FEEDER CATTLE PRICE DIFFERENTIALS USING NORTHEAST TEXAS BEEF IMPROVEMENT ORGANIZATION SULPHUR SPRINGS AND CATTLE AUCTION DATA

A Thesis

by

TAIWO BANKOLE

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ABSTRACT

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Texas A&M University-Commerce, 2016

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The United States is a major contributor to the world's beef production market with its large export market and the largest fed cattle industry in the world (United States Department of Agriculture, 2016). Price fluctuations are sources of risk to producers who are looking to profit from cattle production. Factors such as futures prices, physical and lot characteristics of cattle have been known to also effect cash prices. The objective of this study is to identify inherent market value for feeder cattle lot and physical characteristics of the Northeast Texas Beef Improvement Organization (NETBIO) cattle sold through Sulphur Springs Livestock Auctions (SSLA). NETBIO data over four years from Sulphur Springs Livestock Auction sales in Northeast Texas were used.

Therefore, a hedonic regression model was used to analyze the impact of lot size, weight, sex, and breed and feeder cattle futures prices on feeder cattle cash prices. The results showed that lot size, weight, sex, breed or color and feeder cattle futures prices were significant variables in determining differences in feeder cattle cash prices. In particular, results showed that heifers

were discounted at a price of $8.37 per cwt compared to steers. On average, increase in weight by one cwt resulted in a discount of $0.04 per cwt all things being equal. The English breeds/crosses, such as Angus and Hereford, received the highest premium of $16.62/cwt compared to the base breed category of crossbred cattle. For most of the auction months, the feeder cattle cash prices and futures price were moving together. October futures month was associated with the highest increase ($3.60/cwt) in cash prices.

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INTRODUCTION

Cattle production has been a major contributor to the United States' economy for many years. As the world's largest producer of beef, the United States has the largest fed cattle industry in the world with a large export market. However, the rapid expansion of this market is due to the growing beef demand in the United States. According to the United States Department of Agriculture (USDA), 19% of the total world's beef production comes from the United States (USDA, 2015). The beef cattle industry contains two different segments of production, cow calf operations and feedlots, which all work together to supply inputs into beef production. This research is concerned mainly with the feedlot operation which is the main sector of the U.S beef industry (Eldridge, 2005). In the United States, the majority of feeder cattle are fattened in preparation for slaughter at feedlots, which contain tens of thousands of animals. The increasing size of United States' meat industry coupled with its importance in the international market reflects the need for an analysis in terms of its production, consumption, imports and exports. Furthermore, the expansion of the world's meat industry also reflects the need to understand the most important foreign markets. The influence of United States' production and imports market makes the United States relevant in the world's meat industry.

1.1 United States and the World Meat Market

This section uses the Production, Supply, and Distribution (PSD) online database of representative countries from the Economic Research Service (ERS) of the United States Department of Agriculture (USDA). The PSD database does not necessarily include all countries of the world in their database, but its list of countries is updated periodically to ensure appropriate representation of the major countries. Beef and pork quantities are reported in metric tons (MT) and in carcass weight equivalent (CWE). CWE is the weight of an animal after slaughter, removing the uneatable portions, most internal organs, the head, and the skin. Poultry meat quantities are recorded in metric tons (MT) and ready to cook (RTC) equivalent basis. Total meat in this section is defined as the sum of beef, pork, and poultry meat (broiler and turkey).

1.1.1 Production

From 2004 to 2014, world meat production increased by 23%. Over the last ten years (2004 to 2014), swine meat continues to show the largest annual world production volume with an average share of 42%. This is followed by poultry meat with an average share of 33%, and then beef industry with 25%. Over the same time period, poultry meat production increased by 38% while beef only increased 8%. Figure 1.1 shows that the European Union, United States, and Brazil are significantly larger producers of meat compared to all the other countries in the world. Notwithstanding, all the countries reported in Figure 1.1 have exhibited rapid growth rates. The growth rates of India, Russia, Brazil, Oceania, China, and Argentina are109%, 91%, 37%, 31%, 29%, and 27% respectively. However, Canada had a negative growth rate of 6% and United States had a growth rate of just 4%.

In United States, poultry production has the largest annual production from 2004 to 2014 with an average share of 46%, followed by beef production with an average share of 29% of annual production, and last swine production with an average share of 25%. However, beef production had a negative growth of 1% within this time period compared to the increase in swine, and poultry production of 11% and 12%, respectively. Contrary to the United States, swine meat (pork) was the most produced meat type in the world with an average share of 42% over the period considered in the study. However, focusing on beef production, the United States is the top producer of beef. The country accounts for 19% of the world's beef production from 2004 to 2014.

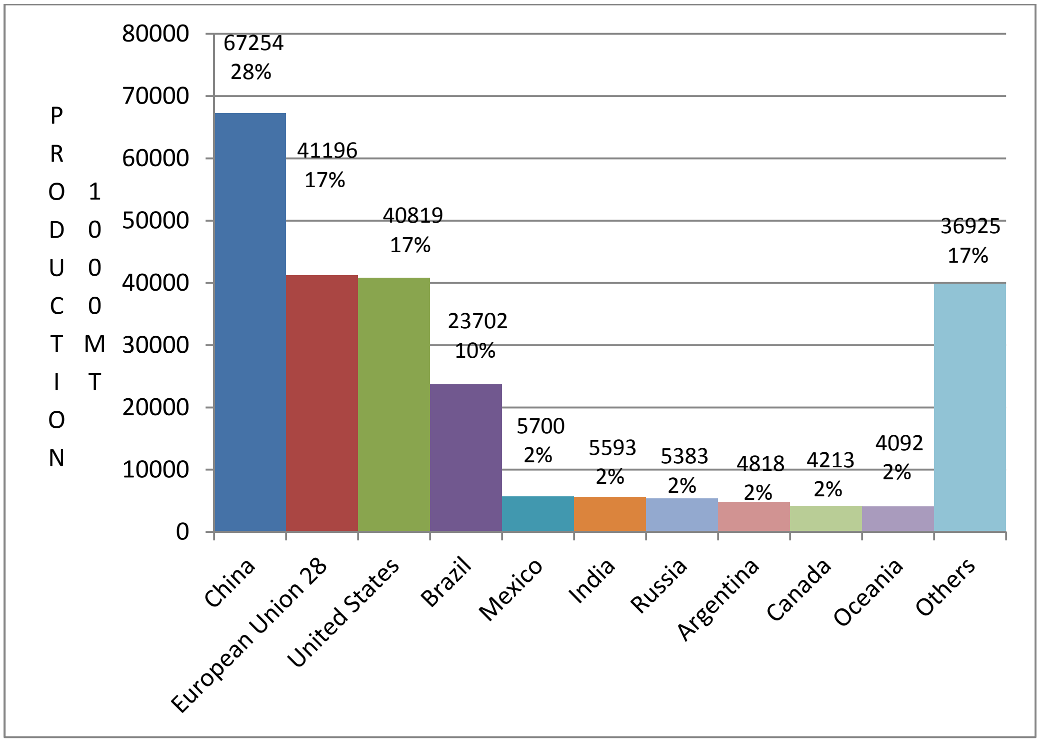

Figure 1.1 World's Largest Meat Producing Countries, Average 2004-2014
Source: USDA-ERS-PSD Online Database, computed by author

1.1.2 Consumption

As the world population grew by 11% from 2004 to 2013, world meat consumption increased by 21%. With an average share of 42%, pork is the world's most consumed meat. Annual poultry consumption continues to follow pork consumption with an average share of 33%, and last is beef with an average share of 23%. Swine and poultry annual world consumption increased by 37% and 21% respectively. This shows a rapidly increasing trend in both cases. However, beef consumption increased by only 5%, which is a small growth compared to poultry and swine. Figure 1.2 shows that China, the European Union, and the United States have a higher consumption rate compared to all the other countries in the world.

Many of the top ten countries in Figure 1.2 have rapid growth rates, except for the United States which has a negative growth of 2%. India had a surprisingly high consumption growth rate of 79% followed by sub-Saharan Africa with 65%.

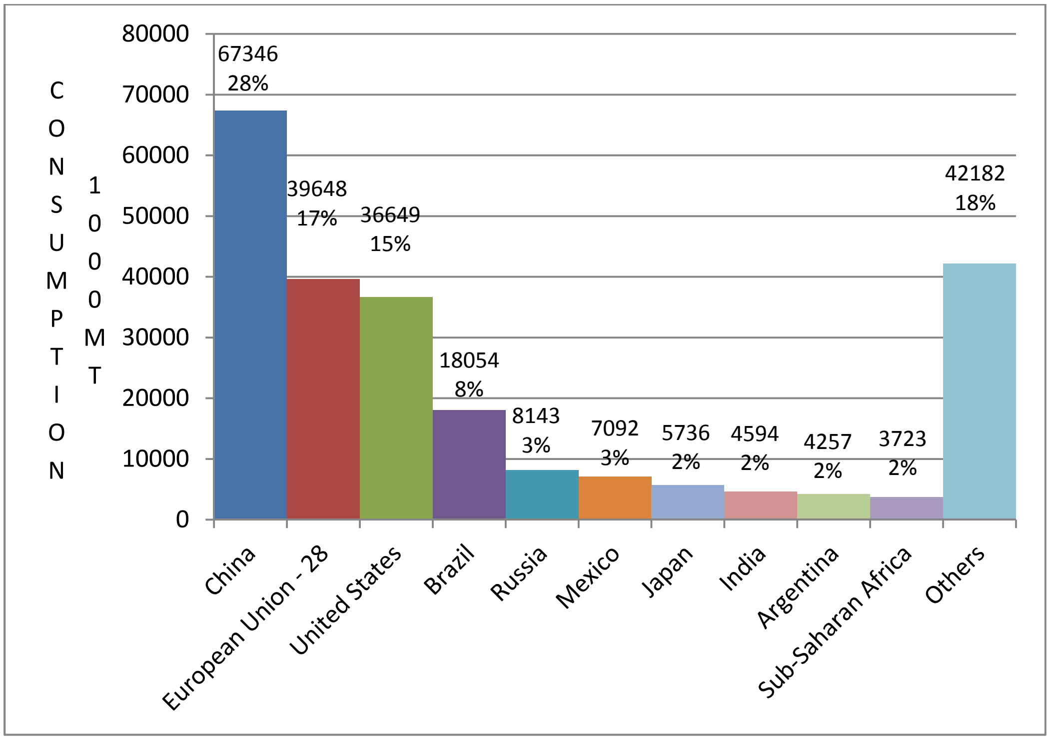

Figure 1.2 World's Largest Meat Consuming Countries, Average 2004-2014
Source: USDA-ERS-PSD Online Database, computed by author

The ranking of these countries changes when annual per capita meat consumption is considered. As Figure 1.3 shows, the United States has the largest annual per capita meat consumption of 119.41 kg/person followed by Argentina with an annual per capita meat consumption of 105.34kg/person. An analysis of United States' meat consumption shows that beef consumption accounts for 52% of all meat types consumed in the country followed by pork consumption with an average share of 37%, and poultry consumption with a 10% average share.

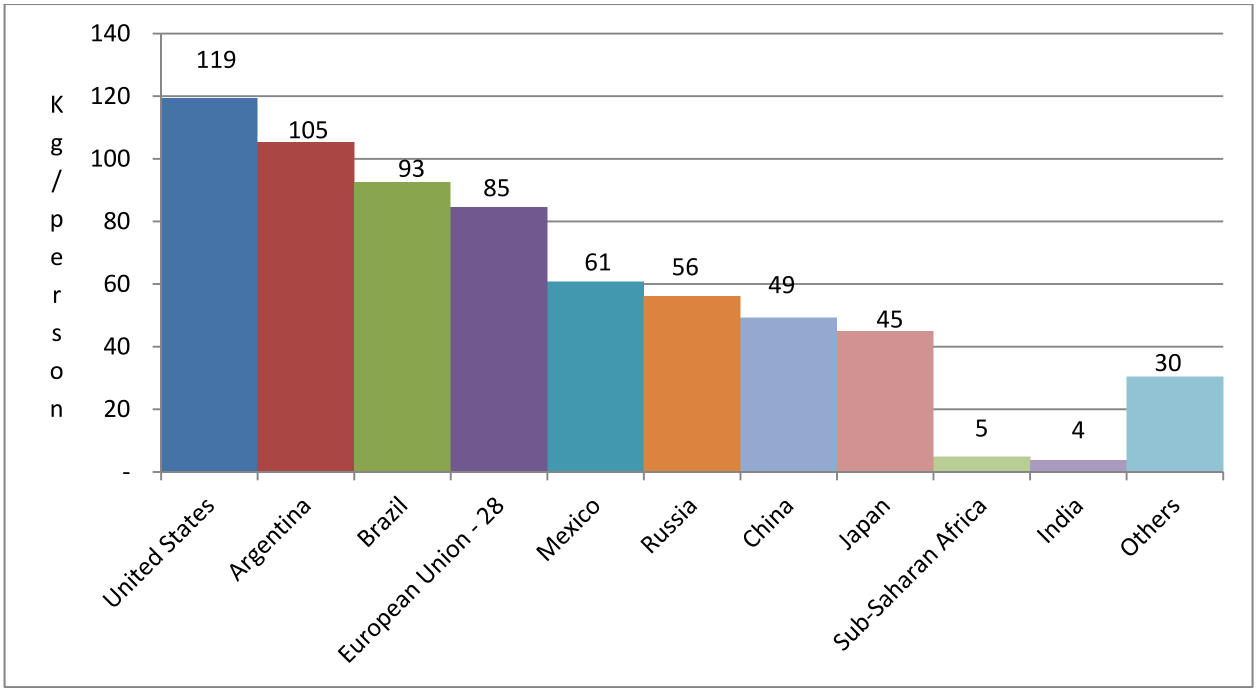

Figure 1.3 World's Largest Meat Per Capita Consuming Countries, Average 2004-2014
Source: Consumption obtained from USDA-ERS-PSD Online Database, computed by author. Population obtained from International Monetary Fund World's Population Data.

