Factors Affecting Feeder Cattle Prices in New York State

A Thesis

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ABSTRACT

Price determination for feeder cattle is complex because many factors (and their interactions) impact feeder cattle markets. Further, feeder cattle price differentials associated with feeder cattle weight vary as economic conditions change over time. By collecting market price data from 2011 through 2013 for a series of feeder cattle auctions at a livestock exchange in upstate New York and futures price data on finished cattle and feed inputs, the effects of various market conditions, lot characteristics, quality attributes, and auction characteristics on local feeder cattle prices are identified. Feeder cattle prices are found to vary importantly by the levels and volatilities in fed cattle and corn futures prices, sex of the animal, and month of sale. Results also reveal significant premiums for feeder cattle based on certain breed, heavy muscling, and preconditioning, while buyers discount for bulls, horns, smaller frame size, light muscling, and unthrifty cattle. The values of these premiums and discounts vary as cattle grow. Larger uniform lots, the number of buyers, and earlier sale time within an auction are also associated with higher prices on average. The values of these price changes are important as producers compare these values with the costs associated with management practices that address them.

BIOGRAPHICAL SKETCH

Jing Qian was born in Fuyang, Zhejiang Province, P. R. China on Jan. 16th, 1990. She attended Zhejiang University from 2004 to 2008 and graduated at an overall GPA of 3.94/4.00 with a Bachelor Degree in Economics. During her undergraduate study, she demonstrated academic records by winning numerous awards including First-Class Scholarship (top 3%), Samsung Scholarship (top 5%) and Bank of Hangzhou Scholarship (top 3%). Besides course works, Jing also put great effort in research. Being the team leader in Zhejiang “New Sprout” Talent Program, she led a team of four people in designing questionnaires, conducting fieldwork and building economic models to analyze the state of industrial clusters in the silicon industry. Her other projects include studying the impact of human capital on mechanisms of economic growth by exploring the measuring methods of human capital investment, calculating the GINI indexes of 18 industries from 1988 to 2006 in China.

In 2012, Jing was admitted by Master of Science program in the Department of Applied Economics and Management at Cornell University. During the past two years, she finished 11 main courses with a GPA of 3.92/4.00. She also conducted a research project with Professor Todd Schmit. The topic is about constructing a regression model to estimate the impact various physical characteristics and market factors have on feeder cattle prices, as well as developing a regression equation to determine the best fit for describing the relationship of local feeder cattle prices to futures prices for feeder cattle and corn. Because of her excellent performance, she was granted a PhD offer and will continue her research in the department.

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Secondly, the data for this research was made available by Dr. Michael Baker through his applied research and extension project entitled "Expanding the Beef Industry through Evaluation of Production and Marketing Strategies", funded by Hatch and Smith Lever Funds from the National Institute for Food and Agriculture, United States Department of Agriculture. I thank him for his assistance, as well as Matt LeRoux, who collected the feeder cattle auction data.

Thirdly, I would like to thank my parents and friends for their continuous support. Life always has highs and lows. With their support, I have been and will always be confident to overcome any difficulties.

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Chapter 1: Introduction and Literature Review

1.1 Background

The United States is one of the leading beef producers in the world, where between 24 and 27 billion pounds of beef are produced annually in the United States. That said, beef consumption has been gradually decreasing since the 1970s (Comerford et al. 2013). As of January 2014, there were 87.7 million cattle and calves in production in the United States (NASS, 2014). Figure 1.1 shows the U.S. cattle inventory from 1989 to 2014. Since reaching its peak in 1995, the cattle inventory is most recently at its lowest level since 1989, at roughly 87.7 million head. This decline has been the result of several factors, including drought, high feed costs, and reduction in both domestic and international demand. The U.S. cattle herd though remains the fourth largest in the world (following India, Brazil and China) (MLA, 2014).

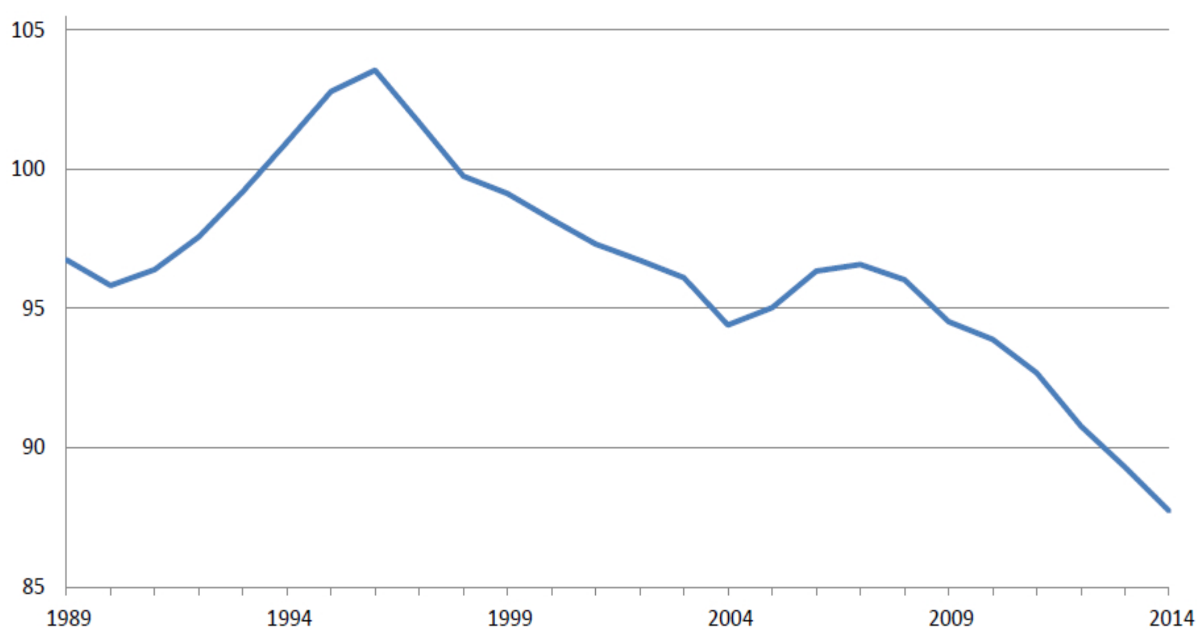


Figure 1.1. Cattle Inventory-United States: January 1, 2014 (Million head)

Source: Cattle (January 2014) USDA, NASS

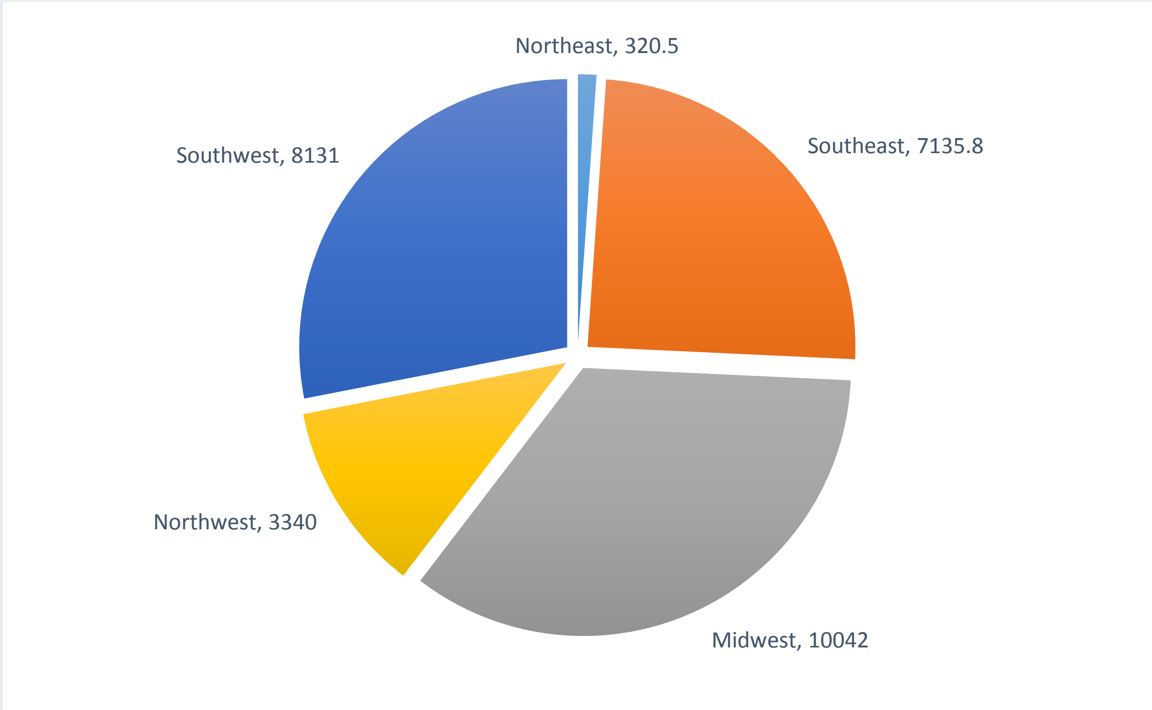


Figure 1.2. Regional distribution of beef cows in the U.S. on January 1, 2014 (1000 head)
Source: Cattle (January 2014) USDA, NASS

Cattle and calves are spread throughout the U.S. with large concentrations in the Midwest and Southwest (NASS, 2014). As of January 2014, there were more than 29 million head of beef cows widely dispersed through the U.S. on over 700,000 farms and ranches (NASS, 2014). The distribution of beef cows is shown in Figure 1.2[1]. Although cow-calves are raised in all regions where there are pasture and hay, we see most calf-cow production is concentrated in the Midwest and Southwest (Figure 1.2). There were just 320,500 head of beef cows in the Northeastern U.S. on January 1st, 2014, and New York State has 105,000 head. “The beef cow-calf business is well

[1] The Northeast consists of 9 states: New York, Pennsylvania, Massachusetts, New Jersey, Connecticut, Maine, New Hampshire, Vermont, and Rhode Island. The Southeast consists of 14 states: Delaware, Maryland, West Virginia, Virginia, Kentucky, Arkansas, Tennessee, North Carolina, Mississippi, Alabama, Georgia, South Carolina, Louisiana, and Florida. The Midwest consists of 12 states: North Dakota, South Dakota, Wisconsin, Michigan, Nebraska, Iowa, Illinois, Indiana, Ohio, Kansas, Missouri, and Minnesota. The Northwest consists of 5 states: Washington, Idaho, Montana, Oregon, and Wyoming. The Southwest consists of 8 states: California, Nevada, Utah, Colorado, Arizona, New Mexico, Texas and Oklahoma. Alaska and Hawaii are not included in any of the above regions.

adapted to small-scale and part-time farmers who have land suitable for pasture and hay production. As in most other regions, cow-calf operations in the Northeastern United States are rather small. Because of the relatively small size of these operations, however, it has been difficult for individuals to develop innovative marketing programs" (Comerford et al. 2013).

Generally beef production systems are composed of cow-calf operations who own cows and produce weaned calves, stocker operations who add additional weight and sell feeder cattle, and feedlots who purchase feeder cattle to finish them for slaughter. Sometimes calves are backgrounded by cow-calf operators as well. Usually, calves sold at weaning will enter a stocker operation to make them better suited to enter feedlots. Growth is comprised of development of the calf's age, weight, maturity and quality. In some cases, calves are backgrounded in the same region where they were born. In other cases, they may go to some other places with abundant pasture and hay. Groups of calves with similar characteristics are assembled as they approach the end of the stocker phase.

Cattle feeding is not nearly as spread throughout the U.S. as cow-calf operations, and the distribution of it tends to be positively correlated with the abundance of grain production since grain and other by-products make up a significant portion of finishing diets. From Figure 1.3[2], cattle feeding is concentrated in the Midwest and Southwest which occupied more than 93% of the total cattle on feed on January 1, 2014. Many states in the Southeast that wean a significant number of beef calves each year account for little or no cattle feeding (Eldridge 2005). Eldridge (2005) took as an example Florida, a state with slightly over 1,000,000 beef cows, but little or no

[2] In this graph, Massachusetts, New Jersey, Connecticut, Maine, New Hampshire, Vermont, Rhode Island, Arkansas, North Carolina, Mississippi, Alabama, Georgia, South Carolina, Louisiana, Florida, New Mexico are categorized into Other States since individual state estimates are not available.

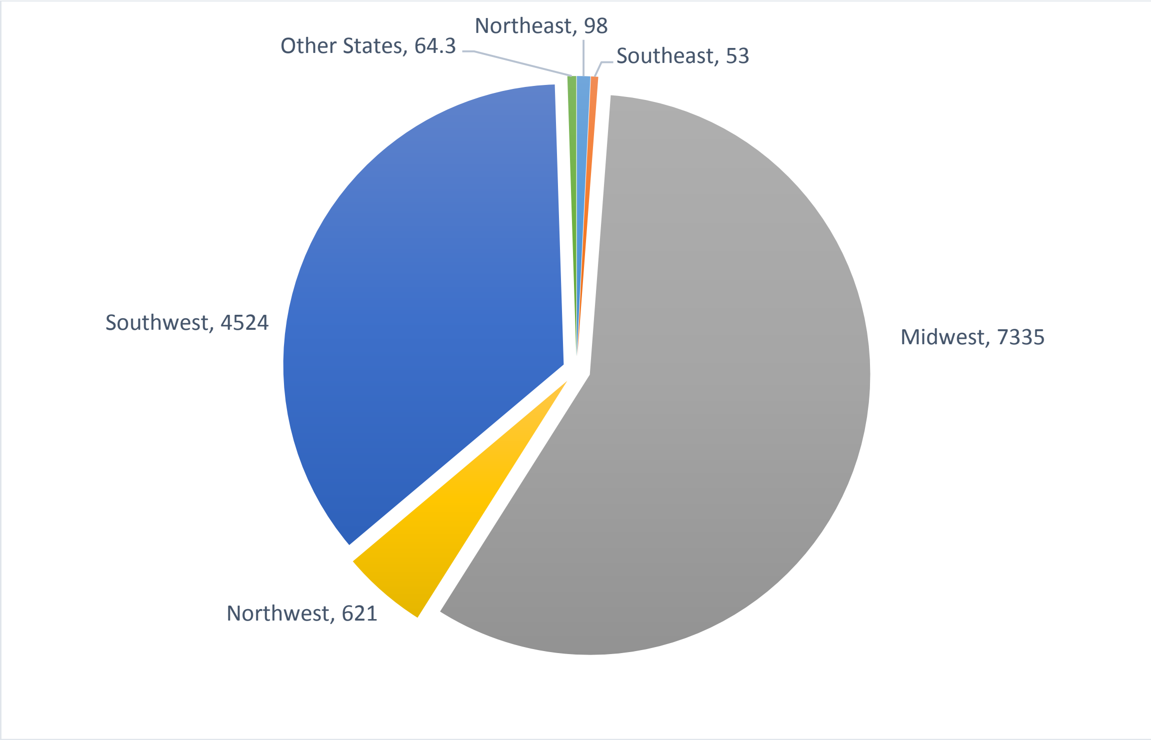


Figure 1.3. Regional distribution of cattle on feed in the U.S. on January 1, 2014 (1000 head)

Source: Cattle (January 2014) USDA, NASS

cattle feeding. In his opinion, it was more efficient to ship cattle out of Florida to the grain producing states than to ship the grain to Florida. This is also the case for New York State. It had just 23,000 head of cattle on feed, which was much smaller than the number of its beef cows, 105,000 head.

