A Hedonic Analysis of Feeder Cattle Auction Prices in Northeast Texas

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Selected Paper prepared for presentation at the Southern Agricultural Economics Association's 2017 Annual Meeting, Mobile, Alabama, February 4-7, 2017

Abstract

The U.S. has the largest fed cattle industry in the world (USDA-NASS, 2016) and makes about $10.5 billion dollars in cash receipts from beef cattle sales (Texas Department of Agriculture, 2015). Our study analyzes sales of pre-conditioned calves from 22 auctions between 2010 and 2013 in Northeast Texas, determines which intrinsic quality attributes add most value, and examines the extent to which physical attributes along with the futures market help explain variation in feeder cattle prices. Our results showed that lot size, weight, sex, breed, and feeder cattle futures prices are all statistical significant factors affecting feeder cattle cash prices. A unit gain in weight resulted in a very slight discount, heifers were discounted compared to steers, and the English breeds received premiums over crossbreds. Feeder cattle cash and futures price were positively associated with the October futures contract providing the largest bump to cash prices. Understanding of the quality attributes and the relationship between feeder cattle cash and future prices may assist local producers in formulating price risk management strategies that have implications on profitability.

Key words: auction data, feeder cattle, futures market, hedonic analysis

JLE codes: Q110, Q210

Introduction

Cattle production has been a major contributor to the U.S. economy for many years. As the world's largest beef producer, the U.S. has the largest fed cattle industry in the world with an increasing demand and a large export market. According to the U.S. Department of Agriculture (USDA), 19% of the total world's beef production comes from the U.S. (USDA-ERS-PSD, 2015).

For the period 2004-2014, world meat production increased by 23% (from 216.7 to 266 million MT CWE) with swine meat exhibiting the largest annual world production volume (101.4 million MT CWE or 43%), followed by poultry meat (80.9 million MT or 33%), and then beef (60.5 million MT or 25%) (USDA-ERS-PSD, 2015).[1] Over the same time period, poultry meat production increased by 38% (from 67.0 million MT to 93.0 million MT) while beef only increased 8% (from 57.8 million MT CWE to 62.4 million MT CWE) (USDA-ERS-PSD, 2015). The European Union, U.S., and Brazil are significantly larger producers of meat compared to all the other countries in the world.

Contrary to world production, poultry production in U.S. exhibits the largest volume (18.9 million MT or 46%) from 2004 to 2014, followed by beef (11.8 million MT CWE or 29%), and swine (10.1 million MT CWE or 25%) (USDA-ERS-PSD, 2015). While beef production had a negative growth of 1% during this period (from 11.26 to 11.13 million MT CWE), swine, and poultry production increased by 11% and 12% (from 9.3 to 10.3 million MT CWE and 17.7

[1] 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. Total meat is defined as the sum of beef, pork, and poultry meat (broiler and turkey). Beef and pork quantities are 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 are in ready to cook (RTC) equivalent basis. All quantities are reported in metric tons (MT).

to 19.9 million MT), respectively (USDA-ERS-PSD, 2015). The U.S. continues to be the top beef producer with an average annual production of 11.8 million MT CWE, which accounts for 19% of the world's beef production (USDA-ERS-PSD, 2015).

As the world population grew by 11% from 2004 to 2013, world meat consumption increased by 21% (from 213 to 258 million MT) (USDA-ERS-PSD, 2015). With an average share of 42% or 101.3 million MT CWE, pork is the world's most consumed meat in the world, followed by poultry (33% or 79.8 million MT), and beef (24% or 57.4 million MT CWE) (USDA-ERS-PSD, 2015). Poultry and swine annual world consumption increased by 36% and 20% (65.8 to 89.4 million MT and from 92.0 to 110.7 million MT CWE), respectively; while beef consumption increased by only 5% (from 55.5 to 58.3 million MT CWE) (USDA-ERS-PSD, 2015). China (28% or 67.4 million MT), the European Union (17% or 39.7 million MT), and the U.S. (15% or 36.7 million MT) have the highest total meat volume consumption compared to all the other countries in the world (USDA-ERS-PSD, 2015). In terms of per-capita consumption, the U.S. has the largest annual per-capita meat consumption of 119.41 kg/person followed by Argentina (105.34 kg/person), and Brazil (92.51 kg/person) (USDA-ERS-PSD, 2015; IMF-IFS, 2013). Poultry is the most consumed meat in the U.S. accounting for 42% or 15.8 million MT of the total meat consumed, followed by beef (33% or 12.2 million MT CWE), and swine (24% or 8.7 million MT CWE) (USDA-ERS-PSD, 2015).

Total meat imports in the world increased by 40% (from 16.5 to 23.1 million MT) from 2004 to 2014 (USDA-ERS-PSD, 2015). Poultry is the most imported meat with an average volume share of 39% or 8 million MT CWE, followed by beef (32% or 6.6 million MT CWE), and pork (29% or 6.1 million MT) (USDA-ERS-PSD, 2015). During this period, poultry imports grew 53% (from 6.0 to 9.1 million MT), followed by swine imports (from 4.7 to 6.5 million MT

CWE or 40%), and then by beef imports (from 5.9 to 6.6 million MT CWE or 28%). Russia is the largest meat importing country accounting for 13.3% (or 2.73 million MT) of the volume of all meat imports, followed by Japan (13.2% or 2.71 million MT), the U.S. (8.3% or 1.7 million MT), Mexico (6.9% or 1.4 million MT), and the European Union (6.7% or 1.4 million MT) (USDA-ERS-PSD, 2015). Although the U.S. imports fell 22% (from 2.2 to 1.7 million MT), the U.S. plays a major economic role in world's meat import market with beef accounting for 73% (or 1.2 million MT) of the meat imports, followed by pork (24% or 0.4 million MT), and poultry (3% or 0.05 million MT).