1.1.3 Imports and Exports

The total meat imports in the world increased by 40% from 2004 to 2014. Poultry imports are the largest meat imports with an average share of 39%, followed by beef importation with an average share of 32%, and pork imports with an average share of 29%. As expected, poultry imports have been rapidly growing with the highest growth rate of 56% compared to beef which has the smallest growth rate of 28%. However, annual swine imports are also increasing with a growth rate of 41% over the ten year period (2004-2014). Figure 1.4 presents the world's largest meat importing countries in descending order with Russia as the largest meat importing country, and Canada as least meat importing country. The first ten countries in Figure 1.4 make up 73% of the world's meat imports. Countries like Japan, China, South Korea, Hong Kong, Saudi Arabia, Canada, and the sub Saharan region of Africa experienced increasing import growth rates from 2004 to 2014. However, Russia, the United States, and the European Union experienced decreasing meat import growth rates. As can also be seen from Figure 1.4, the average shares for Russia, Japan, and the United states were among the highest.

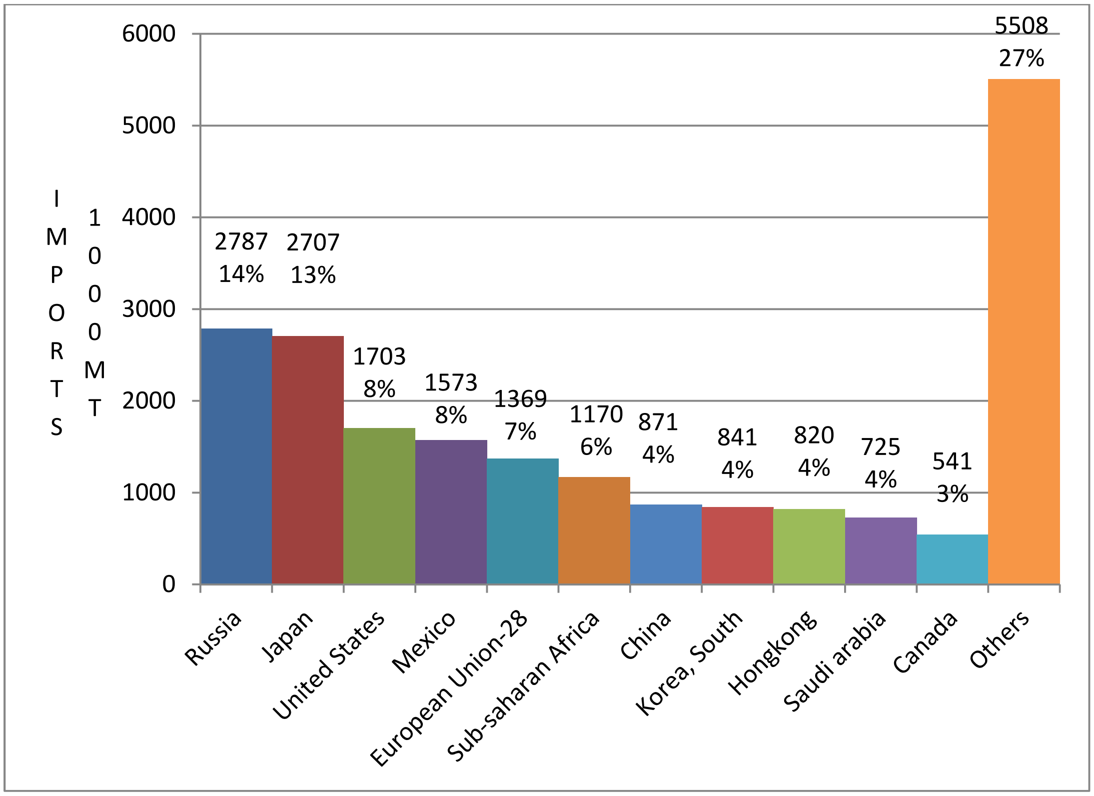

Figure 1.4 World's Largest Meat Importing Countries, Average 2004-2014
Source: USDA-ERS-PSD Online Database, computed by author

The United States plays a major economic role in the world's meat import market. United States' imports fell 22% from 2.2 million metric tons in 2004 to 1.7 million metric tons in 2014. In United States' import market, beef holds the largest volume with an average share of 73%, compared to other meat types followed by pork imports with an average share of 23%, and poultry imports with the least share of only 3%. However, the United States' beef and swine imports reduced by 27% and 14% over the period of ten years. Nevertheless, poultry imports experienced a growth rate of 294% from 2004 to 2014. In total, there was a decline in total imports of all meat types through 2004 to 2014 of about 22%. Mutondo and Henneberry (2007) conducted a meat demand analysis in the United States. They explained that sanitary and phytosanitary measures taken by the United States over the years have been sources of variation in import growth. For example, in May 2003, the country banned beef imports from Canada after the detection of Bovine Spongiform Encephalopathy (BSE). Imports resumed in November 2007 for cattle over 30 months of age, and born after Canada's 1997 feed ban. According to the USDA, the country began to experience a downward trend in its beef imports after this import ban (USDA, 2015). In addition, the USDA reported that the reduction in Oceania's beef supplies and the strengthening of the Australian dollar relative to the U.S dollar has decreased total beef imports to the United States since 2009 (USDA,2015).

1.1.4 Exports

World meat exports went up by 51% from 2004 to 2014. Unlike world meat imports, annual beef exports hold the highest share of 40% of the annual total world exports, followed by poultry and swine exports with shares of 36% and 24%, respectively. Swine exports had the lowest export share during the ten year period considered, yet they experienced the highest growth rate (69%). World beef exports, on the other hand, grew by 40%, presenting the smallest growth rate of the meat types. Figure 1.5 shows that United States accounts for 23% of the world's meat exports making it the world's largest meat exporter. The United States' trade partners, Mexico and Canada, are the largest export market for the United States' meats. It is also interesting to note that Brazil closely follows the United States as the world's largest beef exporter.

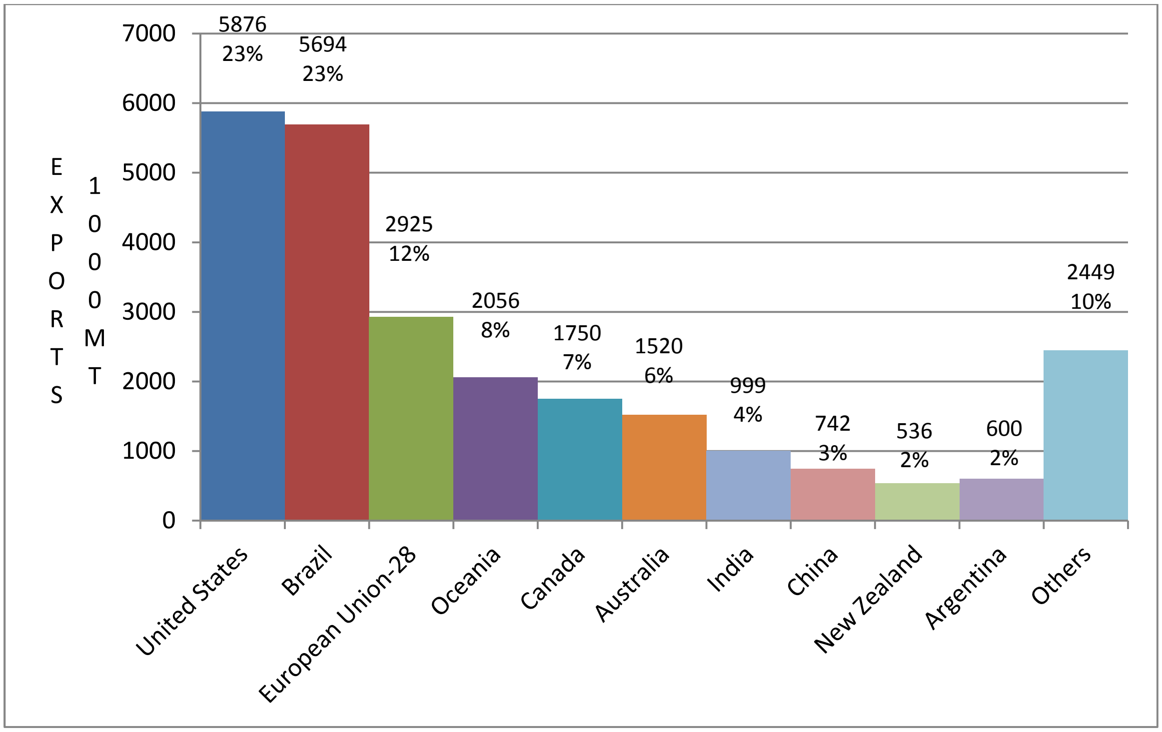

Figure 1.5 World's Largest Meat Exporting Countries, Average 2004-2014
Source: USDA-ERS-PSD Online Database, computed by author

United States and India had a large increase in their rate of meat exports from 2004 to 2014 with a growth rate of 101% and 276%, respectively. India's large export growth comes from its large beef export market which accounts for 10% of India's exports. This is as a result of a popular religious belief against beef consumption in India, hence other meat types like pork and poultry are more acceptable. Other countries like China, New Zealand and Argentina experienced a decline in meat exports with growth rates of -10%, -10%, and -22% respectively. Argentina recorded its highest number of meat exports in 2005. However, in the wake of the 2006 outbreak of foot and mouth disease in Argentina, more than thirty countries closed their borders to Argentina's beef. The decline in exports from 2005 resulting from this event may be a reason for the negative growth rate in Argentina's meat exports.

In United States, poultry holds the largest volume share of the country's export market with an average share of 54%. Swine exports follow with an average share of 31% and beef exports holds the least share of only 14%. Nevertheless, United States beef exports grew by as much as 464% from 2004 to 2014 followed by swine exports which grew by 135% and poultry exports which increased by 54%. The United States is a net exporter of total meat with an export volume of about three times its imports. While the United States' total meat imports declined by 22%, the total meat exports increased by 101% over the ten years of the study period.

Some United States' trade policies and programs introduced in recent years may have impacted export growth experience between the ten years of the study period. For example, the Non-Hormone Treated Cattle (NHTC) introduced in 1999 by the Agricultural Marketing Service facilitated a rise in U.S exports to the E.U. (Arita, Beckman, Kuberka, and Melton, 2014). This program which certifies beef export to the European Union caused steady export growth reaching a peak of 17,286 MT in 2013 (Arita et al., 2014).

Though the analysis by Arita's et al. (2014) indicates that poultry is the most exported meat type in the United States, and the beef market is the most rapidly growing market of all the meat types considered. The 19% of world's beef production accounted for by the United States confirms this growth. This expansion is fueled by United States' large cattle industry.

1.2 The United States Beef Cattle Industry

The size of the U.S beef industry and the economic value it contributes to the United States' economy shows its importance to the country's agriculture. As shown in Figure 1.6, beef cattle were about 29.7 million in inventory as of 2013, and were about 31 million in inventory as of January 2016 (USDA-National Agricultural Statistics Service (NASS), 2016).

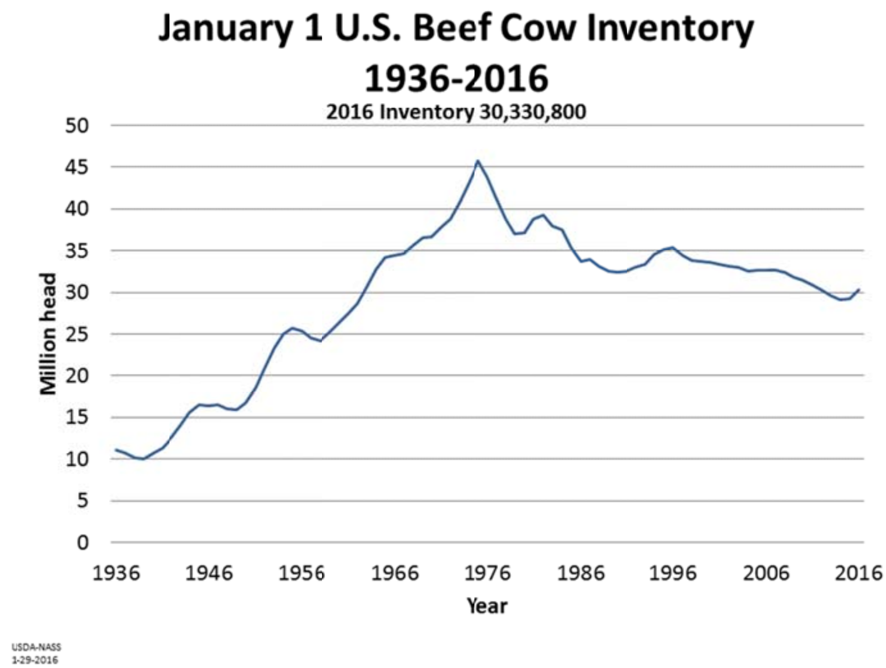

Figure 1.6 January 1 U.S. Cattle Inventory, 1936-2016
Source: USDA-NASS

According to the USDA (2015), in 2014, a total of 24.3 billion pounds of beef in commercial carcass weight was produced in the United States. As shown in Figure 1.7, as of 2015, cattle and calves on feed for all feedlots was about 10.8 million head.

