PRICE EFFECTS OF ECONOMIC AND PRODUCTION FACTORS ACROSS WEIGHTS OF FEEDER STEERS AND HEIFERS IN SOUTHERN GREAT PLAINS STATES

by

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Abstract

Feeder cattle are placed into feedlots at varying weights. This placement weight is the result of procurement decisions by cattle feeders and of marketing decisions by cow/calf and stocker/backgrounder producers. Increased understanding of the behavior of these markets can help both buyers and sellers of feeder cattle make these decisions.

Past research has used linear or quadratic variables or interaction variables in order to model the effects of weight on price. This study instead divides the market for feeder cattle into ten distinct subsets which are evaluated independently. The feeder cattle market for four major cattle feeding states in the Southern Great Plains (Nebraska, Kansas, Oklahoma and Texas) was divided into ten subsets, five in each gender. Each of these represent feeder cattle coming to market in a 50 pound weight range, centered upon 525, 625, 725, 825 and 925 pounds. Each of these subsets was analyzed using seven independent variables selected based upon previous research and economic rationale. These variables were the live futures price, previous feedlot returns, feeder cattle inventory, interest rate, feedlot capacity utilization, cost of gain and pasture conditions. The data for these variables were collected from public sources, aggregated into monthly observations and differenced to correct for nonstationarity. Analysis was conducted using ordinary least squares regressions.

Results are reported and trends between weight classes discussed along with their implications. Findings support that feeder cattle of different weights are not perfect substitutes and that market and production factors do not influence all weights of feeder cattle the same. In fact, factors which positively and negatively affect feeder cattle price seem to signal that demand for, or in the case of pasture supply of, feeder cattle of a particular weight has changed and that placement price-weight relationships will adjust accordingly.

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Dedication

This thesis is dedicated to my family; especially my parents Craig & Jean Lister, my sister Jordyn Ring and my brother-in-law Anthony Ring, for their constant support and encouragement throughout my education.

Chapter 1 - Introduction

In the U.S. beef industry, cattle are typically removed from pasture and placed in a feedlot for the finishing stage of live cattle production, representing the final ante mortem stage of beef production. Although some cow/calf or stocker/backgrounder producers may choose to retain ownership through this phase of production, placement into the feed yard usually involves a market transaction. For this reason, the price of feeder cattle at placement in the feed yard represents the majority of income for many cow/calf or stocker/backgrounder producers and a major variable cost for cattle feeders. Furthermore, the price of feeder cattle at this point in the supply chain represents the opportunity cost for cow/calf and stocker/backgrounder producers choosing to retain ownership of cattle on feed.

The price of feeder cattle is determined by the interaction of derived supply and derived demand. The primary supply in the U.S. beef industry can be defined as either the nation's calf crop or the size of the domestic cow herd if the national market is considered in isolation. If trade is considered, then the calf crop or cow herd of our trade partners would also be included in calculating primary supply. If the cow herd is thought of as the primary supply the total inventory of both beef and dairy cows should be considered and the next level of derived supply, beef calf crop, should adjust not only for calving rate, but should be reduced by the number of calves not destined for the beef industry, including most females born in dairy operations. Since this primary supply is controlled by the cow/calf producer, the difference between it and feeder cattle supply at a later time can be affected by the growth rate of the calves, the rate of death loss, the rate of heifer retention and, if the primary supply is defined as the cow herd, reproductive performance, among other factors. Changes in the total domestic inventory of various weights of feeder cattle can be predicted fairly well based on the inventory of lighter weight calves or the size of the cow herd in the past, taking in to account conditions such as widespread animal disease or weather patterns that could change one of the conditions above or changes in the global trade of live cattle.

The primary demand for the beef industry is the beef consumer. However if the live cattle market is considered specifically, the primary demand is the demand for fed cattle. The demand for feeder cattle can be derived from this demand. The difference between these demands is the feeder margin, and thus this derived demand will be affected by any factor that would affect cattle feeders' expectations of profitability. These include the expected cost of gain and the availability of pen space in existing feed yards, among others.

Furthermore, due to the biological growth process which is the foundation of the beef cattle industry, derived demand and supply equations can be presented for cattle at any stage in the production process or for weights of calves within these stages. The market for feeder cattle is therefore difficult to define precisely. Feeder cattle can vary in weight and age from one another. As feeder calves grow, they become more similar to the final product demanded from the live cattle sector, a finished calf ready for harvest.

Demand for feeder calves, primarily from cattle feeders, cannot be thought of as a level force across all weights of feeder cattle. This is due to the fact that not all feeder cattle are perfect substitutes for one another. Among the most basic differences which make feeder cattle unique from one another are gender and weight. Though a heifer and a steer will both grow on a concentrate diet and produce beef, the rate of gain, feed efficiency and final value of the animals are not constant. Furthermore, although calves of the same gender which weigh 500 and 900 pounds will both grow into harvest-ready cattle, they will require differing time periods on feed and require a slightly different mix of inputs to arrive at this stage.

Many more subtle differences are present which can segregate the feeder cattle markets. Attributes such as breed, lot size, muscle pattern and health are often included in hedonic pricing models and are often accounted for in predictions of feeder cattle price. Predictions can also be made of the effects of weight and gender on prices of feeder cattle. This often considers one market with a standard weight and gender. Premiums and/or discounts are then measured from these standards for the other gender and for other weights.

In practice however, cattle feeders can place feeder cattle at any weight which best fits their production needs. Similarly, cow/calf and stocker/backgrounder operators are able to adjust marketing weights in order to maximize their profitability. This results in placement weights which are not constant and adjust in response to outside market and production forces. Selection of one standard placement weight is therefore difficult for time series market data. Accurately predicting premiums and discounts from a standard placement weight is also a difficult task for a producer or other market participant.

Viewing the feeder cattle market as one of distinct subsets based upon weight and gender can alleviate the problem of selecting standard placement weight and reduce the probability of errors in predicting price-weight relationships. Furthermore, analyzing market subsets for varying feeder cattle weights can increase understanding of how the effects of key factors vary across weight classes. Factors such as price expectations and expected costs of gain may have larger or smaller effects for heavyweight calves compared to lightweight calves.

This thesis seeks to discover the effect of key factors on various weights of feeder steers and heifers. In doing so, this research will allow producers at all stages to better understand the effects of market forces on the price of feeder cattle and make more informed decisions in both buying and selling feeder cattle.

1.1 Objectives

This research seeks to increase understanding of relationships between economic and production factors and the price of feeder cattle and in so doing, improve the accuracy of future models and the decision making process of producers at all stages of the beef industry. In order to accomplish this, three objectives must be met.

First, a review of existing literature on feeder cattle pricing models and the effects of certain economic and production factors on feeder cattle prices will be conducted. Particular attention will be given to the effects of weight and gender on feeder cattle price and interactions between weight and the effects of other variables. Secondly, data will be gathered from public sources and analyzed using Ordinary Least Squares regression analysis for identified market subsets. Finally, the results will be reported and a discussion of the effects of these variables on the price of feeder cattle will be presented. Any differences in the effects of these factors between weight classes will be noted and economic rationalizations of trends will be offered.

1.2 Organization of Thesis

This thesis is presented in five chapters, the first of which is the present introduction. Chapter 2 contains a review of the previous literature of related topics which form the foundation for the work done later in the thesis. Chapter 3 describes the process for collection, management and analysis of the data used. The results of said analysis are presented in Chapter 4. This chapter also presents a discussion of the results and their implications for the feeder cattle market. Chapter 5 provides a brief summary of research and findings along with questions for future research which are raised by this study.

Chapter 2 - Literature Review

The existing literature provides a foundation for the further analysis of the impact of production and market factors on feeder cattle price. This chapter reviews previous research on feeder cattle price as well as the previous body of research related to one or more of the variables included in this study's analysis.

2.1 Feeder Cattle Price

Modeling of feeder cattle prices is well documented. Many of the recent studies have used data from internet and video auctions (Burdine, Maynard & Halich, 2013, Zimmerman et al., 2012, McLemore, Drinnon, Rawls & Campbell, 2010). Older studies tend to rely on observed physical auction data or publicly available compilations of the same (Maki, 1962; Menkhaus & Kearl, 1976). Some studies are hedonic in nature, modeling price on producer decisions such as vaccination and weaning programs, breeds and lot size which provide direct benefit to the buyer apart from the standard commodity (Menkhaus & Kearl, 1976; Faminow & Gum, 1986). Others, similar to the present study, are focused on changes in the inherent aggregate market value of feeder cattle at one or more weights based on supply and demand influencers (Maki, 1962; Buccola, 1980). Later studies were aimed at increasing the understanding of the relationship between price and weight and the ability to predict the cash basis (Dhuyvetter & Schroeder, 2000; Dhuyvetter, Swanser, Kastens, Mintert & Crosby, 2008). This section will first examine the development of forecasting prices for the market at large or individual pens and will then review the literature concerning basis and price-weight relationships.

2.1.1 General Price Forecasting and Hedonic Models

Early research into the modeling of the beef industry was conducted by Maki (1962). His research provides economic interpretation of many phenomena in both the beef and pork markets. A segment on beef price, using Kansas City cash price data, predicts feeder cattle price based on slaughter prices, corn prices and trends in its own price. This model helped to introduce empirically the value of feeder cattle as a function of factors affecting feedlot profitability.

A problem of early economic analysis was the cost to producers of analyzing prices independently. Thus much of the early knowledge of feeder cattle price was of limited value to cattle producers. Attempts at using simple predictive models, such as the trend model proposed by Franzmann and Walker (1972), provided limited forecasting ability for a low cost. However, these models were not thought by the authors to be sufficient for use in short run decision making. Furthermore the main argument presented for using them in long run decision making is the model's low cost, not its forecasting ability.

As time progressed, research began to focus on economic facts which could help producers make marketing decisions, even with limited data. Examples included premiums and discounts for various attributes of feeder cattle. Menkhaus and Kearl (1976) present an early example of a hedonic model identifying premiums and discounts, evaluating the effects of breed, gender, weight and lot-size on the value of feeder cattle at a Wyoming market. They found higher values for steers than heifers, premiums for white faced cattle over Angus, and that lighter weight calves were significantly more valuable on a $/cwt basis than heavier weight calves when prices were high.

The 1980's saw more interest in modeling feeder cattle price and as a result, the further development of our understanding of price behavior. Buccola (1980) evaluates breakeven prices for both sellers and buyers of feeder cattle. He shows changing breakevens across weights and genders as well as different effects of a change in feed price. Buccola's focus on breakevens rather than price specifically accounts for the shifting nature of the feeder calf market, where the true long run equilibrium is never reached.

This study was one of the first to examine causal effects of weight and gender on price rather than simply assuming a placement weight and gender in the model. By using interaction variables between weight and cattle grade, he found that prices of 500 pound choice steers were more positively affected by increases in expected slaughter price and more negatively affected by increasing corn prices than 600 pound choice steers. Similarly, by using interactions of explanatory variables and a gender dummy variable, he discovered that the price differential between steers and heifers was impacted by changes in factors such as corn price. Thus, Buccola became one of the first forecasters to account for changing effects of variables on price across market subsets divided by weights and gender.

Further examining the differences between market subsets, Faminow and Gum (1986) present a model using nonlinear premiums and discounts on the basis of weight and gender and lot size on Arizona markets. The use of quadratic variables and numerous interactions amongst the aforementioned variables provided a model which could be used to determine price premiums and discounts associated with specific weights and lot sizes for each gender.

The concept of static premiums and discounts for attributes is extended by other studies in the area (Marsh, 1985; Schroeder, Mintert, Brazle & Grunewald, 1988; Lambert, McNulty, Grunewald & Corah, 1989) to include numerous attributes. Although the purposes of these studies are largely hedonic in nature; testing variables such as breed, muscle condition, frame size, fill, health and uniformity; or testing for other concepts such as seasonality as in the case of

Marsh, variables affecting the whole market such as weight are included alongside the test variables in these studies. Though there is some variation in values and significance, their findings tend to support the general findings of previous research that weight increases cause prices to decrease at a decreasing rate.