World meat exports, on the other hand, went up by 51% from 2004 to 2014 (from 20.2 to 30.4 million MT) (USDA-ERS-PSD, 2015). Unlike imports, beef is the most exported meat in the world with an average volume share of 40% or 9.9 million MT, followed by poultry (36% or 9.1 million MT) and swine exports (24% or 6.1 million MT). In addition, poultry exports experienced the highest growth rate (from 6.6 to 11.2 million MT or 69%), followed by swine (from 4.7 to 7.0 million MT or 32%), and then beef (from 8.7 to 12.1 million MT or 40%). The U.S. is the world's largest meat exporter accounting for 23.4% (or 5.9 million MT) of the world's meat exports closely followed by Brazil accounting for 22.6% (or 5.7 million MT). Mexico and Canada, our NAFTA partners, are the largest export market for the U.S. meats. The U.S. and India also experienced a large growth rate in meat exports from 2004 to 2014, 101% and 276%, respectively.

In the U.S., poultry holds the largest volume share of meat exports with an average share of 54% (or 3.2 million MT). Swine exports follow with an average volume share of 31% (or 1.8 million MT) and beef with the smallest volume share of 14% (or 0.8 million MT). Nevertheless, U.S. beef exports grew by an outstanding 464% from 2004 to 2014 (from 0.2 to 1.2 million MT

CWE) followed by swine exports (from 1 to 2.3 million MT CWE or 57%) and poultry (from 2.4 to 3.7 million MT or 54%). The U.S. is a net exporter of total meat with an export volume of about three times its imports. While the U.S. total meat imports declined by 22% (from 2.2 to 1.7 million MT), the total meat exports increased by 101% (from 3.6 to 7.2 million MT) from 2004 to 2014.

Some U.S. trade policies and programs introduced in recent years favored the U.S. meat exports. 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 et al., 2014). This program which certifies beef export to the European Union caused steady export growth reaching a peak in 2013 (Arita et al., 2014).

Cattle and calves on feed on all 1,000 head capacity feedlots in the U.S. is about 10.8 million head (USDA-NASS, 2016). Sales of cattle and calves went from $40.76 billion in economic value accounting for 21% of all agricultural output in 2000 (Otto and Lawrence, 2001) to $61.2 billion in economic value and 20% of all agricultural output in 2007, placing cattle and calf sales first in sales rank among all commodities (Mathews and McBride 2011). The revenue from the sale of beef cattle is the largest source of Texas' agricultural revenue (Texas Department of Agriculture, 2015). About 11.8 million MT CWE of beef production and processing (USDA-ERS-PSD, 2015) provides over 1.4 million jobs in terms of direct and indirect employment (Otto and Lawrence, 2001). Through its economic and commercial value, the U.S beef cattle industry has continued as a major driver of the U.S economy.

Beef cattle and calves are produced in almost all areas of the U.S. However, a large percentage of the U.S. beef cows is found in the South, which includes the Southern Plains and the Southeast compared to the Northern Plains and North Central region (USDA-NASS, 2015).

Despite a longer grazing season, the Southern Plains requires less supplemental forage during winter, which reduces feed costs significantly (McBride and Mathews, 2011). However, cow-calf operators in the Northern Plains spend more to maintain herds due to harsher climatic conditions. In 2007, the states of Texas, Missouri, Oklahoma, Nebraska and South Dakota accounted for 40% of all beef cows in the U.S. (Feuz et al., 2008). In 2015, the states with most cattle in feedlots with capacity of more than 1000 head were Nebraska, Texas, Kansas, Colorado and Iowa (National Beef Cattlemen's Beef Association, 2015).

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 U.S. while making about $10.5 billion dollars in cash receipts from beef cattle sales (Texas Department of Agriculture, 2015). In terms of gross income, Texas is the top beef state producing $7.5 billion in beef and feeder cattle (USDA-NASS, 2009). In 2010, Texas was the top state based on cattle on feed inventory producing 24.3% of the U.S. total (USDA-NASS, 2015).

About 5 million calves are born on 130,000 cow-calf operations in Texas (Texas Department of Agriculture, 2015). Despite local feeder cattle cash prices varying significantly depending on breed, weight, frame, uniformity, lot size, and cattle preconditioned status, there is an uptrend in steer prices (Figure 1). Higher steer price may be driven by increasing production costs but also by consumers' demand for beef increasing faster than the producers' beef supply. Most feeder cattle farmers are price takers, and although sources of price fluctuations like seasonality, environmental conditions and demand and supply are beyond producers' control; cattle farmers would benefit from a better understanding of the premiums and discounts they can obtain for their cattle.

Although several studies have been done on feeder cattle prices throughout the U.S., this study is unique in that it focuses on Northeast Texas. Similar to Zimmerman (2010), the general objective of the study is to identify factors that affect feeder cattle price differentials from Northeast Texas Beef Improvement Organization (NETBIO) sales at Sulphur Springs Livestock Auction (SSLA).

Literature Review

There is extensive research on the determinants of price differentials in feeder cattle auction markets. Hedonic pricing models have generally been used to estimate the value of feeder cattle characteristics sold through auction market. They are useful in understanding the relationship between market pricing and genetic, management, and marketing decisions. In particular, they have been found useful in understanding how management at the cow-calf level influences the calf price at auction markets.

