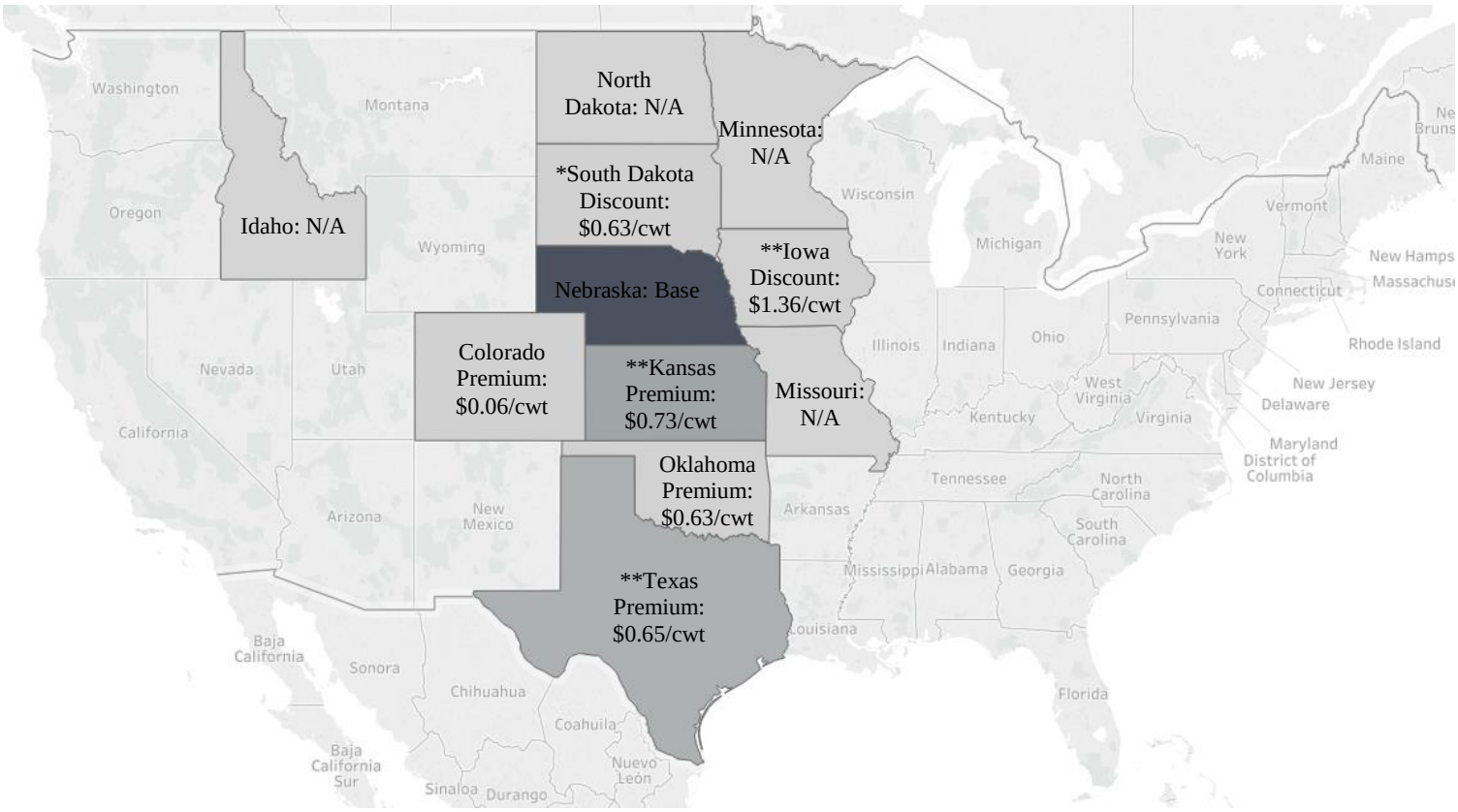
Effect of Beta-Agonist

The use of a beta-agonist is not significant to price. This increase is the opposite of the expected outcome. There is generally not enough of a change for consumers to tell a difference between cattle who are not given a beta-agonist and who are (Garmyn and Miller, 2013).

Effect of Location

The majority of the location variables were significant to the price offered for lots on the FCE. Iowa, Kansas, South Dakota, and Texas were significant at the 5 percent level. This means that as compared to lots sold in Nebraska, there was a significant difference in sold prices for lots in these 4 states. Iowa (P=0.0075) and South Dakota (P=.0626) lots receive $1.40/cwt and $0.63/cwt less than Nebraska respectively. Iowa and South Dakota are both further away from the majority of the major packers than Nebraska. This increases the transportation cost for Kansas (P<.0001) and Texas (P=.0001) lots receive a premium of $0.73/cwt and $0.65/cwt respectively. Kansas is expected to bring a higher price due to the concentration of packers in

Figure 6-1. Model 1 Premiums and Discounts for Lot Location



Darker states indicate a higher frequency of sold lots

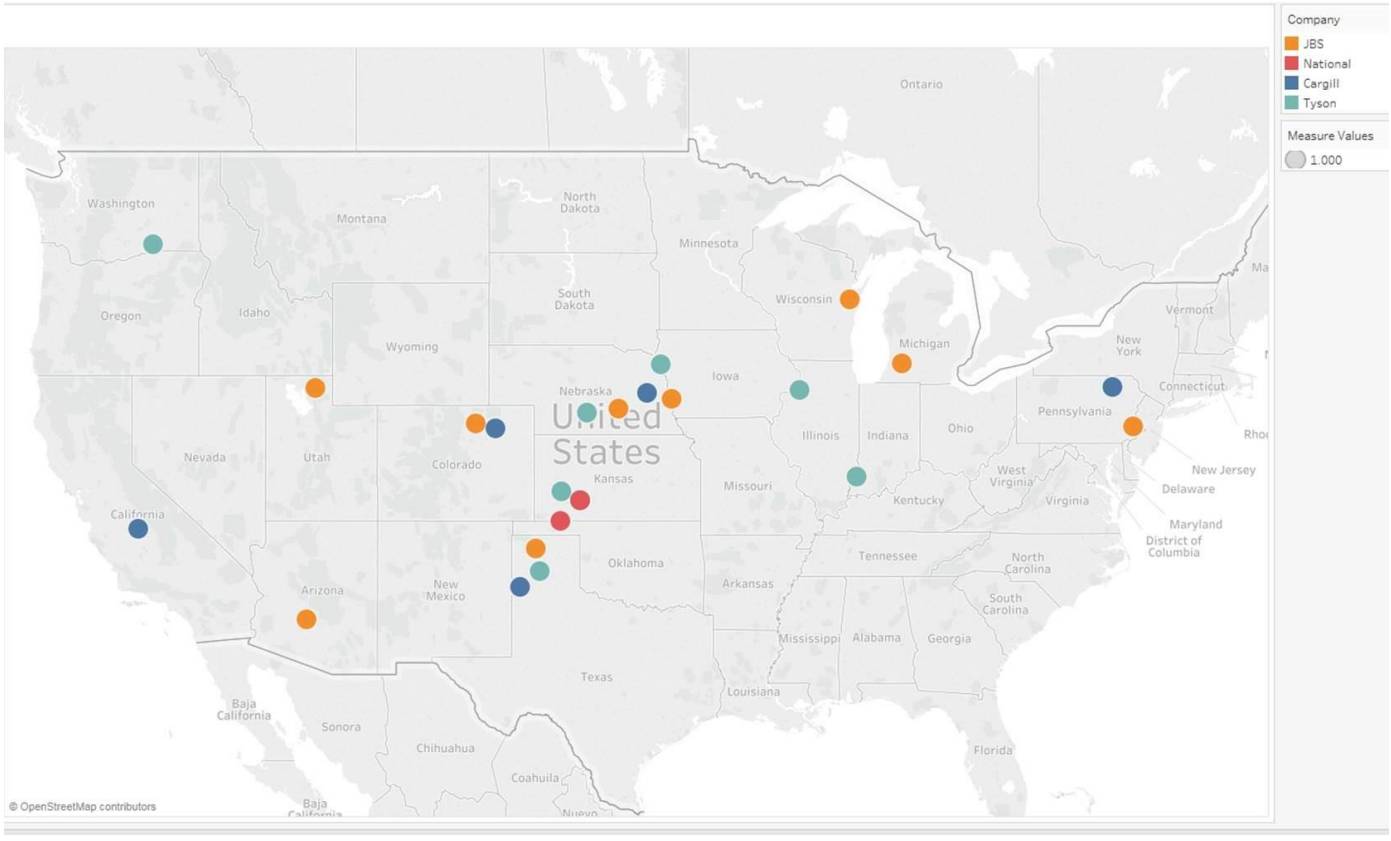
*** Indicates a statistically significant state at the 10 percent level**

**** Indicates a statistically significant state at the 1 percent level**

Source: Author's Own Work

Kansas. This means that the transportation costs are less than transportation from other states. Texas has fewer cattle available in the cash market; this creates a lower supply, raising the price of the lots. The location of many feedlots in Texas are also relatively close to packers. This means that transportation costs are lower relative to other states. Figure 6-2 shows the heavy concentration of plants in the Midwest and Texas panhandle. The remaining states, Idaho, Minnesota, Missouri, and North Dakota, did not have enough sold lots to accurately estimate their price differences.