Recent studies have applied some of the findings of past research to local markets in attempts to forecast prices and the effects of management decisions and cattle attributes on prices (Bulut & Lawrence, 2006; Schulz, Dhuyvetter, Harboth, & Waggoner, 2010; Williams, Raper, DeVuyst, Peel & McKinney, 2012; Zimmerman et al., 2012). Many of these studies analyze prices across weight ranges in one model, define a weight and/or include weight as an independent variable. Few of them however, use sufficient interaction terms or other methods which would allow the model to account for different affects of these factors across weights and genders.

2.1.2 Cash Basis and Price-Weight Relationships

As the understanding of the effects of market forces on the overall value of feeder cattle, and the effects of individual attributes on the value of specific sets of feeder cattle increased, economists sought to improve understanding of other relationships between prices. Two of the relationships studied are the relationship between the cash price and the futures price, referred to as cash basis, and the relationship between price and weight. Rather than assuming basis to be a fairly constant moving average and weights to cause a static premium or discount from a mean, these studies analyzed the effects of market conditions on both basis and price-weight relationships.

Dhuyvetter and Schroeder (2000) analyze price-weight relationships in the feeder cattle market. They find that changes in factors such as corn prices, futures prices and previous feeding margins affect the differences between lightweight and heavyweight weight feeder calf prices. This study helps to explain a possible cause of the wide range of price-weight relationships previously published in research. The fact that these relationships change as market conditions change is not only important for price forecasting, it is also seminal to studies such as this one. Since price-weight relationships are affected by market factors, there is reason to analyze how the effects of these factors are affected by weight.

Dhuyvetter et al. (2008) present an alternative to overall cash price forecasting by developing a forecasting model of feeder cattle basis. This study is founded upon many of the factors found by previous research to influence cash price to model basis for a feeder cattle futures model and a live cattle and corn futures model. Each model of basis is a function of futures prices and lot characteristics which influence cash price. These forecasts are an alternative to the historical averages which are commonly used to predict basis.

Hirschi and Feuz (2010) investigate basis using the prices of feeder cattle from different locations in the United States. They present the hypothesis that differences exist in feeder cattle price apart from transportation costs and those that can be explained using hedonic models. In essence this hypothesis states that geographically diverse markets operate independently and that the feeder cattle cash market is spatially inefficient. Their findings reject this in favor of the null hypothesis for heavyweight calves. Lightweight calves exhibited statistically significant differences, which may have been due to the presence of alternatives to feedlot placement.

Swanser's (2013) working paper examines price-weight relationships, which he calls price slides, using USDA Agricultural Marketing Service (AMS) data. He determines that the actual values of feeder cattle at various weights are consistent with predictions from a derived demand model using two inputs, feeder cattle and corn, to produce one output, fed cattle. This study views differences in prices between weight classes of feeder cattle as reflections of the costs and benefits of feeding them to produce the final output of the live cattle industry, a fed calf ready for harvest.

Previous research shows that the price of feeder cattle is a function of numerous factors. These factors generally represent the profitability of cattle feeders which dictate their demand for feeder calves. While pen-specific hedonic factors such as breed, lot size, muscling and health can be modeled using premiums and discounts, this method is not ideal for considering effects of weight and gender differences. Even nonlinear trends, interaction terms and studies of price-weight relationships have not fully explained the differences in factors' impact across weights. Furthermore, cash markets may be affected differently than futures markets for various reasons, especially for cattle in the cash market outside of the range defined by the futures market. A model predicting futures price should be framed by a basis prediction for it to be applicable.

This study, therefore considers the aggregate cash markets for steers and heifers of different weights as distinct market subsets. The effects of other variables across these subsets are evaluated to determine how their behavior changes.

2.2 Cost of Gain and Feeder Cattle Price

One broad factor which previous research has documented well is the effect of changes in the costs of gain. This is often represented by the changes in the costs of feedstuffs as these price shifts are often larger than changes in feed efficiency, especially over short time periods. An increase in the cost of gain is expected to decrease the price of feeder cattle in an efficient market as it measures the cost of the conversion process of feeder calves into grain-fed cattle. The inclusion of a variable representing the cost of gain, value of feed, feed efficiency or a combination of the three is present in virtually all models of feeder cattle price. Some models, such as those included in this study, use a calculated ration cost consisting of the prices of numerous feedstuffs in a fixed ratio (Anderson & Trapp, 2000b). Other studies (Langemeier, Schroeder & Mintert, 1992; Lawrence, Wang & Loy, 1999) use price of corn, one of the most common energy sources, as a proxy value for overall feed costs.

The impact of costs of gain on feeder cattle price is through its impact on the profitability of cattle feeders, which in turn affects their demand for feeder cattle. Langemeier et al. (1992) demonstrate the importance of corn price to cattle feeding, stating "Changes in corn prices contributed up to 22 percent of the variability in profits (p. 45)." This study demonstrated the benefit to cattle feeders of managing feed price risk along with fed cattle price risk. It also further highlighted the influence of corn prices on feeder profitability, and by extension feeder cattle demand.

Lawrence et al. (1999) researched cattle feeder profitability in Iowa and surrounding states. They found the effects of corn price and the feed conversion ratio varied between weight classes and genders of feeder cattle. Coefficient estimates for these two variables from the regression analysis presented in the study do not exhibit a clear trend in weight. However, a process they refer to as "variability decomposition of returns" indicates that both of these factors are more important (contribute more to the explanatory power of the model) in lighter weight calves due to a longer feeding period.

Anderson and Trapp (2000b) examine the interactive effects of feed efficiency, feed costs, placement weights and slaughter weights. They demonstrate that the effects of a change in feed price are not a static price discount or premium; rather feed price changes change the optimal placement and slaughter weights, which then change feed efficiency and overall gain. Therefore, the impact of a change in feed costs on feeder cattle price cannot be accurately modeled by a “rule-of-thumb estimate” but are better represented by the first derivative of an equation including interaction variables. Commonly used rule-of-thumb estimates which imply an elasticity equal to one will often overstate the effects of a feed price change on the feeder cattle price.

Anderson and Trapp (2000a) discover that common proxy values for the cost of gain based upon corn price may be flawed. These representations are based upon the idea that a percentage increase in corn price produces an equal percentage increase in cost of gain. By finding that the elasticity of cost of gain with respect to corn price was in fact less than one, they indicated that estimates of effects of corn price changes on cost of gain are often upward biased.

They also discuss the estimation of “corn price multipliers” which estimate the price response of feeder cattle to a long-run corn price increase. Many of these multipliers are based on these same common estimations of the cost of gain based on a change in corn price. The bias of cost of feed estimates may cause these multipliers to be incorrect. Since these multipliers are more likely used by feeder cattle producers than cattle feeders, this could lead to information asymmetry in the market. Overall, Anderson and Trapp illustrate that feed costs have many factors influencing them which must be considered in order to accurately measure their effects.

Zhao, Du and Hennesey (2009) support the expectation of a negative relationship between corn price and feeder cattle price. Their finding of significant pass through of a change in corn price supports the theory of Ricardian rent and detracts from the idea of information asymmetry existing between the seller and buyer of feeder cattle. This study does find differences in the time frame for pass through of upward and downward shifts in corn price to the feeder cattle market. An increase in corn price results in an immediate pass through to the feeder cattle market. However, the time frame for the feeder price to increase in response to a corn price decrease is about a month. This indicates that it takes longer for cattle feeders to bid a price up than to decrease their offerings for feeder cattle.

Although Tejeda and Goodwin (2011) find no significant effect on feeder cattle price caused by a change in corn price, they do recognize that a long-run inverse relationship does exist. Therefore, the eventual negative impact of corn price on feeder cattle price is agreed upon, while the length of response time is debated.

Peel (2011 p. 3) points out that the effect of feed costs does not apply uniformly across weights of feeder calves stating "…higher grain prices suggest reduced demand for feeder cattle. However, feedlots can partially mitigate the impact of higher feed costs by increasing the size of feeder cattle placed in the feedlot. In essence the feedlot can substitute more pounds of feeder cattle for more expensive feed." This study goes on to conclude that high corn prices have caused the market to signal for increased forage use in cattle production through increased demand for heavier feeder cattle.

Halich and Burdine (2014) find seasonal variation in the effects of feed costs on feeder cattle value. Rather than using the corn price directly and controlling for weight with a separate variable, this study calculated the corn cost to reach a weight of 750 pounds (or the cost savings associated with an animal heavier than this weight). They discovered that the effect of a $1 change in this total per head cost was less in the spring than in the summer or fall. The rationale presented for this is that beef stocker/backgrounder demand is higher in the spring, when pastures are more readily available, than in other seasons, when beef stocker/backgrounder producers would have to rely on lower quality crop residues to add weight to the calves. They claim this study is the first to document this seasonality and will likely stem further research into seasonal variations in the relationship between cost of gain and the value of feeder cattle.

Feed costs have been shown to be one of the most important factors affecting cattle feeder profitability. Therefore the price of feeder cattle should be heavily influenced by feed costs. However, the effect of these changes on feeder cattle price will not occur evenly across all weights. Changes in time on feed will cause the demand curve for feeder cattle to reflect a new optimal placement weight. Changes in corn price alone do not adequately reflect this impact as the price of other feedstuffs can have significant effects on feeder cattle price.

One aspect of cost of gain which is less widely used is the rate of conversion, or the average feed efficiency. The adaptation of the feed costs variable to a cost of gain variable allows for the true expected costs of gain to be revealed. This may help explain previously observed seasonality and give a clearer picture of the relationship between this factor and feeder cattle weight.

2.3 Rational vs. Naïve Expectation of Fed Cattle Price

The expected price of fed cattle at the end of the feeding period is another factor which is almost universally present in modeling feeder cattle price. The fed cattle price is the output price which the cattle feeder will receive. It can also be thought of as the revenue earned by the cattle feeder for each calf fed. Thus, a cattle feeder's maximum willingness to pay for a feeder calf should be equal to their expectation of this future revenue, less their expected costs to convert the feeder calf into a fed calf.

Expectations of price must be used due to the lagged nature of production. Because biological lags prevent immediate transformation of feeder cattle into fed cattle, there is potential for the price of the finished product to change in the feeding period. This uncertainty of prices leaves individual cattle feeders to form their own expectations of future price. Since it is impossible to know the true expected price each cattle feeder holds without conducting a massive and costly survey (which would need to be repeated each feeding period), economists are left to form predictions they believe match those of most producers. Tomek and Robinson (2003 p. 186) explained the fundamental problem of production lags which causes this need to model expectations in numerous agricultural markets, particularly beef:

> *"In practice, we are uncertain about how farmers form expectations. Indeed, different farmers may form expectations in different ways. The important point is, however, that since time lags exist in the production process and since expectations must be based on existing information, it is possible that cycles are introduced into price behavior. These cycles are likely to be more observable for livestock and livestock products, because except for poultry, animal units require relatively long time periods for change. An increase in the supply of beef, for example, first requires an expansion of the basic breeding herd. Female animals must be withheld from slaughter and reach sexual maturity, and after breeding, a gestation period exists. Then, after birth, the young animals must grow to slaughter weight."*

Tomek and Robinson listed three hypothesis of how producers form price expectations. The first hypothesis is naïve expectations. Naïve expectations simply use the current cash price as the expected future price. In the second hypothesis, quasi rational expectations, the expected future price is a function of past prices. This method assumes autocorrelation among prices. The number of lagged prices used in determining the expectation varies depending on the model. The final hypothesis is rational expectations. Rational expectations are formed based on current information of the variables which are believed to influence future price. In markets such as the beef cattle industry where futures contracts exist, the future's price for the contract nearest the time of finishing can be considered the rational price if markets are efficient. The literature in this area can be broadly divided into two categories: Efficiency of the Fed Cattle Market and Price Expectations in the Fed Cattle Market.