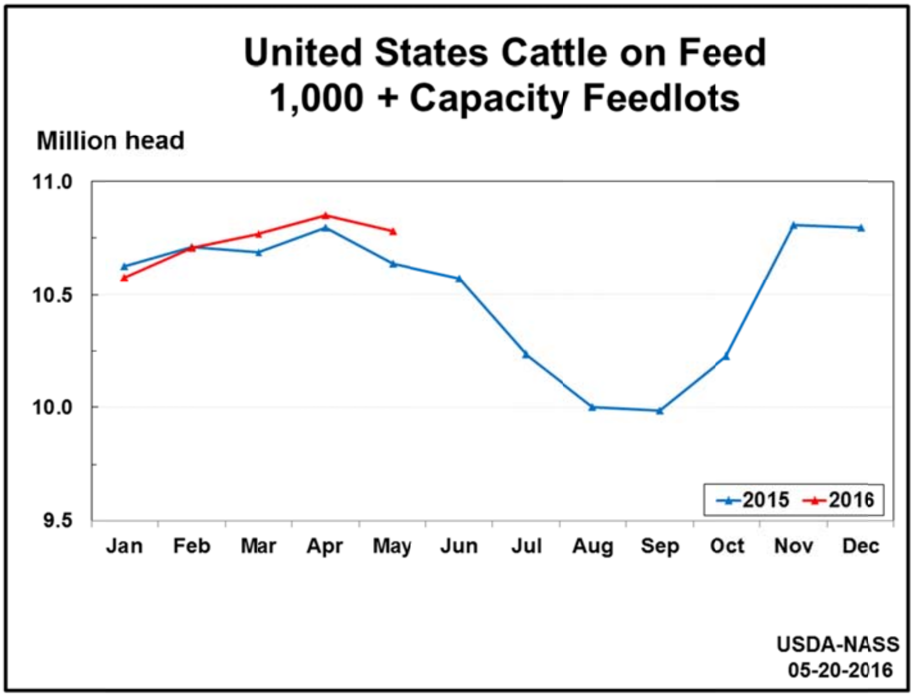

Figure 1.7 United States Cattle on Feed 1,000 + Capacity Feedlots
Source: USDA-NASS

In 2000, the sale of cattle and calves was about $40.76 billion in economic value accounting for 21% of all agricultural output (Otto and Lawrence, 2001). In a 2011 USDA report, Mathews and McBride (2011) explained that cattle and calf sales accounted for about 20% of the total value of agricultural products traded in the United States in 2007 placing it first in sales rank among other commodities. Figure 1.8 shows a general increase in the value of cattle production in the United States, from 2012 to 2015. In addition, the production and processing of beef provides over 1.4 million jobs in terms of direct and indirect employment (Otto and Lawrence, 2001).

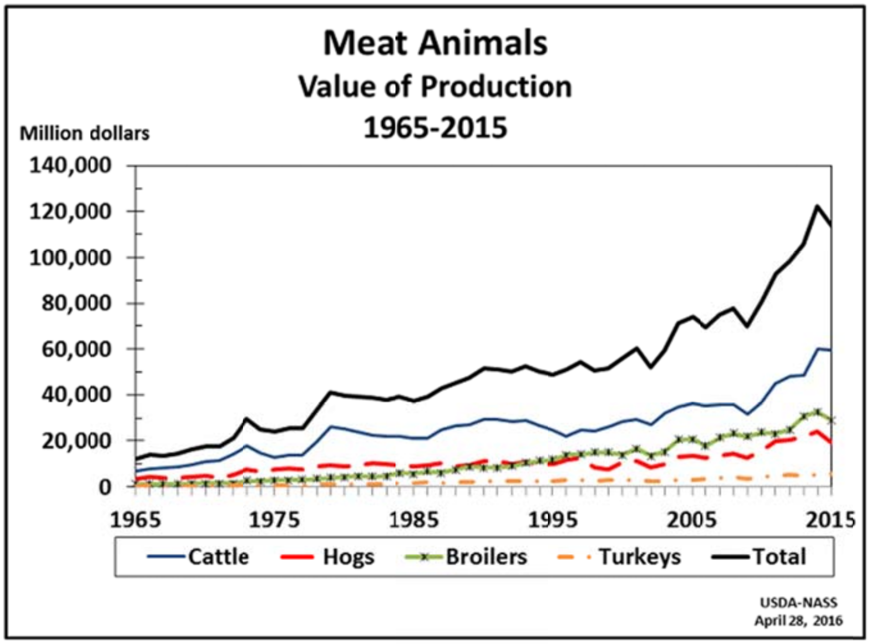

Figure 1.8 Value of Meat Animals Production in United States, 1965-2015
Source: USDA-NASS

1.2.1 Structure of the U.S Beef Cattle Industry

Through its economic and commercial value, the U.S beef cattle industry has continued as a major driver of the U.S economy. As evidenced by the industry's statistics in terms of size and economic value, beef cattle production is rapidly expanding. The United States' beef cattle production can be divided into four primary segments (Lowe and Gereffi, 2009). They include the cow-calf operations, stocker/back grounding operations, feedlot operations and packing and processing operations. The main function of these segments is to produce live beef cattle from which high quality beef is made available to consumers. A brief overview of each of these segments follows, though the main focus of this research is the feedlot operations and the feeder cattle it produces.

1. **Cow-Calf Operations:** This is a process of beef cattle production in which farmers and ranchers breed cows to produce calves for later sale. The cows are raised by careful maintenance on pasture and hay through breeding, gestation and eventually calving. Calves are usually weaned from 6 to 9 months, weighing between 450 to 700 pounds. Farmers sell weaned calves to stockers or feedlot operators for additional grazing and growth. According to Eldridge (2005), a large percentage of cow-calf farmers choose to sell calves at weaning because of inadequate pasture and management facilities. However, about a third of beef cow-calf farms maintain ownership of calves after weaning and continue grazing and back grounding the calves from 30 to 90 days before selling.
2. **Stocker/Back grounding Operations:** Calves sold at weaning are either directly sold to feedlot operators or are sent to stocker operators where they are nurtured to put on additional weight. Calves are further confined to nutritional requirements of hay and forage to raise them to an additional weight of about 200 to 400 pounds for 3 to 8 months. This preconditioning phase is usually called the backgrounder phase. Calves are usually back grounded or retained on the same operation or location where they were born or miles away (Eldridge, 2005). Farmers that retain calves on their operation after weaning avoid the stress of transportation and calves can have the opportunity of adjusting to eating from a feed bunk (McBride and Mathews, 2011). After this stage, matured calves, called feeder cattle, are sold to feeding operations or sold through specialized feeder cattle sales, livestock auctions, and electronic and video auctions.

3. **Feedlot Operations:** Back grounding ultimately prepares calves for the feedlot operations and makes them more suitable for the finishing stage. The feedlot operations involve a process called finishing where matured calves are put on a nutritional requirement of a combination of forage and grain and raised to slaughter weight. These animals are called feeder cattle at this stage because they are fed to reach a market or slaughter weight of about 900 to 1400 pounds or 8 to 14 months of age. As a result of various cow-calf and feedlot operations throughout the United States, there are a large number of local markets for feeder calves. Therefore, this research has chosen to focus on cow-calf operations and feeder cattle they produce.
4. **Packing/Processing Operations:** When cattle reach market weight, they are sent to a processing facility where they are slaughtered, processed, and packaged into beef. For safety, animal welfare and implementing quality standards, the Food Safety and Inspection Service (FSIS), a public health agency of the USDA, ensures compliance with all regulations.

1.2.2 Geographical Location of the U.S Beef Cattle Industry

Beef cattle and calves are produced in almost all areas of the United States. According to the USDA, a large percentage of the United States' beef cows can be found in the South, which includes the Southern Plains and the Southeast compared to the Northern Plains and North Central region (USDA, 2015). The difference in regional environmental conditions is one of the reasons for the geographical dispersion of the U.S beef cattle. McBride and Mathews (2011) explained that herds in the Southern Plains require less supplemental forage during winter despite a longer grazing season, therefore reducing feed costs significantly. However, cow-calf operators in the Northern Plains spend more to maintain hers due to harsher climatic conditions.

According to Feuz, Harris, Bailey, and Halverson (2008), in 2007, the top five states with most cattle were Texas, Missouri, Oklahoma, Nebraska and South Dakota. All together they accounted for 40% of all beef cows in the United States.

Furthermore, a study by Feuz et al. (2008) identified Texas, Oklahoma, Kansas, Nebraska, Eastern Colorado and Iowa as the cattle feeding states. As of March 2015, the top five states for cattle in feedlots with a capacity of more than 1000 head were Nebraska, Texas, Kansas, Colorado and Iowa (National Beef Cattlemen's Beef Association, 2015). Due to environmental differences in various locations, the United States' feeder cattle sector is characterized by varied production methods which influence marketing and price patterns.

1.2.3 The Role of Texas and Northeast Texas in the U.S Beef Cattle Industry

From the discussion on the geographical location of the United States' beef industry in the previous section, the economic importance of Texas as a leading location in the cattle industry is confirmed. The revenue from the sale of beef cattle is the largest source of Texas' agricultural revenue. According to the Texas Department of Agriculture website, Texas is currently the leading state in beef cattle production (Texas Department of Agriculture, 2015). The state produces 46.4% of the total inventory of beef cattle produced in the United States while making about $10.5 billion dollars in cash receipts from beef cattle sales. In terms of gross income, Texas is the top beef state producing $7.5 billion in beef and feeder cattle (USDA-NASS, 2008). According to the USDA, in 2010, Texas was the top state based on cattle on feed inventory producing 24.3% of the United States' total (USDA, 2015).

1.3 Feeder Cattle Fundamentals

The stages of cattle production serve as sources of inputs supply into beef production. The seasonal variability in the supply of cattle causes increasing and decreasing supply over a period of time. This seasonality is observed because consumers increase their demand for beef during the summer and fall months. Another reason is because producers also increase their demand for replacements during the last six months of the year with a resulting substantial increase in feeder market activity. Variation in cattle prices stem from the demand-induced seasonality resulting in varied patterns and trends in cattle market. This confirms the importance of understanding the fundamentals of beef production to explain and analyze these trends. Feeder cattle price levels are subject to supply and demand forces that are working together to reach a point of market equilibrium. The forces of demand and supply influence the price that feedlots are willing to pay for feeder cattle. As a result, feeder cattle prices are usually susceptible to volatility. According to recent USDA report on cattle prices, prices are on the rise due to a combination of strong consumer demand and the reduced supply (Mathews, 2014).

The price of steers in dollars per cwt from 2000 to 2014 is presented in Figure 1.9. As Figure 1.9 shows, there is an uptrend in prices with a record low in year of 2002. However, this high consumer demand was not complemented with an increase in supply leading to a continued increase in prices. The total supply of beef is depicted in Figure 2.

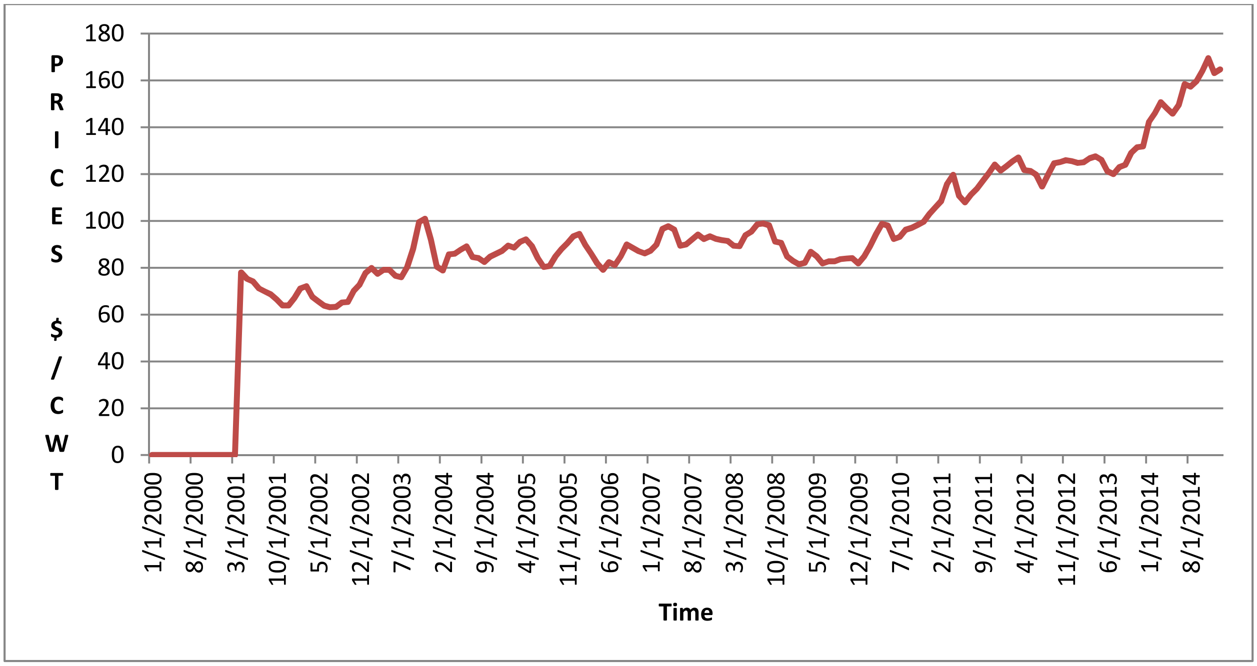

Figure 1:9 Cattle (Steer) Prices, 2000-2014
Source: USDA-ERS Database, computations by the author.

According to Figure 2, there was a slight uptrend in beef supply from 1978-1998 after which supply started to experience a downward trend. The increase in demand and reduced supply are expected to influence prices at the higher level. As a result, feeder cattle prices are expected to rise. Apart from seasonal variations and supply and demand factors, climatic conditions and price expectations are also causes of feeder cattle prices fluctuations. These price fluctuations are sources of risk for producers who are looking to profit from cattle production. As such, producers must be up-to-date with existing market trends and make educated management decisions with accessible information.