Figure 6-2. Plant Locations



Source: Author's own Work

Effect of Days on Feed

Days on feed was statistically significant at the 1 percent level with a positive coefficient of 0.0056. For every 1 additional day the lot is on feed, the price paid for the lot increases by $0.0056. Although the variable was significant, the actual change in price is minimal.

Effect of Lot Size

Lot size has the expected sign and is significant (P=0.0031). For every 1 head increase in a lot of cattle, the price increases by $.007. This model includes a head squared variable. Head squared is significant with a negative sign, which was expected. The inclusion of a squared variable allows us to see the rate at which a variable is changing. In this case, the positive head variable means that price is increasing as lot size increases. However, when the head squared variable is included, we see that the price is increasing but at a decreasing rate. This means that as lot size increases, price increases but peaks at a certain lot size. Price then decreases. The third model will look into this in more detail.

Effect of Weight

Average weight of cattle in each lot and average weight of cattle in each lot squared are both not significant to price. Weight is positive and weight squared is negative, which is expected. However, for this model, weight does not affect the price in any significant manner.

Effect of Quality Grade and Yield Grade

The inclusion of a quality grade, Choice or Select, has a negative effect on the price received. The Choice quality grade is not significant to the price received. The inclusion of the Select quality grade is significant at the 5 percent level. If a feedyard includes a percentage of cattle in the lot that would grade Select, the price they receive decreases by $0.01/cwt.

Neither of the yield grade variables, YG1 or YG23, have a significantly different price than the base, YG45. These findings will be discussed in the Discussion.

Effect of Delivery Time Frame

The time frame that each lot is delivered in is significant to the price offered. Delivery in less than 17 days is statistically significant (P<0.001) than a delivery time frame of greater than 17 days. The longer delivery time frame began in March of 2017, so this applies to the March 2017 to November 2017 timeframe. The coefficient for lots delivering in less than 17 days is 1.76. This means that lots delivering under 17 days receive a $1.76/cwt premium relative to lots that deliver between 17-30 days and 31-60. The longer delivery was added during the early part of 2017 to match sellers marketing programs. The longer between purchase and slaughter time, the higher the chance that a packer will not use the spot market to purchase cattle (Capps et al., 1999).

Model 2 Results

The model was estimated using 848 transactions including sold and PO'd lots. Table 6.1 contains the coefficient estimates, standard errors, and P-values for the hedonic model described earlier. Several of the variables are statistically significant at the P<.0001 and P<0.005 levels. The model has an adjusted R-squared value of 0.9065, meaning that around 90 percent of the price paid for the lots on the Fed Cattle Exchange can be explained by the variables in this model. It is important to note that because of the strong basis and the use of futures in this model, this model does not explain the market as well as the other two models.

Table 6-2. Weekly Average Futures Hedonic Model

Number of Observations Used		848	
Root MSE	3.171	**Adj R-Sq**	0.9065
Variable	**Parameter Estimate**	**Standard Error**	**Pr > |t|**
Intercept	22.88158	17.80042	0.199
Sex (Base = Steer)			
heifer	-0.0811	0.33156	0.8068
mixed	-0.80954	0.77509	0.2966
BAg	1.1501	0.28135	<.0001
Dressed	-1.08924	0.35094	0.002
State (Base = NE)			
CO	-0.76396	0.9073	0.4
IA	-1.79672	1.32173	0.1744
KS	-0.1006	0.37713	0.7897
OK	1.33777	0.95738	0.1627
SD	-1.14301	0.86748	0.188
TX	0.39018	0.426	0.36
Feed	0.01561	0.00341	<.0001
Head	0.00119	0.00588	0.8397
hd2	-0.00000649	0.00001568	0.6792
out_Wt	-0.06266	0.02601	0.0162
wt2	0.00002141	0.00000956	0.0254
QGDUMchc	0.01056	0.00545	0.0529
QGDUMsel	-0.00111	0.01073	0.9176
Delivery (Base = more17daydel)			
less17daydel	0.30931	0.87918	0.7251
Yield Grade (Base = YG45)			
YG1	5.32463	2.91641	0.0682
YG23	-0.27946	0.52773	0.5966
WklyAvgFtrs	1.18405	0.01741	<.0001

Effect of Sex of Cattle

In the futures weekly average model, neither heifer nor mixed lots were significant. A steer lot did not receive a price that was significantly different than the price that a heifer or mixed lot received.

Effect of Beta-Agonist

The use of a beta agonist was significant at the 1 percent level (P<.0001). According to the second model, the price paid for a lot of cattle that was given a beta agonist receives premium of $1.15/cwt.

Effect of Dressing Percentage

The inclusion of a dressing percentage is significant to price. However, the coefficient is much higher than expected and negative. According to model 2, the inclusion of a dressing percentage decreases a lot by $1.09/cwt.

Effect of Location

According to the weekly average futures model, none of the states the lots were located in received a statistically different price than cattle located in Nebraska. This was not expected. Location differences are explained in the effect of location on the first model.

Effect of Days on Feed

Like in the first model, days on feed is statistically significant with a P value of P<.0001. With every day on feed, the price increases by $0.02/cwt. Days on feed has a more significant effect on price in the second model than the first model.

Effect of Lot Size

Neither head nor head-squared are statistically significant. Lot size is anticipated to be significant to price and will be discussed later on in the chapter.

Effect of Weight

Weight and weight-squared are both statistically significant at the 5 percent level. However, the out weight variable is negative and the weight-squared variable is positive. This is the opposite of what is expected.

Effect of Quality Grade and Yield Grade

The dummy variable for inclusion of percentage of Choice cattle in a lot is significant at the 10 percent level. A lot with a Choice percentage receives a premium of $0.01/cwt. The inclusions of a Select percentage was not statistically significant.

The price of a lot with a yield grade of 1 was significantly different from zero at the 10 percent level than a lot with a yield grade of 4 or 5. A lot with a yield grade of 1 will receive a premium of $5.32/cwt to a lot with a yield grade of 4 or 5.