2.3.1 Efficiency of the Fed Cattle Market

The validity of the Efficient Market Hypothesis (Fama, 1970) in at least some form is necessary for the futures contract price of any market to be rational expectations of future price. If markets are strong form efficient, then no firm should use any information other than the futures price for price expectations, since all of the information available is reflected in the price. Fama states that "We would not, of course, expect this model to be an exact description of reality…" (p. 409) it is simply a theoretical concept. If markets are semi-strong form efficient, no publicly available data need be included in calculating price expectations. In this case, only firms who have access to proprietary knowledge would have the ability to enhance the accuracy of their expectations by supplementing the futures price. If markets are weak form efficient, then the futures contract price offers a superior prediction of the actual future price than any naïve or quasi rational price expectation. In this case, any firm with the necessary knowledge to do so would be able to use additional information to enhance the accuracy of their price forecasts. If markets are inefficient in all forms, then producers are better off predicting the future price as a function of historical prices, in other words, naïve or quasi rational expectations are sufficient.

Literature can be found to either support or reject the efficient market hypothesis for the live cattle market at different levels. Koontz, Hudson and Hughes (1992) generally supported the concept of an efficient live cattle market. The live cattle futures contract price becomes a better prediction as the contract date approaches and more information is reflected in the price. Their model uses publicly available data, supporting semi-strong form efficiency in the live cattle futures contract. To the contrary, Kastens and Schroeder (1995) found evidence that the market for live cattle was not weak form efficient through a trading simulation. Kastens and Schroeder admit that research varies widely on the issue stating "past research exists to support whatever preconception a researcher may have." (p. 284)

2.3.2 Price Expectations in the Fed Cattle Market

Due to the diversity of findings present in past literature, it has been difficult for economists to prescribe an exact method of price expectations which will work for cattle producers. Therefore, producers may use any of a myriad of methods in predicting what the fed cattle price will be at the time of finishing. One of the best criteria for evaluation of alternative price expectations is which of them persist over time. Although consensus on best expectations cannot be found, economists seem to commonly hold to the terminology suggesting that futures prices are "rational" expectations and current prices, past prices or functions of current and past prices are "naïve" expectations (Kastens & Schroeder, 1994; Zhang, Epperson & Houston, 2006)

Kastens and Schroeder (1994) studied the behavior of cattle feeders in making placement decisions in order to estimate what form of expectations they use, and what expectations provide the most accurate forecast. They found that cattle feeders seem to use naïve expectations in placing cattle rather than rational expectations, as given by futures prices, or a combination of naïve and rational expectations. They go on to show that rational expectations outperform naïve expectations and that predictions based upon both offer forecasts of future profits which are superior to each method alone.

The continuing use of naïve expectations by cattle feeders may indicate an expectation of upward price movements over the feeding period. Otherwise stated cattle feeders may believe the future price contains a negative bias. This raises questions as to why cattle feeders do not simply take long futures positions in the fed cattle market rather than physically buying cattle. If a negative bias exists, the futures market would offer profits without the capital investment of physical cattle feeding. Possible explanations could include tax incentives including asymmetric treatment of capital gains and losses (Purcell, 1992) or timing of tax deductions (O'Byrne and Davenport, 1988), lack of knowledge or producer utility derived from cattle ownership.

Hampel, Schroeder and Kastens (1998) found no significant effect of lagged profits on expected returns. They explain that increases in live cattle futures may offset the effect of recent profits. It is also possible that autocorrelation offset the effect found by Kastens and Schroeder (1994). This study supported using hedgeable returns in place of expected returns. Evidence was provided that the futures price offering the risk premium required by risk averse cattle feeders in times of increased volatility.

Zhang et al. (2006) find that cattle feeder behavior can be shown to depend on both rational and naïve expectations. They show that cattle feeders rely more on futures prices in making feedlot placement decisions. However, cattle feeders seem more likely to use naïve expectations in making fed cattle marketing decisions.

The evidence both for and against the use of rational or naïve expectations is plentiful. Likewise the efficient market hypothesis which validates the use of the futures contract price as an expectation can be questioned empirically. The absence of a clear resolution on appropriate modeling of expectations prompted the inclusion of both the futures price and a measurement of previous returns in the present study.

Chapter 3 - Methodology

This study creates a time series model which can be used for understanding and forecasting the price of feeder cattle at various weights based on factors shown by previous research or based on economic rationale to be important feeder cattle price determinants. The results and differences between the models will shed light on the differing effects of these factors on prices of steers and heifers of different weights.

3.1 Selection of Dependent and Independent Variables

The dependent variables of this study are selected to highlight differences in effects of factors between similar cattle. All models in this study are price dependent feeder cattle demand models; meaning that price rather than the often used quantity variable is the dependent variable. The prices used for dependent variables are historical monthly averages for steers or heifers in a specific weight group quoted in dollars per hundred pounds ($/cwt). The weights used are each a 50 pound range, with the weight reported as the median value.

The weight ranges chosen for inclusion in the study are centered at 525, 625, 725, 825 and 925 pounds. Analysis was also conducted on ranges centered at 575, 675, 775, 875 and 975 pounds. This data was not included in the discussion of results, but it is considered and is consistent with conclusions made later in the paper. These weight ranges cover a broad range of feeder cattle sizes and maturities. According to data reported for the Kansas feedlot industry, the average weights for steers and heifers to be placed on feed are 779 pounds and 714 pounds respectively(Reinhardt & Waggoner, 2013).. Therefore the weights reported represent steers and heifers placed within roughly 200-300 pounds of the average

The average prices for each of these weight groups are calculated between four southern Great Plains states, which together comprise a large percentage of the cattle feeding capacity of the beef industry. These states are Kansas, Nebraska, Oklahoma, and Texas. The mean values reported for each state are averaged with equal weight; introducing the assumption that cattle price for the area is influenced equally by the price in each of the four states. A value was present for the monthly average price in most states for each observation. In some weight classes, the monthly averages were present for each state, making this number a true four-state average for these months. Regression results for individual states are presented without explanation in Appendix A.

Numerous cattle feeding operations exist outside of these four states, due to their exclusion from the data set, this model will likely be of a more limited use to these feeders and stocker/backgrounder producers selling to them than to producers engaged in transactions within the four states. Since the factors included in this study tend to measure feedlot demand, it is also less applicable for the sale of calves to stockers/backgrounders than it is for those engaged in transactions involving feedlot placement. Still, the economic rationale of the effect of selected factors on the price of feeder cattle can still be helpful to producers throughout the industry.

Independent variables were selected which affect the market as a whole. Variables in this study are such that market averages can be observed and used for forecasting purposes. The variables and their abbreviations are listed in section 3.4. Since this study considers market subsets as being independent, only those factors which directly affect a subset are included in the models. Therefore, factors for which data for steers and heifers can be separated will be considered for the specified gender of each market subset. Likewise, a factor for which the data varies across weight classes will be analyzed for the specific weight class. An underlying assumption of this analysis is that, although these market subsets are substitutes for each other, prices are affected differently by various factors in each subset.

One of the most logical independent variables to include in this study is the expected price for the fed cattle at the end of the feeding period for each respective weight. Both rational and naïve expectations of fed cattle prices in the future are used by cattle feeders in making placement decisions (Kastens & Schroeder, 1994.) Rational expectations are price expectations based on anticipated supply and demand of feeder cattle at some future point. Price expectations can be represented by the price of a futures contract, as changes in supply and demand will be reflected in this price if the market is efficient. Naïve expectations of future prices are defined as the price in the current period. That is, the naïve expectation of the price in period t+1 is equal to the price in period t (Tomek & Robinson, 2003).

Rational expectations in this study are represented by the live cattle futures contract for the month in which a calf placed in month t is expected to reach harvest weight. The selection of the appropriate contract was made assuming a 3.33 pound average daily gain and a 1200-1250 pound weight at harvest. Although both the rate of gain and harvest rate are lighter than present day averages, they are near the average for the data set, which begins in the year 2000. They also represent a number of days on feed which is very near the average for the same time period. This creates a 90-210 day feeding period depending on the initial weight of the feeder calf. The average daily gain of feeder cattle is not constant throughout the lifetime of the animal, however due to structure of live cattle futures contracts (i.e., a contract offered every other month); it is unlikely that a change in feedlot performance will result in the incorrect contract being selected by this method for the futures value. The live cattle futures contract which will be traded as the nearby contract at the end of this feeding period represents the hedgeable value of the calf and the market's best estimation of the future fed cattle price. Since the variable is meant to measure price expectations of the entire four-state region, basis measurements which would vary between states are ignored. Since this variable represents a cattle feeder's best guess of the revenue they will receive at the end of the feeding period, this variable is expected to have a positive effect on the price of feeder cattle. It may have a larger impact on heavier weights of cattle, for which this price is less likely to change during the feeding period.

A 3.33 pound average daily gain, while appropriate for steers over history, is notably higher than the average daily gain for heifers according to historical data on Kansas feedlots as collected from Focus on Feedlots. However, data from the same source and time period also shows that the average harvest weight for heifers is lower than that of steers. The reported average days on feed figure shows less than two days difference in days on feed between steers and heifers. Likewise, the seasonality of average daily gain was accompanied by changing harvest weights, keeping days on feed from varying widely. For this reason, the same time on feed figure was used for both genders and for all months. If the performance of steers and heifers change drastically relative to each other or a drastic change in days on feed is caused by an extreme shock to the market, the contract which cattle feeders use to estimate their future revenue may be different from the one used in this research.

The naïve profit expectation of fed cattle price is represented using the historical feedlot returns of Kansas feedlots. Since this variable measures the historical profit of cattle feeders and not the historical price, it is not strictly a naïve estimate of price. Instead, this variable reflects several other factors in profitability of feedlots including the historical price paid for feeder calves, feed costs, cattle performance and various other costs. This variable of profitability may also help account for some of the seasonality in cattle feeding returns which ultimately affect the demand for feeder calves. Since this is not a direct measurement of naïve price expectations, attempts to compare it with rational expectations are not direct comparisons of price expectations. Rather, this variable captures more factors than a naïve price expectation would directly. This variable directly measures profitability of feedlots, therefore it is expected to have a positive impact on feeder cattle price. Cattle feeders that have made profits in the previous month are more likely to expect profits in the current month. These feeders may also be more likely to have liquid assets available to make the purchase if they have experienced higher recent revenues.

The inventory of steers and heifers over 500 pounds is used as an independent variable for each weight group of each gender in this analysis. This number is not the strict supply of feeder cattle since the inventory at more specific weights is not reported and since it does not indicate how many of the cattle are actually supplied to the market, but it is a good indicator of whether feeder cattle are scarce or plentiful. Supply will already be included in the live cattle futures price; however the hypothesis of this study is that inventory can still hold separate explanatory power of feeder cattle value apart from its correlation with supply's effect on the revenue and profitability of cattle feeders. The inventory is expected to have a negative effect on feeder cattle price.

Feedlot capacity utilization is a potentially important factor determining feeder cattle price. Although closely related to the inventory of cattle on feed, feedlot utilization measures changes in the demand for feeder cattle due to the closing and opening of new feedlot facilities. Including feedlot utilization as a variable can help uncover the effect of fixed costs on demand for feeder cattle. Past research including feedlot utilization in feeder cattle price modeling is not prevalent.   One possible reason is that this particular variable is difficult to quantify. The feedlot capacity of the American beef industry is not easily measured. Feedlot capacity is published only once a year by the USDA and is not easily represented in monthly observations.