Feeder cattle price differentials have been studied from feeder cattle auctions from all over the U.S. using regions (West Rocky Mountain/North Central, South Central, Southeast, Midwest, and Northeast) (Zimmerman, 2010), and from livestock auctions in Arizona (Menzie, et al., 1972; Faminow and Gum, 1986), Arkansas (Troxel et al., 2002), Kansas (Schultz et al., 2010), Kentucky (Burdine, 2011), Missouri (Matthews, 2007; Schultz et al., 2010), Montana, North Dakota, and South Dakota (Leupp et al., 2008). These studies provide insight on the use and development of this study's feeder cattle pricing model. This study also provides the industry with information from livestock auctions in Northeast Texas and explores revenue opportunities that may exist from pre-conditioned feeder calf sales.

Previous research estimates feeder calf prices at livestock auctions as a function of the physical characteristics of the animal (resulting from the animal genetics or management strategy), the marketing strategy, and the market forces of demand and supply (which are also influenced by the marketing and management strategies, and the animal genetics). Lot variables (lot size, lot ID, commingle or non-comingle lot, etc.), [2] genetic variables (breed, color, type, frame score, frame size, gender, horn presence, sex, etc.), management variables (age, base weight, condition, fill, health, health program, horn status, implant status, muscle, muscle thickness, natural, natural program qualified, shrink, slide, type of sale, use of deworming products, vaccination history, vaccination program, weight, etc.), marketing variables (age-verification status, beef-quality-assurance status, date, freshness, grade, location, month, source, source verified, time, weight uniformity, year, etc.), and market variables (corn futures price, diesel price, fat cattle price, etc.) have been identified as relevant variables in formulating hedonic pricing models for feeder cattle.

Menzie et al. (1972) analyzed the influence of weight, grade, sex, breed, lot size, and current fat cattle price on feeder cattle price. Faminow and Gum (1986) used a price discount model for feeder cattle to determine price premiums and discounts based on weight, lot size, sex, breed, and sale year. Troxel et al. (2002) estimated the effects of 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. Mathews (2007) based her hedonic model for cattle sale price on the variables type of sale, month, year, lot, sex, weight, breed, commingled or non-commingled lot, lot size, futures price, and corn price. Leupp et al. (2008) estimated the effects of 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 feeder calf cash prices. Zimmerman (2010) studied

[2] A commingled lot is a lot comprised of cattle from multiple sources.

the price effect of variables breed, 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) on calf (steer and heifer) prices. Schultz et al. (2010) analyzed the influence of 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. Burdine (2011) estimated two separate hedonic models to analyze feeder cattle prices, one including basis and the other including bid price as the dependent variables, and included explanatory variables lot size, base weight, live futures, corn futures, diesel price, gender, location, slide, cattle type, shrink, ASV, and natural. A sales model was also estimated using Certified Preconditioned for Health (CPH) as dependent variable instead of the bid price. Burdine (2011) also used a Heckman model to examine price premiums resulting from age, source verified, and certified natural cattle.

Previous research indicates that crossbred cattle are discounted compared to straight breeds (Faminow and Gum, 1986). Black hide colors receive the highest premium compared to all the other hide color types (Schultz et al., 2010; Zimmerman, 2010; Leupp et al., 2008) and compared to crossbred calves (Mathews, 2007). Similarly, black- and black-white faced cattle receive higher prices than mix colored cattle (Burdine, 2011; Zimmerman, 2010), with red colored calves receiving the lowest price (Schultz et al., 2010). Angus, Angus × Hereford crosses, and "Okie" are priced higher than Herefords (Schultz et al., 2010; Von Bailey and Peterson, 1991; Menzie et al., 1972), but Limousin-influenced cattle receives a premium compared to Angus (Troxel et al., 2002). Among the calves receiving the largest discounts are Longhorn (Schultz et al., 2010; Troxel et al., 2002) and dairy (Schultz et al., 2010; Mathews, 2007). Relative to Brahman calves, the continental-influenced calves generated the smallest premium (Zimmerman, 2010).

Model

Our hedonic price model is based on Lancaster's (1966) theory that the price of a commodity depends on the sum of the monetary values of the commodity's characteristics to the purchaser. Following Schroeder et al. (1988), in our hedonic price model, feeder cattle price is a function of the physical characteristics (C) of cattle, and the lot and the market conditions (M) associated with a particular sale. That is,

$$Price_{it} = \Sigma V_{kt} C_{kt} + \Sigma R_{ht} M_{ht}, \quad (1)$$

where k is a specific trait, h is the market influence and t is the auction date. 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. This hedonic price modeling is also consistent with Williams et al. (2012), Schroeder et al. (1998), Zimmerman (2010), and Faminow and Gum (1986); and is based on the assumption that supply of feeder cattle at an auction on a particular day is fixed, hence demand for a lot of feeder cattle depends on the physical features of the cattle on sale (Faminow and Gum, 1986).