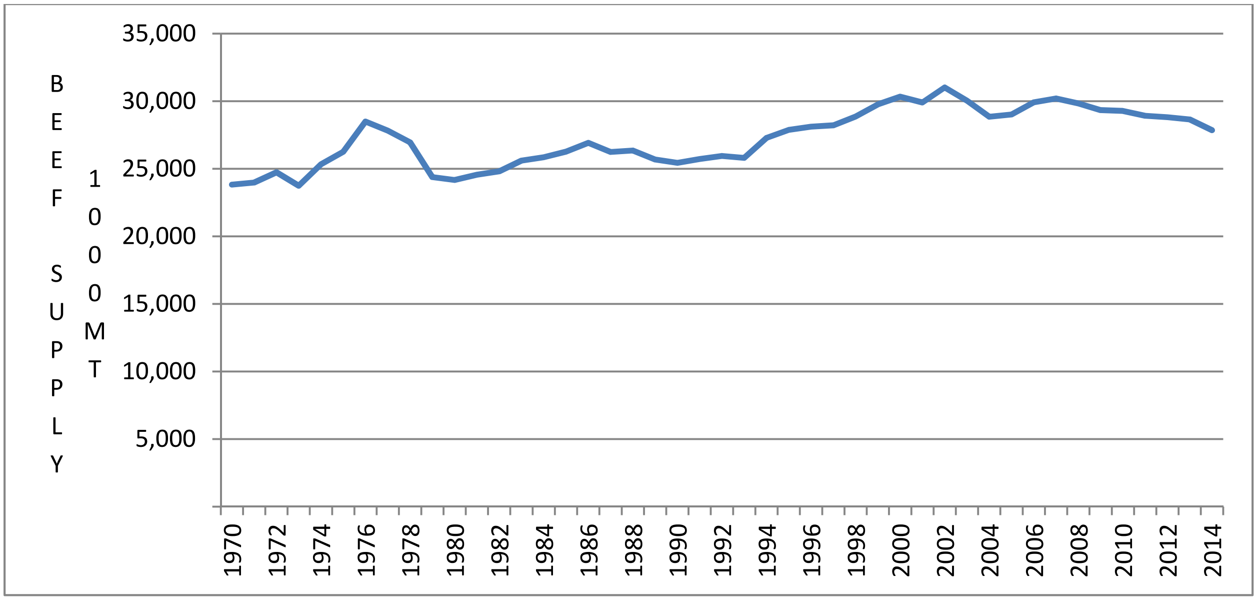

Figure 2 Total Supply of Beef, 1970-2014
Source: USDA-ERS Database, computations by the author.

1.4 Problem Statement

Just like most beef cattle states, the Texas feeder cattle market involves intricacies of marketing and sales. According to the Texas Department of Agriculture, about 5 million calves are born on 130,000 cow-calf operations in Texas (Texas Department of Agriculture, 2015). However, local feeder cattle cash prices vary significantly depending on breed, weight, frame, uniformity, lot size, and cattle preconditioned state. These factors greatly influence profitability and lucrativeness of producers' feeder cattle business.

A profitable cattle marketing, however, is more than being paid the maximum price (Schroeder, Ward, Mintert, and Peel, 1998). Profitability is achieved when feeder cattle farmers produce the type of cattle based on market demand and selling the cattle at appropriate time and place. Regrettably, most feeder cattle farmers are simply price takers. They go along with prices offered to them through the market demand and supply factors. For example, they produce calves that are the easiest to raise and sell at the most suitable market outlet at the most convenient time.

Though, sources of price fluctuations like seasonality, environmental conditions and demand and supply are beyond producers' control, but farmers can actually have an idea of expected premium and discounts they can obtain from their cattle and plan accordingly. Therefore, it becomes imperative to investigate such factors that determine the value of feeder cattle in Texas and more specifically Northeast Texas.

Prior studies have already explored the factors that determine feeder cattle prices in various locations but very few have analyzed Northeast Texas. Taking into account previous research, the general objective of the present study is to empirically identify the factors affecting feeder cattle price differentials using data from the Northeast Texas Beef Improvement Organization (NETBIO) at Sulphur Springs Livestock Auction (SSLA). The factors influencing the feeder cattle cash price from NETBIO at SSLA include feeder cattle futures price, weight, number of heads sold, and the gender of the feeder cattle.

1.5 Objectives of Study

Explicitly, similar to Zimmerman et al. (2010), the study focused on the following objectives:

1. Report an overview of the world's meat industry and the United States' beef cattle industry.
2. Identify factors affecting feeder cattle price differentials using data from the Northeast Texas Beef Improvement Organization (NETBIO) at Sulphur Springs Livestock Auction (SSLA) as well as feeder cattle futures closing price data from Chicago Mercantile Exchange (CME) group.

1.6 Organization of Chapters

The thesis is divided into five chapters. Chapter 2 includes a review of prior literature in the field of determinants of feeder cattle prices. Chapter 3 includes a discussion of the theoretical framework used in developing the research model. The description of data and methods of analysis are also presented in Chapter 3. In addition, in-depth descriptive statistics will focus on showing sample data summaries. The empirical analysis result of the hedonic pricing model is summarized in Chapter 4. Summary, conclusions, recommendations for future studies and implications and limitations of the research results are in Chapter 5.

Chapter 2

LITERATURE REVIEW

There is extensive research on the determinants of price differentials in feeder cattle auction markets. Examining the economic value of various feeder cattle characteristics is not new to agricultural research. However, in order to provide a good foundation for this research, previous research must be reviewed.

Menzie, Gum, and Cable (1972) conducted a study by investigating the major determinants of feeder cattle prices at Arizona auction markets. The general purpose of the study was to examine some of the important determinants of feeder cattle prices at Arizona livestock auctions. However, the study specifically focused on two objectives. The first was to test the hypothesis that feeder cattle prices at the various auctions were significantly influenced by various cattle and lot characteristics. The second objective of the study was to estimate the size of the difference where the effects of these variables significantly affect cash prices.

Data on weight, lot size, breed, sex, and current cattle fat price were obtained from 47 auction sales which included six Navajo Indian sales in 1969. The data were obtained from the following location sales: one Hopi Indian sale; six Fort Apache Indian sales; two Hualapai Indian sales; three San Carlos Indian sales; four Willcox special feeder cattle sales; six sales sponsored by Cattlemen's Associations, three in the spring of 1969 and three in the fall; nine sales in Phoenix, Arizona; and ten sales in Tucson, Arizona. A total of 2,941 feeder cattle lots were observed at the sales while a total of 28, 501 heads were used in the sample. Of the total lots, 64% were steers, 54% were Herefords and 24% other crosses.

A multiple regression model was used for analyzing the influence of weight, grade, sex, breed, lot size and current fat cattle price (independent variables) on feeder cattle price (dependent variable). Menzie et al. (1972) explained that the fat cattle price was used to remove most of the influence of general price level differences for cattle over the different time periods considered by their study. The results of the regression analysis showed that differences in price relationships of steers and heifers depends on cattle weight and fat cattle price at the time of sale. The researchers also found that higher fat cattle prices resulted in greater discounts for heifers compared to steers and vice versa. They also found that weight and price were inversely related and that steers rapidly decreased in price compared to heifers as weight increases. The researchers suggested that the weight-price relationship was nonlinear for heifers and steers with prices declining at a decreasing rate as weight increases.

Furthermore, the researchers pointed out that the difference between grades declined as the quality was enhanced from low standard to low choice cattle grade. Lot size was found to be directly related to prices since prices increased by $0.0234/cwt as lot size increased by 1 unit. Menzie et al. (1972) found lot size squared to be statistically insignificant in the model and concluded that the relationship between the lot size and price was linear. Also, the researchers found that breed had a small price influence with Brahman crosses receiving a $0.89/cwt premium over Herefords. However, prices for Angus, Hereford-Angus crosses and "okie" cattle were $0.27/cwt, $0.37/cwt and $0.28/cwt, respectively, greater than for Herefords.

Faminow and Gum (1986) studied feeder cattle price differentials in Arizona auction markets. The research objective was to use nonlinear price/weight and price/lot relationships to explain differences in Arizona auction market prices. A price discount model for feeder cattle was used to determine price premiums and discounts based on sex, weight, and lot size. The price of feeder cattle was used as the dependent variable and it was regressed against independent variables such as weight, number of head, sex, breed, and sale year. Data were obtained from individual feeder cattle sale lots during the month of May 1984 and 1985 at the Gila and Mohave County cattle association sales. A total of 368 usable sale lot observations were available for analysis.

Faminow and Gum (1986) found a negative coefficient associated with breed suggesting that cross breeds were discounted compared to straight breeds. In addition, significant 1985 heifer year/weight interaction terms indicated that price and weight relationships were different for 1984 and 1985 heifers. However, the insignificant 1984 and 1985 price/weight and price/lot relationship for steers showed that this interaction was not different between the two years. By plotting the prices of 1984 heifers against their weights, Faminow and Gum (1986) discovered that the 1984 heifer price/weight line was almost linear and was significantly different from the 1985 heifer price/weight line, which was concave to the origin. Additionally, by plotting the prices of 1984 and 1985 steers against their weights, both years' price/weight line was found to be convex from below. This study also found that light weight steers and heifers received a higher premium compared to higher weights. For 1985 heifers, marginal value began to reduce at about 615 pounds. Faminow and Gum (1986) found that a quadratic relationship between price and lot size was statistically significant. The price/lot size line reached a peak at approximately sixty head and was not significantly different between years. The researchers concluded that the optimum lot size may differ with location.

In a research article by Troxel et al. (2002), the factors impacting the selling price of feeder cattle sold at Arkansas livestock auctions were investigated. Based on this, the researchers focused on determining the factors that affected the selling price of feeder cattle in Arkansas weekly livestock auctions. The sample consisted of 81,703 feeder cattle, from 17 weekly livestock auctions that were held in Arkansas from January 1, 2000 to December 31, 2000. A multiple regression analysis was used to determine the effects of independent variables such as how the calf was sold, sex, breed, color, horn status, muscle thickness, frame score, fill, condition, age, health, body weight, price, and time of the sale on cattle cash prices (dependent variable).

The regression results indicated that buyers were willing to pay more for calves compared to yearlings. Consistent with prior studies, results also show that price decreased with increasing body weights. Feeder cattle with groups of two to five calves had the highest selling price of about $95.14. The researchers also explained that steers sold the highest, with bulls following, and heifers had the least price. Furthermore, the breed Charolais × Limousin had the highest premium of $23.40 difference compared to the Longhorn which received the lowest price of $74.52. The Limousin-influenced cattle received a premium above the mean selling price compared to Angus. They also found that yellow feeder cattle received the greatest premium compared to the striped feeder cattle which sold the lowest. Troxel et al. (2002) predicted that there would be a greater difference in feeder cattle selling prices throughout the sale, and their results show that the differences in price, throughout the period of sale considered, was very small. Dehorned, healthy, large framed, gaunt and shrunk all received premiums. Calves with average body condition sold for about $3 lower than thin calves.

In 2007, Mathews conducted a study on value-added characteristics in feeder cattle. The research focused on determining the value of characteristics of feeder cattle sold through auction markets and through special source verified feeder cattle sales. Research data came from six year sales held at Joplin Regional Stockyards (JRS) and was obtained from Made for Agriculture (MFA) records in Columbia. The data set consisted of 4,704 lots of MFA cattle, 9,303 lots of other value added cattle, and 140,580 lots sold through regular feeder cattle auctions. Based on the hedonic model, a multiple regression analysis method was used to estimate the relationship between the dependent variable, which was the cattle sale price, and the independent variables. The independent variables included type of sale (MFA, JRS), month, year, lot, sex, average weight, breed, commingled lot, futures price, corn prices, lot size squared, and average weight squared.

Mathews' (2007) results indicated that the MFA coefficient was significant and received a premium of $5.71/cwt while calves in other value added programs obtained a $4.53/cwt premium over the base. Using May as the base month, the research showed that April had the largest premium while October sales received the greatest discount confirming the effects of seasonal price patterns in feeder calves. To account for cyclical changes in price, year 2000 was used as the base and Mathews (2007) found that year 2003-2006 had price premiums while 2001 and 2002 had discounts. Consistent with prior studies, the lot size coefficient was positive and significant while the lot size squared coefficient was negative, indicating that the lot size premium began to decrease as additional head were added to the lot. Furthermore, Mathews (2007) found that prices decreased at a rate of $12/cwt as weights increased and that heifer calves received lower prices than steer calves at same weights. Also, a unit in increase in fed cattle futures prices resulted in a $1.15/cwt increase in feeder cattle prices. However, $1/bushel increase in corn prices caused a $1.71/cwt decrease in cattle prices. Black calves received a premium compared to the base of cross bred calves while Holsteins and dairy breeds received the largest discounts. Furthermore, the commingled lot, which is a lot comprised of cattle from multiple sources, was found to have a negatively affected price. The parameter estimate associated with the commingled lot variable was found to be negative.

In 2008, Feuz et al. investigated the price relationships in geographically dispersed United States' feeder cattle markets after they have been adjusted for transportation and quality differences. Therefore, the overall objective of the study was to use data across broad geographical areas to examine if the law of one price holds in the US feeder cattle market. As opposed to using price as the dependent variable, basis was used. A multiple regression model was used to analyze the influence of sex, weight, breed, frame, flesh, implanted, presence of horns, number of head, ranch weight, shrink, uniformity, sale order, days to delivery, miles shipped, and futures price (independent variables) on basis (dependent variables). The research's auction data were from Superior Livestock Auction for 2004-2006 sales. The data were analyzed by steers and heifers and by three weight categories: 450-499 pounds, 500-599 pounds, and 600-699 pounds.

Feuz et al. (2008) found that heifers were discounted relative to steers, and weight and weight squared variables had a statistically significant negative influence on price. Also, all the other breed types had lower prices and basis compared to the Angus breed. However, the red Angus breed did not differ from the Angus breed. Light flesh cattle received a premium compared to the medium flesh base variable, and the large frame variable was significant and positive while small frame had a negative coefficient. Furthermore, the variable for steroid implants was positively related to basis, and presence of horns was negatively correlated to basis. Also, basis increased up to 541 head and then price started to reduce with larger lot sizes. The researchers also found that the ranch variable was negatively related to basis and a one percent increase in the shrink resulted in a basis increase of $.20 per cwt suggesting that sellers will be better off not offering shrink on their calves.

The researchers found that for every one mile increase, basis is expected to be discounted by $0.003/cwt. The futures price coefficient was found to be negative and significant showing that as the futures increased by $1 the cash market followed by $0.75, thus leaving a decrease in basis by $0.25. The researchers indicated that the Southwest region of the United States consistently had the lowest basis across weight and gender categories, and the Intermountain West and Southeast regions of the United States typically had the highest basis.

In 2008, Leupp, Lardy, Daly, Wright, and Paterson investigated the factors influencing price of North Dakota, South Dakota and Montana feeder calves. Therefore, data were obtained from three auction markets in North Dakota, two auction markets in South Dakota, and two in Montana adding up to a total of seven sale barns. Data were collected from these markets in the weeks of October 23 and 30, and November 6 (fall of 2006) and again in the weeks of January 15, 29 and February 12 (winter of 2007). Multiple regression was used to estimate the effects of independent variables such as lot size, weight, sex, hide color, health programs, vaccination history, use of deworming products, implant status, natural program-qualified, source, age verification status, and beef quality assurance (BQA) status on the dependent variable, feeder calves cash prices. The fall sales regression results indicated that calf prices were significantly influenced by the lot size. Lot sizes with 21 or more calves received the highest premium of $114.74/cwt compared to those of 11 or less calves while 5 or less lot sizes received the least price. Lot sizes of 11 to 20 and 6 to 20 calves had similar prices of $112.81/cwt.