Feeder cattle prices are a major factor affecting the profitability of cow-calf operations. Cow-calf operations sell calves to either stocker operations or feedlots. Thus, the feeder cattle price is a good indicator for the price they will receive for their calves at weaning. The sale prices of feeder cattle vary greatly depending on weight, lot size, breed, sales time, and so on. For example, feed efficiency decreases as cattle grow so that light-weight cattle are preferred by feeder cattle buyers. Due to the dilemma of the price per pound decreasing as the cattle gain weight, cow-calf producers have to decide whether to sell their cattle at weaning immediately or retain them to put on extra weight. As such, price determinants of feeder cattle need to be understood by cow-calf producers to make informed production and marketing decisions.

As inputs of cattle feeding, purchases of feeder cattle represent a large part of costs. Calves that have the genetic ability to grow fast and gain weight efficiently are preferred by cattle feeders. Also, cattle that have been weaned and vaccinated are more likely to stay healthy during feeding. Thus, feeder buyers need to understand price determinants to assess calves' values before purchasing decisions.

1.2 Factors Affecting Feeder Cattle Prices

The above issues have motivated considerable studies exploring feeder cattle pricing. Prices in perfectly competitive markets are determined by the interaction of demand and supply. In the long run, the equilibrium market price is at the level equal to the minimum point of producer's ATC (Average Total Cost) curve, which is a break-even point. All the producers in a perfectly competitive market earn zero profit. The supply of feeders in the long run (from year to year) is primarily a function of changes in the breeding herd and forages. Feeder cattle demand mainly depends on economic conditions in the cattle feeding. The two principle factors that impact feeder cattle prices are fed cattle price expectations and costs of gain (Alberta.ca 2006). Accordingly, Buccola (1980) used a break-even analysis to compute the long-run reservation prices for feeder cattle buyers and sellers by setting their respective profits equal to zero. Feeder cattle prices were found to be determined by physical attributes (weight, breed, grade, and age) and market characteristics (sales size, lot size, auction sale order, market location and day) (Buccola 1980). Moreover, Buccola (1980) found that expected slaughter prices and current feed costs affected the rate that long-run break-even prices rise or fall.

In the short run (within a given year), however, numerous other factors such as price expectations, seasonality, and auction characteristics will affect feeder cattle prices. In any particular auction day, the supply of cattle is fixed, and feeder cattle prices will be determined by the demand for an individual lot of cattle at the market (Faminow and Gum 1986). Break-even methods are not well suited to estimate short-run price relationships. Hedonic modeling has been introduced to investigate short-run feeder cattle price differentials (e.g., Faminow and Gum 1986; Lambert et al 1989; Parcell et al 1995; Sullivan and Linton 1981; Schroeder et al 1988). Hedonic models have been widely used in understanding price determinants of heterogeneous products not limited to cattle. Hedonic demand theory follows a revealed preference method of estimating demand by decomposing the item being researched into its constituent characteristics, and obtains estimates of the contributory value of each characteristic. Hedonic models are commonly estimated using regression analysis. For example, in Faminow and Gum's (1986) research, lot characteristics (weight, lot size, and sex) and auction characteristics (auction location and date) were included in their hedonic model. A more general feeder cattle pricing hedonic model was specified by Schroeder et al. (1988). In their research, $Price_{it} = \sum_k V_{ikt} C_{ukt} + \sum_h R_{ht} M_{ht}$, where i referred to lot of cattle, k referred to specific animal trait, h referred to market influence, and t represented the auction date. The value of each specific trait was represented by V, and R was the price effect of the fundamental market forces that included input prices, output prices and exogenous variables.

Short-term time-series or cross-sectional data are usually utilized in hedonic pricing models for feeder cattle. Using data collected from feeder cattle auctions in two Montgomery, Alabama auction markets during April and May 1981, Sullivan and Linton (1981) found that sex, weight, and finish of cattle were significant factors affecting feeder cattle prices but muscling, body size, defects, breed and grade had no significant effect, which might be caused by misspecification of their regression model. As suggested by Davis, Bobst, and Steele (1976), nonlinear price-weight and price-lot relationships were included in feeder cattle pricing model by Faminow and Gum (1986). They determined that weight, lot size, breed, sex, sex-weight interactions and auction location significantly impacted feeder cattle prices in Arizona. Only using data collected from feeder cattle auctions during May 1984 and 1985, seasonality effects were ignored in their study. Schroeder et al (1988) examined the influence of a wide variety of physical characteristics on feeder cattle prices on four different categories of cattle separated by sex and weight rather than one data series used in previous research. Weight, weight-squared, lot size, lot size-squared, lot uniformity, health, condition, fill, muscling, frame size, horns, breed, time of sale, live cattle futures price, and market location were included in their study. All the factors except for lot uniformity significantly affected feeder cattle prices on any given day. Using data collected from Kansas feeder cattle auctions in fall 1986 and spring 1987, the price impacts of several physical characteristics were found to be dependent on the season (Schroeder et al 1988). For example, as weight increases, the spring price for steer decreased much faster than the fall price. Changing market expectations (mainly fed cattle price expectations and expected costs of gain) during the data collection period were also found to have an important effect on feeder cattle prices. The impact of over time changes in fundamental market forces including expected feeding costs, fed cattle price expectations and exogenous variables such as interest rates were ignored in several studies (e.g., Faminow and Gum 1986; Lambert et al 1989; Sullivan and Linton 1981).

Buccola (1980) found that feeder cattle prices tended to increase as fed steer prices increase, but he used current fed cattle prices which could not have a direct impact on current feeder cattle prices. Accordingly, deferred live cattle futures for the time period that the feeder cattle are expected to be ready for slaughter was used as an indicator of fed cattle price expectations in more recent studies (Dhuyvetter and Schroeder 2000; Eldridge 2005), and a positive relationship between deferred fed cattle futures price and feeder cattle price was found. However, a weakness of their study is that the hedonic variables (i.e., weight, lot size, sex, and breed) used to adjust for various quality attributes of cattle that vary in value with feeder cattle weights are limited. The effects of other important factors (e.g., muscling, body condition, and time of sale) on the feeder cattle prices should also be taken into account. Besides fed cattle price expectations, corn prices were investigated to be negatively related to feeder cattle prices (Anderson and Trapp 2000; Dhuyvetter and Schroeder 2000). Conflicted to these studies, using Kansas and Missouri data for fall 2008 and spring 2009, Schulz et al. (2010) found that corn prices was not a significant factor in explaining feeder cattle price. They thought this unexpected finding was caused by casual observations of today's market behavior. In addition, although a relatively large set of quality attributes were included in Schulz et al.'s (2000) hedonic pricing model, the effects of some market conditions such as variations in futures prices of live cattle and corn were ignored. Since their data was unique to Kansas and Missouri, caution must be used in interpreting the results to other states.

1.3 Price Slides

Price slides (price-weight relationships) refer to the change in feeder cattle price ($/cwt) as cattle grow. Typically lighter-weight cattle receive a higher price per hundredweight than heavier cattle. Feeder cattle buyers make money by fattening feeder cattle. As cattle grow, marginal feed gain becomes less due to decreasing feed efficiency. In addition, there is less weight gain available for feeder cattle buyers. As a result, price per hundredweight decreases as weight increases.

Sartwelle et al. (1996) found that differences in feeder cattle prices across weights depended on the relative profitability of backgrounding and finishing programs, which were affected by expected fed cattle prices, feeder cattle prices, corn prices, interest rates, and feeding performance. This conclusion was supported in Dhuyvetter and Schroeder's (2000) work. Using data from individual lots of cattle sold at the Winter Livestock Auction in Dodge City, Kansas from 1987 to 1996, they showed that the price spread between 500 and 800-pound steers was more than $20/cwt when corn price was $1.68/bu., and declined to about $7/cwt with a $3.52/bu. corn price. When corn price is lower, weight can be added to lighter cattle at a relatively cheaper cost per pound of gain than when corn price is higher. That is why lighter-weight cattle are preferred by feeder cattle buyers when corn price is low. This same data also showed that the prices per pound of light-weight cattle were bidded up with an increase in fed cattle futures prices, while the prices were bidded down with an increase in feeding margin (i.e., revenue less feed cost). Additionally, they also found a seasonality effect on variation in the price slide.

Since the above mentioned factors are constantly changing, there is no set price slide that producers can rely on. Moreover, the price-weight relationship varies seasonally and over time (Dhuyvetter and Schroeder 2000; Sartwelle et al 1996). "For example, Schroeder et al estimated a discount for 750-pound steers relative to 650-pound steers of $1.80/cwt, which was 30% smaller than Bailey, Peterson and Brorsen's (1991) estimate of $2.60/cwt, whereas Faminow and Gum (1986) estimated about a $5/cwt discount" (Dhuyvetter and Schroeder 2000). Thus, current marketing information should be used by producers to make sound management and marketing decisions to make profits.

1.4 Summary

Previous studies have mainly focused on larger cattle producing states, e.g., Kansas (e.g., Bailey and Peterson 1991; Dhuyvetter and Schroeder 2000; Sullivan and Linton 1981; Schroeder et al 1988), Arizona (Faminow and Gum 1986), Nebraska (Bailey and Peterson 1991) and Colorado (Schmitz et al 1996), where cattle production and finishing vary from that in the Northeastern United States, and where price collecting services are supported by USDA Agricultural Marketing Service. This is not the case for the Northeast. Caution must be used in interpreting the results of studies where data is from larger cattle feeding states. Accordingly, better local pricing data and analysis are necessary to inform and guide production and management decisions.

In prior literature, fed cattle price expectations, expected corn prices, weight, sex, lot size, quality attributes (e.g., breed/color, muscle level, frame size), seasonality, time of sale, and auction location have been found to be related to feeder cattle prices. Also, fed cattle price expectations, feeder cattle prices, corn prices, interest rates, and feeding performance are found to impact price slides. However, generally due to data limitations, not all of the above factors have been incorporated in one study.

1.5 Objectives

Price determination for feeder cattle is a complex process because many factors (and their interactions) impact feeder cattle markets. As inputs into a cattle feeding process, the demand for feeder cattle is affected by factors impacting expected input and output prices. Moreover, the feeder cattle market is volatile, and feeder cattle price varies from region to region. As a result of this complexity and volatility, it is necessary for feeder cattle sellers and buyers to understand how feeder cattle prices are determined over time.

The primary objective of this study is to identify the effects of various market conditions, lot characteristics, quality attributes, seasonality, and auction characteristics on the feeder cattle prices in New York State, and how the values of these characteristics change as feeder cattle weights vary. Premiums and discounts associated with particular feeder cattle physical attributes and color are important information as cow-calf producers compare these values with the costs associated with management practices that address them. The results can also be used by producers, given price forecasts, to estimate the value of gain by marketing at alternative weights and comparing those values with cost of that gain. Therefore, producing strategies and timing of buy/sell decisions can be made using the information.

We contribute to and extend the literature in this area of research in three distinct ways. First, we provide the first study focused on feeder cattle price determinants for the Northeastern U.S. Given differences in production systems and scale of operations in this region, we importantly provide information to cow-calf operators guiding production and marketing management decisions. Second, we more comprehensively incorporate relevant feeder cattle, lot, seasonality, and auction characteristics within our model. Individual lots of cattle are evaluated for a range of genetic (breed) and quality (e.g., muscling, thriftiness, preconditioning) characteristics. Importantly, the values of these characteristics are allowed to vary with weight (age) of the animal. Finally, characteristics of the auction itself (e.g., time of sale, number of buyers) bring additional information relative to previous research.

Chapter 2: Pricing Model

2.1 Conceptual Framework

In this section, we formally consider the derivation of expected market prices of feeder cattle under varying market conditions. Following Dhuyvetter and Schroeder (2000), for a competitive market, risk averse cattle feeders are assumed to maximize expected utility, following equation (1):

$$MAX\ E[U(\pi)] = E[U(p_L q_L - r_F q_F - r_C q_C - Z)] \quad (1)$$

where

p_L = fed cattle price

q_L = fed cattle quantity

r_F = feeder cattle price

q_F = feeder cattle quantity

r_C = corn price over feeding period

q_C = corn quantity

Z = other costs.

Maximizing (1) with respect to the quantity of feeder cattle (q_F) to buy implies:

$$r_F = f(LCF, CF, q_F, \sigma_{LCF}, \sigma_{CF}, Z) \quad (2)$$

where LCF is the expected fed cattle sales price and CF is the expected corn price over the feeding period with second moments of σ_{LCF} and σ_{CF}, respectively. Futures prices are used as price expectations based on previous research, suggesting that they are reasonable and appropriate proxies for expected prices.

Relevant variables associated with characteristics of economic condition, lot, quality and auction, and fixed effects of time (season and year) are incorporated within equation (2) to control for their impacts on feeder cattle prices. Thus, equation (2) is specified as follows:

$$r_F = f(LCF, CF, WT, \sigma_{LCF}, \sigma_{CF}, FMARGIN, LOTSIZE, SEX, QUALITY, COLOR, MONTH, YEAR, QTRSALE, NOBUYERS). \quad (3)$$

Following Dhuyvetter and Schroeder (2000), q_F is not included in equation (3) because the market supply of feeder cattle is reflected in the fed cattle futures price. *WT* is the average weight per head per lot of cattle. *FMARGIN* represents the most recent, lagged, cattle feeding margin, and is incorporated since recent actual profit has been shown to significantly impact feeder cattle prices (Dhuyvetter and Schroeder 2000). *SEX* represents whether the lot is steers, heifers or bulls (mixed sex lots were excluded from our analysis). *QUALITY* consists of preconditioning, muscling, frame size, thriftiness, and horns, which are categorical variables. *COLOR* consists of nine color/breed delineations. *QTRSALE* is the time of sale within auction day by quarter. *NOBUYERS* is the number of buyers at the auction which was rarely included in previous studies. A detailed description of the above variables are given in Table 2.1.

Table 2.1 Description of variables in the empirical model.