In this study, the percentage of the local maximum value of the number of cattle on feed is used to estimate feedlot capacity utilization. The cattle on feed value for each period is compared to the highest value from the previous 12 monthly periods. This variable is therefore represented by the equation:

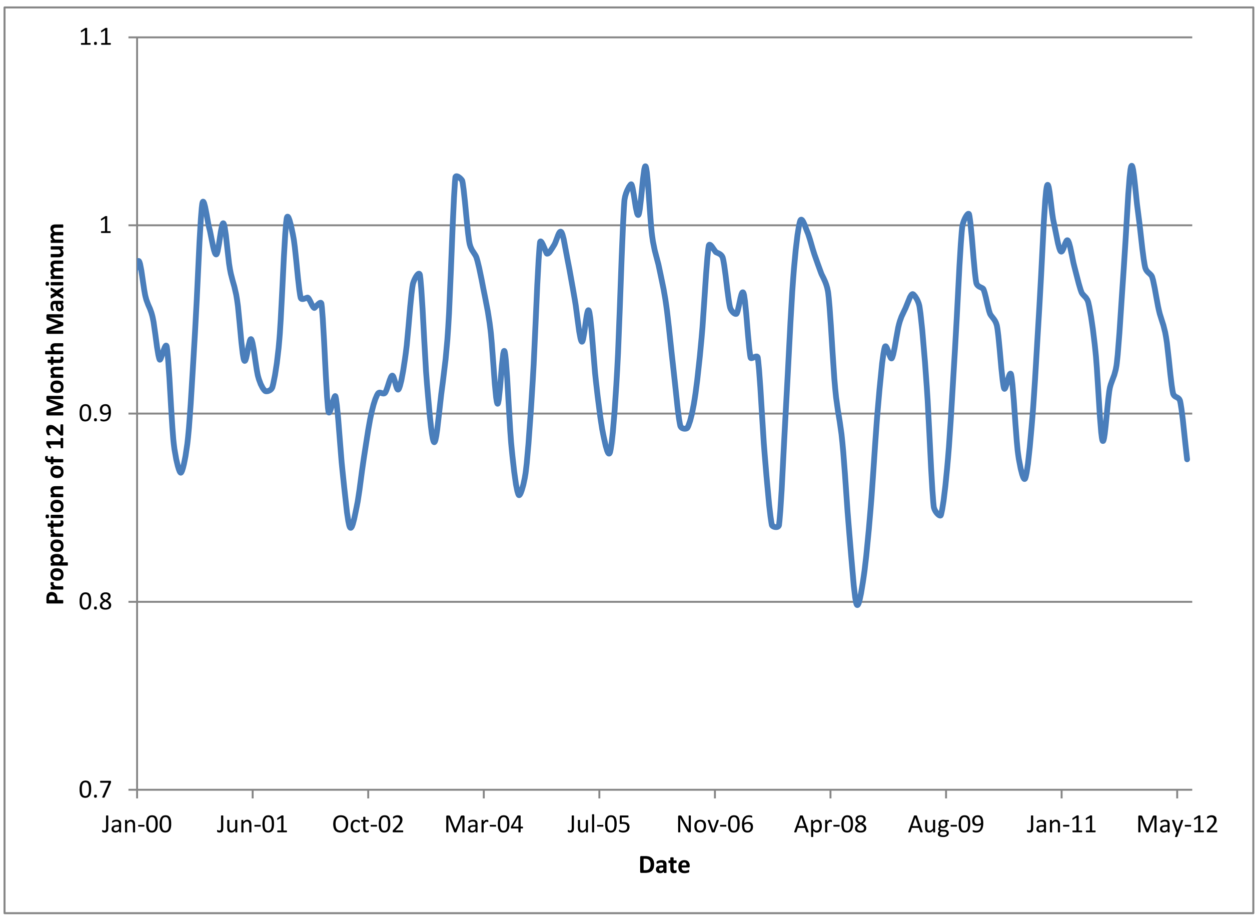
$$Utilization_t = Cattle\ on\ Feed_t * 100 / Max(Cattle\ on\ Feed_{t-12} \ldots Cattle\ on\ Feed_{t-1}).$$

This method allows estimating the percentage of capacity being utilized relative to the largest feedlot inventory over the past 12 months for the combined region of Nebraska, Kansas, Oklahoma and Texas. During times of extreme drought or cattle herd reductions, many feedlots may not have operated at capacity over the past year and as such the utilization measure here represents utilization relative to just the past year’s maximum which may be less than physical industry capacity. Longer lags which would have given a truer representation of feedlot capacity were rejected because they would not have allowed for capacity variation within the sample period. A 12 month lag is long enough for a change in the number of cattle on feed, and therefore the amount of feedlot pen space left unused, to be at least partially captured by this variable.

This utilization variable cannot be negative, as the cattle on feed values which form the numerator and denominator are restricted to positive numbers. A value less than one indicates that the number of cattle on feed has decreased from the maximum of the last twelve months. This is interpreted to mean that cattle feeders have empty space in their feedlots and therefore have a greater incentive to place more calves to further spread fixed costs and optimize their production systems ceteris paribus. A value of greater than one for this variable indicates that more cattle are currently on feed than have been on feed at any point in the past twelve months. This is interpreted to mean that the cattle feeding capacity of the industry is expanding by creating new feedlot space, or at least using feedlot capacity which had previously been idle for at least a year. The utilization values calculated are shown in Figure 3.1. This figure shows that this value takes on a cyclical pattern with local maxima and minima occurring in one to two year intervals.

Due to the added costs associated with expansion of feedlot capacity, a value greater than one indicates less incentive to place feeder cattle ceteris paribus. Conversely, a value of less than one implies that feedlots have excess capacity and have high incentives to place cattle on feed. For this reason a high value of utilization is expected to negatively affect price, and the resulting coefficient is expected to be negative.

Figure 3-1 Monthly Feedlot Utilization (Proportion of 12 Month Maximum) for Nebraska, Kansas, Oklahoma and Texas, January 2000-July 2012



Expected cost of feeding cattle is another factor which is expected to influence demand for feeder cattle. The cost of feeding can be measured as a feed cost per pound of gain. As a complementary input to feeder cattle in the production of fed cattle, the cost of gain should play an important role in determining the price cattle feeders are willing to pay for feeder cattle. The expected cost of feed for one pound of gain is the product of two other variables, the expected cost per pound of feed and the feed-to-gain ratio. One simple approximation for the future cost of feed is the cost of feed in the present; therefore the current period's cost of feed is used in this expectation. The current feed costs represent the actual value of the cost of feed for the first month of cattle feeding assuming the fixed ration described in Section 3.2. This then becomes a naïve expectation of cost of gain for the remaining months of the feeding period. The total time period on feed ranges from three to seven months depending on the placement weight, so the accuracy of this method of predicting feed prices varies with placement weights and will likely be more accurate for heavyweight calves.

A dilemma exists in choosing the appropriate feed-to-gain ratio to model a producer's expectations. One method would be to use the immediate past month's value for feed to gain, however this would distort the effects of seasonality of feed efficiency which exists in the industry. Another method would be to use the feed-to-gain ratio from the same month of the previous year. This method would account for seasonality, but would not account for the effect of implementing new technology, which will cause the cattle feeder to expect better performance from their cattle on feed than the previous year. This would also assume that weather conditions are predicted to be the same every year. This is not always correct, as weather forecasts can give producers different expectations of temperature, precipitation and other weather factors which may affect performance. For these reasons, this study assumes that on average, cattle feeders are able to perfectly predict what the industry's feed-to-gain ratio will be over the feeding period at placement. The feed-to-gain ratio used is a value reported for Kansas feedlots that reports the average gain for cattle steers or heifers marketed that month. Therefore this value represents an average ratio of feed efficiency, which accounts for the changing feed efficiency of growing cattle on feed. Although the calf may have a different feed efficiency in the first month on feed, the value should approach this average value by the time of harvest. Although seasonal weather changes and variations in feeder cattle weight will result in different feed to gain ratios which are not adjusted for, this portion of the cost of gain variable accounts for the technical advancement of the cattle feeding industry.

Therefore the feed to gain ratio (*Sfeedtogain* for steers and *Hfeedtogain* for heifers) used in calculating cost of gain is the value which is reported for cattle finished that month. Thus, the cost of gain is represented by (t refers to month):

$$SCostofgain_t = Feedcosts_t * Sfeedtogain_t$$

for steers and:

$$HCostofgain_t = Feedcosts_t * Hfeedtogain_t$$

for heifers. Cost of gain is expected to negatively affect the price of feeder cattle due to its role as an input cost into feeding cattle.

Another independent variable in this analysis is the interest rate. Interest may affect both supply and demand of feeder cattle in different ways. The interest rate figures prominently into the costs of production for a cow/calf producer or cattle feeder that is highly leveraged. For producers who do not pay large amounts of interest on outstanding debt, interest rates are still an important measure of opportunity costs of capital. Due to the fact that interest rate affects both the supply and demand for feeder cattle, the overall impact of interest is unknown and may vary widely between genders and weight groups. However, since cattle feeding often requires more liquidity than cow/calf production, feeders may be more likely to respond to interest rate changes. Therefore it is estimated that this model will show interest rate to have a negative effect on demand and therefore feeder cattle price.

The final variable included is the state of pastures in the country. This is measured as the percentage of pasture land rated as less than good, therefore under stress. The primary effect of pasture condition is on the supply of feeder cattle, as forage availability is important to both cow/calf and stocker/backgrounder producers in the beef industry. An additional aspect of forage availability is the alternative use it offers for cattle of lighter weights. Stocker/backgrounder producers can choose to hold cattle on pasture until they reach a heavier weight, but the ability to do this is diminished in times of limited pasture availability. Although there is no direct effect of pasture conditions during the winter months, information is still gathered during these months as to what future conditions would be and effects of the previous springs pasture conditions will still carry over. For these months, values are calculated, as described in Section 3.2. An eventual effect of poor pasture conditions is a lower availability of feeder calves due to the decreased size of the cow herd. However, this effect is largely captured by the inclusion of the inventories of steers and heifers already included; therefore the present value of pasture condition is deemed sufficient and a lagged pasture condition variable is not included.

Other independent variables were considered, but ultimately excluded from the model. Among these are the average dressed prices of steer and heifer carcasses respectively. Dressed price represents a price in the supply chain which will have a large effect on demand for feeder cattle. However the expectation of this value will be almost entirely reflected in the futures price and including it in the model would be redundant.

3.2 Data Sources

All data used in this study are from publicly available information which is representative of the industry average for its respective characteristic. Some of the variables utilize data published for the Kansas cattle feeding industry specifically. These include historical feeder returns for steers and heifers as well as the expected cost of gain which are collected from Kansas feed yards. These therefore introduce the assumption that cattle on feed in all of these states and cattle feeding firms in the rest of the four-state area experience performance and profitability at the same level as, or directly proportional to, their Kansas counterparts. This should be a reasonable assumption given that the changes in technology which drive most major changes in feeding performance are adopted across the region and that seasonality can be predicted similarly throughout the region. Profit functions for these firms should generally be similar, and seasonal profitability is usually experienced industry wide since general market prices for fed cattle and feed costs should be correlated spatially. There may however, be differences in local factors such as weather conditions which could make the feed efficiency of Kansas cattle and the profitability of Kansas cattle feeders either better or worse than the average of the region during any given time period. However, these weather effects should be random and not distort the model.

Other than the previously mentioned variables, the rest of the independent variables used in this study are not unique to any one state and should apply to the entire region concerned with this study. The data for these variables are either collected by the federal government, or are historical data from the Chicago Mercantile Exchange (CME).

The cattle inventories and cattle on feed numbers reported by the United States Department of Agriculture are used to calculate the monthly historical data for steer and heifer inventories, and feedlot utilization. Likewise, the values reported by the National Agricultural Statistics Service for feedstuffs are used to calculate the cost of feed which is then used to calculate the overall cost of gain.

Since the inventory of steers and heifers is reported semiannually (on the first days of January and July) rather than monthly, acceptable proxy values for the true but unknown monthly inventory of cattle in the country must be found. This study assumes that the cattle inventory changes at a constant rate over the six month period between each of the two reported values. Therefore the value of the monthly cattle inventory used in this study for the months January through June is given by:

$$Inv_t = Inv_{Jan} + M * (Inv_{Jul} - Inv_{Jan})/6,$$

where Inv_t is equal to the inventory of calves of the specified gender in month t, Inv_{Jan} is equal to the inventory of calves of the specified gender in January of the same calendar year as month t, Inv_{Jul} is equal to the inventory of calves of the specified gender in July of the same calendar year as month t, and M corresponds the number of months after January of the same year that month t occurs (i.e. M=0 if month t is January, 1 if month t is February, …, 5 if month t is June.) For the months July through December the monthly cattle inventory is given by:

$$Inv_t = Inv_{Jul} + M * (Inv_{Jan} - Inv_{Jul})/6.$$

In this equation the variables are defined the same as above, except that Inv_{Jan} is equal to the inventory of calves of the specified gender in January of the year following month t and that M takes the number of months after July of the same year that month t occurs (i.e. M=0 if month t is July, 1 if month t is August, …, 5 if month t is December).