In addition, similar to prior studies, a significant difference ($9.78/cwt) was found between the price of steers and the price of calves. Black cattle sold for a premium of approximately $114.40/cwt more than the other color types. However, the mixed-color, red and white cattle had a similar average price of $111.50/cwt. Leupp et al. (2008) found that calves vaccinated with only the four-way viral vaccine or vaccination program were priced greater than calves without a vaccination history. Also, producers received a small premium for calves that qualified for a natural program and implant status did not have any effect on sale price of calves. Analysis of the winter sales indicated a similar result with that of the fall sales. Lots with 21 or more calves also received a premium compared with calves sold in lot sizes of 11 or less heads of cattle. This showed that calves from the larger lot sizes received a higher premium compared to smaller lot sizes. Calves sold in small lot sizes of 5 or less received the highest discount of about $94.47/cwt. Also, steers received a $8.40/cwt premium higher than heifers. However, in contrast to fall sales results, black and white cattle received greater prices compared with mixed-color and red calves.

In 2010, Zimmerman investigated the factors influencing the price of value-added calves (VAC) at Superior livestock auction. The primary research objective was to understand how management at the cow-calf level influences the price of calves sold through SLA video markets. The researcher studied the price effect of independent variables like breed influence, vaccination programs, age, and source verified calves (ASV), futures prices, presence of horns, frame size, weight, calf age, sale date, lot size, sex, shrink, and natural non-hormone treated cattle program (NHTC) using a multiple regression analysis based on the hedonic pricing model. Data used for the hedonic pricing model included SLA sales from 1995 to 2009 which was obtained from SLA video market database. The researcher used separate models for 450- to 750 lb. steers and 400- to 700-lb. heifers' analysis.

The result of 2008 to 2009 hedonic pricing models showed that the average base weight of both steers and heifers were between 500 and 649 lb. Of all the lot characteristics, the effect of region on calf price was the only one evaluated in the study. Zimmerman (2010) found a statistically significant (95% confidence interval) difference between regions and between genders. Of the genetic variables, frame score had the least influence on sale price. Steer lots with a smaller frame received a discount compared to medium to large sized steers. Presence of horns got a discount of $0.80 per cwt for steers and heifers. Also, Brahman-influenced calves received the lowest prices and Red Angus received the highest. The price differences between Angus calves, black-faced calves, and black-white faced calves were statistically different for steers only. The non-linear price-weight relationship was found to be statistically significant for both steers and heifers. Heifers received the largest discount of about $15/cwt at 652 lb. while the largest weight discount for steers was about $17/cwt at 708lb. Uniform sale lots were also found to receive premiums. However, uniform lots of heifers were found to receive a higher premium compared to uniform lots of steers. Furthermore, steer lots with light-medium to medium mixed flesh scores received a premium.

The use of implants was statistically insignificant in the pricing model. However, unknown or partially implanted sale lots received a discount. Zimmerman (2010) also found that premiums for VAC protocols increased as program requirements increased. Heifers received a lower premium for the programs compared to steers. The VAC 45 received the highest premium for both steers and heifers because of its combination of vaccination and weaning. The researcher showed that non certified respiratory vaccination received a premium of $1.32/cwt. Pink eye vaccinations also received a premium with pink eye vaccinated heifers receiving a higher premium compared to steers. Heifers that were bang vaccinated were discounted compared to non-vaccinated ones. Lot size had a non-linear relationship with price, but heifer lot size did not have a statistically significant non-linear relationship. The optimal steer lot size was 575 head. Zimmerman’s 2010 research also found that buyers discounted feeder calves as the difference between sale and delivery increased. ASV marketing characteristics showed statistically significant premiums for steers and heifers in the 2008 and 2009 model. The premiums for NHTC eligible steers and heifers were statistically significant and generated an additional $1.51/cwt in sales prices. The researcher also found that SLA video markets for steers and heifers are not a perfect reflection of feeder calf price variation compared to national feeder calf futures contract prices.

The results of the 2004 to 2009 annual SLA hedonic model showed that heifers were priced $5 to $8/cwt less than steers with an annual average lot size of 110 to 115 head. The West and Southeast region calves were discounted compared to the South Central calves. Small to medium framed calves were also discounted similar to 2005 to 2008 results. However, larger framed cattle are not statistically different than medium framed calves. Calves horned in 2006 had a premium of $1.18/cwt. Breed-influence price differentials for heifers showed more variability among coefficient estimates than steers, which likely contributed to the test results. Angus, black-faced, and black-white faced calves received the highest premiums ranging from $4.15 to $8.20/cwt, while Continental-influenced calves generated the smallest premium relative to Brahman calves with an additional $1.20 to $5.05/cwt. The statistical significance of flesh score as a price determinant in feeder calves varied considerably from year to year. Zimmerman (2010) found that a heavier condition is negatively correlated with feeder calf prices. A non-linear price-weight relationship existed for steer and heifer sales throughout the six model years. Sale lot uniformity favored heifers because they received more premiums compared to steers. The premiums for VAC 24 calves compared to non-weaned and non-vaccinated calves were consistently among the lowest of the certified health programs. Furthermore, premiums for weaning and respiratory vaccinations were highly dependent on health program requirements.

Additionally, price differentials for lower-tiered health and vaccination programs were less consistent compared to more stringent certified health programs. Compared to non-implanted calves, the price determinants for implanted calves, and sale lots with some implanted calves, or calves with unknown implant history were generally weak over the six years analyzed. The days-to-delivery variable was statistically significant in all steer and heifer models. Premiums existed in SLA video market sales for natural-eligible steers and heifers in 2004, 2006, and 2008. ASV also generated premiums for steers and heifers throughout the analysis.

In 2010, Schultz, Dhuyvetter, Harborth, and Waggoner studied the factors affecting feeder cattle prices in Kansas and Missouri. The purpose of the study was to gain knowledge of the current relationship between market pricing and genetic, management, and marketing decisions (Schultz et al., 2010). Transaction-level feeder cattle market data were collected on 8,200 feeder cattle lots in Dodge City, Kansas and Carthage, Missouri. Multiple regression analysis was used to analyze the influence of independent characteristics such as size, sex, color, breed, condition, fill, muscle, frame size, weight uniformity, freshness, presence of horns, time of sale, weight, and futures prices on feeder cattle cash prices. The regression results showed that Angus breeds crossbred with Angus × Hereford breeds received the highest premium compared to Hereford-influenced calves. However, Dairy and longhorn-influenced calves obtained the lowest discounts. Black hide colors received the highest premium compared to all the other hide color types. The red colored calves received the lowest price. Furthermore, heavy and extremely heavy muscled cattle received higher premium compared to the average muscled ones.

Schultz et al. (2010) found that steers brought the highest prices regardless of weight. Bull prices were discounted at lower weights and the discounts increased as weight increased. The researchers also pointed out that price weight slides varied by sex and season. Corn prices were statistically insignificant and so were not included in the model. They also found that buyers discounted calves that appeared to be non-healthy, had horns, or that were too thin or too fat. Weight uniform lots also received a premium. The researchers found that prices paid for calves were at their highest for lot sizes approaching the size of a truck load (Schultz et al., 2010). Furthermore, very full and full cattle compared to average fill cattle received discounts. The time of sale variable estimates showed that cattle sold in the third quarter of the sale obtained premiums relative to first quarter.

In 2011, Burdine conducted a study to determine causes of variation in feeder cattle prices in the Southeast. Burdine (2011) pointed out that pricing issues have major implications for cattle farmers in the southeast. Therefore, the primary purpose of his research was to explore these various pricing issues in feeder cattle markets. The research was based on three major objectives. The first was to examine cattle pricing relationships in Kentucky feeder cattle markets. The second objective of the study was to assess the price benefits farmers receive for marketing age and source verified cattle and for cattle sold as natural. The final research objective was to statistically analyze factors that influence basis for feeder cattle in Kentucky.

January 2008 to April 2011 internet sales data were obtained from the Bluegrass Stockyards in Kentucky, totaling about 1,600 observations. Transactional level data of the Kentucky Certified Preconditioned for Health (CPH) sales from the same period were also acquired from Bluegrass Stockyards. Feeder cattle and corn daily futures prices were obtained from the Livestock Marketing Information Center which databases futures prices from the Chicago Mercantile Exchange (CME; Burdine, 2011). Historical diesel fuel price data were also obtained from the Energy Information Administration (EIA) to determine transportation costs effects. A hedonic model was used for analyzing the two datasets. In addition, the Heckman model was used to examine the premium of age, source verified, and certified natural cattle. Based on the internet sales, the model included both the basis and bid price as the dependent variables in separate models. They were regressed on explanatory variables such as lot size, base weight, live futures, corn futures, diesel price, gender, location, slide, cattle type, shrink, ASV, and natural. The same was done for the CPH sales model except that the final CPH price was used as dependent variable instead of the bid price.

Results from the internet sales showed that each increase in lot size resulted in an increase ($0.02/cwt) in cattle price. The parameter estimate on lot size squared was negative showing its nonlinear nature. Base weight was significant with a negative parameter estimate of 0.025. Burdine (2011) also found that an increase in live futures of $1/cwt was associated with an increase internet sale price by $1.12/cwt while an increase in corn price by $1/bushel was associated with a decrease in cattle prices by $2.97/cwt. Heifers received a discount of approximately $6.99/cwt compared to steers. Seasonal effects were significant with the months of April to August receiving the highest prices while September to December received the lowest prices. The mix colored cattle received the lowest price ($1.94/cwt) compared to the black-faced and black-white faced cattle base variable. The Holsteins also had a discount of $22/cwt compared to the same base variable. With Tennessee as the base state, states closer to major cattle feeding areas were associated with higher prices (Burdine, 2011).

Shrink was statistically insignificant in explaining variation in prices, but the distance the cattle were hauled was significant. A unit increase in slide1 (which was the price adjustment for cattle that weigh more than advertised) resulted in a $0.49/cwt increase in price. Burdine (2011) also found that implanted cattle obtained a higher price of more than $0.39/cwt, suggesting that they may have seemed heavier muscled than their non-implanted counterparts. PVP cattle, natural cattle, and cattle with both attributes resulted in higher price levels than cattle that were neither PVP nor natural. He also found that as feeder futures increased, basis decreased and that a unit increase in diesel fuel prices resulted in a \$0.46 decrease in basis. However, corn prices were statistically insignificant in the CPH basis model. The results from the CPH price model showed that a one head increase in lot size resulted in about a \$0.09/cwt increase in price. However, the parameter estimate of lot size squared was negative, suggesting a decreasing return to the increased lot size. Burdine (2011) also found that an increase in weight was associated with a decrease in price for calves, and a \$1/cwt increase in deferred live cattle futures was associated with a \$1.2/cwt increase in price for groups of cattle in the CPH sales. A \$1 per bushel increase in corn price was associated with a decrease in price of \$4.20; however, diesel price was insignificant in explaining price in the CPH sales.

Heifers obtained about a lower price (\$11/cwt) in the CPH sales compared to that of the internet sales. Uniformity of the black and smoke cattle types were preferred over the black sort, which was received a lower price. Furthermore, the spring and summer months of April and June were associated with higher prices than January by \$2.69/cwt and \$2.30/cwt respectively. Burdine (2011) also found that one of the large order buying firms was discounted compared to the others. However, diesel price were insignificant in explaining variation in basis for CPH calves. Feeder cattle futures had a negative relationship with basis levels. However, corn futures and live futures were insignificant in explaining variation in basis.

Chapter 3

METHOD OF PROCEDURE

Each of the interlinked segments of the beef production industry discussed in section 1.2.1 depends on the number of inputs produced by its preceding production stage. For example, calves/feeder cattle serve as a form of input in the production of fed cattle and ultimately beef production. This interconnectedness causes the demand for feeder cattle to also create demand for beef and related products. Therefore, investigating the state of beef and cattle derived demand will aid in proper comprehension of how these intricacies influence the final market value of feeder cattle.

Examining demand as related to the cattle and beef industry usually centers on beef demand. Therefore, it is pertinent to note that there is a distinct difference between the consumer demand for meat and industry demand for cattle. Though, at the end of the beef supply chain, consumer demand is still the main impetus of the chain. For instance, a decrease or increase in consumer demand for beef will result in a leftward or rightward shift in the demand curve, respectively. Additionally, significant shifts in the beef demand curve will cause resulting shifts in the demand curve for cattle. For instance, if the demand for beef drops, cattle producers will experience a drop in their operations as feed producers experience a drop in demand.

3.1 Hedonic Pricing Model

The hedonic model is an important concept in estimating the value of input characteristics on final price. In the Lancaster (1966) model of consumer demand, the product characteristics approach was applied to production inputs. The model was based on Lancaster's (1966) consumer demand theory stating that the price of a purchased input depends on the sum of the monetary values of the input's characteristics to the purchaser. One of the most useful characteristics of this model is the hedonic pricing approach that the model adopts, which indicates that the demand for an input is impacted by the input's characteristics. Likewise, the hedonic pricing models consider the demand for a product and input as a function of its characteristics. In other words, hedonic pricing theory says that the price of an item is dependent upon the characteristics of that item.

Schroeder et al. (1988) explained that feeder cattle prices should be a function of the physical characteristics (C) of cattle, the lot and the market conditions (M) associated with that particular sale. This was summarized into a hedonic model pricing equation as

$$\text{Price}_{it} = \Sigma V_{kt} C_{kt} + \Sigma \text{R}_{\text{ht}} \text{M}_{\text{ht}}, \quad (1)$$

where k is a specific trait, h is the market influence and t is the specific auction date or month as the case may be. The value of a specific trait in a sale lot is represented by V, and R represents the effect of individual market forces on price.