Variable	Description
$r_{F_{it}}$	Feeder cattle price in lot i and time t
	Market Conditions
LCF_{it}	Live cattle futures contract price corresponding to the month the feeder cattle in lot i would be expected to be sold
CF_{it}	Average corn futures contract prices relevant over the feeding period for the feeder cattle in lot i
FMARGIN_{t-1}	Actual 21-week cattle feeding margin for fed cattle marketed the previous week
$\sigma_{\text{LCF}_t}, \sigma_{\text{CF}_t}$	Coefficients of variation of daily prices for the past 21 weeks for corn futures (CF) and live cattle futures (LCF)
$Year_y$	Year of sale. Consist of three binary variables assigned a 1 if cattle are sold in (i) 2011, (ii) 2012, or (iii) 2013, and = 0 otherwise.
	Lot Characteristics
WT_i	Feeder cattle weight (average per head)
LOTSIZE_i	Number of head in the pen
SEX_i	Consist of three binary variables assigned a 1 if the sex is (i) steer, (ii) heifer (HFR), or (iii) bull (BULL), and = 0 otherwise.
	Quality Characteristics
$PCON_i$	Preconditioned cattle = 1 and = 0 otherwise
$Muscling_i$	Consist of three binary variables assigned a 1 if with (i) light muscled (MUSCLEL), (ii) medium muscled (MUSCLEM), or (iii) heavy muscled (MUSCLEH), and = 0 otherwise.
$Frame\ Size_i$	Consist of two binary variables assigned a 1 if with (i) large frame (FRAMELARGE), or (ii) medium frame (FRAMEMED), and = 0 otherwise.
$Thriftiness_i$	Consist of two binary variables assigned a 1 if cattle are (i) thrifty (THRIFTY), or (ii) unthrifty (UNTHRIFTY), and = 0 otherwise.
$Horns_i$	Cattle with horns (HORNS)= 1 and no horns (NO HORNS)= 0 otherwise
	Color/Breed
$Color/Breed_i$	Consists of nice binary variables assigned a 1 if the cattle in the lot are (i) red, (ii) black, (iii) brown, (iv) white, (v) Holstein, (vi) dairy, (vii) exotic, (viii) mixed, or (ix) Hereford, and each variable = 0 otherwise.
	Seasonality
$MONTH_m$	Month of sale. Consists of seven binary variables assigned a 1 if the month is (i) March, (ii) April, (iii) May, (iv) Sep, (v) Oct, (vi) Nov, or (vii) Dec, and each variable = 0 otherwise.
	Auction Characteristics
$QTRSALE_{qs}$	Time of sales within auction day by quarter. It is split into four equal periods and lots are assigned a 1 if sold in (i) the first quarter, (ii) the second quarter, (iii) the third quarter, or (iv) the fourth quarter, and = 0 otherwise.
NOBUYERS_t	Number of unique buyers at auction date t

2.2 Empirical Model

Reviewing to Dhuyvetter and Schroeder's (2000) empirical method and prior literature (e.g., Faminow and Gum 1986; Lambert et al 1989; Parcell et al 1995; Sullivan and Linton 1981; Schroeder et al 1988), a hedonic model is used to specify equation (3).

Conceptually, feeder cattle of various weights during different seasons of the year have separate expected profit functions for that weight and season. Following Dhuyvetter and Schroeder (2000), aggregating individual input demands for feeder cattle across producers and allowing for different slopes associated with different production functions for each weight of feeder cattle gives the model for feeder cattle price:

$$r_{F_{it}} = \beta_0 + \beta_{lcf}LCF_{it} + \beta_{cf}CF_{it} + \beta_w WT_i + \beta_{w2}WT_i^2 + \beta_{lcfw}LCF_{it}WT_i + \beta_{cfw}CF_{it}WT_i + \beta_{cvlcfw}\sigma_{LCF_t}WT_i + \beta_{cvcfw}\sigma_{CF_t}WT_i + \beta_{fw}FMARGIN_{t-1}WT_i + \beta_{fw2}FMARGIN_{t-1}WT_i^2 + \beta_l LOTSIZE_i + \beta_{l2}LOTSIZE_i^2 + \beta_h HFR_i + \beta_{hw}HFR_iWT_i + \beta_b BULL_i + \beta_{bw}BULL_iWT_i + \beta_{pcon}PCON_i + \beta_{pconw}PCON_iWT_i + \beta_{mh}MUSCLEH_i + \beta_{mhw}MUSCLEH_iWT_i + \beta_{ml}MUSCLEL_i + \beta_{mlw}MUSCLEL_iWT_i + \beta_{fm}FRAMEMED_i + \beta_{fmw}FRAMEMED_iWT_i + \beta_u UNTHRIFTY_i + \beta_{uw}UNTHRIFTY_iWT_i + \beta_{hn}HORNS_i + \beta_{hnw}HORNS_iWT_i + \beta_c COLOR_c + \beta_{cw}COLOR_cWT_i + \beta_{mw}MONTH_mWT_i + \beta_{mw2}MONTH_mWT_i^2 + \beta_y YEAR_y + \beta_{qs}QTRSALE_{qs} + \beta_{nb}NOBUYERS_t + \varepsilon_{it} \quad (4)$$

where

i = a specific pen of cattle

t = time

COLOR = a set of dummy variables for color/breed (c = Hereford (default), red, black, brown, white, Holstein, dairy, exotic, or mixed)

MONTH = a set of dummy variables for month (m = Dec (default), Mar, Apr, May, Sep, Oct or Nov)

YEAR = a set of dummy variables for year (y = 2011 (default), 2012, or 2013)

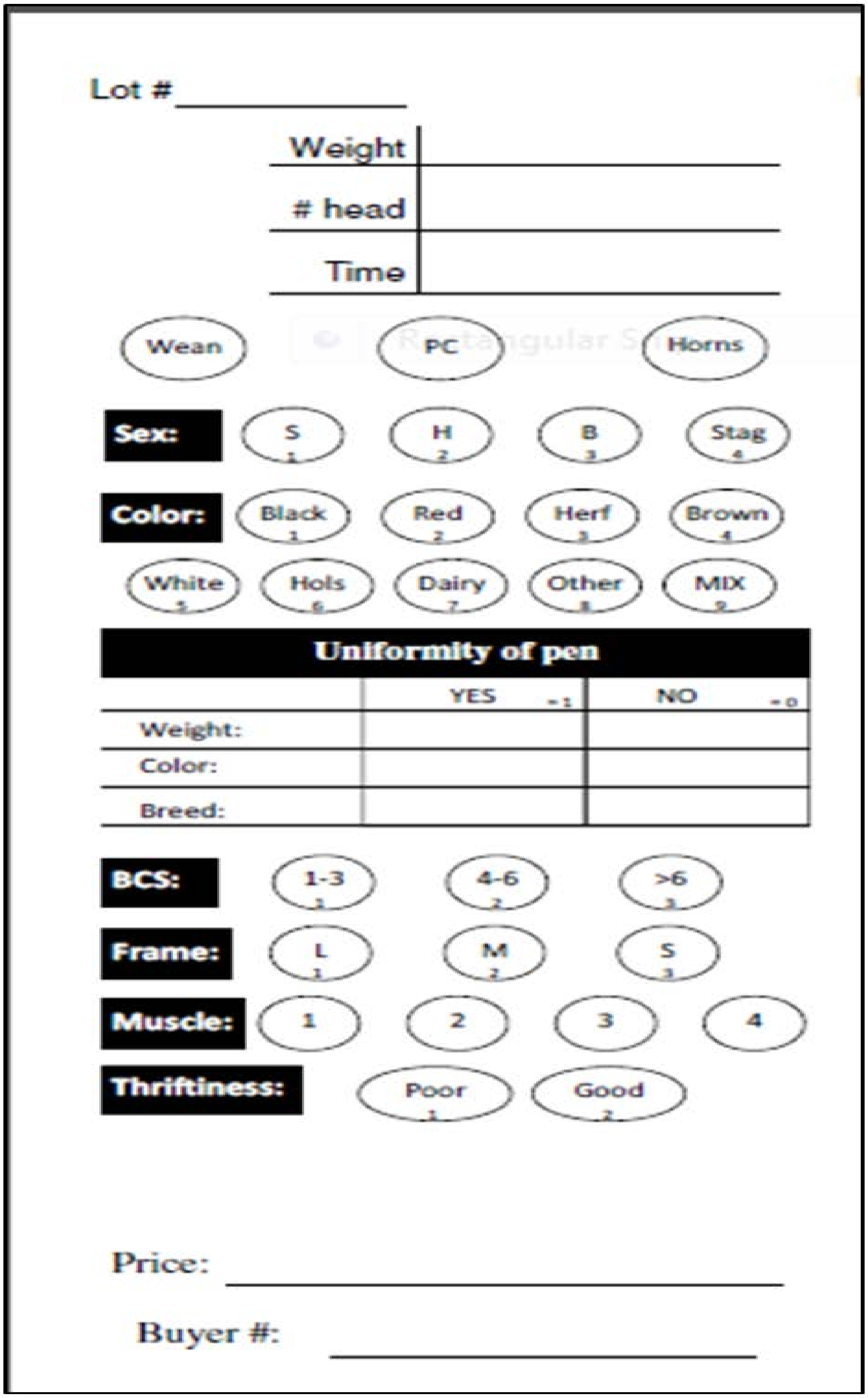
QTRSALE = a set of dummy variables for time of sale (qs = 4 (default), 1, 2, or 3).

Compared with Dhuyvetter and Schroeder (2000), a larger set of color and quality attributes are included in our model. These hedonic variables are incorporated to adjust for quality attributes of cattle that can vary with weight of feeder cattle. Based on past research, weight and lot size have nonlinear effects on feeder cattle prices. Since the relative importance of economic conditions and quality characteristics changes with cattle weight, these variables are interacted with feeder cattle weight. Quadratic term of weight and these interaction terms allow feeder cattle input-demand to have different coefficients associated with different feeder cattle weights, which is consistent with varying production functions for each weight of feeder cattle. Consistent with previous research, monthly dummy variables are incorporated to reflect seasonal impacts. To account for other annual factors, year dummies are also included. Timing of lot sales within the auction day is included as previous research has shown this to be significant. Given detailed auction data, we also include a proxy for auction size by including the number of unique buyers of the auction which was rarely investigated in the literature prior, but helps determine price levels and differentials.

Chapter 3: Data

Transaction-level feeder cattle market data were collected from feeder cattle auctions at the Finger Lakes Livestock Exchange in Canandaigua, NY during spring (Mar, Apr, and May) in 2012 and 2013 and fall (Sep, Oct, Nov, and Dec) in 2011, 2012 and 2013. Data collected totaled individual transactions from 5,525 feeder cattle lots (1,340 in spring and 4,185 in fall) encompassing 13,963 head (3,580 in spring and 10,383 in fall) over 26 auction dates. Using the data collection template (Figure 3.1), a trained technician recorded the time of sale, feeder price, lot size, and lot weight. The technician then evaluated each lot for several quality characteristics including color (breed), whether the animal was preconditioned, the level of muscle, frame size, thriftiness, the presence of horns, and animal body condition score. Buyer bid numbers were also recorded so that the number of unique buyers participating in each auction could be computed.

Of the 5525 lot observations, 5390 observations contained complete data. Of those, 4818 lots had an average weight per head ranging from 300 to 900 pounds. Since feeder cattle in this weight range are more typical for market, lots with weights outside of this range are excluded in our analysis, consistent with prior literature (e.g., Dhuyvetter and Schroeder 2000; Lamber et al. 1989; Schroeder et al. 1988; Schulz et al. 2010). Summary statistics of selected variables are reported in Table 3.1 for the 4818 sample size. The average weight per head was 548.3 pounds, and its distribution is shown in Figure 3.2. The average feeder cattle price was $120.35/cwt ranging from $22/cwt to $200/cwt. Almost half of the lots (41.4%) were steers, with 39.4% being heifers, and 19.2% being bulls. The average lot size was 2.6 head, which was much smaller than that obtained from large cattle producing states, and the lot size ranged from 1 to 14


Lot # ____________

Weight |
head |
Time |

Wean PC Horns

Sex: S 1 H 2 B 3 Stag 4

Color: Black 1 Red 2 Herf 3 Brown 4
White 5 Hols 6 Dairy 7 Other 8 MIX 9

Uniformity of pen		
	YES =1	NO =0
Weight:		
Color:		
Breed:		

BCS: 1-3 1 4-6 2 >6 3

Frame: L 1 M 2 S 3

Muscle: 1 2 3 4

Thriftiness: Poor 1 Good 2

Price: ____________

Buyer #: ____________

Figure 3.1. Data collection template

head. 74.4% of the lots were heavy muscled, with 15.1% being light muscled, and 10.4% being medium muscled. Nearly half of the lots (46.4%) were preconditioned, and most of the lots were large framed, thrifty, and dehorned with the ratio 90.1%, 95.1%, and 95.2% respectively. There were 9 colors/breeds defined: black, Hereford, mixed, red, dairy, exotic, Holstein, white, and brown. More than half of the lots (55%) were black, and just 2% of the lots were brown. The data of number of lots, total head and number of buyers across auction dates are shown in Figure 3.3. The average number of lots over the 26 auction days was 213, and the number of lots ranged from 122 to 303. The number of total head in each auction averaged 538 ranging from 278 to 871. The number of buyers averaged 51 and ranged from 28 to 78.

Auction data were merged with data on live cattle futures and corn futures specific to each lot of cattle. The live cattle futures contract used depends on the sales weight of the feeder cattle. In particular, futures contract prices for the day prior to the auction were the fifth, fourth, and third distant contracts for feeder cattle weighing 300-499, 500-699, and 700-900 pounds, respectively. The corn futures price was a simple average of all contracts relevant over the feeding period from the day prior to the feeder cattle auction date. For example, the corn price for 300-499 pound feeder cattle is the average of the nearby through fifth distant contracts. Cattle feeding margin[3] and coefficients of variation for corn and live cattle futures prices were calculated using daily futures prices for the 21-week period preceding the feeder cattle sale week. Live cattle futures prices averaged $128.66/cwt and ranged from $118.85/cwt to $136.13/cwt. Corn futures prices averaged $6.03/bu., ranging from $4.30/bu. to $7.99/bu.

[3] Cattle feeding margin is defined as the nearby live cattle futures price ($/cwt) times 12 cwt minus the nearby feeder cattle futures price ($/cwt) 21 weeks prior times 7.5 cwt minus the average nearby corn futures price ($/bu.) over the preceding 21 weeks times 56.4 bushels (Dhuyvetter and Schroeder 2000).