Pasture conditions are reported by the USDA for the months May through October. Therefore 6 of the months would have a value of zero. This is not acceptable since it would indicate that pasture conditions were 100% good to excellent during the winter and early spring months every year. It is equally unacceptable to hold the value constant at the October value over the winter and spring. This would mean that producers gained no new knowledge of the future condition of forage outside of this growing season, or that all of this knowledge is reflected in the market between April and May. To address this issue, the value of pastures stressed in the non-reported months was assumed to move from the October value to the May value at a constant rate. This takes a similar form to the calculation of cattle inventory. The value for the pasture stress is equal to:

$$Pasture_t = 100 - (Good + Excellent)$$

in the reported months of May, June, July, August, September and October where the variables Good and Excellent are the percentage of pasture rated as good and excellent respectively. In the unreported months of November, December, January, February, March and April the pasture stress variable is equal to:

$$Pasture_t = Pasture_{October} + M(Pasture_{October} - Pasture_{May})/7$$

where $Pasture_{October}$ equals the pasture condition in the October prior to the period, $Pasture_{May}$ equals the pasture condition in the May following the period and M equals the number of months since October (1 if the month is November, 2 if the month is December, ... 6 if the month is April). This valuation of the variable over winter months assumes that information on future pasture conditions is gathered at a constant rate over the winter months and that these expectations effect the market similar to their effect in the spring and summer months.

The cattle on feed number which is used to calculate feedlot capacity utilization as described in the previous section is calculated based on monthly cattle on feed numbers reported by the USDA. The data used in this study is the sum of the numbers reported for the four states in this study. This value then would not reflect a significant change in utilization in a neighboring state, which could affect the price of cattle in these states due to a change in the demand for feeder cattle from another state, but instead focuses entirely on the feedlot utilization of the region. The states which neighbor one of the four included states and have enough cattle on feed to be reported by the government (Colorado, Iowa, New Mexico and South Dakota) exhibit cycles in cattle on feed numbers that are similar to the states included in the region during this time series.

The average dry matter feed cost is used to calculate cost of gain. This cost is calculated based on a ratio of prices of three individual feedstuffs: corn, hay and soybean meal. The prices of corn and hay are the cash prices received by feed producers as reported by the National Agricultural Statistics Service. Since any processing of these products into a feedable form produces few if any byproducts, the cash price received by feed producers is an accurate reflection of changes in the price of these two feed products. Soybeans do not follow this rule, as the processing of whole soybeans produces two major products; soybean meal, which is used in cattle feeding, and soybean oil. For this reason the value of whole soybeans is not a good representative of the price of soybean meal used in cattle feeds. Therefore, the price data used for soybean meal is the CME soybean meal contract monthly average price. For this reason, it is important to recognize that the price of soybean meal used in this analysis is not the cash price, but the futures market price. Therefore the calculated feed costs, and consequently the cost of gain data will vary in its accuracy with changes in the average soybean meal basis of the region.

A change in the volume of soybean processing in or near this region or a shift in transportation costs which would result in a change in the delivery costs of soybean meal during this time series would result in a slight decrease in the accuracy of the cost of gain used in this analysis.

Each of these three feed ingredients are converted to a price per pound of dry matter and weighted according to the proportions in a typical feedlot diet. The conversion of each of these values to cost per pound of dry matter is accomplished by dividing the price by the number of pounds in the unit the original price is reported in and dividing this value by the percent dry matter of the ingredient. The corn price is reported in pounds per bushel, with an average bushel of corn weighing 56 pounds and corn is assumed to be 88% dry matter. The price of hay is reported in dollars per ton and hay is thought to be 90% dry matter. Soybean meal price is also listed in dollars per ton and soybean meal is estimated to be 91% dry matter. In this study, the cattle feeding diet is assumed to be a fixed ratio of these three feedstuffs. This ratio is, 85% corn, 12% hay and 3% soybean meal. Therefore the value for the cost of feed is given by:

The values used for the variable of expected fed cattle price is the monthly average of the daily reported closing prices of the CME Live Cattle Futures contract for the appropriate month. The selection of the appropriate contract for this measurement is described in Section 3.1. Since the price expectation for the entire region is of interest and since basis will vary across the region, no basis adjustments are made to the futures price.

3.3 Testing for and Correcting Nonstationary Data

In time series analysis which is conducted in this study, data can be described as either stationary or nonstationary. Unlike stationary data, nonstationary data either does not have a constant mean or a constant variance across the data set. The changing mean of nonstationary data often leads to spurious results in regressions. For this reason, analysis of nonstationary data should generally be avoided.

A nonstationary dataset contains a unit root; therefore testing for a unit root is the common method of identifying nonstationarity. An Augmented Dickey Fuller (ADF) test was performed on the data used in this study to test for unit roots. The ADF test introduces the issue of selecting a proper lag length for the test. In order to address this problem, this test was conducted at lags ranging from one to four for each variable and the results which produced the minimum value for Akaike's Information Criterion (AIC) was selected. If the minimum AIC occurred for the lag value of four, additional tests were run at higher lag values until an increase in AIC occurred. The optimal lags, test statistics and p values of this test are presented in Table 3.1.

Table 3-2 Augmented Dickey Fuller Test Results for Original and Differenced Data

		raw data			differenced data		
	Optimal lag	rho	p value	AIC	rho	p value	AIC
s525	2	-0.17	0.64	2.91	-95082.00	0.0001	2.95
s625	2	0.10	0.70	2.84	-126.92	0.0001	2.86
s725	2	0.24	0.74	2.65	-117.88	0.0001	2.65
s825	2	0.30	0.75	2.63	-121.31	0.0001	2.74
s925	2	0.26	0.74	2.71	-116.90	0.0001	3.48
h525	5	0.23	0.74	4.38	-126.94	0.0001	2.69
h625	2	0.16	0.72	2.67	-126.99	0.0001	3.83
h725	4	0.38	0.77	3.82	-117.11	0.0001	2.51
h825	2	0.25	0.74	2.49	-114.29	0.0001	2.86
h925	1	0.32	0.76	2.87	-129.79	0.0001	-3.15
Pasture	2	-0.83	0.50	3.48	-152.76	0.0001	3.50
Sreturn	2	-48.67	0.00	7.86	-135.37	0.0001	7.77
Hreturn	2	-49.23	0.00	7.60	-126.03	0.0001	2.33
Fedfuture90	5	0.49	0.80	2.33	-94.76	0.0001	2.33
Fedfuture120	2	0.54	0.82	2.21	-115.17	0.0001	2.22
Fedfuture150	2	0.58	0.82	2.08	-88.64	0.0001	2.07
Fedfuture180	3	0.64	0.84	2.02	-87.53	0.0001	2.01
Fedfuture210	2	0.61	0.83	2.09	-87.01	0.0001	2.05
Hfr	5	-0.84	0.50	10.40	-70.57	0.0001	10.68
Str	4	-0.33	0.61	10.74	-70.48	0.0001	11.02
Interest	3	-0.56	0.56	-3.61	-150.00	0.0001	-4.16
Utilization12	2	-0.34	0.61	1.88	-128.38	0.0001	2.15
Scostofgain	8	1.30	0.95	-7.13	-94.71	0.0001	-7.19
Hcostofgain	2	1.34	0.95	-7.05	-84.19	0.0001	-7.09

This ADF test revealed that nearly all of the variables considered are nonstationary, with the only exceptions being the variables for the previous period’s return to feedlots on steers and heifers. For this reason the first difference of each value was calculated. The differenced data was again subjected to an ADF test. This test revealed this differenced data is stationary. Analysis for this study will therefore use differenced data, and will avoid the problems associated with nonstationarity.

3.4 Model

The model used in this study is identical for all weights within the same gender. The formulas for steers and heifers are very similar, with the same variables being used, simply specified differently for each of the genders. The model for the price of steers of weight *i* in month *t* is given by:

$$dSprice_{it} = \beta_0 + \beta_1 * dFedfuture_{it} + \beta_2 * dSreturn_t + \beta_3 * dStr_t + \beta_4 * dInterest_t + \beta_5 * dUtilization_t + \beta_6 * dScostofgain_t + \beta_7 * dPasture_t + e_{it}.$$

Similarly, the model for the price of heifers of weight *i* in month *t* is given by:

$$dHprice_{it} = \beta_0 + \beta_1 * dFedfuture_{it} + \beta_2 * dHreturn_t + \beta_3 * dHfr_t + \beta_4 * dInterest_t + \beta_5 * dUtilization_t + \beta_6 * dHcostofgain_t + \beta_7 * dPasture_t + e_{it}.$$

The characteristics which influence price are represented by the variables:

- $dSprice_{it}$ = first difference of the price of steers of weight *i* in month *t*
- $dHprice_{it}$ = first difference of the price of heifers of weight *i* in month *t*
- $dFedfuture_{it}$ = first difference of the Live Cattle Futures contract for the month nearest the date which a calf placed on feed at weight *i* during month *t* is expected to reach harvest weight
- $dSreturn_t$ = first difference of average feedlot return for steers sold during month *t*-1
- $dHreturn_t$ = first difference of average feedlot return for heifers sold during month *t*-1
- $dStr_t$ = first difference of the overall inventory of feeder steers in month *t*
- $dHfr_t$ = first difference of the overall inventory of feeder heifers in month *t*
- $dInterest_t$ = first difference of the interest rate in month *t*
- $dUtilization_t$ = first difference of the estimated proportion of overall feeding capacity utilized in month *t*

- *dScostofgain*$_t$ = first difference of the estimated cost of feed necessary for one pound of gain for the average feeder steer in month *t*
- *dHcostofgain*$_t$ = first difference of the estimated cost of feed necessary for one pound of gain for the average feeder heifer in month *t*

Descriptions of each variable and the initial units each is reported in are given in Table 3.2. The number of observations, mean values, standard deviations, maximum and minimum values of the original data are presented in Table 3.3. The same values for the differenced data are presented in Table 3.4.

Table 3-3 Description of Monthly Variables

Variable	Description	Unit
s525	Average price of 500-550 pound feeder steers	$/cwt
s625	Average price of 600-650 pound feeder steers	$/cwt
s725	Average price of 700-750 pound feeder steers	$/cwt
s825	Average price of 800-850 pound feeder steers	$/cwt
s925	Average price of 900-950 pound feeder steers	$/cwt
h525	Average price of 500-550 pound feeder heifers	$/cwt
h625	Average price of 600-650 pound feeder heifers	$/cwt
h725	Average price of 700-750 pound feeder heifers	$/cwt
h825	Average price of 800-850 pound feeder heifers	$/cwt
h925	Average price of 900-950 pound feeder heifers	$/cwt
Pasture	Percent of the countries pasture which is stressed, that is not rated as good-excellent	%
sreturn	Previous month's average feedlot return for steers	$/hd
hreturn	Previous month's average feedlot return for heifers	$/hd
fedfuture90	Nearby futures contract price for a 90 day feeding period	$/cwt
fedfuture120	Nearby futures contract price for a 120 day feeding period	$/cwt
fedfuture150	Nearby futures contract price for a 150 day feeding period	$/cwt
fedfuture180	Nearby futures contract price for a 180 day feeding period	$/cwt
fedfuture210	Nearby futures contract price for a 210 day feeding period	$/cwt
Hfr	National inventory of nonreplacement heifers over 500 pounds	Thousand head
Str	National inventory of steers over 500 pounds	Thousand head
Interest	Agricultural interest rate for the period	% APR
Utilization12	Estimated feedlot capacity utilization	%
sCostofGain	The average cost of a pound of gain for a steer	$/lb
hCostofGain	The average cost of a pound of gain for a heifer	$/lb