Effect of Delivery Time Frame

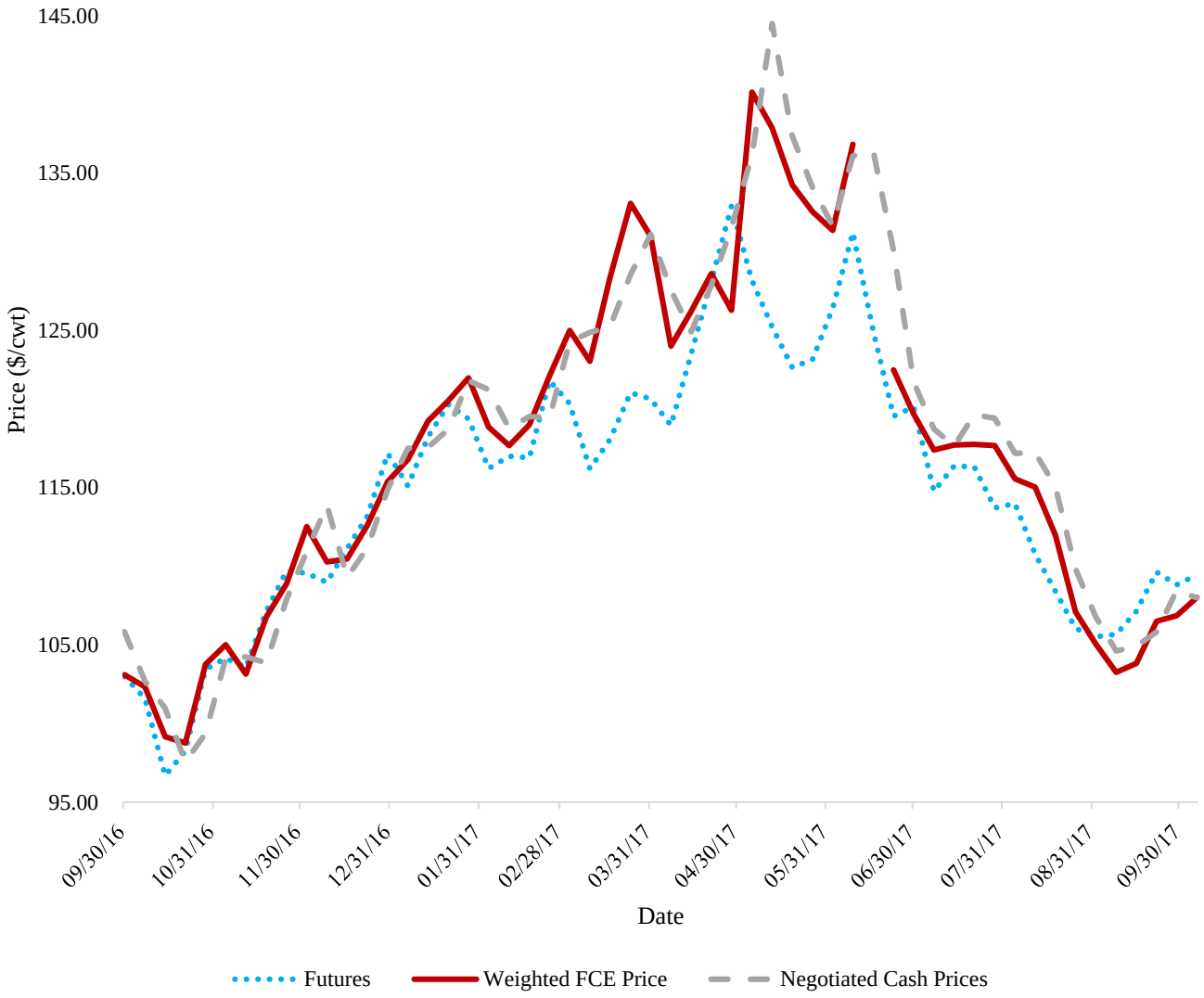
The time to delivery was not statistically significant. This means that a lot offering a shorter delivery does not get paid a significantly different price than the lots that have a delivery time of over 17 days.

Effect of Weekly Live Cattle Futures

The weekly average futures price is statistically significant at the 1 percent level. For every $1.00/cwt increase in futures, the average price offered through the Fed Cattle Exchange increases by $1.18/cwt. The coefficient is positive, as expected. However, the price change is much higher than expected. If the FCE was increasing at this rate as compared to the futures market, it would be used more because sellers would be receiving significantly more than what is paid to the sellers in the futures market. Figure 6-5 illustrates how a coefficient of 1.18 could be possible. The basis during the duration of this study is strong. Around 3/31/2017 and 5/31/2017,

the futures price is much lower than the negotiated cash price as well as the weight FCE price. It is important to note that basis during the time of data collection was strong. The cash price was higher than the futures in several places due to this (Figure 6-3). Some of the price difference could also be explained by Fed Cattle Exchange rolling over to the next contracts before the futures.

Figure 6-3. Futures, Cash, and Fed Cattle Exchange Prices



***Fed Cattle Exchange had a technical error June 14th, 2017. There is not a data point for Weighted FCE Price because of the glitch.**

Source: Author's Own Work

Model 3 Results

The third model includes both the weekly dummy variables as well as the weekly average futures price. The weekly average futures price is restricted to equal 1. Restricting the futures price allows us to look at basis. The R-squared value is .99, meaning that 99 percent of the price variability can be explained by this model. Like model 1, this model may be over fit.

Table 6-3. Restricted Weekly Average Futures and Weekly Dummy Variables Hedonic Model

Number of Observations Used		848	
Root MSE	1.02206	**Adj R-Sq**	0.9903
Variable	**Parameter Estimate**	**Standard Error**	**Pr > |t|**
Intercept	-21.26717	6.05202	0.0005
Sex (Base = Steer)			
heifer	0.13718	0.11258	0.2234
mixed	0.18612	0.25906	0.4727
BAg	0.23912	0.09453	0.0116
Dressed	0.2339	0.16387	0.1539
State (Base = NE)			
CO	0.11607	0.30464	0.7033
IA	-1.37858	0.4353	0.0016
KS	0.66677	0.13108	<.0001
OK	0.47372	0.32834	0.1495
SD	-0.65901	0.29075	0.0237
TX	0.55686	0.14359	0.0001
Feed	0.00503	0.00118	<.0001
Head	0.00668	0.00196	0.0007
hd2	-0.00001622	5.2E-06	0.0019
out_Wt	0.02314	0.00891	0.0096
wt2	-0.00000848	3.26E-06	0.0095
QGDUMchc	-0.00104	0.00209	0.6173
QGDUMsel	-0.00961	0.00393	0.0147
Delivery (Base = more17daydel)			
less17daydel	2.14136	0.32565	<.0001
Yield Grade (Base = YG45)			
YG1	-1.07334	0.9993	0.2831
YG23	0.09464	0.1898	0.6182
WklyAvgFtrs	1	0	<.0001
WKDUM1	2.09901	0.40738	<.0001
WKDUM2	2.5372	0.41397	<.0001

Variable	Parameter Estimate	Standard Error	Pr > |t|
WKDUM3	4.40202	0.39698	<.0001
WKDUM4	2.45974	0.35387	<.0001
WKDUM5	2.06953	0.34689	<.0001
WKDUM6	2.83954	0.39698	<.0001
WKDUM7	1.29447	0.32916	<.0001
WKDUM8	1.57714	0.32602	<.0001
WKDUM9	1.26168	0.36407	0.0006
WKDUM10	4.51738	0.36314	<.0001
WKDUM11	3.17687	0.42748	<.0001
WKDUM12	0.88372	0.38896	0.0234
WKDUM13	0.99913	0.37448	0.0078
WKDUM14	-0.07251	0.36801	0.8439
WKDUM15	3.34001	0.38532	<.0001
WKDUM16	2.54353	0.35917	<.0001
WKDUM17	1.87525	0.37346	<.0001
WKDUM18	3.8879	0.36842	<.0001
WKDUM19	4.14147	0.39434	<.0001
WKDUM20	2.5925	0.3615	<.0001
WKDUM21	3.59414	0.4213	<.0001
WKDUM22	1.83404	0.36908	<.0001
WKDUM23	6.08374	0.38378	<.0001
WKDUM24	8.32554	0.48313	<.0001
WKDUM25	11.19544	0.37671	<.0001
WKDUM26	13.12076	0.41066	<.0001
WKDUM27	11.33721	0.41977	<.0001
WKDUM28	6.23736	1.06703	<.0001
WKDUM29	4.21159	0.65973	<.0001
WKDUM30	2.09114	0.51784	<.0001
WKDUM31	-0.79692	0.54466	0.1438
WKDUM32	13.28055	0.59239	<.0001
WKDUM33	14.33316	0.42008	<.0001
WKDUM34	13.42445	0.41512	<.0001
WKDUM35	10.74479	0.44978	<.0001
WKDUM36	6.57864	0.40561	<.0001
WKDUM37	7.01875	0.78796	<.0001
WKDUM38	4.54762	0.66694	<.0001
WKDUM39	0.90216	0.54395	0.0976
WKDUM40	4.25725	1.06643	<.0001
WKDUM41	3.95679	0.40703	<.0001
WKDUM42	3.65422	0.4428	<.0001
WKDUM43	5.29348	0.44877	<.0001
WKDUM44	3.00132	0.56011	<.0001

Variable	Parameter Estimate	Standard Error	Pr > |t|
WKDUM45	5.88478	0.5469	<.0001
WKDUM46	5.23504	1.07945	<.0001
WKDUM47	2.35098	0.78281	0.0028
WKDUM48	0.96568	0.58994	0.1021
WKDUM49	-1.0563	1.06726	0.3226
WKDUM50	-2.37514	0.58617	<.0001
WKDUM51	-1.89836	0.5073	0.0002
WKDUM52	-0.53911	0.54101	0.3193
WKDUM54	-1.07439	0.54083	0.0473
WKDUM55	-1.10546	0.59015	0.0614
WKDUM56	-1.03655	1.06697	0.3316
WKDUM57	-2.49416	0.66115	0.0002
WKDUM58	1.86	0.54292	0.0006
WKDUM59	0.50606	0.54241	0.3511
RESTRICT	24.43817	15.83559	0.1228*

*** Probability computed using beta distribution.**

Effect of Sex of Cattle

In the third model, neither the heifer or mixed lots were statistically significant. Like in the Weekly Average Futures Hedonic Model (Table 6-2), the results mean that there was not a significantly different price paid for heifer or mixed lots compared to steer lots.