Table 3.1 Summary of variables in the empirical model (N=4818)

Variable	Mean	Standard deviation	Minimum	Maximum
r_F ($/cwt)	120.35	25.81	22	200
Market Conditions				
LCF ($/cwt)	128.66	3.55	118.85	136.13
CF ($/bu.)	6.03	1.13	4.30	7.99
MARGIN ($/cwt)	63.97	108.58	-112.54	264.95
σ_{LCF} (%)	2.84	0.87	1.53	5.04
σ_{CF} (%)	9.05	5.06	2.88	17.68
Year				
Y11 (Base)	0.20	0.40	0	1
Y12	0.37	0.48	0	1
Y13	0.43	0.49	0	1
Lot Characteristics				
WT (pounds)	548.31	145.72	300	900
LOTSIZE (head)	2.62	2.21	1	14
Sex				
STEER (Base)	0.41	0.49	0	1
HFR	0.39	0.49	0	1
BULL	0.19	0.39	0	1
Quality Characteristics				
Pc				
PRECONDITIONED	0.46	0.50	0	1
Muscling				
MUSCLEL	0.10	0.31	0	1
MUSCLEM (Base)	0.74	0.44	0	1
MUSCLEH	0.15	0.36	0	1
Frame Size				
FRAMELARGE (Base)	0.90	0.30	0	1
FRAMEMED	0.10	0.30	0	1
Thriftiness				
THRIFTY (Base)	0.95	0.21	0	1
UNTHRIFTY	0.05	0.21	0	1
Horns				
NOHORNS (Base)	0.95	0.21	0	1
Color/Breed				
HEREFORD (Base)	0.13	0.34	0	1
RED	0.11	0.31	0	1
BLACK	0.55	0.50	0	1
BROWN	0.02	0.14	0	1
WHITE	0.02	0.15	0	1
HOLSTEIN	0.03	0.18	0	1
DAIRY	0.04	0.19	0	1
EXOTIC	0.03	0.18	0	1
MIXED	0.06	0.24	0	1

Table 3.1 Summary of variables in the empirical model (N=4818) (continued)				
Seasonality				
Month				
MAR	0.09	0.28	0	1
APR	0.10	0.30	0	1
MAY	0.06	0.25	0	1
SEP	0.14	0.34	0	1
OCT	0.23	0.42	0	1
NOV	0.23	0.42	0	1
DEC (Base)	0.16	0.36	0	1
Auction Characteristics				
Time of Sale				
QTRSALE1	0.26	0.44	0	1
QTRSALE2	0.25	0.43	0	1
QTRSALE3	0.23	0.42	0	1
QTRSALE4 (Base)	0.26	0.44	0	1
NOBUYERS	52.78	11.02	28	78

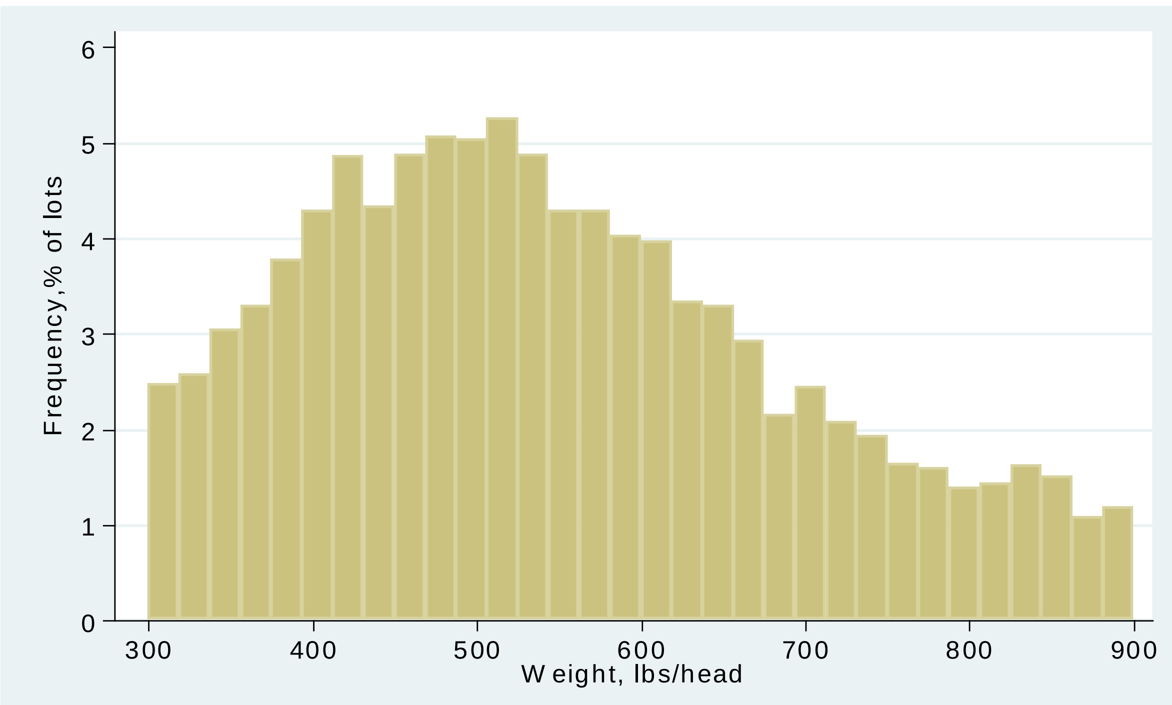


Figure 3.2. Distribution of average weight per head across 4818 lots

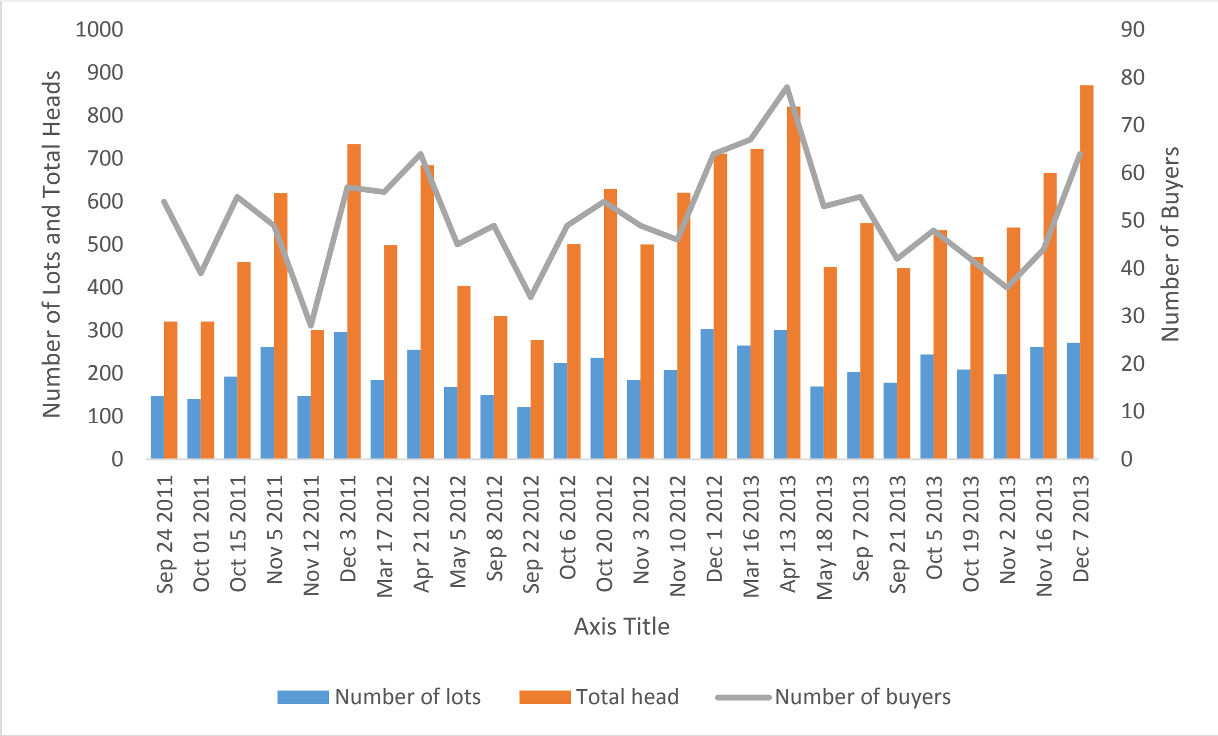


Figure 3.3. Auction Data: Number of lots, total head, and number of buyers

Chapter 4: Empirical Results

4.1 Estimation Issues

OLS estimators with corrected standard errors are reported in Table 4.1 for both the full model for all feeder cattle lots (97-1960 pounds), and the restricted model including lots with average weight of 300-900 pounds. As mentioned previously, our results follow from the second model. This is chosen for two reasons. First, including lots with average weight of 300-900 pounds is commonly applied in prior literature (e.g., Dhuyvetter and Schroeder 2000; Lambert et al. 1989; Schroeder et al. 1988; Schulz et al. 2010) since those weights are typically marketed in auctions. Second, the R-squared value of the 300-900 pound model is slightly larger, implying that this model explains a slightly larger portion of variance in feeder cattle prices. In an extension from previous literature (Dhuyvetter and Schroeder 2000; Schroeder et al. 1988; Schulz et al 2010), color and quality attribute interactions with weight are also incorporated in our model, allowing the values of color and quality attributes to vary with weight of the animal. [4]

In our cross-sectional data, heteroskedasticity is tested through the White test. The p-value from the test of the null that the standard errors are homoscedasticity is 0.0000. Hence, the calculated chi square statistic (2,144) is rejected, indicating conventional OLS standard errors should be corrected. Accordingly, White-Huber standard errors are reported in our results. Although serial-correlation within a day could exist, it is likely that this serial correlation diminishes across all the auction dates. The estimated parameters are reported in Table 4.1. Our 300-900 model

[4] For both 97-1960 and 300-900 models, the models with quality-weight interactions are statistically preferred to their respective non-interaction model. For the 97-1960 models, the AIC (Akaike information criterion) value of the model with interactions is 44,221, which is smaller than that of the corresponding non-interaction model (the AIC value is 44,440). For the 300-900 models, the AIC value of the model with interactions is 39,293, which is smaller than that of the corresponding non-interaction model (the AIC value is 39,412). Preferred model is the one with minimum AIC value since it includes a penalty that is an increasing function of the number of estimated parameters.

explains more than 70% of the variation in feeder cattle prices. The majority of the model's coefficients are significant at 90% confidence level or higher. Because of the numerous quadratic and interaction terms in the model, expected signs and significance of individual variables are difficult to anticipate solely through the regression results, because they often depend on cattle weight. For example, the estimated coefficients on weight are both positive, but when interaction effects are accounted for, the expected negative relationship holds. Recall that, heavier weight feeder calves, ceteris paribus, sell at a lower price compared with lighter weight feeder calves, reflecting the lower feed conversion associated with feeding heavier weight cattle. This can be seen in Figure 4.1, with all the variables except for weight held at their sample means (and dummy variables at their defaults[5]), the estimated price decreases as cattle grow (the price slides uses a 300lb feeder as the base). Accordingly, we estimate price-weight slides for the continuous variables interacted with weight, and interpret the results. Similarly, we compute the price changes for the binary variables at alternative cattle weights. Finally, we compute elasticities of the continuous variables and marginal effects of the binary variables with all the other variables held at their sample means (and dummy variables at their defaults). Elasticities for the continuous variables are reported in Table 4.2 , while marginal effects for the dummy variables are reported in Table 4.3.

[5] Defaults in the model: steer, not preconditioned, average muscled, large frame, thrifty, no horns, color Hereford, Dec, the fourth quarter of sale, and year 11.

Table 4.1[6] Regression results of feeder cattle price determinants				
	300-900 lbs.		97-1960 lbs. (all observations)	
Variable	Parameter Estimate	Standard Error	Parameter Estimate	Standard Error
Intercept	6.598	44.51	3.615	34.12
Market Characteristics				
Live cattle futures (*LCF*)	1.158***	0.363	1.306***	0.275
LCF *weight (*LCFWT*)	-0.00163***	0.000547	-0.00204***	0.000380
Corn futures (*CF*)	-4.933***	1.414	-8.158***	1.141
CF*weight (*CFWT*)	0.00295	0.00231	0.00700***	0.00171
MARGIN*weight (*MARGINWT*)	1.63e-06	2.80e-05	-1.52e-05	1.93e-05
MARGIN*weight squared ($MARGINWT^2$)	1.30e-08	4.03e-08	4.94e-08**	2.43e-08
Live cattle futures C.V.*weight ($\sigma_{LCF}WT$)	0.986***	0.123	0.758***	0.104
Corn futures C.V.*weight ($\sigma_{CF}WT$)	0.339***	0.0243	0.295***	0.0215
YEAR 2012 (*YEAR12*) (default=2011)	17.06***	1.089	17.69***	1.023
YEAR 2013 (*YEAR13*)	7.900***	1.483	6.462***	1.388
Lot Characteristics				
Weight (*WT*)	0.0710	0.0702	0.104**	0.0506
Weight squared (WT^2)	1.13e-05	1.12e-05	2.06e-05***	5.17e-06
Lot size (*LOTSIZE*)	2.384***	0.279	2.475***	0.273
Lot size squared ($LOTSIZE^2$)	-0.120***	0.0277	-0.127***	0.0273
Heifer (*HFR*)	-16.81***	1.881	-13.91***	1.538
Heifer*weight (*HEIFERWT*)	0.0123***	0.00326	0.00759***	0.00250
Bull (*BULL*)	4.691*	2.515	2.236	2.114
Bull*weight (*BULLWT*)	-0.0229***	0.00440	-0.0182***	0.00351
Quality Characteristics				
Preconditioned (*PCON*) (default-not preconditioned)	-0.208	1.780	2.419*	1.416
PCON*weight (*PCONWT*)	0.00605**	0.00303	0.00102	0.00223
Heavy Muscled (*MUSCLEH*) (default=Medium Muscled)	4.977**	2.445	5.748***	1.892
MUSCLEH*weight (*MUSCLEHWT*)	0.00136	0.00396	0.000252	0.00286
Light Muscled (*MUSCLEL*)	-32.09***	5.243	-29.07***	4.729
MUSCLEL*weight (*MUSCLELWT*)	0.0230**	0.00908	0.0178**	0.00789
Medium frame (*FRAMEMED*) (default=Large frame)	-5.042	3.434	-12.50***	2.941
FRAMEMED*weight (*FRAMEMEDWT*)	0.00294	0.00557	0.0148***	0.00448
Unthrifty (UNTHRIFTY) (default=Thrifty)	-39.36***	5.969	-38.50***	5.620
Unthrifty*weight (*UNTHRIFTYWT*)	0.0226**	0.0101	0.0208**	0.00931
Horns (HORNS) (default=No horns)	-26.60***	3.977	-21.27***	3.647
Horns*weight (*HORNSWT*)	0.0279***	0.00670	0.0192***	0.00563

[6] OLS was used to estimate both the full model and restricted model, and White-Huber standard errors are reported for these two models.