Table 3-4 Summary of Monthly Variables

Variable	N	Mean	Std Dev	Minimum	Maximum
s525	151	120.43	21.04	87.69	193.70
s625	151	111.71	19.77	83.07	180.28
s725	151	106.14	18.54	79.05	160.07
s825	151	101.70	17.88	73.98	150.35
s925	151	96.70	17.06	68.34	141.01
h525	151	108.91	18.94	79.80	169.62
h625	151	102.83	17.81	77.17	157.21
h725	151	98.72	16.82	73.44	146.23
h825	151	95.79	16.10	68.64	138.41
h925	151	93.38	15.16	67.50	134.16
Pasture	151	59.21	16.67	18.71	91.64
sreturn	151	-18.89	101.64	-293.59	308.54
hreturn	151	-4.01	96.48	-274.24	289.39
fatfuture90	151	88.44	15.77	62.81	127.52
fatfuture120	151	88.61	16.22	63.05	127.52
fatfuture150	151	88.80	16.55	65.79	129.57
fatfuture180	151	89.01	16.86	65.88	130.31
fatfuture210	151	89.22	17.05	67.40	133.12
Hfr	151	8810.37	646.58	7400.00	10147.00
Str	151	15558.98	713.54	14000.00	17185.00
Interest	151	7.86	1.20	6.01	10.52
Utilization12	151	93.89	4.94	79.89	103.14
sCostofGain	151	0.40	0.17	0.20	0.83
hCostofGain	151	0.42	0.18	0.21	0.87

Table 3-5 Differenced Variable Data Summary

Variable	N	Mean	Std Dev	Minimum	Maximum
ds525	151	0.37	4.75	-26.30	13.78
ds625	151	0.38	4.43	-17.41	10.20
ds725	151	0.37	3.97	-14.45	10.69
ds825	151	0.37	3.90	-12.78	10.34
ds925	151	0.34	4.04	-12.94	11.73
dh525	151	0.35	4.45	-21.78	13.76
dh625	151	0.35	4.03	-15.76	8.87
dh725	151	0.35	3.83	-13.43	10.86
dh825	151	0.31	3.80	-12.90	11.61
dh925	151	0.27	4.10	-16.83	10.19
dfatfuture90	151	0.35	3.34	-10.28	10.14
dfatfuture120	151	0.37	3.06	-10.72	9.22
dfatfuture150	151	0.38	2.82	-10.14	6.98
dfatfuture180	151	0.40	2.74	-10.37	6.08
dfatfuture210	151	0.40	2.70	-13.32	6.85
dHfr	151	-15.93	344.93	-378.17	381.33
dStr	151	-15.24	359.70	-410.50	398.00
dInterest	151	-0.03	0.16	-1.06	0.35
dPasture	151	0.30	6.29	-21.25	23.96
dUtilization12	151	-0.01	3.20	-6.35	8.97
dsreturn	151	-2.27	55.82	-166.94	132.75
dhreturn	151	-2.54	49.77	-150.42	100.35
dsCostofGain	151	0.00	0.03	-0.09	0.10
dhCostofGain	151	0.00	0.03	-0.09	0.13

Of the variables used, only *dPasture*, *dStr* and *dHfr* are expected to relate to the quantity supplied. The rest of the independent variables are all expected to shift the demand of cattle feeders for feeder cattle due to their effects on profitability of placing cattle in the feedlot at that time.

This model uses only quantitative continuous, not qualitative variables. Each value is able to be measured; no binary variables are used in this study.

The model proposed above was estimated with multivariate regression analysis. The coefficient estimates are Ordinary Least Squares (OLS) estimates. The same variables were estimated for each of the five weight groups within each gender for a total of ten models. These analyses were conducted using SAS 9.1 software. Coefficients, standard errors and p-values presented in the results section are taken from the output of the REG procedure. ADF tests previously described were conducted using the VARMAX procedure.

The data used for each observation of each variable is the difference between each monthly value for the time period from January of 2000 to July of 2013 and the month prior. There are a total of 151 observations in this data set. The start date of 2000 was chosen to allow for multiple cattle cycles, while minimizing the amount of structural change. Opportunities for structural change exist in this time period; most notably the BSE occurrence in 2003 and rising feed costs. However, the turn of the century provided an opportunity to include a large number of observations with fewer opportunities for structural change than a longer time series would present. The process of differencing usually results in the loss of the first observation. However, data was located for December of 1999 allowing differenced values for January of 2000 to be calculated as well.

Figure 3-1 Correlation of Independent Variables

	dfatfuture90	dfatfuture120	dfatfuture150	dfatfuture180	dfatfuture210	dHfr	dStr	dInterest	dPasture	dUtilization12	dsreturn	dhreturn	dsCostofGain
dfedfuture90	1.0000	0.5728	0.7290	0.5364	0.5063	0.0900	0.0745	0.0779	0.1165	-0.1531	0.4476	0.4285	0.1266
dfedfuture120	0.5728	1.0000	0.5572	0.7040	0.5703	-0.1903	-0.2039	0.1612	0.1738	-0.2076	0.4191	0.4117	0.1153
dfedfuture150	0.7290	0.5572	1.0000	0.5694	0.7006	-0.2018	-0.2162	0.0420	0.0993	-0.1699	0.4604	0.4458	0.2089
dfedfuture180	0.5364	0.7040	0.5694	1.0000	0.6393	-0.2902	-0.3009	0.0395	0.1284	-0.4712	0.4559	0.4416	0.2003
dfedfuture210	0.5063	0.5703	0.7006	0.6393	1.0000	-0.2948	-0.3056	0.1537	-0.0121	-0.2952	0.3577	0.3546	0.3666
dHfr	0.0900	-0.1903	-0.2018	-0.2902	-0.2948	1.0000	0.9950	-0.1039	0.1619	0.4530	-0.0756	-0.0294	0.1034
dStr	0.0745	-0.2039	-0.2162	-0.3009	-0.3056	0.9950	1.0000	-0.1124	0.1627	0.4524	-0.0948	-0.0509	0.1029
dInterest	0.0779	0.1612	0.0420	0.0395	0.1537	-0.1039	-0.1124	1.0000	-0.0103	-0.0542	0.0184	0.0404	-0.0427
dPasture	0.1165	0.1738	0.0993	0.1284	-0.0121	0.1619	0.1627	-0.0103	1.0000	-0.1699	-0.0880	-0.0475	0.0233
dUtilization12	-0.1531	-0.2076	-0.1699	-0.4712	-0.2952	0.4530	0.4524	-0.0542	-0.1699	1.0000	-0.0134	-0.0129	0.0244
dsreturn	0.4476	0.4191	0.4604	0.4559	0.3577	-0.0756	-0.0948	0.0184	-0.0880	-0.0134	1.0000	0.9068	-0.0695
dhreturn	0.4285	0.4117	0.4458	0.4416	0.3546	-0.0294	-0.0509	0.0404	-0.0475	-0.0129	0.9068	1.0000	-0.0734
dsCostofGain	0.1266	0.1153	0.2089	0.2003	0.3666	0.1034	0.1029	-0.0427	0.0233	0.0244	-0.0695	-0.0734	1.0000
dhCostofGain	0.1747	0.1801	0.2678	0.3013	0.4048	0.0257	0.0273	-0.0725	0.0200	-0.0660	-0.0050	-0.0487	0.9320

Table 3.3 presents the correlations between independent variables used in this study. A preliminary look would suggest many of the variables are correlated above 0.4. However, few of these variables are included in the same model. For example, the variable representing the futures price for each weight class is correlated with the equivalent variable for all other weight classes. Likewise, a high level of correlation exists between variables measuring the same factor for the two genders.

There are two pairs of independent variables which are correlated above 0.4 and will be included in the same models. These are the measurement of historical return and futures price and the domestic inventory and utilization. The former is expected as both are a method of profit or price expectations. The latter is also not surprising as cattle on feed inventories are used to calculate feedlot utilization. Neither of these correlations; however are above 0.5 indicating that although correlations exist, they are generally weak within any particular model.

Chapter 4 - Results

The ordinary least squares (OLS) regressions described in the previous chapter reveal the effect of each of the identified factors on feeder cattle price in each of the five weight classes for steers and heifers. This chapter will report the results of these regressions and provide interpretations indicating how the effects of the tested factors of production change as steers or heifers reach heavier weights.

4.1 Feeder Steer Results

Feeder steer prices were analyzed for five sets of 50-pound weight ranges. These ranges had respective medians of 525, 625, 725, 825 and 925 pounds. These weight ranges will be referred to by their median weight for the remainder of the chapter. Regression analysis was conducted as described in Chapter 3 with all variables in first differences. The results of these regressions for steers are reported in Table 4.1.

Table 4-1 Regression Parameter Estimates for First-Differenced Feeder Steer Models for Selected Weight Ranges, Monthly Data, January 2000 to July 2013

Median Weight	525		625		725		825		925	
	Estimate	p-value	Estimate	p-value	Estimate	p-value	Estimate	p-value	Estimate	p-value
Intercept	0.31424	0.3201	0.34752	0.2258	0.30029	0.1869	0.2451	0.2591	0.19684	0.3882
dfedfuture	0.77706	0.0001	0.46483	0.0014	0.57731	0.0001	0.66699	0.0001	0.70221	0.0001
dsreturn	0.029	0.0001	0.03176	0.0001	0.02526	0.0001	0.02169	0.0001	0.01636	0.0005
dStr	0.00296	0.0046	-0.00013644	0.8816	-0.00015419	0.8341	-0.00021555	0.7571	-0.00287	0.0001
dInterest	0.78349	0.684	2.86146	0.0973	2.24863	0.1014	0.49044	0.7105	1.3871	0.3148
dUtilization12	0.09455	0.4082	-0.19266	0.0871	-0.33241	0.0001	-0.21021	0.007	0.02081	0.8011
dsCostofGain	-24.55269	0.0628	0.63064	0.9543	-14.93495	0.0864	-17.68046	0.0289	-18.66997	0.0276
dpasture	-0.13701	0.0084	-0.10629	0.0251	-0.04713	0.2113	-0.05566	0.1274	0.02828	0.4484
Adj R2	0.3825		0.417		0.5403		0.5674		0.5541	
RMSE	3.73316		3.38069		2.6887		2.56429		2.69728	
n	151		151		151		151		151	

The model generally appears to become better fitting (adjusted R-squared value rises) as the cattle weight category increases. This is fitting with expectations as heavier weight steers should be valued with more certainty given the shorter time horizon to harvest and the fact that the models are more focused on explaining feedlot demand rather than stocker/backgrounder demand for feeder cattle. This shortened time frame means that both the cow/calf or stocker/backgrounder producers who sell feeder steers and cattle feeders who buy feeder steers have more certainty of the value of the animal in the feedlot and the opportunity costs representing alternative uses.

The previously reported coefficients are the values of a one-unit change in the variable of interest. This can be difficult to interpret as the units of variables are different. It also makes determining the practical economic impact of the variable difficult since this unit could represent something as common as a 1,000 head change in the national feeder cattle inventory or something as uncommon as a $1 change in cost of gain which would represent nearly a 115% increase over the sample maximum. Therefore Table 4.2 below shows what the impact of these variables is when the first difference is one standard deviation above its mean. This table therefore presents an economic impact which can be compared regardless of the units of the variable it is based on. Diagrams presented after the discussion of each variable show the range of a one standard deviation increase or decrease from the mean (about a 68% confidence interval if the data are normally distributed). It should be noted that these ranges are centered at the mean, not at zero. This consideration of a one standard deviation movement from the mean rather than the standard deviations themselves is due to the differenced data used in this analysis. Each variable represents a change in the value of data, not actual data values. Therefore, the impact of a normal period's change in data values is best evaluated as a distance from the mean, not as a standard deviation alone.

One assumption that must be kept in mind in interpreting results this way is that individual impacts to each variable are considered independently. Given that the x-variables are correlated with each other, independent changes in one variable alone are not probable. As such, these estimates simply reveal marginal impacts, holding all else constant, and need to be interpreted as such.