Expanding equation (1) according to the characteristics recorded in the NETBIO data, our hedonic pricing model is:

$$P_{casht} = \beta_0 + \beta_1 Lot_t + \beta_2 Lot^2_t + \beta_3 Heifer_t + \beta_4 WT_t + \beta_5 WT^2_t + \beta_6 Black + \beta_7 Brahman + \beta_8 Continental + \beta_9 Dairy + \beta_{10} English + \beta_{11} Okie + \beta_{12} Other + \beta_{13} JanuaryFutures + \beta_{14} MarchFutures + \beta_{15} AprilFutures + \beta_{16} MayFutures + \beta_{17} AugustFutures + \beta_{18} SeptemberFutures + \beta_{19} OctoberFutures + \beta_{20} NovemberFutures + \varepsilon_t, \quad (2)$$

where $\beta_0, \beta_1, \ldots \beta_{20}$ are parameters to be estimated; P_{casht} is the auction feeder cattle cash price in month t ($/cwt); *Lot* is the number of feeder cattle heads in the lot sold; Lot^2 is the number of heads squared; *Heifer* is a dummy variable for sex which equals 1 if heifer and 0 if steer; *Black*, *Brahman*, *Continental*, *Dairy*, *English*, *Okie*, and *Other* are dummy variables for breed; and *JanuaryFutures, MarchFutures, AprilFutures, MayFutures, AugustFutures, SeptemberFutures, OctoberFutures, and NovemberFutures* is the closing prices of January, March, April, May, August, September, October, and November futures contract ($/cwt), respectively; and ε_t is the error term.

Feeder cattle futures are traded based on established contract specifications. Futures contracts prices for feeder cattle at the Chicago Mercantile Exchange (CME) Group are available for eight months of the year (January, March, April, May, August, September, October and November). The corresponding closing future market price was used for each auction's date plus those of the remaining months and next year futures prices for the previous months.

Data

Data on feeder cattle characteristics (cash price, lot size, breed, sex, and weight) for the period of 2010 to 2013 were obtained from the Northeast Texas Beef Improvement Organization (NETBIO) special sales at the Sulphur Springs Livestock Auction in Sulphur Springs, Texas while data on feeder cattle futures market prices were obtained from the Chicago Mercantile Exchange (CME) Group.

NETBIO pre-conditioned calf sales are held six times a year on the third Wednesday of every other month at the Sulphur Springs Livestock Auction (SSLA) barn. Pre-conditioned calves are calves that have been weaned from their mothers a minimum of 45 days, taught how to eat grain and drink from a water trough, given the proper vaccinations requirements set forth by the organization, met established health requirements by veterinarians approved by the NETBIO board of directors, and have a NETBIO tag in their left ear. These standards reduce stress in the calves when they go to the sale barn, thereby reducing incidence of calf illness. Pre-conditioned calves usually go to a stocker or a feed yard. Calves sold at an ordinary sale barns are at higher risk of becoming sick than preconditioned calves.

The NETBIO data consisted of 116,436 feeder cattle sold through SSLA from 2010 to 2013. The 116,436 feeder cattle were comprised of steers and heifers, with weights ranging from 62-1,132 lbs. Table 1 summarizes the breeds or crosses that were reported by NETBIO from 2010 to 2013. To simplify analysis and focus on the most important breeds in terms of market share, breeds with smaller market shares were consolidated with similar breeds. The breeds reported in Table 1 were consolidated into Black, Brahman or Brahman crosses (Brahman, Bradford, Brangus, and Tigerstripe), English breeds or crosses (Angus and Hereford), Crossbred, Continental (Charolais, Exotic, and Longhorn), Dairy (Dairy, Holstein, and Jersey), Okie, Other. Table 2 reports the breed categories used in this study while Table 3 reports NETBIO transactions by sex and by year. There were a total of 3,046 feeder cattle transactions from 2010 to 2013, 640 transactions in 2010, 798 in 2011, 701 in 2012, and 907 in 2013. Equivalently, there were 1,401 heifer and 1,645 steer lots sold from 2010 to 2013.

Overall (regardless of breed and sex) descriptive statistics are reported in Table 4. 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 lbs. per head. Of all the cattle, 54% were steers and 46% were heifers.

In addition, from 2010 to 2013, Crossbred made up the largest percentage (37%) among the eight breed categories with steers being the most popular sale (Figure 2). 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. Table 5 reports summary statistics of price, lot size, and weight by sex. Steers had on record the highest price with a mean of $132.48/cwt and an average weight of 36.39 lbs. Steers generally gain weight about 8 to 10 times faster than heifers and they are much more efficient, maturing at a heavier weight compared to heifers, which explains why buyers are willing to pay more for steers than heifers (Dunkel, 2000).

Similar to Zimmerman (2010) and Von Bailey and Peterson (1991), Brahman and Brahman-influence breeds were classified as Brahman or Brahman cross. Breeds with predominantly black color were classified as Black. English breeds or English crosses were classified as English. Similarly, Continental breeds or their crosses were classified as continental. Angus was classified as English breed because it had an average breed share of 10%. Dairy cattle or Dairy-influenced cattle were classified as Dairy. Okie, from the word Oklahoma, represents predominantly bald-faced, Hereford, Angus cross steers (Brown, 1992). Following Burdine (2011) and Feuz et al. (2008), breeds were included in the hedonic model as dummy variables; and crossbred, which has the largest breed (37.46 %), was used as the base category. Figure 2 summarizes the breeds reported in the NETBIO data while Figure 3 summarizes the breed categories used in this study. The top three breeds of feeder cattle demanded by auction buyers from 2010 to 2013 were Crossbred, Okie, and Black.

Results

The parameters of the hedonic regression model, Equation (2), were estimated using ordinary least squares (OLS) in the Statistical Software System (SAS), version 9.3. The resulting parameter estimates along with their standard errors, *t* values, and *p* values are reported in Table 6. The goodness of fit measures indicate a relatively good fit of the model. The R^2 shows that the independent variables in the regression model explained 65% of the total variation 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).