For this research, the feeder cattle price differentials was modeled as a function of its physical traits and market forces similar to Williams et al. (2012), Schroeder et al. (1998), Zimmerman et al. (2010), and Faminow and Gum (1986). This is based on the assumption that the supply of feeder cattle at the NETBIO SSLA on a particular day is fixed; hence demand for a lot of feeder cattle are impacted by the physical features of the cattle on sale (Faminow and Gum, 1986). Specifically, the physical traits include lot size, sex, average weight, and color. The effect of market forces was represented by feeder cattle futures prices since future price of cattle is a reasonable indication of where beef prices are headed.

3.2 Feeder Cattle Hedonic Pricing Model for NETBIO Sales at SSLA

The hedonic pricing model explained in Section 3.2 was estimated using Ordinary Least Squares (OLS) method. This feeder cattle hedonic pricing model, explained in

Equation 2, was explicitly adapted to the characteristics recorded in the NETBIO data used in the study. A multiple regression method was used to estimate the relationship between the dependent and independent variables. The proposed model is given as follows:

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

Where β_0, β_1, … β_7 are parameters to be estimated;

P_{casht} is the cash price of feeder cattle in month t ($/cwt);

Lot size is the number of feeder cattle heads in the lot sold;

Sex is feeder cattle gender, a dummy variable: heifer=1, otherwise=0;

WT is the average weight of feeder cattle (pounds);

Breed is the breed type as indicated by color, representing 7 dummy variables;

JanuaryFutures is the closing prices of January futures contract ($/cwt);

MarchFutures is the closing prices of March futures contract ($/cwt);

AprilFutures is the closing prices of April futures contract ($/cwt);

MayFutures is the closing prices of May futures contract ($/cwt);

AugustFutures is the closing prices of August futures contract ($/cwt);

SeptemberFutures is the closing prices of September futures contract ($/cwt);

OctoberFutures is the closing prices of October futures contract ($/cwt);

NovemberFutures is the closing prices of November futures contract ($/cwt);

Lot^2 is the number of heads squared,

WT^2 is the average weight squared,

u_t is the error term.

The ordinary least squares (OLS) multiple regression method was used to estimate model parameters based on an observed set of values. Lot size, average weight, and futures closing prices are quantitative variables while sex and breed are qualitative variables. The parameters quantify the relationships between the independent variable and the response variable. The variables sex and color or breed type were represented by dummy variables whose coefficient estimates reflect the dollar per hundredweight change in feeder cattle cash price that follows when the variable characteristic is existent in the lot. SAS 9.3 and SAS Enterprise Guide 3.0 were used to estimate parameters in Equation 2. Feeder cattle futures are usually traded based on established contract specifications. These specifications, which include the contract size and trading months, are regulations that are set as standards for futures trading. The CME feeder cattle futures contract size is for 50,000 pounds of steers weighing up to 650-849 pounds each and they are grouped as medium-large frame #1-2 steers (Lacy et al., 2014). The futures prices are usually quoted in cents per pound units of measurement. According to Chicago Mercantile Exchange Group (2016), the last trading day is usually the last Thursday of the contract month. Futures contracts prices are available for only eight months out of twelve months in a year. These months include January, March, April, May, August, September, October and November. Therefore, the futures prices for these eight months are listed at a time. For example, in April 2015, futures prices were available for April contract month and subsequent months through January of 2016. In this research for example, in January 2010, all contracts that are traded during the remaining months of the year plus those from next year available on the date corresponding to the auction date were included in the hedonic model. The same was done for the subsequent months until November 2013 which was the last month considered. The corresponding monthly futures contract prices for each auction month were used in this research's analysis. The 2010 to 2013 closing future market prices for feeder cattle were used for the research analysis.

3.3 Description of Model Characteristics and Expectations

The data used in this study consist of 116,436 feeder cattle sold through SSLA from 2010 to 2013. The 116,436 feeder cattle were comprised of steers and heifers, with average weight ranging from 62-1,132 pounds. Feeder cattle characteristics recorded in the NETBIO data and the futures prices from the CME group were analyzed to meet the study's main objective.

3.3.1 Cattle Characteristics

Two dummy variables were created to represent gender where heifers received a value of 1 and steers received a value of 0. Previous research has shown gender to have a statistically significant influence on price, and it was expected that heifers will be discounted relative to steers (Faminow and Gum, 1986; Zimmerman et al., 2010). This discount may be due to heifers' features such as lower average daily gains, decreased feed efficiency, estrus cycle, as well as sudden pregnancies and problematic births that follow in the feedlot (Eldridge, 2005). Average weight was represented as weight variable in the hedonic model analysis. It was recorded as the total weight of cattle in a lot size divided by the number of heads in that lot. Consistent with Faminow and Gum (1986), average weight was expected to have a negative coefficient as it is hypothesized that price will decrease as average weight increases. To account for non-linear relationships between lot size and average weight, average weight squared was also included as an independent variable (Faminow and Gum 1986, Shultz et al., 2010). Prior studies found weight squared to be statistically significant variables in explaining variation in feeder cattle prices.

Most of the previous research has found breed (and breed combinations) to be either positively or negatively correlated to feeder cattle cash prices (Feuz et al., 2008; Mathews, 2007; Shultz et al., 2010). In this research, breed is a reflection of breed combinations and color. Originally, there were 47 breeds of cattle recorded in the NETBIO database. A list of each breed category starting from the original 47 breeds, and then 16 and 8 breeds are represented by the one way frequency tables 3.1, 3.2 and 3.3 respectively. A frequency table on the NETBIO breeds showed numerous breed types with similar names and less than one percent market share which makes analysis more difficult. Therefore, in order to simplify analysis and focus on the most important breeds in terms of market share, breeds with smaller market shares were consolidated into smaller breeds under one category. Table 3.4 shows the 16 breeds and the eight major categories into which they were classified.

Table 3.1

Frequency Table of 47 Breeds from NETBIO Sales at SSLA, 2010-2013

Breed	Frequency	Percent	Cumulative Frequency
#1	34	1.12	34
#1 1/2 Crossbred	315	10.34	349
#1 1/2 Okie	170	5.58	519
#1 Black	2	0.07	521
#1 Black & Black Baldy	19	0.62	540
#1 Black Yellow Red Feeder	21	0.69	561
#1 Crossbred	332	10.90	893
#1 Crossbred & Exotic	1	0.03	894
#1 Crossbred Feeder	19	0.62	913
#1 Exotic	35	1.15	948
#1 Feeder	70	2.30	1018
#1 Feeder Exotic	20	0.66	1038
#1 Okie	103	3.38	1141
#1 Okie & Crossbred	2	0.07	1143
#1 Okie & Exotic	71	2.33	1214
1 1/2 Crossbred	103	3.88	1317
1 1/2 Okie	1	0.03	1318
1/2 Crossbred	2	0.07	1320
Black Baldy	1	0.03	1321
Black Dairy	1	0.03	1322
Black Yellow Red Feeder	1	0.03	1323
Braford	10	0.33	1333

Table 3.1 Continued

Breed	Frequency	Percent	Cumulative Frequency
Brahman	114	3.74	1447
Brangus	148	4.86	1595
Brangus Baldy	20	0.65	1615
Brax Replecement	1	0.03	1616
Butcher Calf	1	0.03	1617
Black & Black Baldy	362	11.88	1979
Charolais	177	5.81	2156
Crossbred	358	11.75	2514
Dairy	91	2.99	2605
Dairycross	13	0.43	2618
Exotic	13	0.43	2631
Feeder	53	1.74	2684
Feeder Exotic	1	0.03	2685
Gert	1	0.03	2686
Hereford	5	0.16	2691
Holstein	100	3.28	2791
Jersey	18	0.59	2809
Longhorn	102	3.35	2911
Mixed	9	0.30	2920
Okie	62	2.04	2982
Okie & Crossbred	1	0.03	2983
Okie & Exotic	6	0.20	2989
Red Angus	3	0.10	2992
Red WF	1	0.03	2993
Tigerstripe	53	1.74	3046

Table 3.2

Frequency Tables of 16 Breeds and Breed Influences from NETBIO Sales at SSLA, 2010-2013

Breed	Frequency	Percent	Cumulative Frequency
Angus	3	0.10	3
Black	407	13.36	410
Bradford	10	0.33	420
Brahman	114	3.74	534
Brangus	168	5.52	702
Charolais	177	5.81	879
Crossbred	1141	37.46	2020
Dairy	104	3.41	2124
Exotic	146	4.79	2270
Hereford	5	0.16	2275
Holstein	100	3.28	2375
Jersey	18	0.59	2393
Longhorn	102	3.35	2495
Okie	337	11.06	2832
Other	161	5.29	2993
Tigerstripe	53	1.74	3046

Table 3.3

Frequencies of Final 8 Breeds and Breed Influences from NETBIO Sales at SSLA, 2010-2013

Breed	Frequency	Percent	Cumulative Frequency
Brahman	345	11.33	752
Continental	425	13.95	1177
Crossbred	1141	37.46	2318
Dairy	222	7.29	2540
English	8	0.26	2548
Okie	337	11.06	2885
Other	161	5.29	3046

The final eight breeds were included as dummy variables in the hedonic model. Feuz et al. (2008) and Burdine (2011) used the largest percentage of breed type represented in their data set as the base category for creating breed dummy variables. Therefore, to remain consistent with prior literature, crossbred cattle were used as the base category since crossbred cattle made up of about 37.46 percent of all breeds in the dataset. Brahman and breeds with Brahman influence were classified as Brahman or Brahman cross. Breeds with predominantly black color were put in the Black category. Breeds classified as English breeds or crosses and Continental included cattle from these categories and their crosses. Since the Angus cattle accounted for less than 10 percent of the breeds, it was classified under the English breeds or crosses. Dairy cattle and Dairy- influenced cattle were classified as Dairy. Okie, from the word Oklahoma, represents predominantly bald-faced, Hereford, Angus cross steers (Brown, 1992). These classifications are similar to research by Zimmerman et al. (2010), and Von Bailey and Peterson (1991), which used seven different binary variables to represent the various breed-influence categories. Von Bailey and Peterson (1991) found English breeds and crosses received the highest premium. In Mathews (2007), black cattle received the highest premium while dairy cattle were discounted relative to the crossbred breed. Therefore, based on past research it is expected that black cattle will receive the highest premium compared to the crossbred while the dairy or dairy crosses will be discounted compared to the base breed.

Table 3.4

Classifications of Breed and Breed Influences from NETBIO Sales at SSLA, 2010-2013

	Black	**Brahman / Brahman Cross**	**English breeds / crosses**	**Crossbred**	**Continental**	**Dairy**	**Okie**	**Other**
Angus			Angus					
Black	Black							
Brahman		Brahman						
Braford		Braford						
Brangus		Brangus						
Charolais					Charolais			
Crossbred				Crossbred				
Dairy						Dairy		
Exotic					Exotic			
Hereford			Hereford					
Holstein						Holstein		
Jersey						Jersey		
Longhorn					Longhorn			
Okie							Okie	
Tigerstripe		Tigerstripe						
Other								Other

Note: Classification of breed and breed influences was done by the author.

3.3.2 Lot characteristics

Lot size is expected to positively impact cash prices. According to Feuz et al. (2008), prices may actually decrease if the number of cattle in a herd was perceived as too large for most buyers. As a result, it was likely that increasing heads of cattle beyond a certain point would have a decreasing effect on prices. To account for non-linear relationships between lot size and price, lot size squared was also included as an independent variable (Faminow and Gum 1986, Shultz et al., 2010). Therefore, it is expected that lot size squared will have a negative relationship with feeder cattle cash prices.

3.3.3 Market Characteristics

The futures prices variable was included in the model to interpret the effects of market conditions on feeder cattle cash prices and also to determine if futures market prices can be used to forecast cash prices. As explained in section 3.5, for each auction date corresponding to the contract month considered, all available traded monthly contracts for the year all through next year were included in the hedonic model. The same was done for the subsequent months until November 2013, which was the last month considered. Therefore, January, March, April, May, August, September, October, and November futures were included in the hedonic model since these are the months in which futures prices are generally traded. Since the futures price is considered a tool that can be used to determine the future worth of cattle at slaughter, it is expected that the feeder cattle prices will increase as their corresponding futures price increases (Eldridge, 2005). Based on prior research, the expected signs and description of lot size, weight, and futures prices are summarized in Table 3.5. However, for the breed variables, the resulting signs will depend mainly on the reference breed category.

Table 3.5

Expected Signs of Parameter Estimates of the Hedonic Pricing Model

Variable	Variable Definition	Expected sign	Studies
Lot Size	Number of heads of feeder cattle in a lot sold	positive	Mathews (2007), Feuz et al. (2008), Burdine (2011).
(Lot Size)^2	Number of heads squared	negative	Mathews (2007), Feuz et al. (2008), Menzie et al. (1972), Burdine (2011).
Weight	Average weight of feeder cattle in a lot	negative	Mathews (2007), Menzie et al. (1972), Zimmerman (2010), Burdine (2011) Lunsford (2005).
(Weight)^2	Average weight of feeder cattle squared	positive	Menzie et al. (1972), Zimmerman (2010), Burdine (2011).
January Futures		positive	
March Futures		positive	
April Futures		positive	
May Futures		positive	Mathews (2007), Von Bailey and Petterson's (1991)
August Futures		positive	
September Futures		positive	
October Futures		positive	
November Futures		positive	

Table 3.5 Continued

Variable	Variable Definition	Expected sign	Studies
Sex (Heifers)	Cattle sex; Heifers = 1, Steers = 0	negative	Eldridge (2005), Zimmerman (2010), Mathews (2007), Burdine (2011)
Black	Cattle breed/breed combinations; Black= 1; otherwise= 0		
Brahman Influence	Cattle breed/breed combinations; Brahman= 1; otherwise= 0		
Continental	Cattle breed/breed combinations; Continental= 1; otherwise= 0		
Dairy	Cattle breed/breed combinations; Dairy= 1; otherwise= 0		
English	Cattle breed/breed combinations; English= 1; otherwise= 0		
Okie	Cattle breed/breed combinations; Okie= 1; otherwise= 0		
Other	Cattle breed/breed combinations; Other= 1; otherwise= 0		

3.4 Data Sources

Data on cattle characteristics were obtained from the Northeast Texas Beef Improvement Organization (NETBIO) sale catalogs at the Sulphur Springs Livestock Auction in Sulphur Springs, Texas. The animals' physical traits were recorded in written descriptions in catalogs. Monthly data were collected on cash price, lot size, breed, sex, and total weight for feeder cattle sold for the period of 2010 to 2013. However, to account for the influence of market conditions on feeder cattle cash prices, feeder cattle futures market contract prices were obtained through the Chicago Mercantile Exchange (CME) Group website.