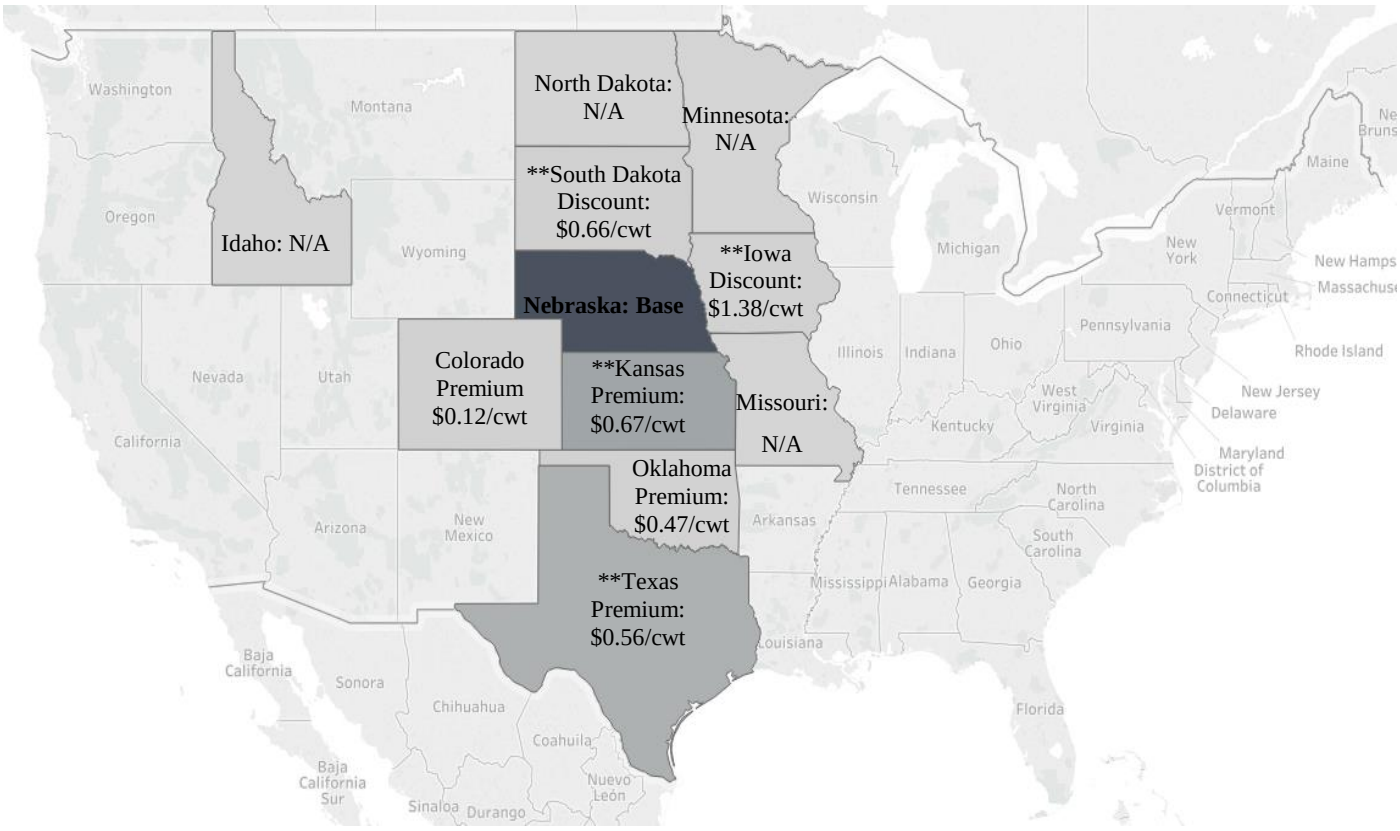
Effect of Beta-Agonist

Use of a beta-agonist on a lot of cattle was significant at the 5 percent level. If a seller used a beta-agonist on lot x, the lot will bring a premium of $0.24/cwt versus a lot that did not receive a beta-agonist.

Effect of Location

Four states were statistically significant to price when compared to lots in Nebraska. Iowa and South Dakota receive a discount of $1.38/cwt and $0.66/cwt respectively. Kansas and Texas receive a premium of $0.67/cwt and $0.56/cwt respectively. These results are similar to those in model 1. Figure 6-4 depicts the discounts and premiums of the states as compared to the price in Nebraska.

Figure 6-4. Model 3 Premiums and Discounts for Lot Location



Darker states indicate a higher frequency of sold lots

*** Indicates a statistically significant state at the 5 percent level**

**** Indicates a statistically significant state at the 1 percent level**

Source: Author's Own Work

Effect of Days on Feed

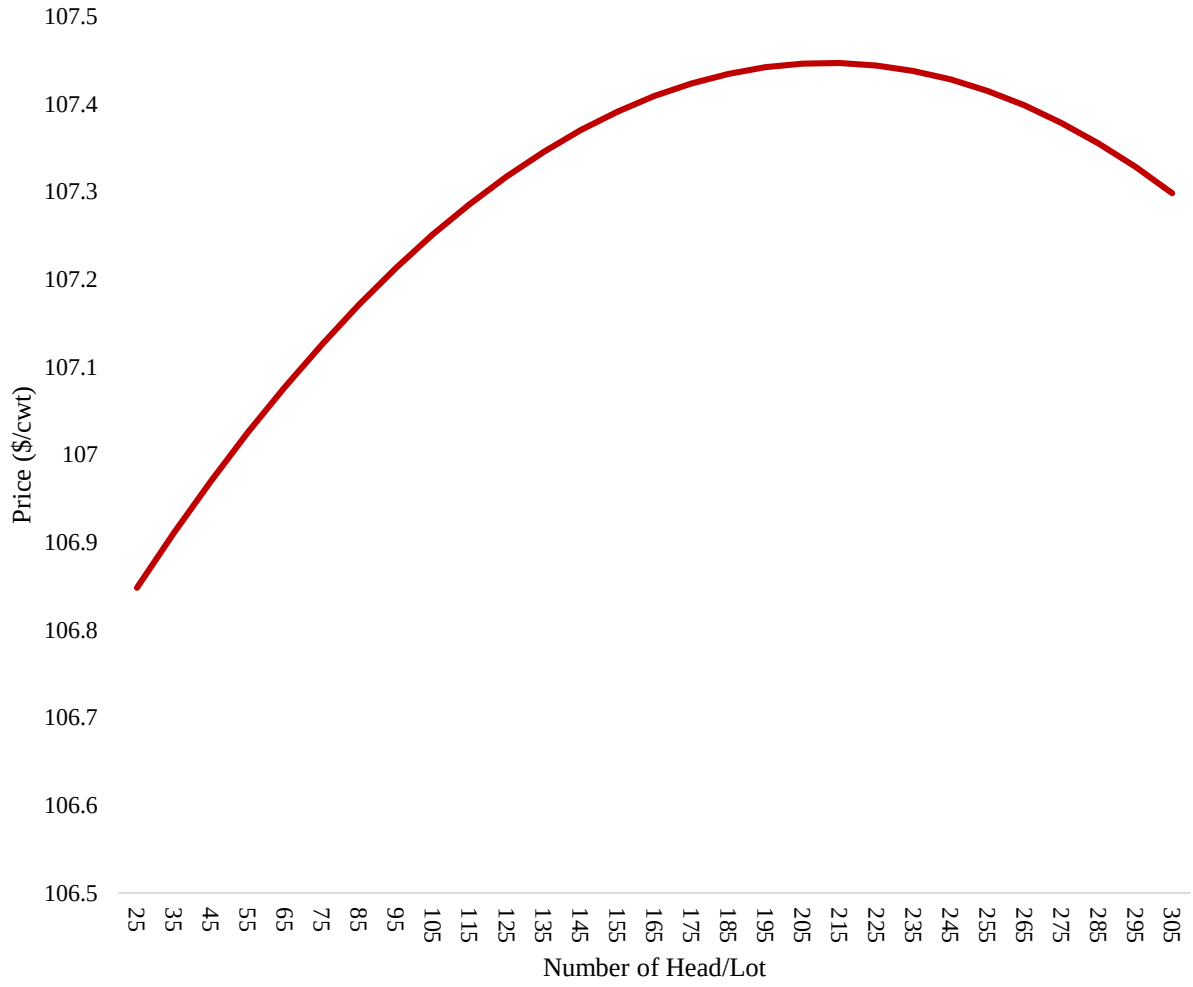
Days on feed, like in model 1 and 2, is significant at the 1 percent level. Days on feed is very significant; however, it has a small effect on price. For every 1 day increase in days on feed, the price offered for the lot increases by $0.005/cwt.