Table 4-2 Estimated Impacts on Feeder Steer Price of a One Standard Deviation Increase in Variables

Median Weight	One Standard Deviation Above Mean	525	625	725	825	925
dfedfuture	$3.10-3.69/cwt*	$ 2.87	$ 1.59	$ 1.85	$ 2.09	$ 2.18
dsreturn	$53.55/hd	$ 1.55	$ 1.70	$ 1.35	$ 1.16	$ 0.88
dStr	344,460 hd	$ 1.02	$(0.05)	$(0.05)	$(0.07)	$(0.99)
dInterest	0.13 % APR	$ 0.10	$ 0.37	$ 0.29	$ 0.06	$ 0.18
dUtilization12	3.19%	$(0.30)	$(0.61)	$(1.06)	$(0.67)	$ 0.07
dsCostofGain	$0.034/lb gain	$(0.83)	$ 0.02	$(0.51)	$(0.60)	$(0.63)
dpasture	6.59 % stressed	$(0.90)	$(0.70)	$(0.31)	$(0.37)	$ 0.19

*The live cattle futures contract of interest varies across weight classes, therefore means and standard deviations also vary. The value of this movement for 525, 625, 725, 825 and 925 pound weight classes are $3.69, $3.43, $3.20, $3.14 and $3.10 per hundred pounds, respectively.

Comparison of the coefficients and the effects of variables between weight ranges are used to help us observe trends in the effects of each factor as steers reach heavier weights. The 525 weight range seems to behave differently than the rest of the weight ranges. It seems to be an exception to other trends and often gives a different sign of the coefficient than the other weight ranges. Calves in this light weight category are likely not going directly to finishing feedlots and as such might be better modeled with more variables specifically tailored toward stocker/backgrounder producers not included in this study. Likewise, the 925 pound range seems to exhibit some irregularities with the other weight classes, though they are sometimes less profound than the differences among very light calves. These heavier weight cattle may be relatively thinly traded and thus exhibit different price behavior than the more traditional placement weight ranges. For these reasons, trends that are observed within the middle three weight ranges (625, 725 and 825 pound steers) will be reported in this section even if calves in the very light and very heavy ranges do not follow the trend. Explanations of the observed effects of factors on the price of cattle in these extreme weight classes will be offered in this section although these are made with less certainty than observations in the middle weight ranges. These explanations must be tested further with models designed more specifically to measure the effects of factors on lightweight or heavyweight calves before they are to be trusted with certainty.

The price of the live cattle futures contract has a positive and increasing effect as steers reach heavier weights. This trend is observed in the four heaviest weight ranges as the estimate of the effect of the future price on feeder steer price is numerically increasing and remains statistically significant at the 99 percent confidence level as weight increases, including the very heavy range. This increasingly positive effect on the price of feeder steers is expected because the length of time to finishing shortens as cattle become heavier. Therefore, if heavier cattle are placed in the feedlot, the certainty with which a feeder can consider the futures contract to be an accurate prediction of the price they will receive for a fed steer increases. A one standard deviation increase in the futures price produces a response between $1.50/cwt and $3.00/cwt. Thus, common changes in futures prices have noticeable effects on the feeder cattle price. The effects of a $1/cwt change are presented in Figure 4.1 while the effects of a change of one standard deviation above or below the mean are presented in Figure 4.2.

Figure 4-1 Effect of a $1/cwt increase in futures price on feeder steer price

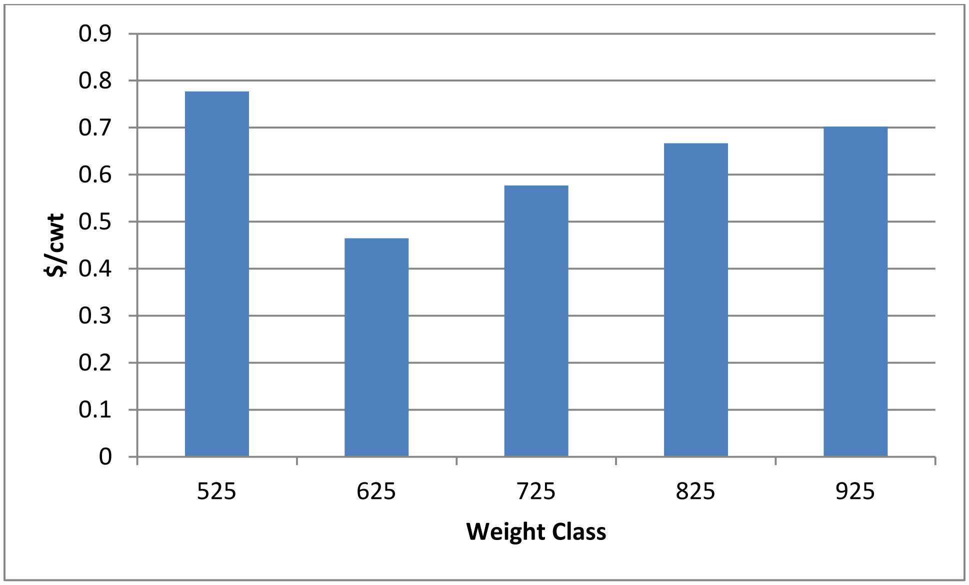
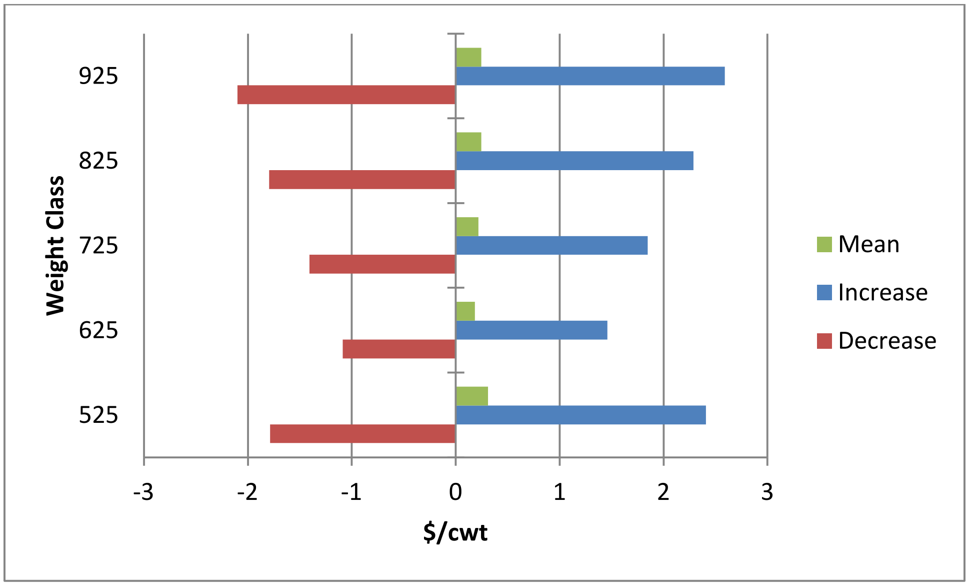


Figure 4-2 Effect of a One-Standard Deviation Change in Futures Price on Feeder Steer Price



The effect of the previous period's return is also positive, but decreases as the steers become heavier among the top four weight ranges. These coefficients are all significant at the 99% confidence level. This indicates that the naïve profit expectations are more important for lightweight steers than heavier steers. The economic impact of an increase of one standard deviation above the mean is greater than $1.00/cwt for all except the heaviest weight class. This economic impact is not likely to be as large as the effect of the futures price but is still a noticeable change in prices. Figure 4.3 presents the effects of $1/hd increase in feedlot returns on the price of feeder cattle. The effects of a change one standard deviation above or below the mean are given in Figure 4.4.

Figure 4-3 Effect of a $1/head increase in previous feedlot returns on Feeder Steer Price

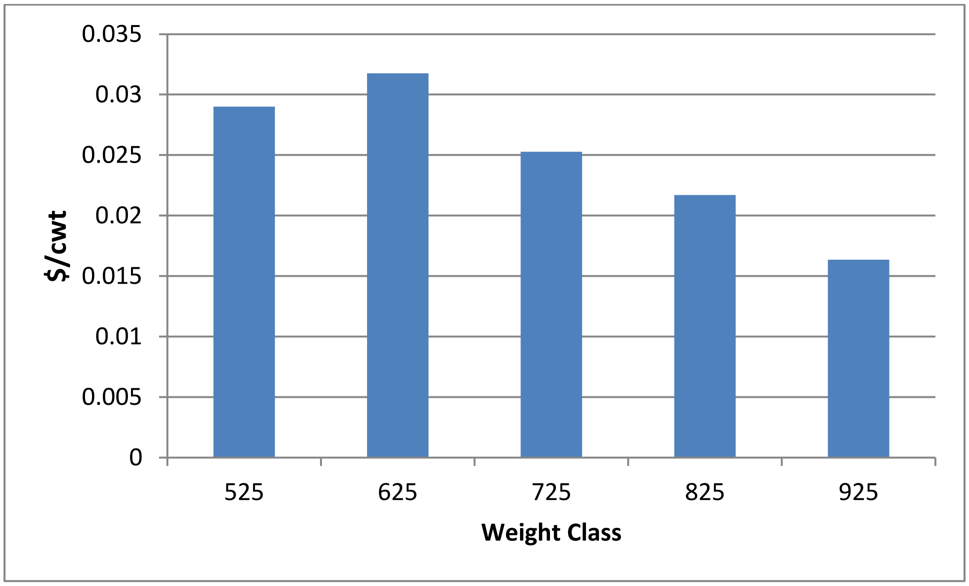
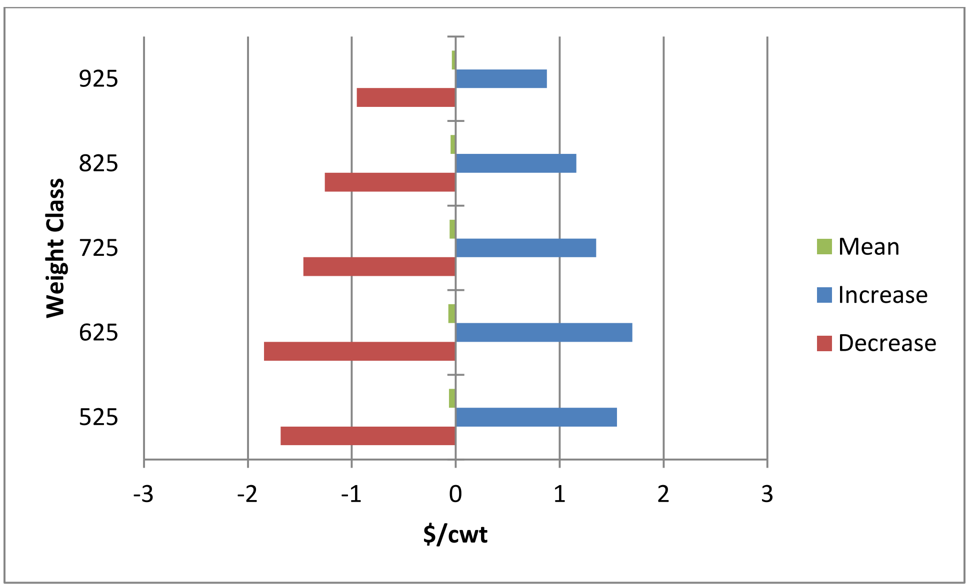


Figure 4-4 Effect of a One-Standard Deviation Change in Historical Return on Feeder Steer Price



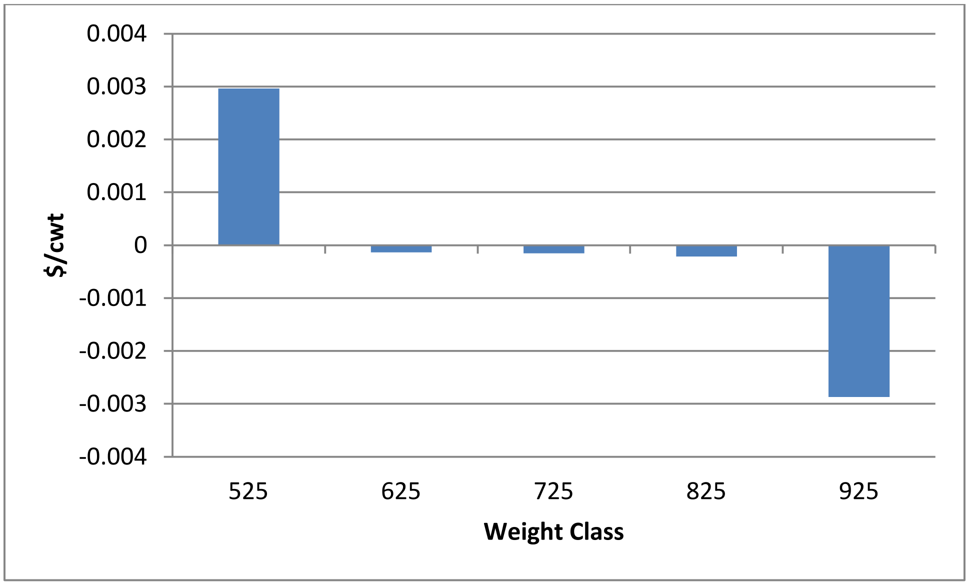
The trend in historical returns, which is opposite of the trend in the effect of futures price may provide a further explanation of the effects of rational and naïve expectations on the behavior of firms in the beef industry. This research appears to show that naïve profit expectations are more important (have a larger impact) relative to rational expectations of price for lighter weight steers. This changes as steers grow and the naïve expectations become less important and are offset by the rational expectations. This is also evidenced by the economic impacts of one standard deviation changes, as the effects tend to increase for futures price as calves become heavier, while the effects of historical returns decrease as calves increase in weight.