3.5 Description of NETBIO Sales at SSLA

A livestock auction market is a common option for selling and buying cattle. Buyers go to a centrally located facility where cattle producers take their cattle to be sold and cattle consumers (including producers and processors) go to bid and buy cattle. The Sulphur Springs Livestock and Dairy Auction (SSLA) was established in 1952 and it is owned and operated by David Fowler and Joe Don Pogue. It is located in Sulphur Springs, Texas, halfway between Dallas and Texarkana. After the success of a multi-county, all breed bull sale and special feeder calf sale held by the Hopkins County Chamber of Agricultural Committee, the idea of developing a special feeder cattle market in East Texas was birthed. According to Parker (2015), in June 1998, a group of cattle producers and businessmen gathered at the Sulphur Springs sales barn to discuss this idea of establishing a better cattle market in Northeast Texas. A few months later in November 1998, the first NETBIO stocker and feeder calf sale was held at SSLA. It was also the first preconditioned commingled sale in Texas. Based on its mission to produce healthier and genetically improved cattle, NETBIO gradually gained a reputation for selling preconditioned calves. These preconditioned calves are calves that received required vaccinations and met established health requirements by participating veterinarians (Feedlot magazine, 1999). In addition, these calves, which usually have a NETBIO ID tag, must receive feed and water trough training, weaned a minimum of 45 days, and dehorned or castrated (Feedlot magazine, 1999). Preconditioned calves or cattle are then commingled or mixed into groups of the same weight, color, and breed type.

NETBIO pre-conditioned stocker sales are held six times a year on every Wednesday of every other month at the Sulphur Springs Livestock Auction (SSLA) barn. The SSLA also holds stocker sales every Monday while dairy sales are held on the first and third Thursdays of the month (SSLA website). The Monday beef sales include feed yard stocker calves, heifers, cow-calf pairs and slaughter cattle. Thursday sale options offer new-born calves, replacement dairy heifers, and dairy cows. Online bids are allowed during the NETBIO special stocker and feeder calf sales. The data used in this study were the data for NETBIO pre-conditioned stocker sale events from 2010 to 2013.

3.6 NETBIO Data

The NETBIO at Sulphur Springs Livestock Auction (SSLA) was used to achieve the primary objective of this study. SSLA sale sheets from special sales were obtained from NETBIO over the period of 2002 to 2015. These sales sheets included data on cattle characteristics such as lot size, sale number, auction date, and gender. Only those years with less than two missing months were used in the data analysis, years 2010-2013. Table 3.6 summarizes the feeder cattle traits recorded in the NETBIO data.

Table 3.6

Feeder Cattle Characteristics Recorded in the NETBIO Data from SSLA, 2010-2013

Trait Classification	Trait
Lot Characteristics	Year
	Lot number/Sale number
	Sale Price
Genetic Characteristics	Breed/color description
Marketing Characteristics	Auction date
	Number of cattle per lot sold
	Gender
	Weight/average weight
	Buyer name

For the years 2010, 2011, 2012, and 2013, there were 640, 797, 701, and 907 cattle transactions recorded in the NETBIO data analyzed, respectively. Table 3.7 reports a detailed description of the NETBIO database based on the sex of cattle. There were a total of 3,046 feeder cattle transactions from 2010 to 2013. Figure 3.1 summarizes the breeds reported in the NETBIO data. The top three breeds of feeder cattle demanded by buyers from 2010 to 2013 were Crossbred, Okie, and Black.

Table 3.7

NETBIO Data by Gender from SSLA, 2010-2013

Year	Steers	Heifers	Total Transactions	% of Total Transactions	
				Steers	Heifers
2010	337	303	640	53%	47%
2011	412	386	797	52%	48%
2012	393	308	701	56%	44%
2013	503	404	907	55%	45%
Total	1,645	1,401	3,046		

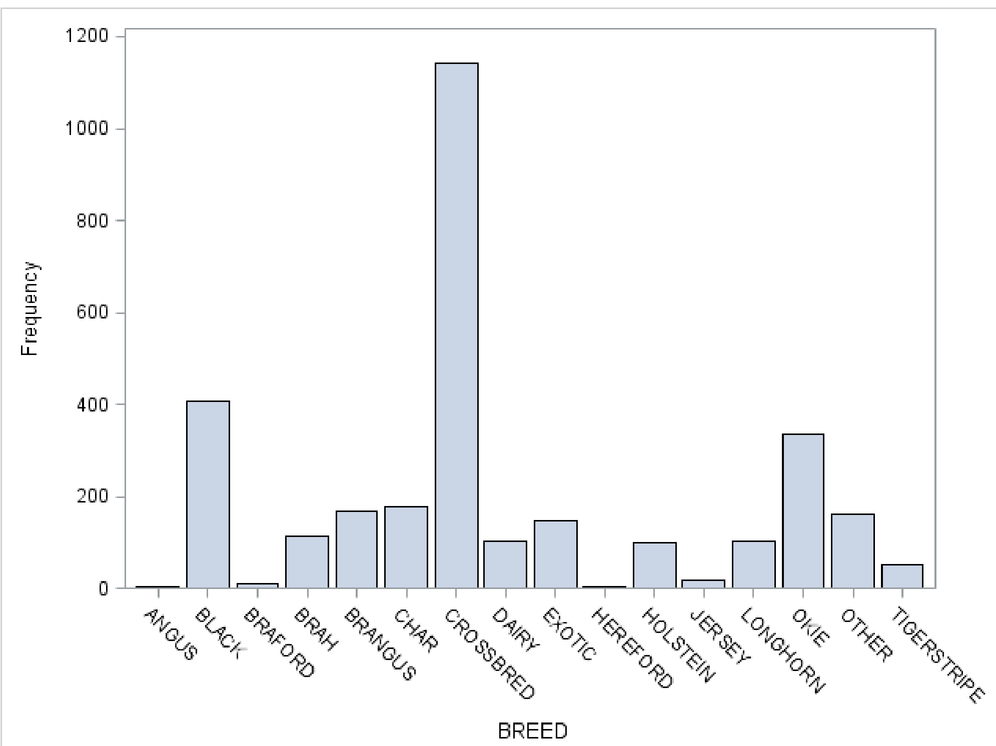

Figure 3.1 The 16 Breeds Reported from NETBIO Sales at SSLA, 2010-2013.

3.7 Descriptive Statistics

The NETBIO data set reports information on cash prices, lot size/number of heads, weight, average weight and buyer information e.g. buyer names. All feeder cattle characteristics reported were used in the hedonic pricing model. The model was estimated using 1,401 heifer lots and 1,645 steer lots sold on the SSLA market.

Both lots contained a total of 116,436 cattle sold from 2010 to 2013. Table 3.8 contains descriptive statistics of all measured lots and market characteristics. The average price for all cattle sold in the SSLA was $131.56/cwt and the highest price offered for a specific lot of cattle was $290.50/cwt. The average lot size was 38.23 head, with the lot size ranging from 1 head to 163 heads of cattle. The mean weight of all cattle sold was 567.99 pounds per head. Of all the cattle, 54% were steers and 46 percent were heifers. According to Figure 3.2, the crossbred made up the largest percentage (37%) of all the color or breed type included in the analysis. This reveals that crossbred cattle are popular amongst feeder cattle producers.

The Continental and Black cattle made up 14 and 13% of the cattle sold, respectively. The Brahman-influenced and Okie cattle both made up 11% of the cattle. The Dairy, English cross, and other breed types combined made up 12% of the cattle. The summary statistics of price, lot size, and weight were sorted by sex and are summarized in Table 4.2. Steers had on record the highest price with a mean of $132.48/cwt and an average weight of 36.39 pounds. Steers have a characteristic ability to rapidly gain weight about 8 to 10 times faster than heifers and they are much more efficient, maturing at a heavier weight compared to heifers. This may be the reason steers cost more than heifers as shown by Table 3.9 (Dunkel, 2000). The distribution of breeds sorted by sex is represented by the bar charts in Figure 3.3.

The figure shows that of all the breeds and sex considered in the NETBIO data, crossbred feeder cattle steers were the most popular amongst producers and buyers in the SSLA sales from 2010 to 2013.

Table 3.8

Descriptive Statistics from NETBIO Feeder Cattle Sales at SSLA and CME Futures Prices, 2010-2013

Variable	**Mean**	**Std. Dev.**	**Minimum**	**Maximum**
Price ($/cwt)	131.56	32.58	36.50	290.50
Lot Size (#heads)	38.23	30.05	1.00	163.00
Weight (lbs.)	567.99	156.76	62.00	1132.00
January Futures ($/cwt)	139.33	19.26	97.93	162.75
March Futures ($/cwt)	138.83	19.58	99.88	163.18
April Futures ($/cwt)	139.76	19.44	100.80	164.20
May Futures ($/cwt)	138.85	18.92	101.08	164.88
August Futures ($/cwt)	140.31	18.63	102.03	165.60
September Futures ($/cwt)	139.67	18.56	101.50	164.95
October Futures ($/cwt)	139.79	19.07	100.80	164.50
November Futures ($/cwt)	140.50	19.39	100.85	164.58
Steers ($/cwt)	0.54	0.50	0.00	1.00
Heifers ($/cwt)	0.46	0.50	0.00	1.00

Table 3.9

Descriptive Statistics by Sex from NETBIO Sales at SSLA

	Steers				Heifers			
Variable	Mean	Std. Dev.	Min.	Max.	Mean	Std. Dev.	Min.	Max.
Price ($/cwt)	132.48	35.67	46.50	290.00	130.47	28.51	36.50	240.00
Lot size (#heads)	36.39	29.57	1.00	163.00	40.38	30.46	1.00	151.00
Weight (lbs.)	572.89	163.19	62.00	1124.00	562.24	18.00	216.00	1132.00

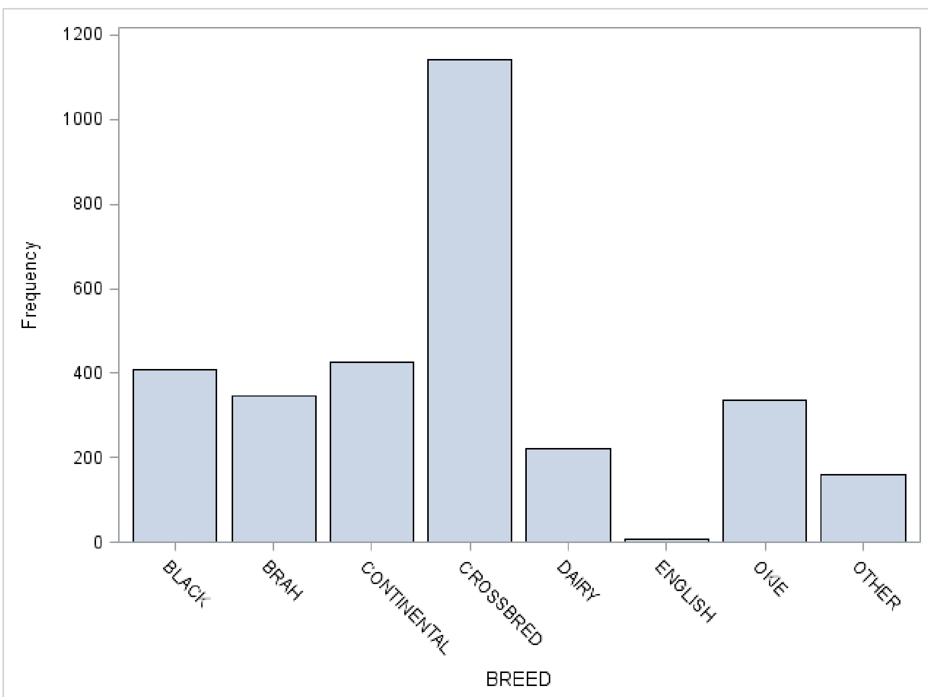

Figure 3.2 Frequency Distributions by Breed from NETBIO Sales at SSLA, 2010-2013

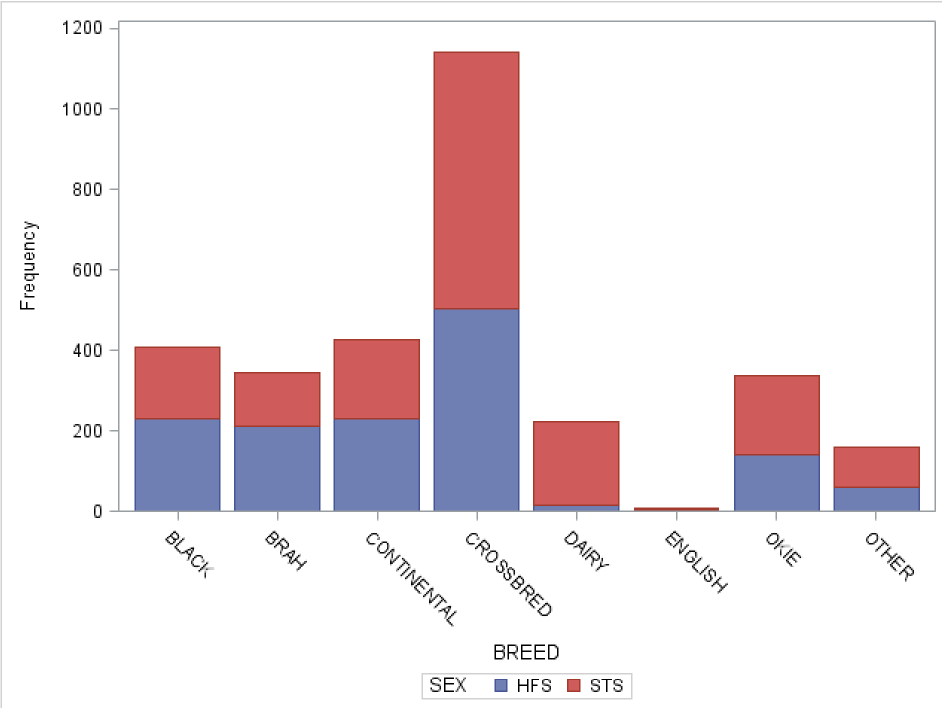

Figure 3.3 Frequency Distributions by Breed and Sex from NETBIO Sales at SSLA, 2010-2013

3.8 Model Assumption Diagnostics

Regression results must meet basic assumptions of the ordinary least square regression to be considered unbiased and efficient. However, some datasets do not meet basic assumptions of the ordinary least square. The validity of a research is increased if such violations are corrected or their effects on regression results acknowledged (Burdine, 2011). This is why it is important to use diagnostic tools to check and correct assumption violations.