Effect of Lot Size

The head and head-squared variables are both statistically significant to price. As expected, head is positive and head-squared is negative. Price increases at a decreasing rate. As seen in Figure 6-5, the price paid for a lot increases as the lot size increases. The price peaks at 205 head and then begins to decrease at an increasing rate. For the lot sizes offered in this study,

there is a difference of $3.13/cwt for a lot of 1377 pound steers, from Nebraska on feed for 162 days, sold on week 53 of the sale. The highest price is for a lot of 205 steers.

Figure 6-5. Price versus Number of Head in Lot

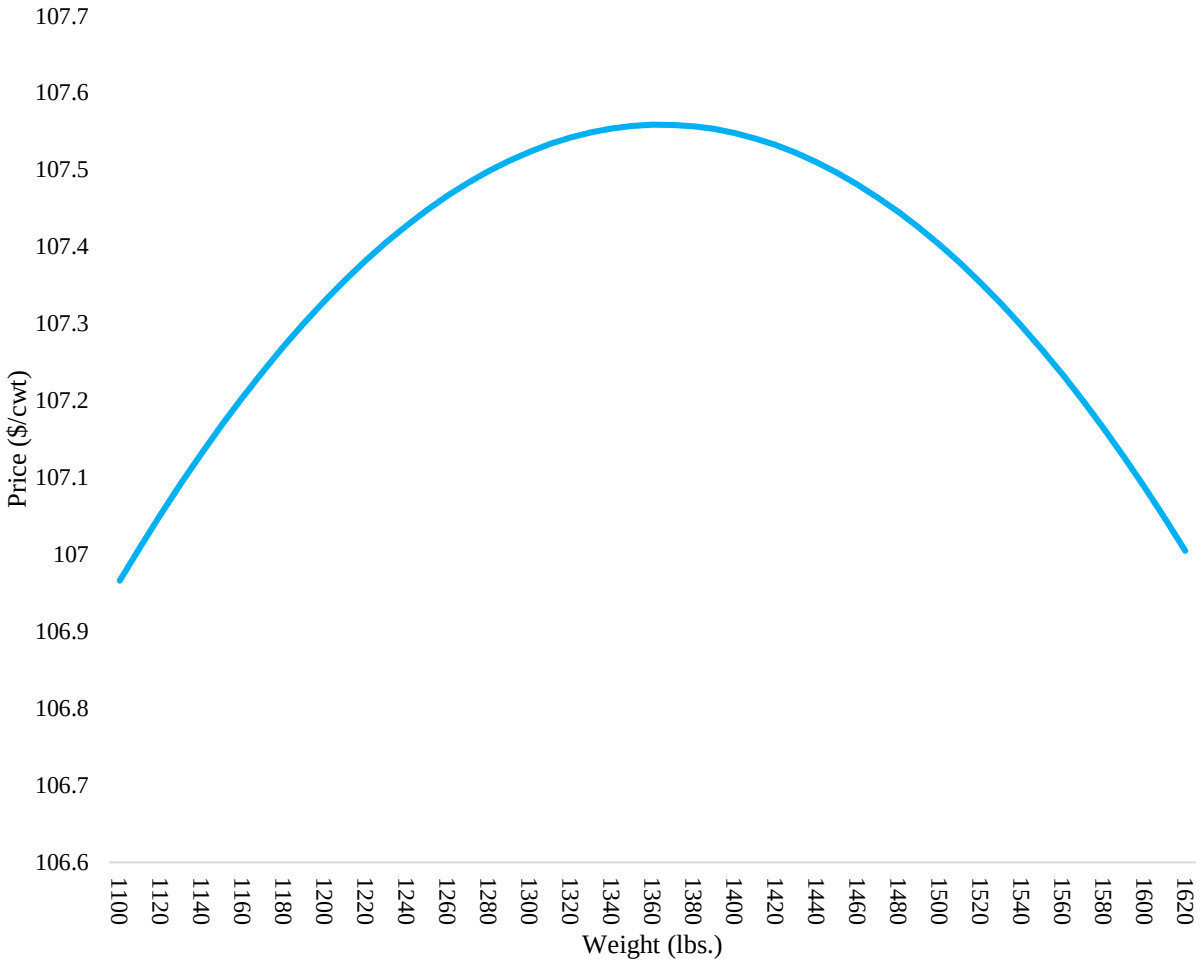


Effect of Weight

Weight and weight-squared were significant at the 1 percent level. Like in model 1, weight has a positive coefficient and weight-squared has a negative coefficient. According to Figure 6-6, heavier steers receive a premium up to 1360 pounds. After the lot of steers reaches over 1360 pounds, the premium begins to decrease. For the scope of this research, a $0.59/cwt price difference can be attributed to the weight of a lot of 160 steers from Nebraska, that have been on feed for 162 days, on the 53rd week of the sale. Cattle that are heavier, or of excessive

weight, have a larger carcass. These larger cattle can yield a ribeye and loin eye that are too big to fit in beef boxes (Savell). This causes extra work for packers; therefore, heavy cattle are discounted. About 60 percent of cattle sell on a value based grid commitment, which starts larger discounts, $1 to $3, when cattle reach 1650 to 1700 pounds. The cattle have a carcass weight starting around 1050 pounds (Molitor, 2017).

Figure 6-6. Price versus Average Weight of Lot



Effect of Quality Grade and Yield Grade

The inclusion of a Choice percentage was not significant. However, including a Select percentage was statistically significant with a P-value of 0.0147. Lots that included a Select value received a discount of $0.01/cwt. A discount for including a Select percentage was not expected.

Both yield grade 1 and yield grade 2 and 3 were not statistically significant. This means that having a better yield grade score did not bring a significantly different price than having a yield grade of 4 and 5.

Effect of Delivery Time Frame

A delivery time of 17 days or less was highly significant when compared to a delivery time of 17 days or more. Like in Model 1, the longer delivery time frame began in March of 2017, so the model applies to the March 2017 to November 2017 timeframe. As expected, a lot with a delivery time of 17 days or less receives a premium of $2.14/cwt. This could be because the delivery time could move to the next contract, which may be priced lower at the time. Packers could also pay less for a longer delivery time frame because they have extra time to fill their orders and are not willing to pay as high of a price because their demand is relatively low.

Effect of Weekly Live Cattle Futures

The average weekly futures price in the third model is restricted to 1. Restricting the futures variable to 1 and including weekly dummy variables allows us to look strictly at basis.

Restricted Variable

Model 3 includes a restriction on the average weekly futures price. The P-value for the RESTRICT variable is 0.1228. This means that at a 90% confidence level, the restriction that the futures coefficient is different from 1.0 is not rejected.

Discussion

Three different models were used to analyze the data collected from the Fed Cattle Exchange and the live cattle futures data pulled from the Livestock Marketing Information Center. Models 1 and 3 follow the hypotheses from Chapter 4 closely with a few deviations. Model 2 does not follow the hypotheses closely. This discussion will talk about why these models could have deviated from the hypotheses.

All three models had variables that acted differently than expected. Model 2 and 3 both did not find lots with heifers and mixed cattle to be priced different than a lot with steers. This is surprising because steers typically bring a higher price than heifers because they have less fatty tissue. Model 2 found that the inclusion of a dressing percentage was significant and also negative. The inclusion of a dressing percentage is expected to be positive. The majority of the dressing percentages included are higher than the industry average of 62 percent. Therefore, these lots should receive a higher price. Both model 1 and model 3 have a positive coefficient for dressing percentage. However, they are not statistically significant to price.

Model 2 found that the prices of the cattle sold in Colorado, Iowa, Kansas, Oklahoma, South Dakota, and Texas were significantly different than the prices of lots sold in Nebraska. This result is unexpected because each state has different transportation costs, amount of cash trade and supply of cattle than Nebraska.