Similar to Faminow and Gum (1986) and Shultz et al. (2010), to account for the non-linear relationship between feeder cattle cash prices and the variables lot size and weight, the latter two variables squared were included in the model. Consistent with Burdine (2011), Feuz et al. (2008), Mathews (2007), and Menzie et al. (1972), the parameter estimate associated with lot size variable was positive while the parameter estimate associated with the lot size variable squared was negative, which suggests that feeder cattle price increases at a decreasing rate as lot size increases. In general, if lot size increases by 1 head, the feeder cattle cash price is expected to increase by $0.20/cwt, everything else constant. In addition, consistent Faminow and Gum (1986), the variable weight obtained a negative sign and it was statistically significant at the 1% significance level. Similarly, consistent with Faminow and Gum (1986) and Shultz et al. (2010), the variable weight squared was found to be positive and statistically significant at the 1% significance level.

The parameter estimate corresponding to the variable weight shows a statistical significant negative relationship with the cash price variable, which is consistent with Burdine

(2011), Zimmerman (2010), Mathews (2007), Lunsford (2005), Faminow and Gum (1986), and Menzie et al. (1972). Similarly, consistent with Burdine (2011), Zimmerman (2010), and Menzie et al. (1972) the coefficient of the weight squared variable is positive. In general, our results indicate that if feeder cattle weight increases by 1 lb., the feeder cattle price is expected to decrease by $0.04/cwt, everything else constant. In general, this suggests that buyers pay less for heavier-weight feeder cattle, and that feeder cattle prices decrease at a decreasing rate as feeder cattle weight increases. This is because there is less opportunity to put weight on heavier calves at the feed yard (i.e., less opportunity to make a profit).

As expected, heifers were discounted $8.37/cwt compared to steers, everything else constant. Our negative estimate for the coefficient further supports the results that buyers usually pay more for steers than heifers (Burdine, 2011; Zimmerman, 2010; Mathews, 2007; Eldridge, 2005; and Faminow and Gum, 1986). Eldridge (2005) explains that heifers are usually discounted primarily due to lower average daily gains, decreased feed efficiency, estrus cycle, and sudden pregnancies and problematic births that follow in the feedlot.

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 crossbred feeder cattle. The Brahman breeds/crosses received the second highest premium of $12.26/cwt compared to crossbred feeder cattle. In addition, consistent with Mathews (2007), the Black breeds obtained a premium of $10.53/cwt relative to crossbred feeder cattle ceteris paribus. Okie breeds received the lowest premium of $4.02/cwt 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, which is consistent with the results from Mathews (2007).

Since the futures price represents 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). In addition, when anticipated demand increases, it is expected that feeder cattle bids in both the futures and cash markets would increase as well. All the coefficient estimates for the variables corresponding to the futures months were statistically significant at least 0.01 significant level, except for the August and March futures price. Each estimated coefficient corresponding to the futures market prices describes how much feeder cattle cash prices ($/cwt) would change for a one unit change in the feeder cattle futures prices ($/cwt). Consistent with Mathews (2007), Von Bailey and Peterson (1991), and Schroeder et al., (1988), it is 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. Our results indicate that a $1/cwt increase in feeder cattle April and November futures 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 cash prices with the October futures prices being associated with the highest increase.

Conclusion

The U.S. 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 (USDA-NASS, 2016). In 2007, Texas was the top-ranked cattle-feeding area in the U.S. followed by Kansas, Nebraska, Colorado and Iowa (Feuz et al., 2008). 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 affect cash prices. Our study identified physical characteristics of feeder cattle and lot and the market conditions at the time of the auction that are significant determinants of feeder cattle cash prices from NETBIO sold at SSLA. Using these characteristics, overall, our hedonic model was found statistically significant, it explained 64% of the total variation in the feeder cattle auction prices, and twenty of twenty one parameter estimates were statistically significant. By using knowledge of price relationships between futures prices, cattle, lot characteristics, and cattle cash prices; feeder cattle farmers can make efficient management decisions about herd expansion and cattle purchases and estimate discounts and premiums associated with feeder cattle sales, which may also assist in formulating likely profitability scenarios. In addition, the summary statistics presented in this study also reflected that value added programs are relevant to cattle producers and buyers. Consistent with previous literature (Faminow and Gum, 1986; Mathews, 2007; Zimmerman, 2010), our study reinforces the relevance of futures prices as a tool to predict the feeder cattle auction 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 while the Dairy breeds received the highest discount compared to Crossbred. 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.

Future research could explore using panel data estimation techniques and incorporate dummy variables for the auction months to account for any seasonality in cattle marketing. The costs of production to farmers from NETBIO could be included to conduct benefit/cost and/or profitability analyses. Future research could also expand to include other value added programs and conduct comparative analyses of these programs with NETBIO.

Extensive research has also been conducted on the effect of physical and lot and market characteristics on basis. Further research could explore the effect of these variables on basis rather than on feeder cattle cash prices. Basis may be 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 than local cash prices and is also considered to have higher predictability than cash prices. Using basis as opposed to cash prices may be a more efficient risk management tool. Understanding of basis can be very useful to Northeast Texas feeder cattle farmers in making important marketing decisions. Future research can also focus on developing an accurate basis forecast for several months into the future that can be applicable to Northeast Texas farmers. Obtaining an accurate basis forecast may lead to increased participation in hedging strategies by feeder cattle producers and farmers in Northeast Texas and greatly benefit them.

Though the results of this research provide useful information for Northeast Texas cattle farmers, additional information could be incorporated into the model to further assist producers in identifying the factors that determine feeder cattle premiums and discounts. For example, the effects of buyers' income, government policies, price of substitutes, seller reputation, transportation costs, feed costs, and feed futures prices (e.g., corn futures) can also be analyzed.