One assumption of the OLS method is that independent variables are linearly independent. This means there is no linear relationship amongst independent variables, otherwise, the independent effect of each of the explanatory variables on the dependent variables will be difficult to determine. If this assumption is violated, multicollinearity occurs. When multicollinearity exists, the estimated standard errors are inflated and the statistical significance of coefficients is affected. The variance inflation factor (VIF) was used to examine the model for multi-collinearity. The VIF measures the speed variances are inflated.

Examining the correlations between independent variables can sometimes be limiting because even if correlations may be small, a linear relationship may still exist between variables. As a result, variance inflation factor is usually used to help detect multicollinearity. The VIF test showed that all of the independent variables had a VIF of between 10 and 20 except the average weight and the futures prices variables. Since these variables were important in explaining the cash price, it seemed inappropriate to exclude one of them in order to avoid misspecification error (O'Brien, 2007). Another assumption of the OLS model is that error terms are independent of each other. In a time series data, however, this assumption may not be met as a current time period's error term may be related to a previous time period's error term. Serial correlation or autocorrelation exists when this occurs. As a result, coefficient estimates may be biased. Consequently, coefficient standard errors may be under or overestimated, regression standard errors will be biased, and t values will be inflated.

The Durbin Watson test is one of the most common methods of detecting serial correlation in an OLS model. According to Stuart (1951), the Durbin-Watson procedure test statistic is *d* and is calculated theoretically as follows:

$$d = \frac{\sum_{t=2}^{n}(e_t - e_{t-1})^2}{\sum_{t=1}^{n} e_t^2} \tag{3}$$

The symbol e_t in Equation 3 represents the residuals or observed error terms. A zero d value indicates perfect positive correlation while a d value of 4 indicates perfect negative correlation. In addition, a d value of 2 shows the absence of correlation and a d value below 2 shows positive first order serial correlation. A d value of above 2 shows negative serial correlation. The result of the Durbin Watson (DW) coefficient from the PROC REG option in SAS was used to detect autocorrelation. Pr < DW is the p value for showing positive autocorrelation while Pr > DW is the p value for showing negative autocorrelation. The Pr < DW value resulted in a significant probability indicative of positive first order autocorrelation. The PROC AUTOREG option in SAS was then used to correct for first order autocorrelation.

Chapter 4

RESULTS

4.1 Regression Estimation Results

The hedonic regression model summarized in Equation 13 was estimated using a total of 3,045 observations out of a total of 3,046. In order to empirically determine the factors that impact the feeder cattle price differences, the hedonic model was estimated using the PROC REG procedure in SAS 9.3. The ordinary least squares (OLS) parameter estimates along with the standard error, *t* value and probabilities are displayed in Table 4.1. The R^2 shows that the independent variables in the regression model explained 65 percent of the differences in feeder cattle cash prices. The *F* test suggests that there is enough statistical evidence to support the claim that at least one of the parameter estimates is different from zero at the 0.01 significance level (p-value = 0.01).

Each estimated coefficient describes how much feeder cattle cash prices would change in dollars per hundredweight ($/cwt) for a one unit change in each of the quantitative explanatory variables. Parameter coefficient estimates corresponding to the variables lot size and weight squared had the expected positive sign. Furthermore, the parameter estimates associated with the dummy variable heifer and quantitative variables weight and lot size squared had the expected negative sign. The coefficient estimates associated with breeds Black, Brahman, Continental, Okie, English and other breeds were statistically significant in explaining variation in cash prices at the one percent significance level.

4.1.1 Results for Lot Characteristics

According to Table 4.1, the regression results show that, as expected, the parameter estimate associated with lot size was positive, which suggests that as lot size increase, the cash price increases. For every unit increase in lot size, the feeder cattle cash prices increased, on average, by $0.20/cwt., ceteris paribus. However, the negative relationship between price and lot size squared, as represented by the negative coefficient, shows that the lot size began decreasing at a point as lot size becomes larger. These results are consistent with studies by Burdine (2011), Feuz et al. (2008), and Mathews (2007) which also reported a positive but between price and lot size.

4.1.2 Cattle Characteristics

The coefficient estimate associated with heifers was approximately -8.30 which show that heifers were discounted at a price of $8.37/cwt compared to steers with all other variables being equal. This also is as expected and supports the hypothesis explained by Eldridge (2005) that heifers are usually discounted primarily due to lower average daily gains, decreased feed efficiency and unexpected difficult births that sometimes happen in the feedlot. Our negative estimate for the coefficient corresponding to the variable heifer further supports the results that buyers are usually pay more for steers compared to heifers.

The weight coefficient estimate shows a significant negative relationship with cash price variable. Consistent with Faminow and Gum (1986), Mathews (2007), Menzie et al. (1972) and Zimmerman (2010), as the animal weight increased by 1 pound, the SSLA prices decreased on average by $0.04/cwt. This seems to suggest that buyers generally pay more for lighter weight of feeder cattle, and that buyers generally pay less as more pounds are purchased.

Table 4.1

Parameter Estimates from NETBIO SSLA for Specific Feeder Cattle Characteristics

Variable	Parameter Estimate	Standard Error	t value	Pr > |t|
Intercept	49.0310	5.2929	9.26	<.0001
Lot size	0.3949	0.0418	9.44	<.0001
(Lot size)^2	-0.0025	0.0004	-6.72	<.0001
Heifer	-8.3732	0.7261	-11.53	<.0001
Weight	-0.1580	0.0160	-9.85	<.0001
(Weight)^2	0.0001	0.0000	4.77	<.0001
Black*	10.5289	1.1352	9.28	<.0001
Brahman*	12.2608	1.3422	9.13	<.0001
Continental*	-5.1715	1.1239	-4.60	0.0010
Dairy*	-43.8271	1.5878	-27.60	<.0001
English*	16.6234	6.8691	2.42	<.0001
Okie*	4.0195	1.2068	3.33	<.0001
Other*	9.0060	1.8471	4.88	<.0001
January Futures	0.4968	0.1505	3.30	0.0010
March Futures	1.3386	0.4763	2.81	0.0050
April Futures	-1.8615	0.5246	-3.55	0.0004
May Futures	0.3946	0.0866	4.55	<.0001
August Futures	-0.1896	0.1193	-1.59	0.1122
September Futures	0.9114	0.1697	5.37	<.0001
October Futures	3.5984	0.3401	10.58	<.0001
November Futures	-3.6215	0.4755	-7.62	<.0001
R^2	0.6533			
F-Value	284.88			<.0001

*=crossbred as base category

The parameter estimates associated with Black, Brahman, Continental, Dairy, English, Okie and Other breed variables were all statistically significant at 0.01 significant level. The English breeds/crosses such as Angus and Hereford received on average the highest premium of $16.62/cwt, compared to the base breed category of crossbred feeder cattle ceteris paribus. The Brahman breeds/crosses received the second highest premium of $12.26 per hundredweight compared to crossbred feeder cattle ceteris paribus. In addition, consistent with Mathews (2007), the Black breeds obtained a premium of $10.52/cwt relative to crossbred feeder cattle ceteris paribus. Okie breeds received the lowest premium of $4.02 per hundredweight compared to crossbred feeder cattle. As opposed to Mathews (2007), Continental breeds such as Charolais received a discount of about $5.17/cwt compared to crossbred cattle ceteris paribus. Dairy breeds received the highest discount of about $43.83/cwt ceteris paribus, which is consistent with the results from Mathews (2007).

All the coefficient estimates for the variables corresponding to the futures months were statistically significant 0.01 significant level, except the August and March futures price. Consistent with Mathews (2007), Schroeder et al., (1988), and Von Bailey and Petterson (1991) it was expected that the parameter estimate associated with each of the futures month would be positive since in general cash prices and futures prices are positively correlated. In addition, when anticipated demand increases, it was expected that feeder cattle bids in both the futures and cash markets would increase as well. However, contrary to expectations, a $1/cwt increase in feeder cattle April futures and November closing prices was associated with a $1.86/cwt and $3.62/cwt decrease in feeder cattle cash prices respectively. January, May, September and October futures closing prices were positively correlated with feeder cattle closing prices. However, October futures prices were associated with the highest increase of $3.60/cwt in cash prices for every $1/cwt increase in futures prices, all other things being equal. This shows that for most of the auction months, the feeder cattle cash prices and futures price were moving together.

Chapter 5

SUMMARY AND CONCLUSIONS

In 2007, Texas was the top-ranked cattle-feeding area in the United States followed by Kansas, Nebraska, Colorado and Iowa (Feuz et al., 2008). Because of the large size of cow-calf operations in Texas, there are various local markets for feeder calves, including local livestock auctions. However, local feeder cattle cash prices differ greatly depending on breed, weight, frame, uniformity, lot size, and cattle preconditioned state. These factors greatly influence profitability and lucrativeness of producers' feeder cattle business. The primary objective of this research was to empirically identify the factors affecting feeder cattle cash price differentials by using a hedonic pricing model to estimate data from NETBIO at SSLA.

A total of 3,045 observations were used in the estimation of the multiple regression model. Data were collected from NETBIO sales at SSLA on independent variables such as the weight, lot size, sex, breed type/color of cattle, cash prices, and futures prices. Data on feeder cattle futures prices corresponding to auction date were obtained from the Chicago Mercantile Exchange (CME) group. Statistical analyses of the data were employed in this research.

The multiple regression analysis of the effect of the explanatory variables on feeder cattle cash price showed that 64% of the variability in the feeder cattle cash prices is explained by the independent variables. The model's F value showed the overall significance of the hedonic model and the parameter estimate results were reliable. The ordinary least square parameter estimation showed that seventeen out of eighteen independent variables used were significant in explaining variation in cash prices. The lot size variable positively impacted the feeder cattle cash price. In addition, it was found that lot size squared and prices were negatively correlated. Heifers also had a negative relationship with feeder cattle cash prices. Average weight variable positively impacted cash prices. The English breeds/crosses such as Angus and Hereford received the highest premium while the Dairy breeds received the highest discount compared to Crossbred. As we approached the end of the year, futures prices increased which is important knowledge for producers bidding on calves to be sold later in the year.

5.1 Recommendations for Further Research

Future research could be done to explore the effect of explanatory variables on cattle cash prices using data from other value added programs. Farmers can benefit from the results of a comparative analysis of NETBIO and these other value added programs. This poses more questions for further research. Which value added program is more beneficial to Northeast Texas farmers? Furthermore, since the last year considered in this study, 2013, the U.S cattle industry has since experienced several challenges such as rising cattle prices and tight supply. Therefore, further studies can be done to include the latest available data in order to investigate the influence of these changes on feeder cattle cash prices.

Another area which may be considered in further research is the effect of specific market, lot, and genetic cattle characteristics on basis using NETBIO feeder cattle cash prices. The difference between NETBIO cash prices and futures prices is referred to as basis. Basis is a better reflection of the demand and supply situation in an auction market as it changes as local market conditions change. In addition, basis is usually less volatile compared to local prices. Therefore, using basis as opposed to prices themselves is considered a more efficient risk management tool. In spite of the variability of basis, it has a higher predictability compared to cash prices. Along with researching the influence of basis on feeder cattle cash prices, future research can also be done on developing accurate basis forecast for several months into the future that can be applicable to Northeast Texas farmers. In addition, future research could explore the use of dummy variables to represent the auction months to account for seasonality in cattle marketing in regression analysis. Though the results of this research provide useful information for Northeast Texas farmers, additional information could further assist producers in identifying the factors that determine the premiums and discounts farmers' cattle receive in the market. For example, the effects of other specific market considerations that influence demand and supply of cattle like buyers' income, government policy, price of substitutes, seller reputation, transportation costs, feed costs, feed futures (e.g. corn futures) and so on can be analyzed. These factors are also important in determining how much buyers pay for cattle and how much farmers will receive for cattle and calves. Future research can also explore the use of panel data estimation techniques to determine parameter estimates and coefficients.

Another area that should be researched is the profitability of the Northeast Texas Beef Improvement Program. This could serve as a stronger piece of evidence to support or reject the hypothesis that the Northeast Texas Beef Improvement Program is a beneficial program. The cost of production of farmers in the NETBIO can be included in the research model in order to compare the gross revenue obtained and costs incurred. Therefore, in addition to feeder cattle cash prices, the study can also analyze profits.

5.2 Policy Implications

By using knowledge of price relationships between futures prices, cattle, lot characteristics, and cattle cash prices, farmers can make efficient management decisions. Farmers can use knowledge of price predictions to estimate discount and premiums associated with cattle sales so as to increase profitability. Also, using the knowledge from resulting price relationships between various characteristics, producers can make educated decisions for herd expansion and cattle purchases in order to increase profitability. The results of this study show

how value added programs are relevant to cattle producers and buyers alike. Therefore, there is a need for establishing more of programs like NETBIO in Northeast Texas to better serve the expanding feeder cattle market. According to previous literature, futures prices can be used to predict cash prices of agricultural commodities (Faminow and Gum, 1986; Mathews, 2007; Zimmerman, 2010). However, this study reinforces this observation in that futures prices can be used as a tool to predict the expected direction of the feeder cattle market. Finally, these results justify the fact that historical data on sales and market value are a useful tool in technical and fundamental analysis of agricultural businesses to mitigate losses from risks and uninformed decisions.

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