Model 1 and 2 contain coefficients and p-values that act differently than expected for the weight and weight squared variables. Model 1 did not find weight to be significant and Model 2 has a negative coefficient for weight as well as a positive coefficient for weight squared. Schroeder (1997) found that weight was highly significant to price. Several studies have found that weight has a positive coefficient and weight squared is negative (Schroeder, 1997 and Zimmermann, 2010). Price increases as weight increases, peaks and begins to decrease after cattle hit a certain weight. This follows the results from Model 3 as well as the way the industry buys fat cattle.

All three models found the inclusion of either a Choice percentage or a Select percentage to not be statistically significant to price. All but 1 of the Choice and Select variables were negative. This was not anticipated because, like the dressing percentage, you would expect sellers to include the percentage if it was a selling point. The lack of finding the inclusions as statistically significant to price could be due to packers repeatedly mentioning that they do not typically make their decisions from the quality grades and yield grades submitted by the seller. Packers have representatives who look at each lot and determine quality and yield grades themselves.

While none of the models are a perfect depiction of the fed cattle market, Model 3 follows the market the most accurately. The model takes into account the differences in prices between the states. As mentioned in an interview, days on feed also contributes to the price difference, (Thoni,2017), as demonstrated in this model. The head and head squared, and weight and weight-squared variables have similar results to other studies as far as price increasing at a decreasing rate.

Lessons Learned

The Fed Cattle Exchange was created with the intention of increasing negotiated cash trade in the live cattle market. The sale used input from both the feedyards as well as the packers to create the online fed cattle sale. Since the start of the sale, the changes made have heavily favored feedyards. The PO price change from $10/head to $1/head, had a large, negative, impact on the FCE. Feedyards with a 200 head lot went from paying $2000 to PO, to $200 to PO. After the price change, there was a higher frequency of feedyards that exercised the option to PO (Figure A-3). This increase frustrated packers because they were taking the time to bid, and not getting the lot they had bid for. They believed this allowed feedyards to play games using the sale. The FCE as well as the feedyards did not see this change as an issue. Another change that was focused on feedyards was to increase delivery time periods. This did not hurt feedyards, however it did come about from talking to feedyards. A change that was made for the packers, including an option to offer cattle as dressed, did not work. The listing was FOB, meaning delivery price was not included in the sale price. This is not standard for the industry, requiring more work for the packer because the price is going to be different than the standard dressed offering price.

Having representatives promoting the FCE would help the sale. At the beginning of the sale, Ed Greiman was reminding feedyards to post their lots as well as reminding packers to bid. After Greiman left, there was no one left to promote the sale. Superior Livestock Auction is the parent company to the FCE. The reps are paid for cattle offered through SLA, and are not paid for cattle sold through FCE. The reps for SLA would actually lose some money to the FCE if they promoted the sale. Therefore, SLA reps are not going to remind feedyards to put lots on the sale or remind packers to bid through FCE.

The FCE could benefit from more balanced input from packers and feedyards. The sale also needs someone to promote and represent the sale publicly.

Chapter 7- Conclusion and Limitations

Conclusion

The goal of this thesis was to determine the effects that physical characteristics as well as marketing characteristics of cattle sold through Fed Cattle Exchange have on price. The results of this study give sellers a better understanding of what characteristics packers buying through the Fed Cattle Exchange platform are giving premiums and discounts for.

The Fed Cattle Exchange was created in 2016 to create more price discovery through the live cattle cash market. During the first half of my research, FCE seemed to be creating a tremendous amount of price discovery with as many 13,428 head offered through the sale during one week. However, the high number of head did not last. Nonetheless, with the small number of head, the industry still believes that the online platform is sparking trade during the middle of the week.

This study uses hedonic models much like Schroeder et al., (1988), Zimmermann (2010), and Mitchell (2016) to look at the value of both physical and marketing characteristics of fed cattle. Three different models were used. The first uses weekly dummy variables to look at the basis relative to futures. The second uses futures prices to create a depiction of where the live cattle market is and the third looks strictly at basis using both weekly dummy variables and a restricted futures variable.

The third model, arguably the most accurate, uses 848 observations over 59 weeks to find what premiums and discounts sellers are receiving. The use of a beta agonist draws a premium of $0.24/cwt. Location has a big impact on price. As compared to Nebraska, the states that draw a premium are Kansas and Texas with premiums of $0.67/cwt and $0.56/cwt respectively. The states that are discounted compared to Nebraska are Iowa and South Dakota with discounts of

$1.38 and $0.66 respectively. Every 1 day increase of days on feed leads to a $0.01/cwt increase in price. Premiums paid for number of head in a lot increases at a decreasing rate. Premiums peak at 205 head and then decrease as lot size continues to grow. Similar to head, premiums for weight increase at a decreasing rate. Premiums for weight peak at 1360 pounds and then begin to decrease. Including a percentage of cattle that will be Select will bring a discount of $0.01/cwt. Lots for sale with a delivery time of 17 days or less will bring a premium of $2.14/cwt as compared to lots with a delivery time of 17 days or more.

Previous research supports the above conclusions. However, the majority of the research has been done using feeder cattle instead of fed cattle. This could account for some of the deviations in the models.

Further research could be done on how the PO price change effected the amount of PO'd lots and the decline of packers bidding on lots. Research could also be done on seasonality by collecting data from the FCE since the conclusion of my data collection.

Limitations

There are several limitations in this thesis. The biggest one is the amount of data that is available. At the time the data were collected, the Fed Cattle Exchange had only been working for about a year and a half, even less if you consider the time the FCE was out of commission for technical problems. If the majority of the sale had a larger amount of participation, around 5,000 head, the data would give a more accurate picture of the market. Seasonality also cannot be calculated due to the limited time the FCE has been running.

Another big limitation is the lack of data reported from feedyards. The majority of lots did not have a yield grade reported, and about half had a quality grade reported. It is difficult to determine how important these variables are to price when they are missing.

The buyer data would also be useful. With both the feedyard and packer data, distance between the two could be found. A discount for further distances could be found.