Table 4.1[6] Regression results of feeder cattle price determinants (continued)				
Color/breed Characteristics (default=Hereford)				
Color Red (*RED*)	16.58***	3.267	11.64***	2.534
Color Red*weight (*REDWT*)	-0.0134**	0.00575	-0.00552	0.00406
Color Black (*BLACK*)	22.01***	2.536	18.87***	1.928
Color Black*weight (*BLACKWT*)	-0.0147***	0.00431	-0.0105***	0.00295
Color Brown (*BROWN*)	14.89**	7.257	-3.397	6.266
Color Brown*weight (*BROWNWT*)	-0.00906	0.0125	0.0221**	0.0106
Color White (*WHITE*)	10.80**	5.349	12.27***	4.470
Color White*weight (*WHITEWT*)	-0.00471	0.00928	-0.00819	0.00784
Color Holstein (*HOLSTEIN*)	-23.32***	6.778	-31.97***	5.837
Color Holstein*weight (*HOLSTEINWT*)	0.0101	0.0112	0.0251***	0.00912
Color Other Dairy (*DAIRY*)	-11.79*	6.981	-20.56***	6.426
Color Other Dairy*weight (*DAIRYWT*)	0.00204	0.0117	0.0158	0.0103
Color Other Exotic (*EXOTIC*)	-27.31***	6.314	-20.77***	4.692
Color Other Exotic*weight (*EXOTICWT*)	0.0337***	0.0104	0.0221***	0.00763
Color Mixed (*MIXED*)	6.594	4.008	4.841	3.646
Color Mixed*weight (*MIXEDWT*)	-0.000537	0.00677	0.00109	0.00591
Seasonal Characteristics (default=December)				
Mar*weight (*MARWT*)	0.0625***	0.00785	0.0699***	0.00589
Mar*weight squared ($MARWT^2$)	-2.63e-05**	1.25e-05	-4.41e-05***	8.22e-06
Apr*weight (*APRWT*)	0.0352***	0.00692	0.0351***	0.00493
Apr*weight squared ($APRWT^2$)	-1.94e-05*	1.13e-05	-2.64e-05***	6.46e-06
May*weight (*MAYWT*)	0.0538***	0.00882	0.0508***	0.00608
May*weight squared ($MAYWT^2$)	-5.04e-05***	1.34e-05	-4.67e-05***	8.00e-06
Sep*weight (*SEPWT*)	-0.0302***	0.00652	-0.0117***	0.00437
Sep*weight squared ($SEPWT^2$)	2.63e-05***	9.63e-06	5.87e-07	5.33e-06
Oct*weight (*OCTWT*)	-0.0227***	0.00630	-0.00644	0.00408
Oct*weight squared ($OCTWT^2$)	8.49e-06	9.17e-06	-1.31e-05***	4.62e-06
Nov*weight (*NOVWT*)	0.00812	0.00642	0.0129***	0.00460
Nov*weight squared ($NOVWT^2$)	-2.53e-05***	8.99e-06	-2.60e-05***	5.25e-06
Auction Characteristics				
Number of Buyers (*NOBUYERS*)	0.0990**	0.0472	0.152***	0.0448
Time of sale – First Quarter (*QTSALE1*) (default=4th quarter)	6.958***	0.685	7.340***	0.659
Time of Sale – Second Quarter (*QTSALE2*)	5.862***	0.659	6.032***	0.635
Time of Sale – Third Quarter (*QTSALE3*)	3.443***	0.634	4.011***	0.606
Number of Observations	4818		5388	
R-squared	0.702		0.697	

*** p<0.01, ** p<0.05, * p<0.1

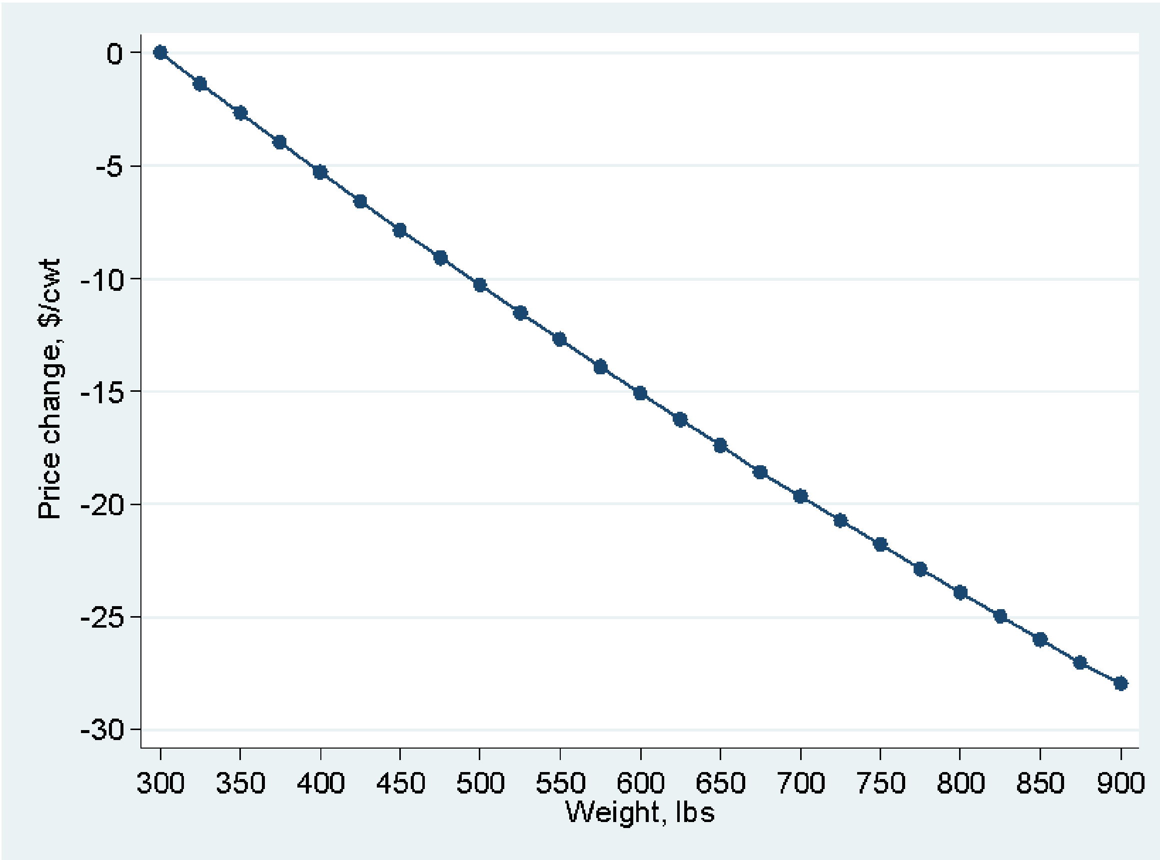


Figure 4.1. Steer price differentials by weight

Table 4.2[7] Elasticities of continuous variables (%)				
VARIABLE	Elasticity	Std. Err.	t-value	p>|t|
Live cattle futures (*LCF*)	0.319	0.192	1.66	0.097
Corn futures (*CF*)	-0.189	0.033	-5.70	0.000
Live cattle futures c.v. (*CVLCF*)	0.145	0.019	7.78	0.000
Corn futures c.v. (*CVCF*)	0.159	0.011	14.29	0.000
Margin (*MARGIN*)	0.003	0.003	0.90	0.368
Average weight (*WT*)	-0.256	0.032	-8.10	0.000
Lot Size (*LOTSIZE*)	0.043	0.004	11.90	0.000
Number of Buyers (*NOBUYERS*)	0.049	0.024	0.02	0.036

[7] With all the other variables held at their sample means (and dummy variables at their defaults), elasticities and marginal effects were computed using the estimators of restricted model in Table 4.1, and their standard errors were computed using delta method.

Table 4.3[7] Marginal effects of dummy variables at means ($/cwt)

Variable	Marginal Effects	Std. Err.	t-value	p>|t|
Heifer (*HFR*)	-10.063	0.464	-21.71	0.000
Bull (*BULL*)	-7.853	0.652	-12.04	0.000
Preconditioned (*PCON*)	3.109	0.528	5.89	0.000
Heavy Muscled (*MUSCLEH*)	5.721	0.567	10.09	0.000
Light Muscled (*MUSCLEL*)	-19.498	1.244	-15.67	0.000
Medium frame (*FRAMEMED*)	-3.431	0.864	-3.97	0.000
Unthrifty (UNTHRIFTY)	-26.953	1.499	-17.89	0.000
Horns (HORNS)	-11.284	1.167	-9.67	0.000
Color Red (*RED*)	9.223	0.851	10.84	0.000
Color Black (*BLACK*)	13.928	0.668	20.84	0.000
Color Brown (*BROWN*)	9.925	1.393	7.13	0.000
Color White (*WHITE*)	8.213	1.382	5.94	0.000
Color Holstein (*HOLSTEIN*)	-17.803	1.784	-9.98	0.000
Color Other Dairy (*DAIRY*)	-10.673	1.774	-6.02	0.000
Color Other Exotic	-8.854	1.756	-5.04	0.000
Color Mixed (*MIXED*)	6.299	1.037	6.07	0.000
Mar (MAR)	26.349	1.450	18.17	0.000
Apr (APR)	13.490	1.517	8.89	0.000
May (MAY)	14.323	1.519	9.43	0.000
Sep (SEP)	-8.672	1.162	-7.46	0.000
Oct (OCT)	-9.887	1.199	-8.25	0.000
Nov (NOV)	-3.160	1.256	-2.52	0.012
Time of Sale – First quarter (QTSALE1)	6.958	0.685	10.15	0.000
Time of Sale – Second quarter (QTSALE2)	5.862	0.659	8.90	0.000
Time of Sale – Third quarter (QTSALE3)	3.443	0.634	5.43	0.000
Year 2012 (YEAR12)	17.063	1.089	15.66	0.000
Year 2013 (YEAR13)	7.900	1.483	5.33	0.000

4.2 Results and Implications

4.2.1 Expected Live Cattle Price

As expected, live cattle futures price is positively related to feeder cattle prices (the coefficient of LCF is positive), but this effect diminishes as weight increases (the coefficient of WT*LCF is negative). These two coefficients are both statistically significant at the 1% significance level (Table 4.1). This decreasing effect as weight rises is consistent with the work of Buccola (1980), Dhuyvetter and Schroeder (2000), and Trapp and Eilrich (1991). The output price elasticity, evaluated at sample means (and dummy variables at the defaults) is 0.319, indicating that feeder cattle prices increase by 3.19% as output (live cattle) price increases by 10% (Table 4.2). Live cattle futures price also has a sizable impact on price slides. With a $135.76/cwt (mean price plus two standard deviations) live cattle futures price, the price spread between 500 and 800-pound steers is $17.54/cwt, whereas with a $121.56/cwt (mean price less two standard deviations) live cattle futures price, the spread decreases to $10.59/cwt (Figure 4.2). The results are consistent with previous literature – increases in live cattle futures prices are associated with increases in feeder cattle price spreads (Buccola 1980; Dhuyvetter and Schroeder 2000), and implies that a higher live cattle futures price leads to a preference for lighter weight feeder cattle because the return on each unit of gain is higher.

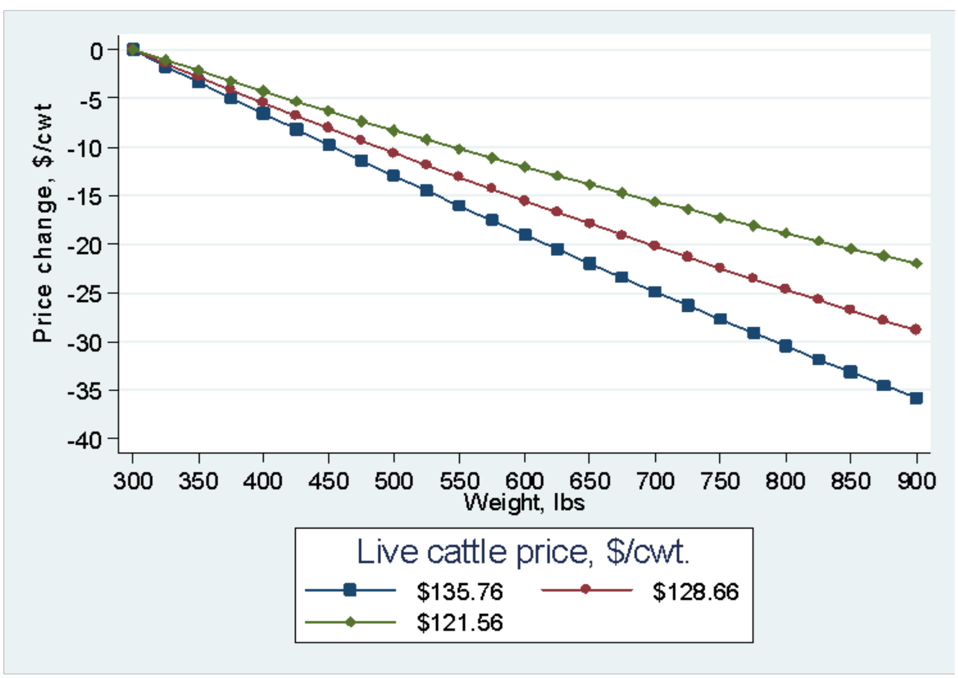


Figure 4.2. Steer price differentials by weight, various live cattle futures prices

4.2.2 Corn Futures Price

From Table 4.1, corn futures price has a significant negative impact on feeder cattle prices, which is consistent with most studies, but in conflict with the Kansas and Missouri case (Schultz et al. 2010) that corn price was not a significant factor in explaining feeder cattle price. The input price elasticity, evaluated at sample means (and dummy variables at the defaults) is -0.189, indicating that a 10% increase in input (corn) price decreases feeder cattle prices by 1.89% (Table 4.2). The results also materially influence price slides where for lower corn prices, feeder steer prices decline more rapidly as feeder cattle weight increases. In particular, the price slide between 500 and 800-pound steers is more than $16.07/cwt when corn futures price is $3.79/bushel (mean price minus two standard deviations). As corn futures price increases to $8.29/bushel (mean price plus two standard deviations), the relative price slide declines to $12.06/cwt. This indicates that for lower corn prices, lighter weight feeder cattle are worth more relative to heavy weight cattle because the cost of gain is lower.