References

Arita, S., J. Beckman, L. Kuberka, and A. Melton. Sanitary and Phytosanitary Measures and Tariff-Rate Quotas for US Meat Exports to the European Union. U.S. Department of Agriculture, Economic Research Service. Special Outlook Report No. LDPM-245-01, 2014. Internet site: http://www.ers.usda.gov/media/1712394/ldpm-245-01.pdf

Burdine, K. H. "Factors Affecting Feeder Cattle Prices in the Southeast." Ph.D. dissertation, University of Kentucky, Lexington, KY, 2011. Internet site: http://uknowledge.uky.edu/cgi/viewcontent.cgi?article=1001&context=agecon_etds

Brown, T.D. "Factors Affecting Calf Value and Marketing Terminology Used In Describing Them." Florida Beef Cattle Short Course, *Conference Proceedings*, 1992. Internet site: http://animal.ifas.ufl.edu/beef_extension/bcsc/1992/docs/brown.pdf

Chicago Mercantile Exchange Group-Cattle Futures and Options. Internet site: https://www.cmegroup.com/trading/agricultural/files/fact-card-cattle-futures-options.pdf (Accessed May 30, 2016).

Dunkel, J. "Factors Affecting the Performance of a Feedlot Cattle." Feedlot Magazine Volume V111 No.1, 2000. Internet site: http://feedlotmagazine.com/archive/archive/issues/200001/cattleperformance.html (Accessed August 2015).

Eldridge, R. W. "Kentucky Feeder Cattle Price Analysis: Models for Price Predictions and Grazing Management." Master's Thesis, University of Kentucky, Lexington, 2005. Internet site: http://uknowledge.uky.edu/cgi/viewcontent.cgi?article=1175&context=gradschool_theses

Faminow, M. D., and R. L. Gum. "Feeder Cattle Price Differentials in Arizona Auction Markets." *Western Journal of Agricultural Economics* 46 (1986):156-163. Internet site: http://ageconsearch.umn.edu/bitstream/32255/1/11020156.pdf

Feuz, D. M., C. Harris, D. Bailey, and G. Halverson. "Transportation and Quality Adjusted Basis: Does the Law of One Price Hold for Feeder Cattle?" Paper presented at Western Agricultural Economics Association Annual Meetings, Big Sky, Montana, June, 2008. Internet site: http://ageconsearch.umn.edu/bitstream/42311/2/Adjusted%20Basis.pdf

International Monetary Fund (IMF) - International Financial Statistics (IFS) Browser, World's population (Data file). Internet site: http://elibrary-data.imf.org/ (Accessed March 6, 2013).

Lancaster, K.J. "A New Approach to Consumer Theory." *The Journal of Political Economy* 74(1966):132-157. Internet site: https://www.iei.liu.se/nek/730g83/artiklar/1.328858/Lancaster2.pdf

Leupp, J. L., G. P. Lardy, R. Daly, C.L. Wright, and J. A. Paterson. "Factors Influencing Price of North Dakota, South Dakota and Montana Feeder Calves." *Proceedings, Western Section, American Society of Animal Science*, 2008, 59:129-131. Internet site: http://www.asas.org/docs/western-section/2008-western-section-proceedings.pdf?sfvrsn=0

Mathews, C. D. "Measuring Value-Added Characteristics in Feeder Cattle." Ph.D. dissertation, Texas A&M University, August 2007. Internet site: http://oaktrust.library.tamu.edu/bitstream/handle/1969.1/ETD-TAMU-1404/MATHEWS-THESIS.pdf?sequence=1&isAllowed=y

Mathews, K., and W.D. McBride. *The Diverse Structure and Organization of U.S. Beef Cow-Calf Farms.* Washington, DC: U.S. Department of Agriculture, Economic Research Service. Economic Information Bulletin No. 73, 2011. Internet site: https://www.ers.usda.gov/webdocs/publications/eib73/7611_eib73.pdf?v=41063

Menzie, E. L., R. L. Gum, and C. C. Cable. *Major Determinants of Feeder Cattle Prices at Arizona Livestock Auctions.* Tucson, AZ: College of Agriculture, University of Arizona. Arizona Agricultural Experiment Station Technical Bulletin, No. 197, 1972. Internet site: https://arizona.openrepository.com/arizona/bitstream/10150/556152/1/TB197-1972.pdf

National Cattlemen's Beef Association. Beef Bytes. Internet site: http://www.beefusa.org/beefindustrystatistics (Accessed October 2015).

Otto, D., and J.D. Lawrence. "Economic Impact of the United States Beef Industry." Iowa State University, Department of Economics, 2001. Internet site: www.beef.org/uDocs/Econ%20Impact%20Beef%20v2.doc

Schroeder, T. C., C. E. Ward, J.R. Mintert, and D. S. Peel. "Value-Based Pricing of Fed Cattle: Challenges and Research Agenda." *Review of Agricultural Economics* 20(1998):125-134.

Schroeder, T., J. Mintert, F. Brazle, and O. Grunewald. "Factors Affecting Feeder Cattle Price Differentials." *Western Journal of Agricultural Economics* (1988):71-81. Internet site: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.528.7242&rep=rep1&type=pdf

Schultz, L., K. K. Dhuyvetter, J. Harborth, and J. Waggoner. "Factors Affecting Feeder Cattle Prices in Kansas and Missouri." Special Report, Cooperative Extension Service, Kansas State University, March 2010. Internet site: http://www.agmanager.info/livestock/budgets/production/beef/Factors%20Affecting%20Feeder%20Cattle%20Prices%20%28Nov2009--RevisedMar2010%29.pdf

Texas Department of Agriculture. Texas Ag Stats. Internet site: https://texasagriculture.gov/About/TexasAgStats.aspx (Accessed November, 2015).