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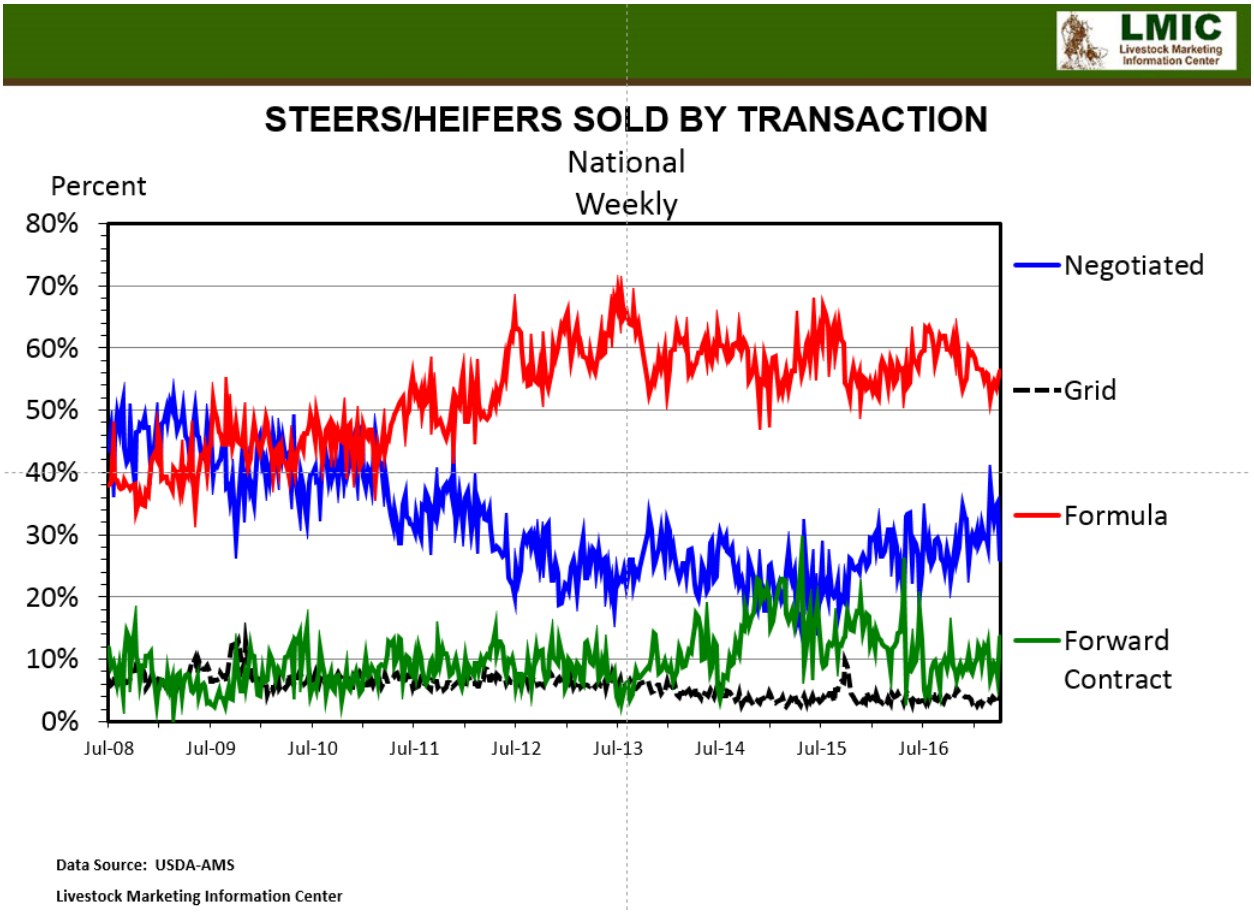
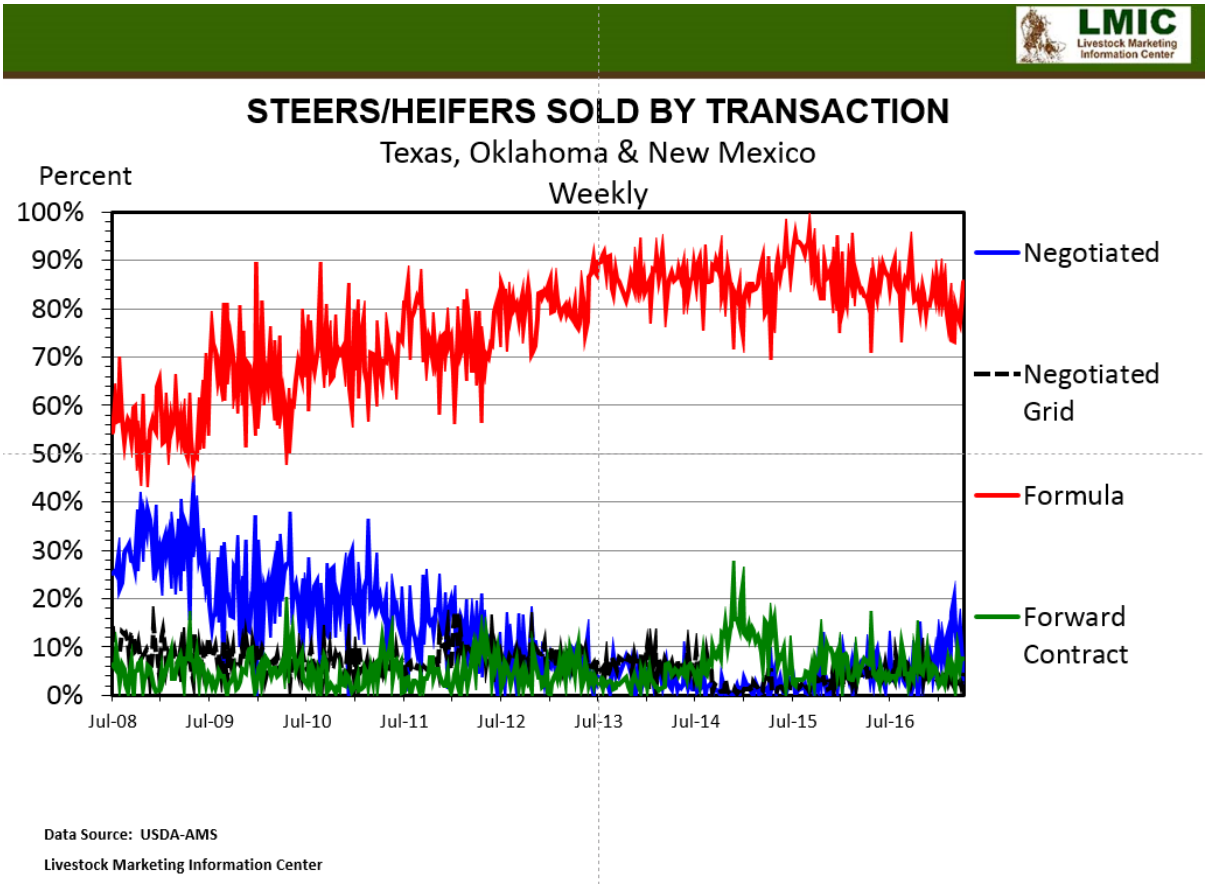
Appendix A - Supplemental Figures

Figure A-1. National Method of Transactions



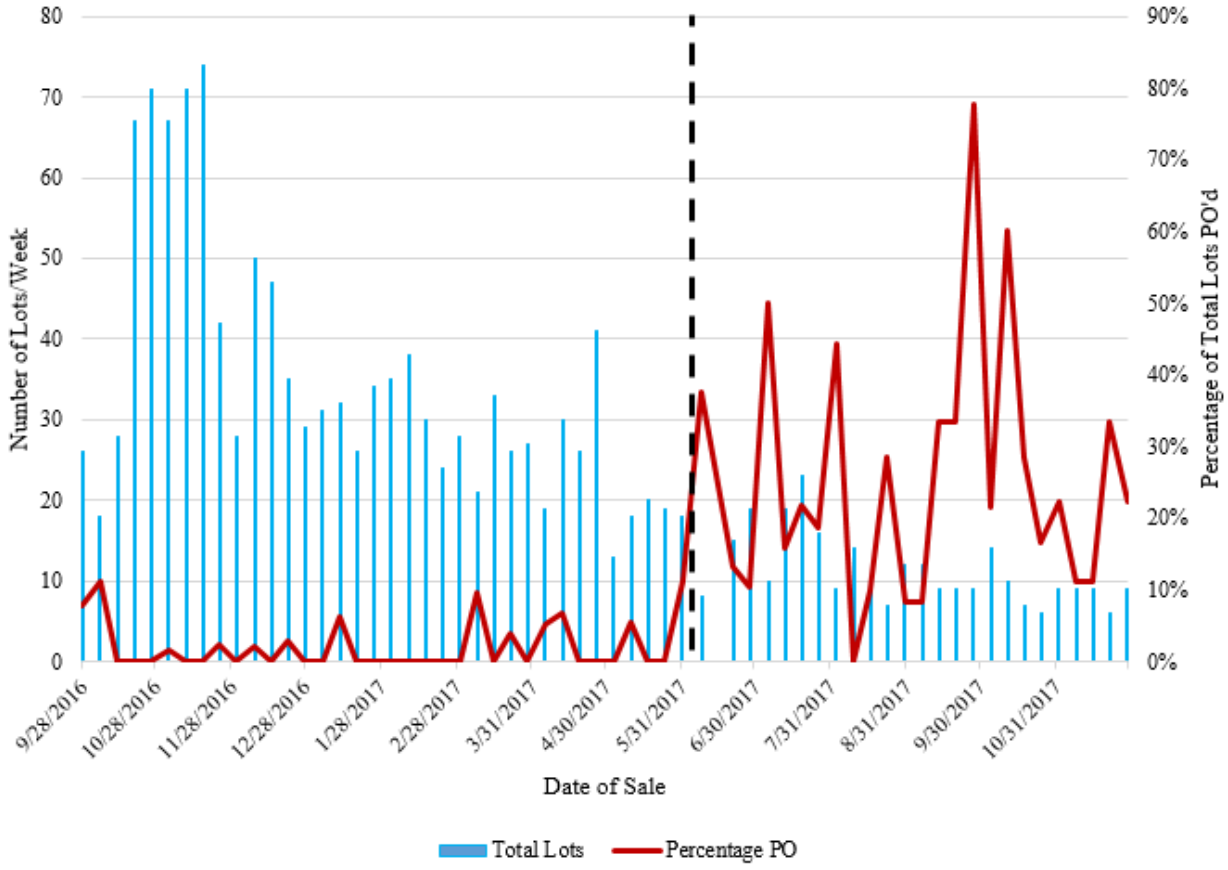
Source: Livestock Marketing Information Center – Percentage of cattle nationally sold by Negotiated, Grid, Formula and Forward Contract

Figure A-2. TX, NM, OK Method of Transactions



Source: Livestock Marketing Information Center – Percentage of cattle in Texas, Oklahoma and New Mexico Markets sold by Negotiated, Grid, Formula and Forward Contract

Figure A-3. Percentage of PO Lots vs. Total Lots



Data show that there was an increase in the percentage of lots that were PO'd. This occurred when there was a decrease of lots sold.