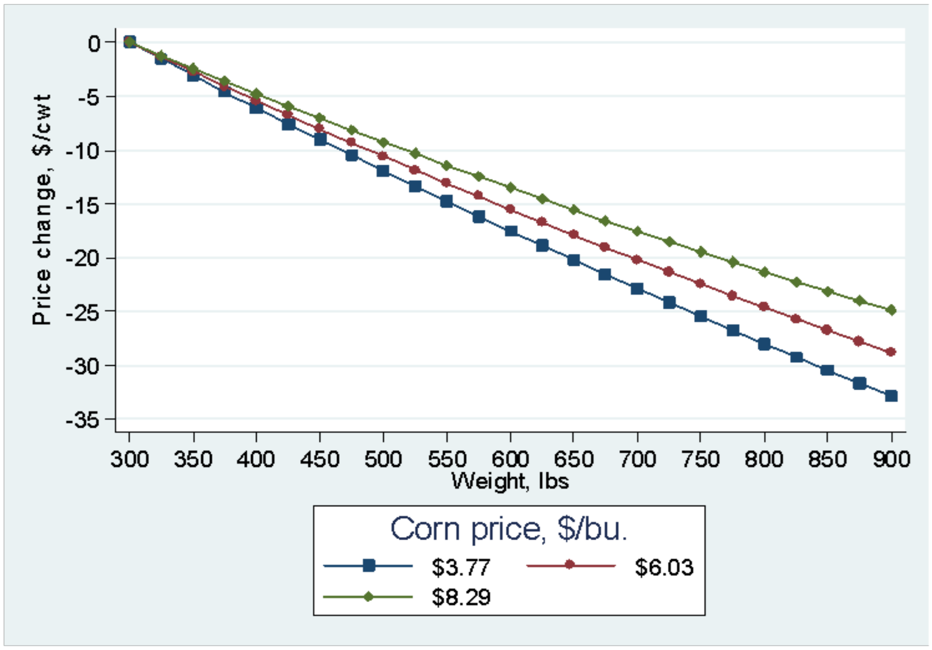


Figure 4.3. Steer price differentials by weight, various corn futures prices

4.2.3 Price Volatility

The coefficients of the interaction terms of weight with coefficients of variation for fed cattle and corn futures prices are significantly positive at the 99% confidence level (Table 4.1). In contrast to Dhuyvetter and Schroeder (2000) who found negative cv-weight interaction effects, positive interactions in our finding may be an indication that buyers are more price risk sensitive for lighter weight cattle than for heavier weight cattle. Further, while statistically significant, Dhuyvetter and Schroeder (2000) found that the coefficients of variation for fed cattle and corn prices had no economically important differential impacts on feeder cattle prices across weight. Economically important differential effects are found in our study. For example, with a coefficient of variation for fed cattle price of 4.60% (mean coefficient plus two standard deviations), the fed cattle price slide between 500 and 800-pound steers is $8.94/cwt. When the coefficient of variation is 1.10% (mean coefficient minus two standard deviations), the predicted slide increases to $19.19/cwt (Figure 4.4). The results imply that when fed cattle price volatility is lower, light-weight feeder cattle are worth more relative to heavy feeder cattle due to lower output price risk. In other words, buyers prefer heavier weight cattle under higher levels of price volatility. Variability in corn futures price has a similar impact on price-weight differentials. For instance, with a 19.17% (mean plus two standard deviations) coefficient of variation for corn price, the corn price spread between 500 and 800-pound steers is $3.79/cwt, whereas with a 0 coefficient of variation, the spread increases to $23.27/cwt (Figure 4.5). Due to lower input price risk, the price slide between 500 and 800-pound steers increases substantially with a decreasing coefficient of variation.

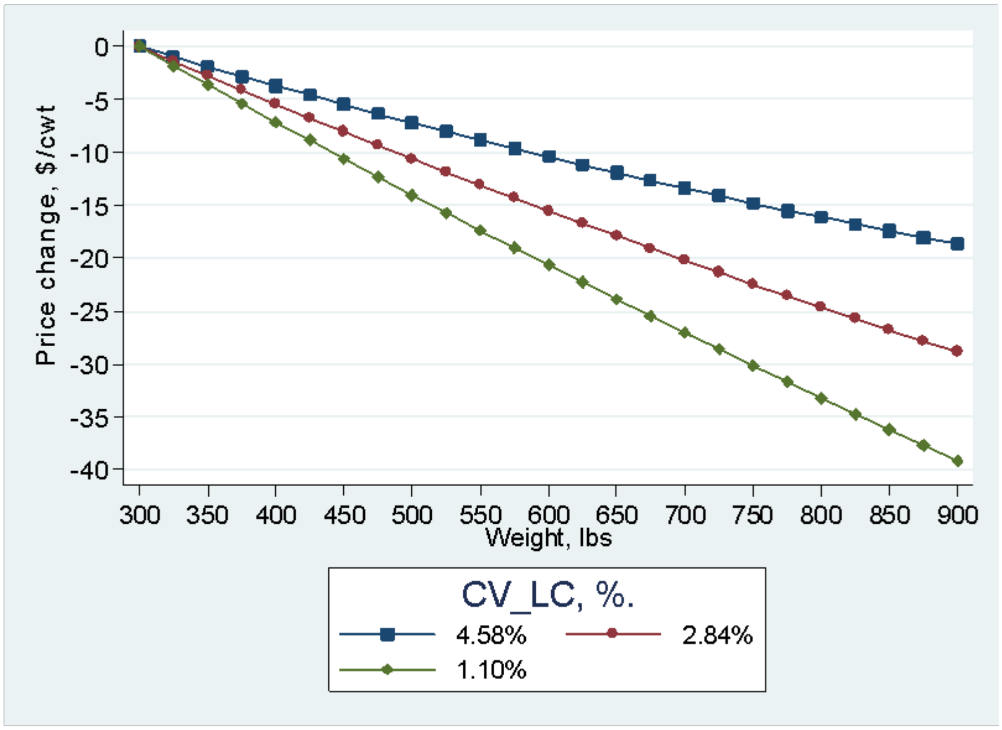


Figure 4.4. Steer price differentials by weight, various CVs for live cattle futures prices

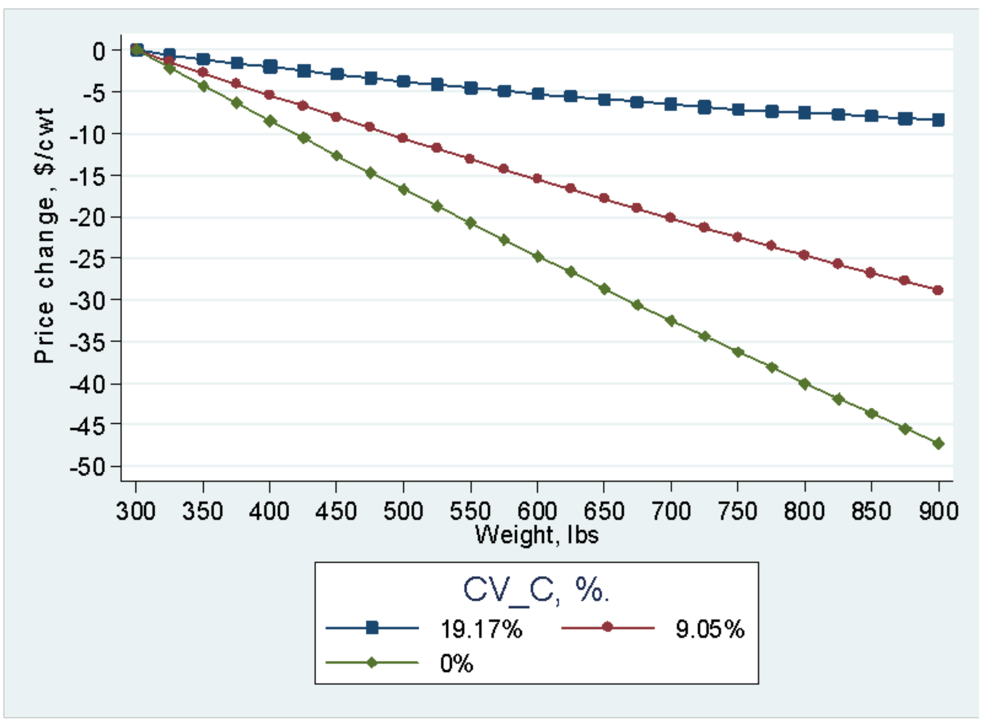


Figure 4.5. Steer price differentials by weight, various CVs for corn futures prices

4.2.4 Sex of the Animal

The coefficients of sex (Heifer and Bull) and their interactions with weights are all statistically significant. At the sample means (and other dummy variables at their defaults) heifers are discounted by $10/cwt, while bulls are discounted by nearly $8/cwt, relative to steers (Table 4.3). However, these differentials vary importantly by weight of the animal. Model estimated prices, by sex, are shown for the sales months of March and December with all other variables at sample means (continuous variables) and defaults (dummies) in Figures 4.6 and 4.7. Consistent to previous studies (Hersom and Thrift 2012; Schultz et al. 2010), steers bring the highest prices regardless of weight (Figure 4.6 and Figure 4.7) because steers will gain weight more efficiently than heifers and bulls. An important interaction between heifer and bull prices occurs around 600 pounds which is smaller compared with the Arkansas case (Hersom and Thrift 2012). As cattle grow, the discount associated with bulls increases so that at around 600 pounds, bulls and heifers are priced similarly. After this interaction, bulls receive a larger discount versus heifers because risk associated with castration and related performance retardation increase as cattle gain weight (Figures 4.6 and 4.7). Also, heifers may be purchased by cow-calf operations for breeding purposes. The price effects can also be seen by looking at the associated price slides. As weight increases, the discount on bulls is the largest, whereas the discount on heifers is the smallest. Specifically, the discount for bulls increases by $12.43/cwt as weight increases from 500 to 800 pounds, but the corresponding discounts for steers and heifers are only $5.57/cwt and $1.88/cwt, respectively, in March (Figure 4.8). Relative to the March price spreads, price spreads for steers, heifers and bulls increase dramatically in December (Figure 4.9). As weight increases, the December price for calves decreases at a much faster rate than the March price. It can be concluded that the price-weight spreads vary substantially by sex and season.