Troxel, T. R., M.S. Gadberry, S.Cline, J. Foley, G. Ford, D. Urell, and R. Wiedower. "Factors Affecting the Selling Price of Feeder Cattle Sold at Arkansas Livestock Auctions." *The Professional Animal Scientist* 18(2002):227-236. Internet site: http://arkansasagnews.uark.edu/545-13.pdf

United States Department of Agriculture (USDA) – National Agricultural Statistics Service (NASS). 2007 Census of Agriculture. 2009. Internet site: https://www.agcensus.usda.gov/Publications/2007/Full_Report/index.asp (Accessed October, 2015).

United States Department of Agriculture (USDA) – National Agricultural Statistics Service (NASS). 2016. Internet site: https://www.nass.usda.gov/Charts_and_Maps/Cattle/index.php (Accessed June, 2016).

United States Department of Agriculture (USDA) – National Agricultural Statistics Service (NASS). Livestock Slaughter 2014 Summary. 2015. Internet site: http://usda.mannlib.cornell.edu/usda/nass/LiveSlauSu//2010s/2015/LiveSlauSu-04-27-2015.pdf (Accessed October, 2015).

United States Department of Agriculture – Economic Research Service – Production Supply Distribution Online Database. 2015. Internet site: http://www.fas.usda.gov/psdonline/psdQuery.aspx (Accessed August, 2015).

Von Bailey, D., and M.C. Peterson. A Comparison of Pricing Structures at Video and Traditional Cattle Auctions. *Western Journal of Agricultural Economics* (1991):392-403.

Williams, G. S., K.C. Raper, E.A. DeVuyst, D. Peel, and D. McKinney. "Determinants of Price Differentials in Oklahoma Value-Added Feeder Cattle Auctions." *Journal of Agricultural and Resource Economics* 37(2012):115. Internet site: http://ageconsearch.umn.edu/bitstream/122309/2/DeVuyst,%20pg.%20114-127.pdf

Zimmerman, L. C. "Factors Influencing the Price of Value-Added Calves at Superior Livestock Auction." Master's Thesis, Department of Agricultural Economics, Kansas State University, Manhattan, 2010. Internet site: http://krex.k-state.edu/dspace/bitstream/handle/2097/6991/LanceZimmerman2010.pdf?sequence=3&isAllowed=y

Tables

Table 1. Breeds reported in 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
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 2. Breeds Categories Used in this Study 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

Table 3. NETBIO Transactions by Sex from SSLA, 2010-2013.

Year	Steers	Heifers	Total Transactions	% of Total Transactions	
				Steers	**Heifers**
2010	337	303	640	53%	47%
2011	412	386	798	52%	48%
2012	393	308	701	56%	44%
2013	503	404	907	55%	45%
Total	1,645	1,401	3,046		

Table 4. 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 5. 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

Table 6. 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
$(\text{Lot size})^2$	-0.0025	0.0004	-6.72	<.0001
Heifer	-8.3732	0.7261	-11.53	<.0001
Weight	-0.1580	0.0160	-9.85	<.0001
$(\text{Weight})^2$	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
Goodness of Fit				
R^2	0.6533			
F-Value	284.88			<.0001

* Crossbred is the base category.

Figures

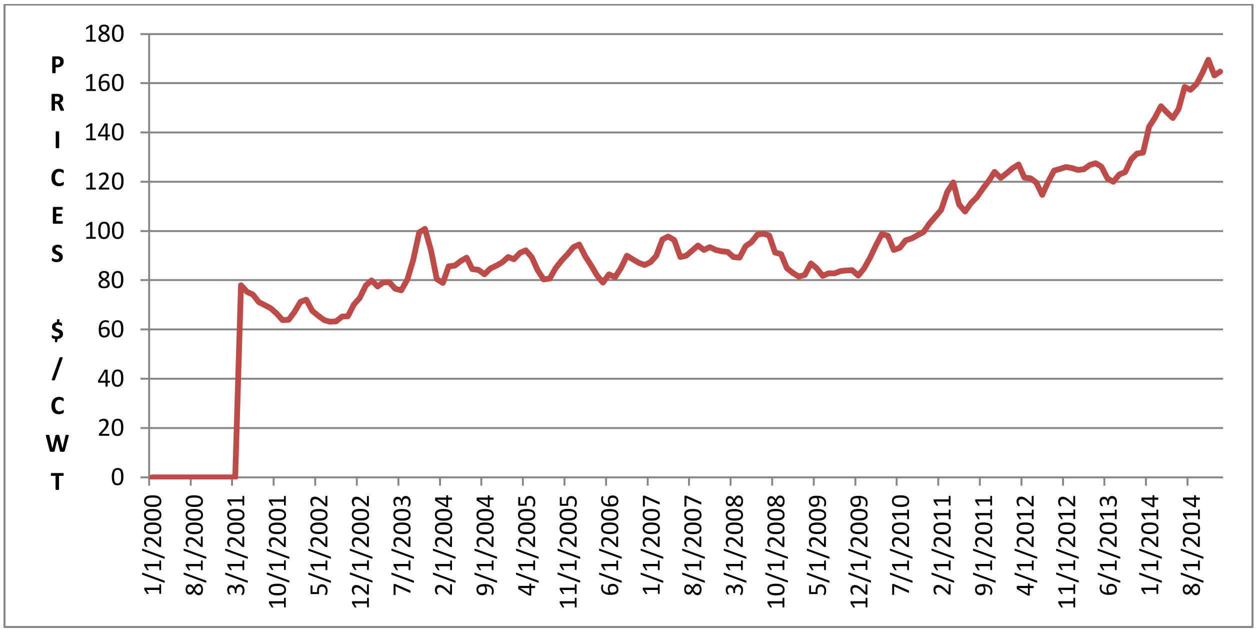

Figure 1. Cattle (Steer) Prices, 2000-2014.
Source: USDA-ERS-PSD (2015).