Source: Author's Own Work

Figure A-4. Status of Lots Before the PO Price Change

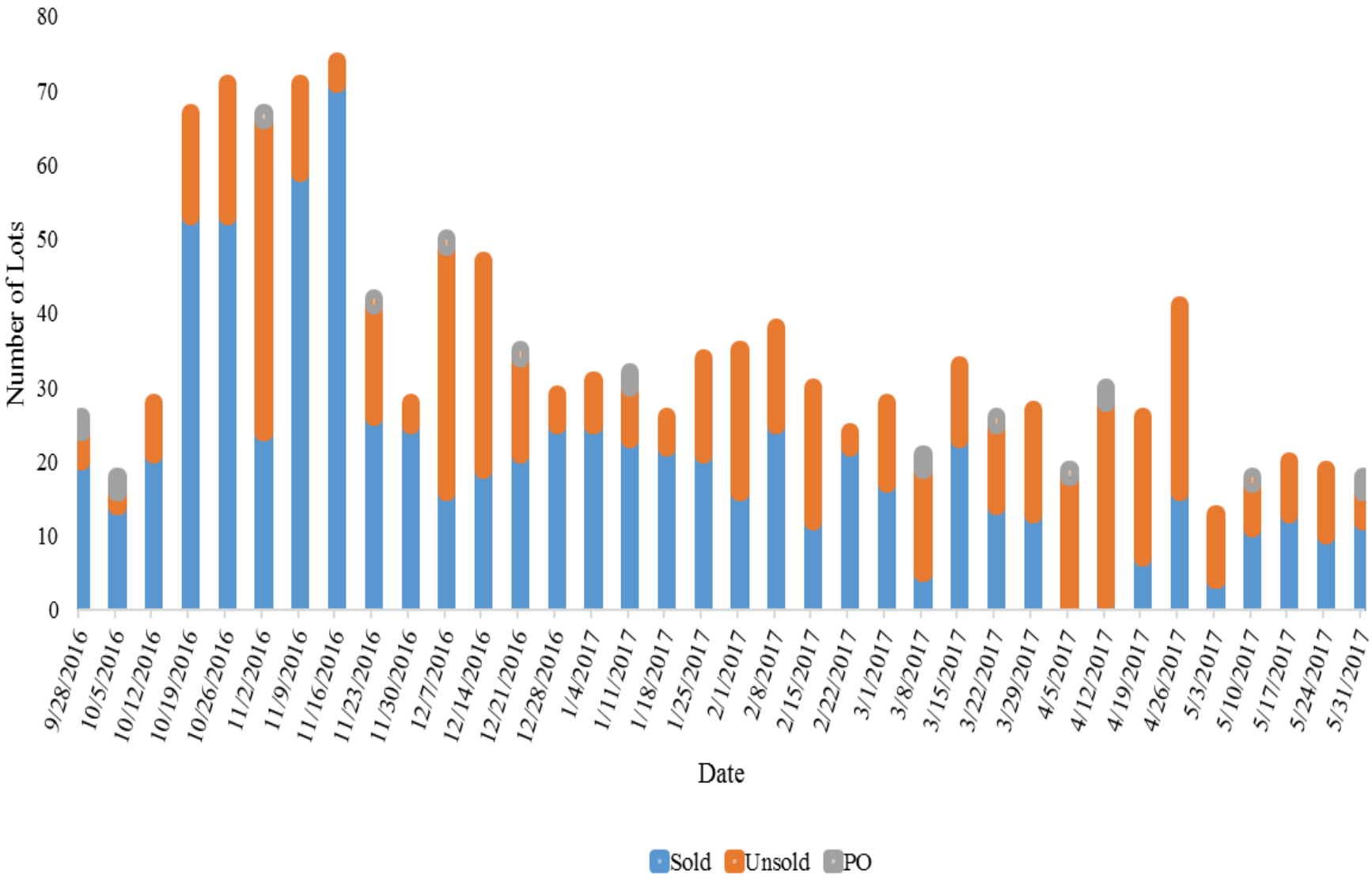


Figure shows the high volume of lots and the high volume of sold lots prior to the PO price dropping from $10/head to $1/head.

Source: Author's Own Work

Figure A-5. Status of Lots After the PO Price Change

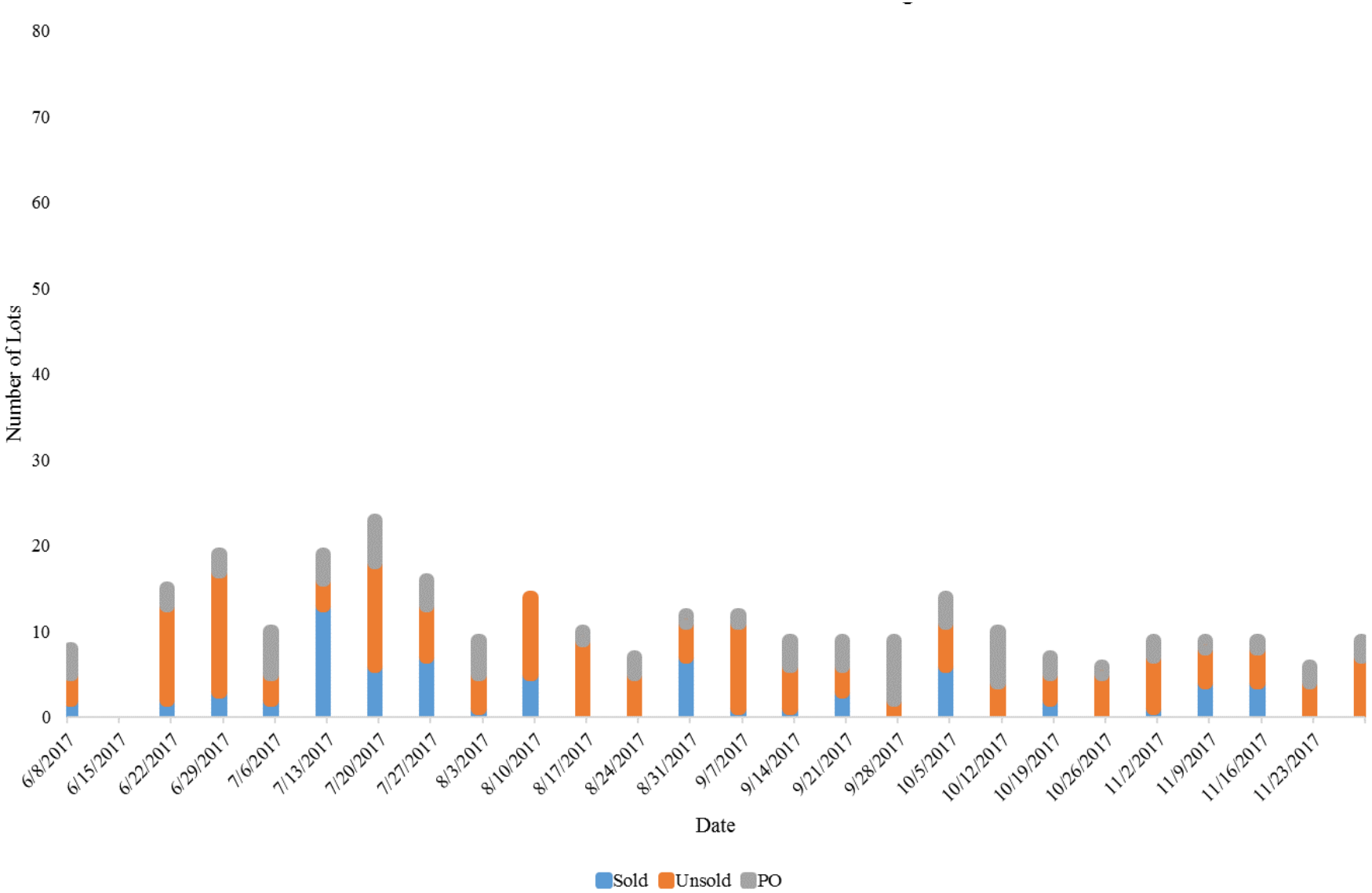


Figure shows the lower volume of lots as well as the high volume of PO lots after to the PO price dropping from $10/head to $1/head

Source: Author's Own Work

Figure A-6. Fed Cattle Exchange Timeline