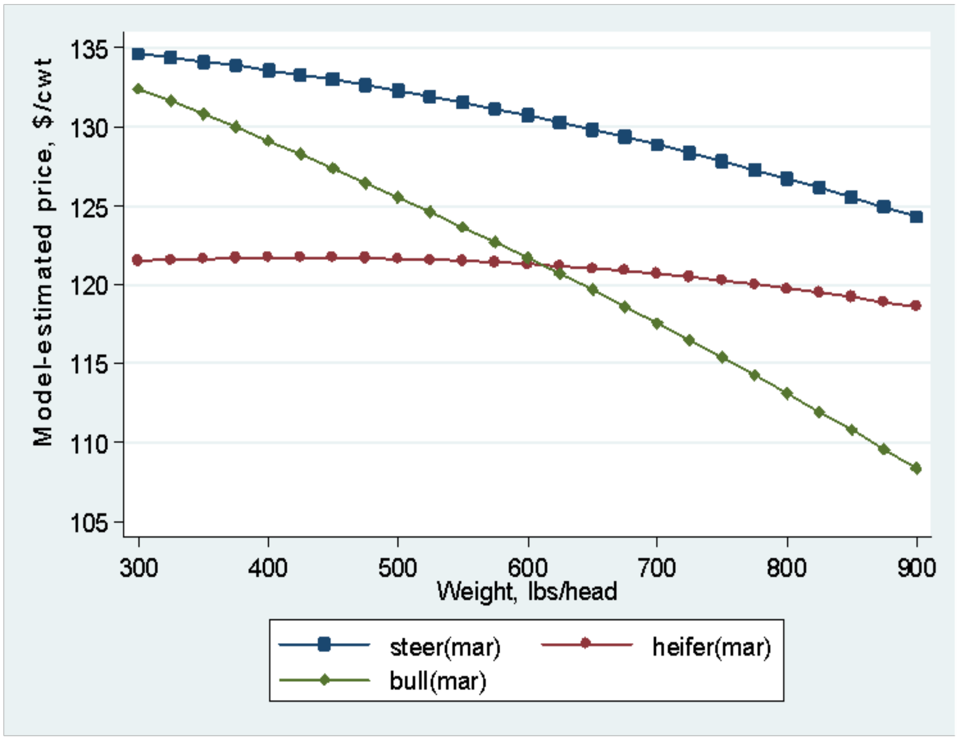


Figure 4.6. Effect of weight and sex on March feeder cattle price

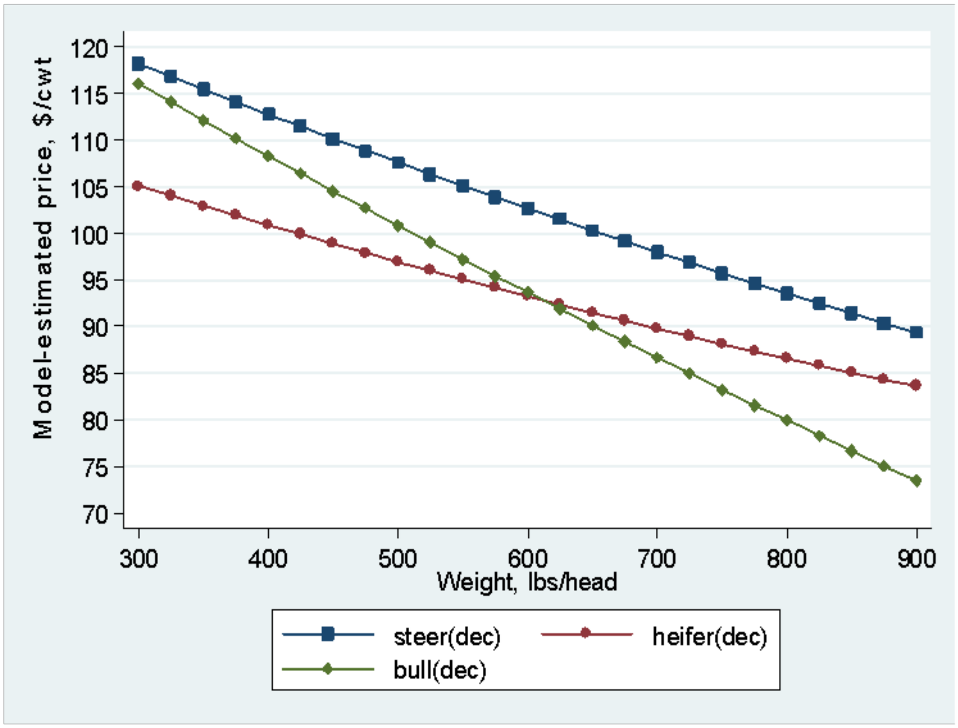


Figure 4.7. Effect of weight and sex on December feeder cattle price

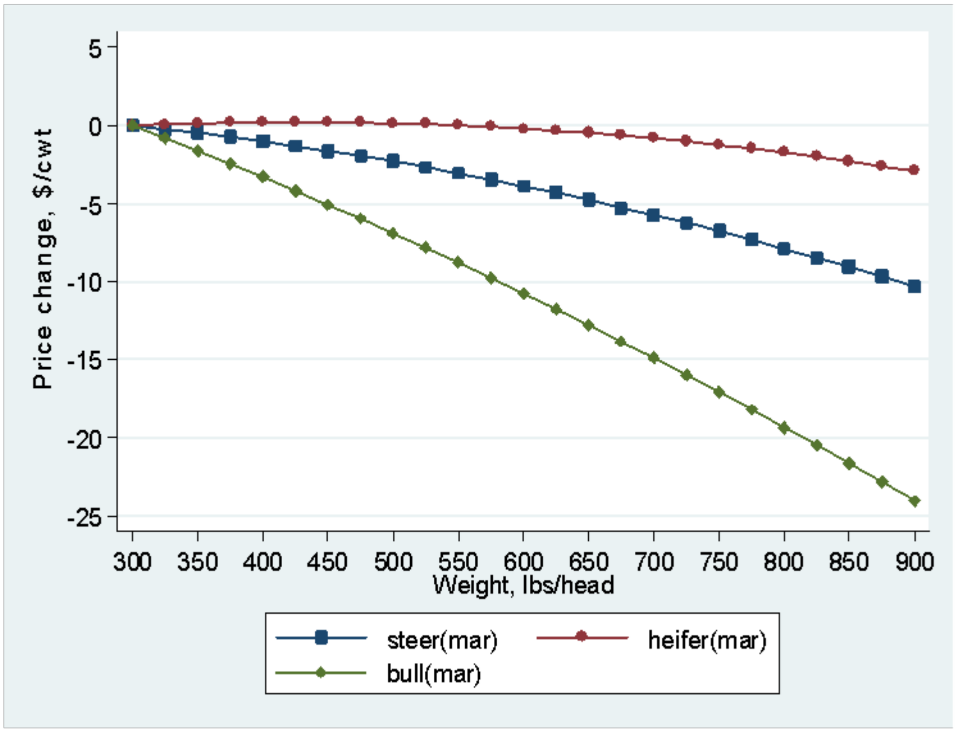


Figure 4.8. Price differentials by weight and sex, March

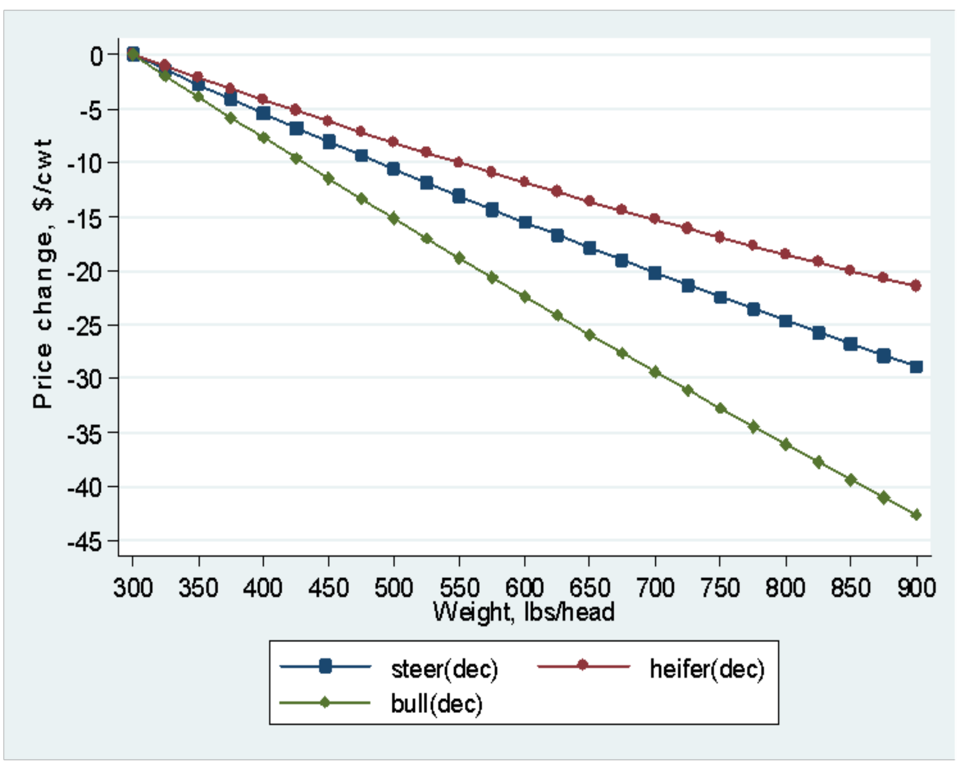


Figure 4.9. Price differentials by weight and sex, December

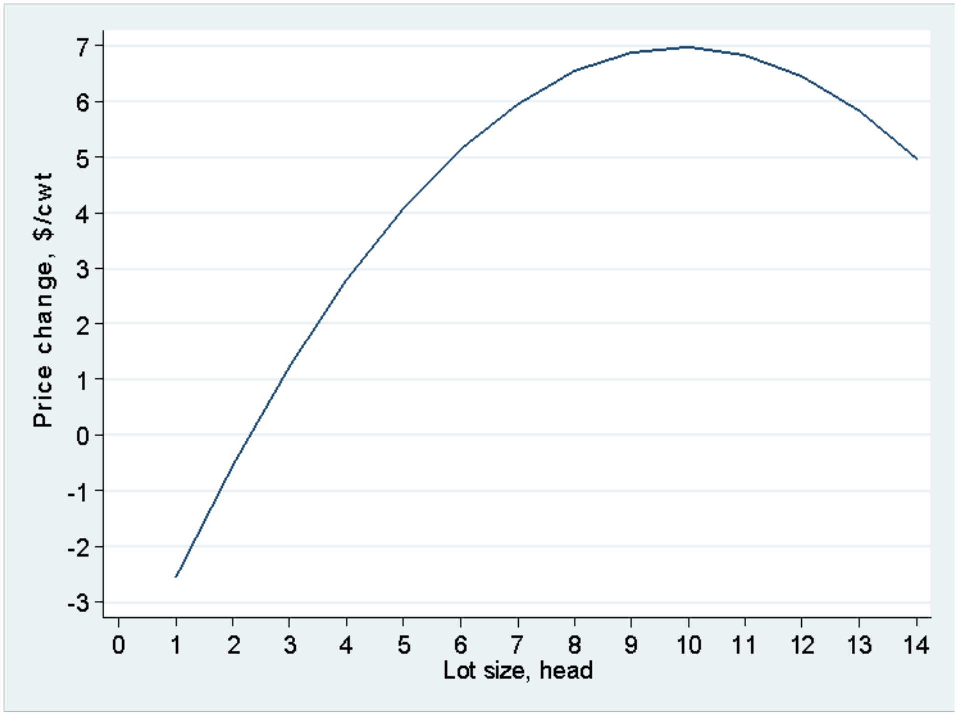


Figure 4.10. Effect of lot size on feeder cattle price

4.2.5 Lot Size

It is common for researchers to find concavity in the relationship between price received and lot size (Dhuyvetter and Schroeder 2000; Faminow and Gum 1986; Schultz et al. 2000). A similar nonlinear relationship is found in this study. The coefficient of the square of the lot size variable is significantly negative at the 1% significance level, and the coefficient of the lot size variable is significantly positive at the 1% significance level (Table 4.1), which suggests that initial price impacts associated with lot size are greatest and the positive impact on price decreases in magnitude as lot size increases. At around 10 head, the price received reaches a maximum (Figure 4.10). In previous studies, however, the optimal lot size was much larger approaching common “truck-load” sizes (about 60 head) (Faminow and Gum 1986; Schulz et al. 2010). This difference is likely to be caused by differences in cow-calf and feedlot operations between New York State and larger cattle producing states. In the Northeastern U.S., small farms are typical.

The aggregation of cattle from multiple farms can lead to an increase in respiratory disease. The data collected in our study also show the small producing scale with mean lot size around 2.6 head. Finally, the result may also be influenced by the relatively small size of the sales ring (compared to sales in Midwestern states). When cattle are packed in too tightly, buyers will be less able to see and evaluate them and, hence, are more resistant to bid the price up.

4.2.6 Quality Characteristics

As shown in previous literature, feeder cattle buyers exhibit a strong preference for thrifty and dehorned cattle with heavy muscling, and larger frame sizes (Lambert 1989; Schroeder et al. 1988; Schulz et al. 2010). At the average feeder weight (548 pounds), heavy muscled feeder cattle receive a $5.72/cwt premium relative to average muscled feeder cattle (Table 4.3). Buyers, however, discount feeder cattle that appear to be light muscled, medium framed, unthrifty, and with horns by $19.50/cwt, $3.43/cwt, $26.95/cwt, and $11.28/cwt compared with their bases, respectively (Table 4.3). In addition, these premiums and discounts brought by quality characteristics vary as cattle grow. From Figure 4.11, heavy muscling brings the highest premiums, and unthriftiness causes the largest discounts no matter what the weight is. Positive value for the weight by heavy muscling interaction implies that premium brought by heavy muscling versus medium muscling increases as weight increases, whereas positive value for the light muscling by weight, smaller frame size by weight, unthriftiness by weight and horns by weight interactions indicates that all the discounts caused by light muscling, smaller frame size, unthriftiness and horns decline as weight increases (Figure 4.11).

Preconditioning prepares calves to enter feedlots by putting them through a health program of different vaccinations, weaning them from their mothers, and getting the calves on dry feeds. Preconditioning is designed to mitigate the transitional period between weaning and dry feeding for calves entering feedlots. By increasing the calf's resistance to respiratory diseases prior to weaning and boosting that resistance at weaning where exposure to pathogens is generally minimal while calves are still at the ranch, they are better prepared to enter the marketing system or other phases of beef production. Premiums received for preconditioned calves in different operations are difficult to be compared since preconditioning programs vary. In this study, preconditioning impacts feeder cattle price positively. At the average feeder weight, preconditioned calves receive a $3.11/cwt premium compared to the non-preconditioned (Table 4.3). The positive sign of weight by preconditioning interaction indicates that the effect of preconditioning programs increases as weight increases (Figure 4.11).

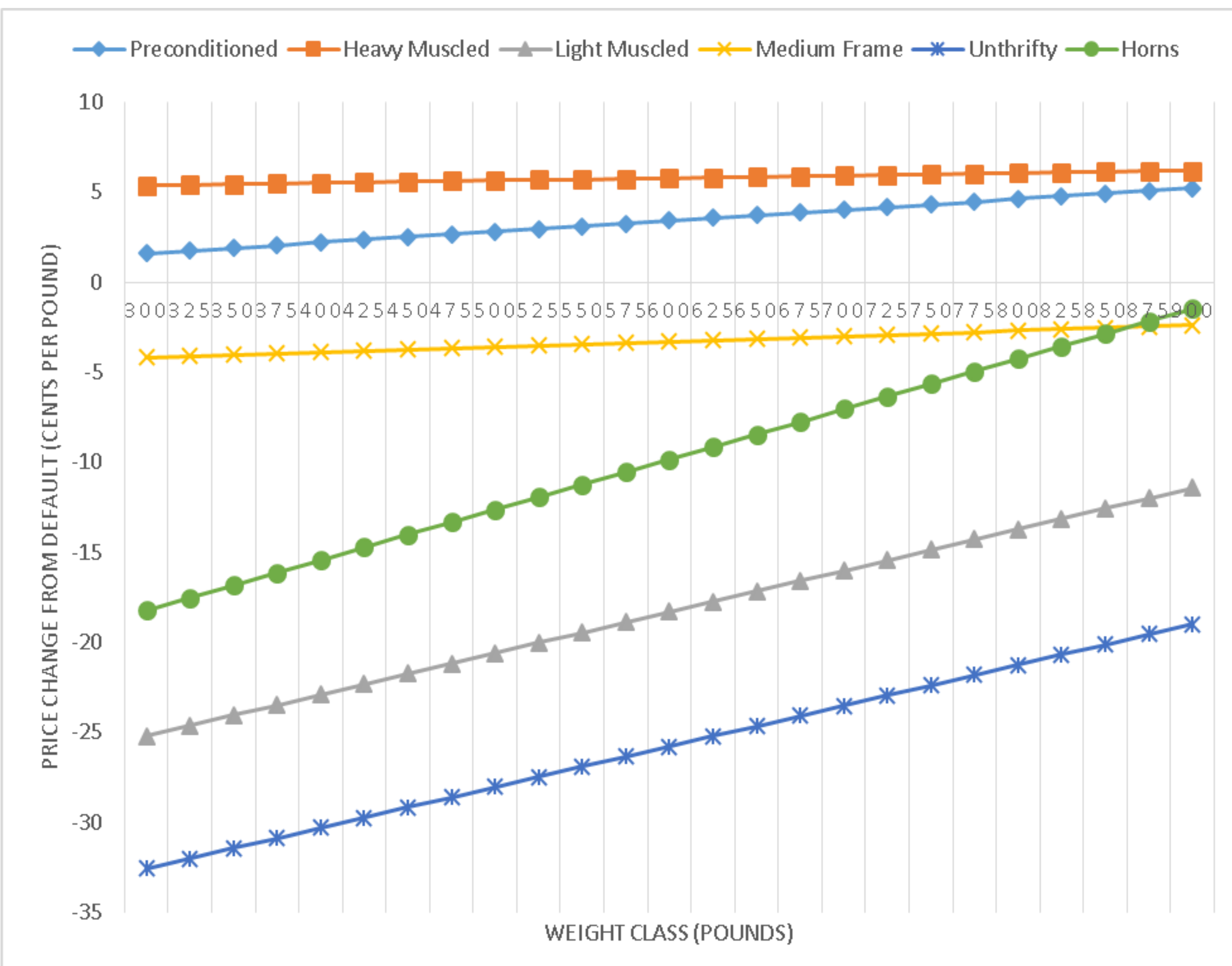


Figure 4.11. Quality effects by weight

4.2.7 Color/Breed

Breed pricing differentials are often regional, meaning certain breeds tend to be more popular in certain areas, and classification of cattle is often inconsistent across regions (Burdine 2011). Dhuyvetter and Schroeder (2000) broke Kansas cattle into mixed, continental and English groups. In our study, cattle are divided into nine categories based on color/breed. Table 4.3 shows marginal effects of color at sample means, which are deviations in price from the base color, Hereford. Red, black, brown, white, and mixed cattle bring premiums relative to Herefords, among which largest premium ($13.93/cwt) is brought by black color (Angus). As expected, Holsteins, dairy, and exotic cattle are found to sell at a price discount to Herefords. Among them, the largest discount ($17.80/cwt) is brought by Holsteins which have reduced feedlot growth performance and a lower per hundred weight value at the end of the feedlot fattening phase. In previous study, premiums or discounts brought by breed remain constant across weights (e.g., Dhuyvetter and Schroeder 2000; Schroeder et al. 1988; Schulz et al. 2010). In our work, however, price-color relationships vary as weight increases due to changes in feeding performance. For example, compared to white cattle, red cattle receive a higher premium before approaching 650 pounds, whereas a lower premium after this weight (Figure 4.12[8]), contradicting the finding that white cattle always receive a premium versus red cattle (Schulz et al. 2010). For the colors bringing premiums, their interactions with weight are negative, whereas for the colors causing discounts, their interactions with weight are positive. The results demonstrate that premiums or discounts paid for all these colors decrease as cattle grow, implying that color has a larger impact on the price of lighter-weight cattle.