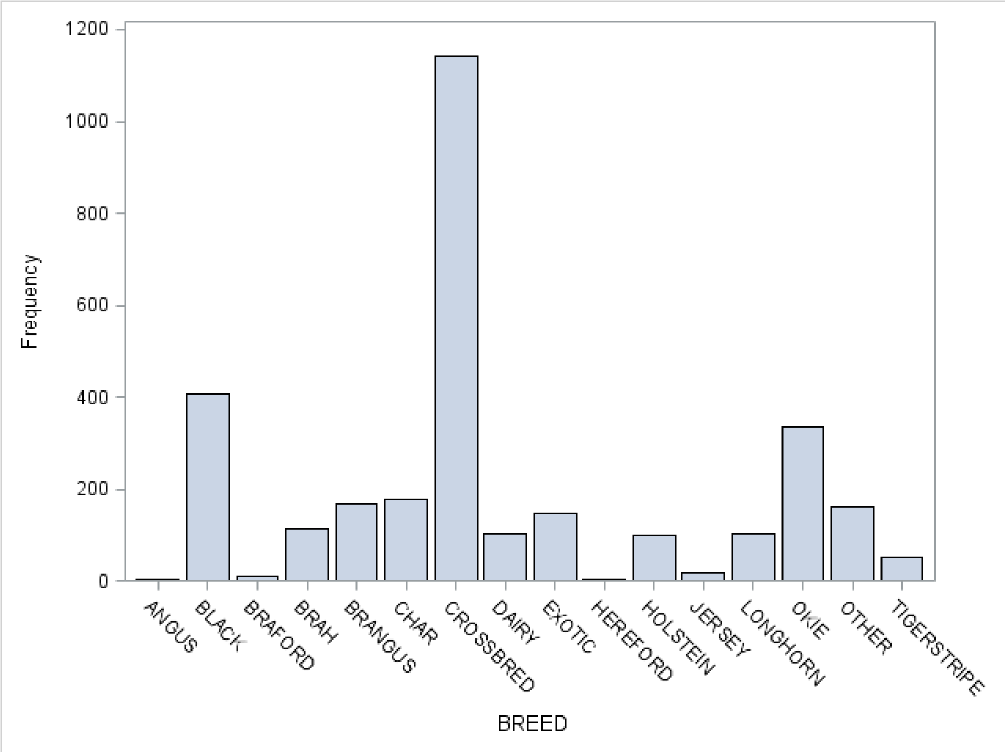

Figure 2. Breeds Reported in NETBIO Sales at SSLA, 2010-2013.

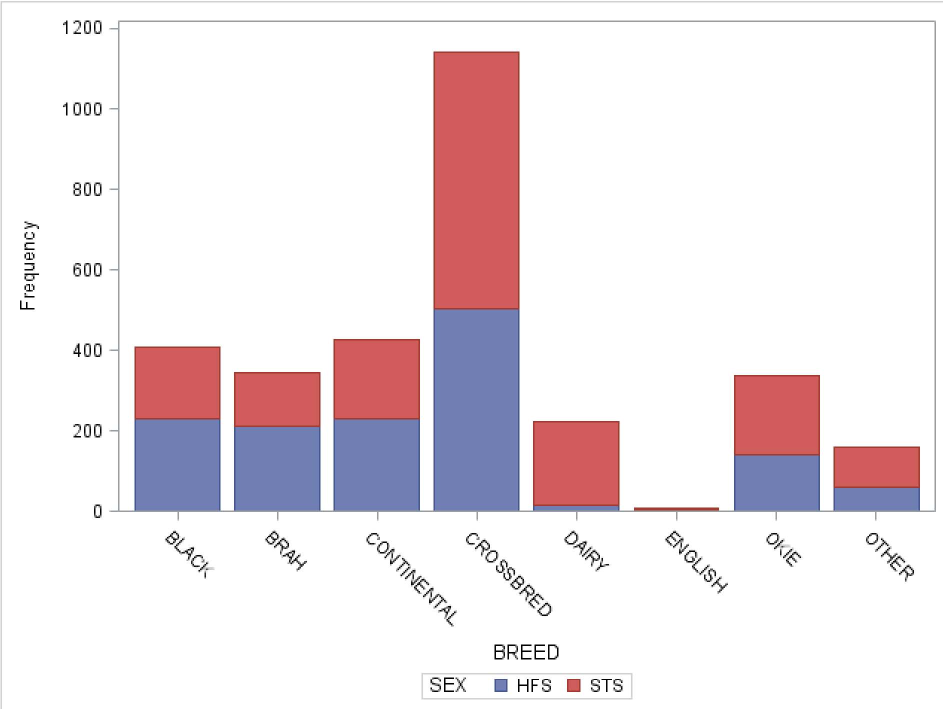

Figure 3. Breed categories Used in this Study from NETBIO Sales at SSLA, 2010-2013.