[8] Marginal effects of color are calculated at every 25 pounds from 300 to 900 pounds, and these points are displayed in the figure which takes Herefords as baseline.

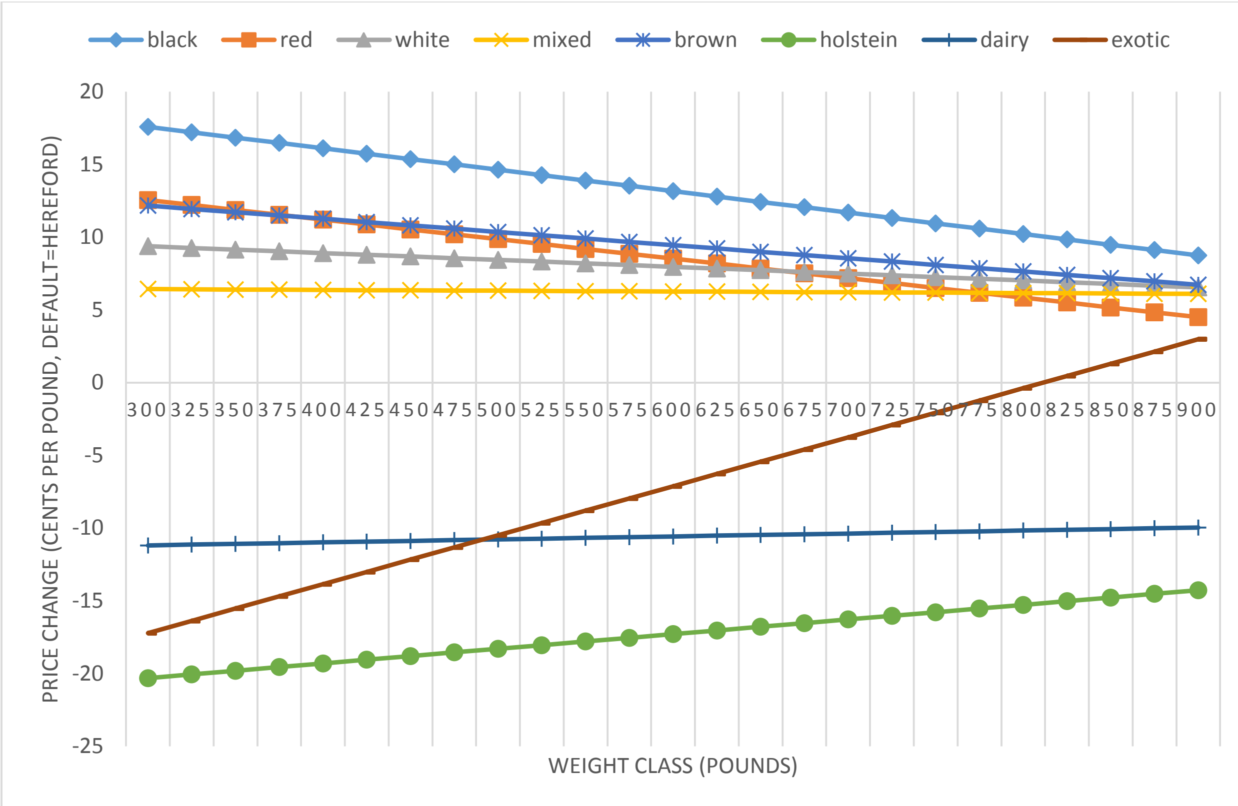


Figure 4.12. Color effects by weight

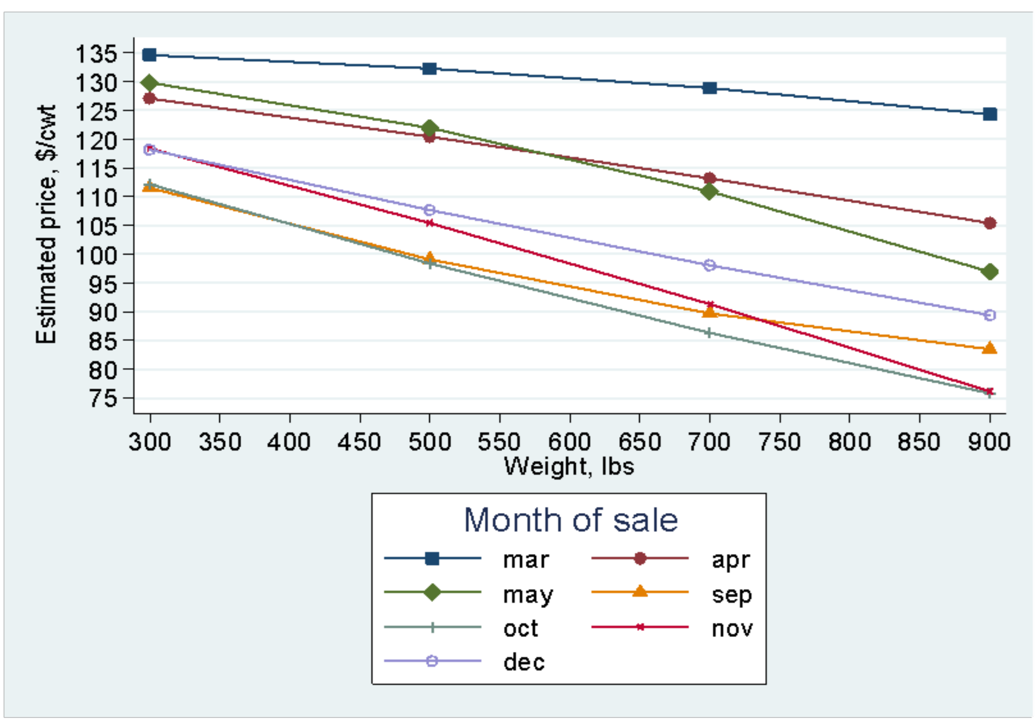


Figure 4.13. Seasonality effect by weight

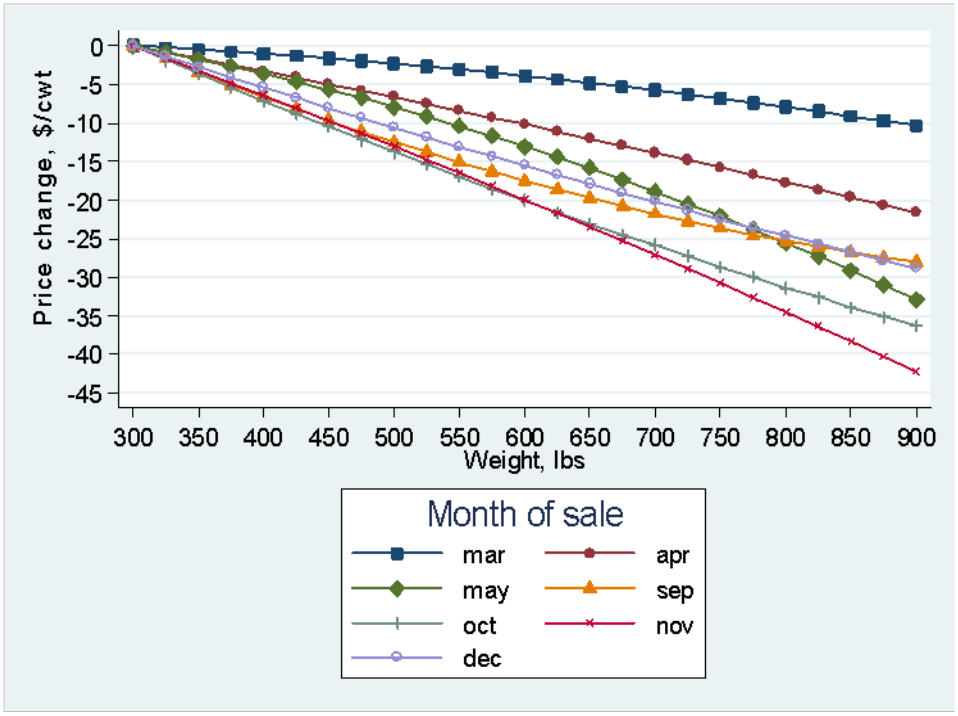


Figure 4.14. Steer price differentials by weight, various months

4.2.8 Seasonality

In general, feeder cattle prices have been found to be higher in spring, while fall and winter are associated with lower prices (Dhuyvetter and Shroeder 2000; Schultz et al. 2010). This result is held in the New York State case (Figure 4.13). In the Northeastern United States spring calving is usually preferred[9]. Grouping calving in the spring for sale in the fall leads to larger feeder cattle supply in the fall. As weight increases, however, the fall price for feeder cattle declines faster than the spring price, which is in conflict with the findings of Schroeder et al (1988) and Schulz et al (2010). Figure 4.14 shows the relative price patterns for different weights of steers in different months, mainly spring (Mar, Apr, and May) and fall (Sep, Oct, and Nov), indicating a

[9] According to the report of Penn State Extension, a variety of reasons result in preference for spring calving in the northeastern United States: feeding least-cost high-quality forages soon after calving; making the best use of low-quality forages early in the winter during the immediate post-weaning period; rearing calves in a more healthy environmental on pasture as opposed to rearing fall calves in a dry lot over the winter.

stronger demand for light-weight feeder cattle in the fall. Relatively larger weight discounts in the fall might be caused by seasonal variations in national feeder cattle supply. The data collected reveal larger supply of heavier weight cattle in the fall, thus resulting in higher demand for light weight feeder cattle in the fall. The other possible reason is that low-quality forages can be used in the fall for cow herd calving in the spring, leading to a lower cost.

4.2.9 Time of Sale

The effect of sale order is significant. From Table 4.1, the coefficients of sale quarters are significantly positive at the 99% confidence interval. Feeder cattle sold in the first, second, and third quarters receive $6.96/cwt, $5.86/cwt, and $3.44/cwt premiums versus cattle sold in the fourth quarter, which implies that the best prices are obtained in the first quarter of the auction, and then fall steadily from the first quarter to the fourth quarter since more and more buyers quit the bidding. While Kuehn (1979) found sale price was higher in the last third of the sale, and Schroeder et al. (1988) found sale price was higher in the second and third quarters, our results support Lambert et al.’s (1989) finding that best prices are obtained in the first quarter except that the premium paid for the cattle sold in the first quarter is higher in our work.

4.2.10 Number of Buyers

As an auction characteristic, auction size measure, number of buyers[10], has not been investigated in the recent literature. In our work, it is significantly positively related to feeder cattle prices at the 10% significance level (Table 4.1). Kuehn and Ssekitooleko (1979) introduced both linear and quadratic terms of number of buyers into their analysis, and found that price decreased as the

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[10] The number of buyers variable is potentially endogenous in our empirical model, but identifying a suitable set of instruments from available data is unclear and we leave for future research. In our research, removing the variable has little effect on the rest of the results; i.e., the remaining results are robust to its inclusion or not.

number of buyers increased up to 36. In contrast to their finding, linear relationship between price and number of buyers is explored in our model, and a positive effect of number of buyers is obtained, which is consistent with economic theory. The coefficient of number of buyers is 0.1, which demonstrates that every ten more buyers present in the auction leads to $1/cwt increase in the feeder cattle price. In addition, its elasticity, evaluated at sample means (and dummy variables at the defaults) is 0.05, which is statistically significant (Table 4.2). Obviously, competition among feeder cattle buyers is a positive influence on selling prices at a cattle sale. Although feeder cattle sellers cannot control the number of buyers, they perhaps can choose sale locations through comparison between premiums brought by these locations and transportation costs.

Chapter 5: Conclusion

This work combines an empirical approach and a recent New York State data set that has not previously been used in feeder cattle pricing research. Thus, the literature on factors affecting feeder cattle prices is enhanced. More importantly, the results are directly applicable to the cattle industries in New York State. Since cow-calf and feedlot operations are similar throughout much of the Northeastern area, the results can be used by producers in these areas as well.

A wide variety of factors affecting feeder cattle prices are examined in New York State. For factors reflecting market conditions, live cattle futures price has an expected positive effect on feeder cattle prices, while corn futures price has a significant negative impact on feeder cattle prices. While volatilities of live cattle and corn futures prices were shown to have no economically important influence on price slides by Dhuyvetter and Schroeder (2000), our work revealed an opposite conclusion: Lighter weight cattle are preferred when volatilities are low. For lot characteristics, similar to previous research, a nonlinear price-lot size relationship is found. However, the optimal lot size is around 10 heads in New York State, which is much smaller than the optimal lot size in larger cattle producing states (e.g., Kansas, Missouri, and Kentucky). Steers always receive the highest price, and there is an interaction between heifer and bull prices. In addition, bulls bring the largest price-weight spread, while heifers demonstrate the smallest price-weight spread in all seasons. For quality characteristics, similar premiums brought by black color, heavy muscling and preconditioning, and discounts caused by Holsteins, light muscling, smaller frame size, unthriftiness, and horns are found, which is consistent with previous literature. The price-weight relationship is found to vary by season. Consistent to previous work, feeder cattle sold in spring can receive a higher price than those sold in fall. However, in the fall rather than spring, light-weight cattle are preferred.

Besides the factors mentioned above, characteristics of auction itself are investigated. Our results show that the best prices are obtained in the first quarter of the auction, and then fall steadily thereafter. In addition to sale order, competition among feeder cattle buyers has a positive influence on selling prices at a cattle sale. In prior literature, however, this effect was rarely discussed. Kuehn and Ssekitooleko (1979) found a curvilinear relationship between price and number of buyers. In our study, a statistically significant positive linear relationship between price and number of buyers is found. These auction characteristics bring additional information relative to previous research.

Moreover, the impacts of color and quality characteristics are allowed to vary as feeder cattle grow. Cross interactions of weight by color and quality characteristics are incorporated in our hedonic model. As weight increases, premiums or discounts brought by color decline, implying that color has a larger impact on the price of lighter-weight cattle. Premiums paid for heavy muscling and preconditioning increase, and discounts caused by light muscling, smaller frame size, unthriftiness, and horns decrease as cattle grow. These results indicate that color and quality attributes have a larger effect on light-weight feeder cattle prices in general.

When beef producers are making management and marketing decisions, this study documents market conditions, seasonality, and characteristics of auction, lot and quality to consider to increase price received for feeder cattle. Buyers can also develop more informed price slides. Premiums and discounts brought by certain characteristics are estimated in our research. The values of these price changes are important as producers compare these values with the costs associated with management practices that address them.

Future research could be done to further explore the effects of some explanatory variables on the price of feeder cattle. For example, detailed information on buyers could be collected to see the nature of different buyers, and endogeneity between number of buyers and feeder cattle price could be further studied. Moreover, since the research focuses on New York State, studies could be extended to other states in the Northeastern area to provide further insight into the impacts of factors on the feeder cattle price.

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