This phenomenon may be explained as cattle producers not trusting futures prices for longer term contracts and instead relying on their previous experience in forming price expectations. This should not be the case theoretically, as a rational producer should realize that although the price of a late maturing futures contract can vary widely, it is likely to reflect the future price of fed cattle than the a possible wealth effect reflected by previous returns if markets are efficient as discussed in Chapter 2. The significance of historical return seems to suggest that the Efficient Market Hypothesis proposed by Fama (1970) does not hold in its strong or semi-strong form in the beef market. It instead supports the theory that both rational price expectations and naïve profit expectations are important to the beef market as suggested by Kastens and Schroeder (1994).

An interesting difference from this trend occurs in the very lightweight (525 pound) steer range. This range of steers shows a large effect of futures price and an effect of previous returns that is near the highest of the other ranges. As previously stated, this range of cattle may behave differently since they are substantially lighter than the normal placement weight. A feeder choosing to place steers at this light weight may require additional certainty of profit due to the longer feeding period. This could lead them to consider both naïve profit expectations and rational price expectations in order to gain more certainty of future price given the inherent uncertainty in taking longer term cash market positions. They may also require a higher expected return due to the longer capital commitment associated with this feeding period.

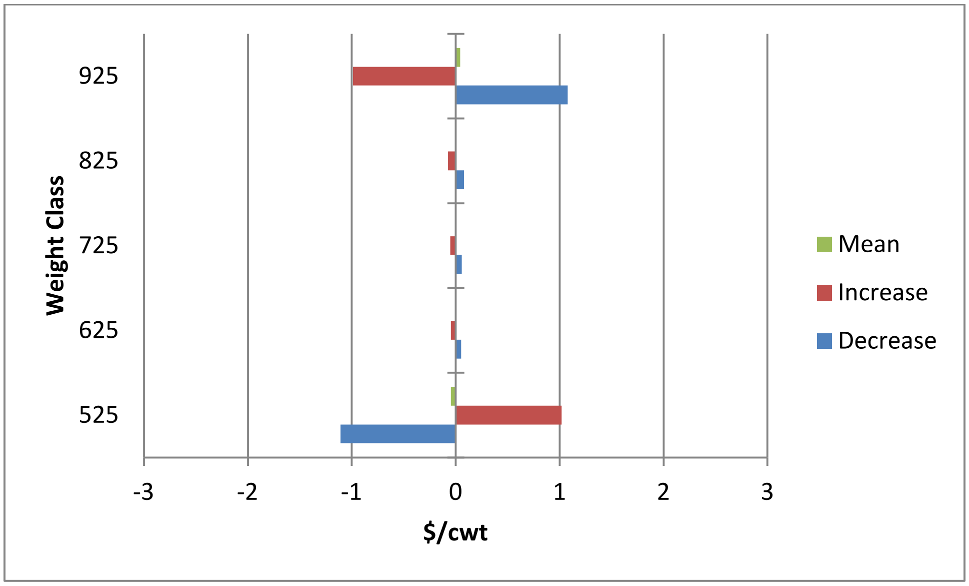
The national inventory of feeder steers exhibits a decreasing numeric trend across all weight ranges, including the 525 and 925 weight ranges. This value is negative for all ranges except for very light calves as seen in Figure 4.5. However, this factor only exhibits statistical significance amongst very light weight steers, where it is positive and very heavy weight steers, where it has the expected negative sign. This seems to indicate that for the most part, the domestic population of steers has very little effect on price changes from month to month within a specific weight range. This is likely the result of inelastic production of feeder steers, with the only alternative to placing a calf on feed being to hold the animal for feedlot placement at a heavier weight. Furthermore, much of this inventory effect is likely being captured already in the fed cattle futures price. As such, the individual incremental estimated impact of inventory on feeder prices is likely underestimated here as much of it is probably already reflected in other explanatory variables.

Figure 4-5 Effect of a 1,000 Head Increase in Steer Inventory on Feeder Steer Price



The statistically significant values for steer inventory are found where this substitutability is at its highest and lowest. These are also by far the widest intervals of economic impact as they are the only two to be near $1/cwt in absolute value. With lightweight steers, the beef stocker/backgrounder or cow/calf producer has the option to place a steer on feed, but also has the option to keep them on a forage diet until they reach a heavier weight. When the steer is at a heavy weight the producer's options become fewer. It therefore becomes logical that an increase in the overall number of feeder cattle would affect these two weight classes differently with a less profound effect on weight classes in between. The economic effects are illustrated in Figure 4.6.

Figure 4-6 Effect of a One-Standard Deviation Change in Steer Inventory on Feeder Steer Price



When the number of calves in the country increases, prices decrease since cattle feeders can source calves from more potential sellers. If these low prices are accompanied by expectations for the price to recover in the near future, demand for lightweight calves among stocker/backgrounder operations increases because slower gain associated with forage based growth allows for cattle to be held for sale to a feedlot in the future when calf numbers are lower and prices are higher. If these calves are already at heavier weights, the possibility of profitable temporal arbitrage by these producers is reduced because calves will gain less efficiently on forage and the amount of time they can be held before significantly lowering demand due to age is shorter.

Changes in feeder calf inventory can be seen in the annual cycle in which the feeder calf inventory is higher in the winter months, when spring born calves make up most of the over 500 pound inventory, and lower in the summer when the less abundant fall born calves reach these weights. Therefore differences in the effect of supply on prices show that firms are willing to buy lighter calves with the intent to sell heavier cattle when prices are seasonally higher. Still, these differences are viewed more critically than other results since the most common weight classes were not significantly different from zero.

The interest rate does not appear to have a major impact on feeder cattle price. It is only significant at a 90 percent confidence interval in the 625 pound weight class and is insignificant elsewhere. The coefficients all have positive signs, which is the opposite of what was hypothesized. The lack of statistical significance and the low economic impact of this variable indicate that it is not a major factor in the pricing of feeder cattle given the range of interest rates present during the time period analyzed. Still, the theoretical reasons for including the interest rate in this analysis are sound and this variable should be considered for use in certain models. Figures 4.7 and 4.8 show the effects of a change in interest rate of one percent APR and one standard deviation above or below the mean respectively.

Figure 4-7 Effect of a 1% APR Increase in Interest Rate on Feeder Steer Price

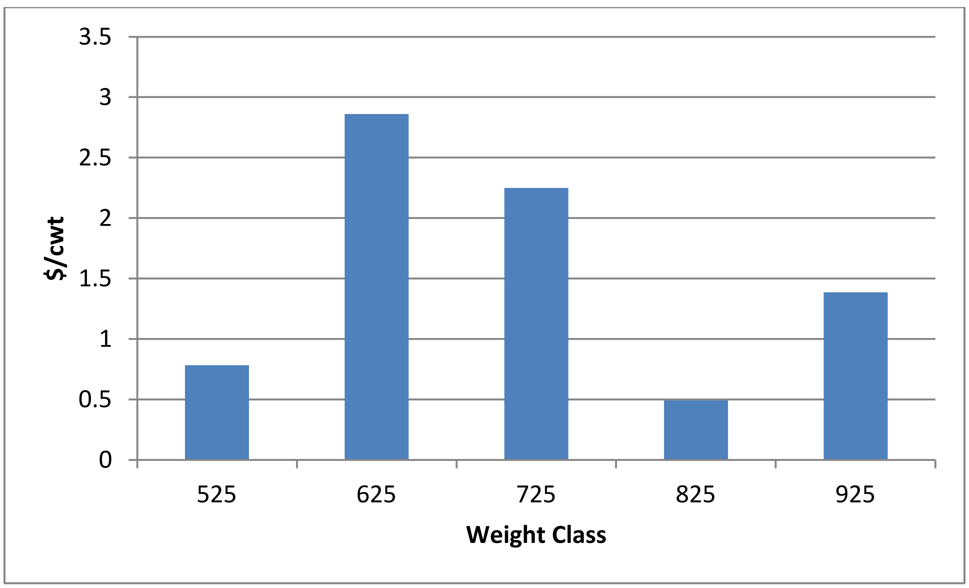
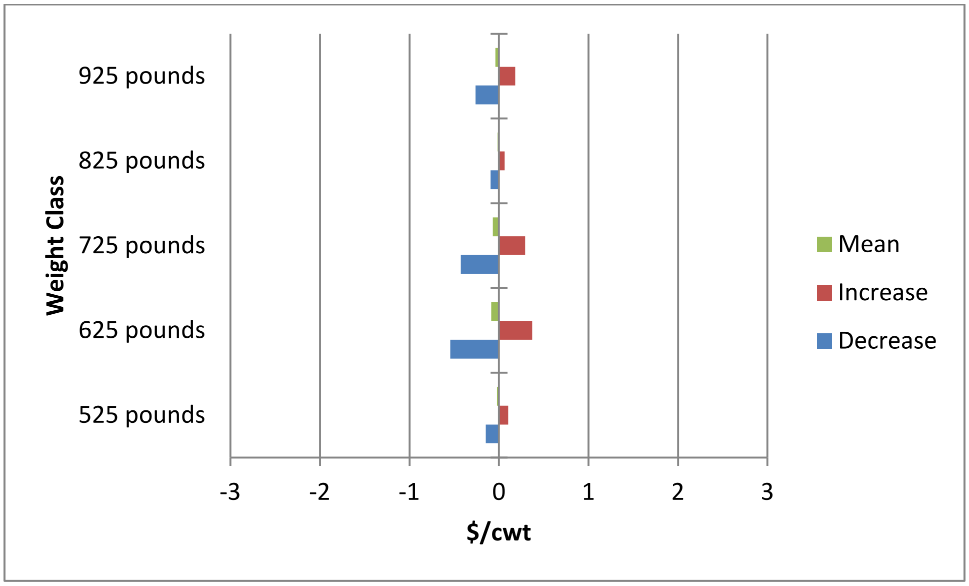


Figure 4-8 Effect of a One-Standard Deviation Change in Interest Rate on Feeder Steer Price



The utilization of feedlots is significant at either the 90% or the 99% confidence level in the three middle weight ranges. Figure 4.9 illustrates that the coefficients in this weight class also exhibit the expected negative sign indicating that a decrease in feedlot capacity utilization increases the price of feeder cattle. This is likely due to an increased willingness to pay by feed yards, which are more likely to place cattle on feed in these scenarios at prices where they are not likely to earn a positive profit, but are able to cover variable costs and help to pay for the fixed costs associated with cattle feeding. This effect can have a noticeable economic impact on these middle ranges, with increases of one standard deviation changing feeder cattle price by $0.50-$1.00/cwt. Figure 4.10 illustrates common economic impacts of utilization.

Figure 4-9 Effect of a 1% Increase in Feedlot Utilization on Feeder Steer Price

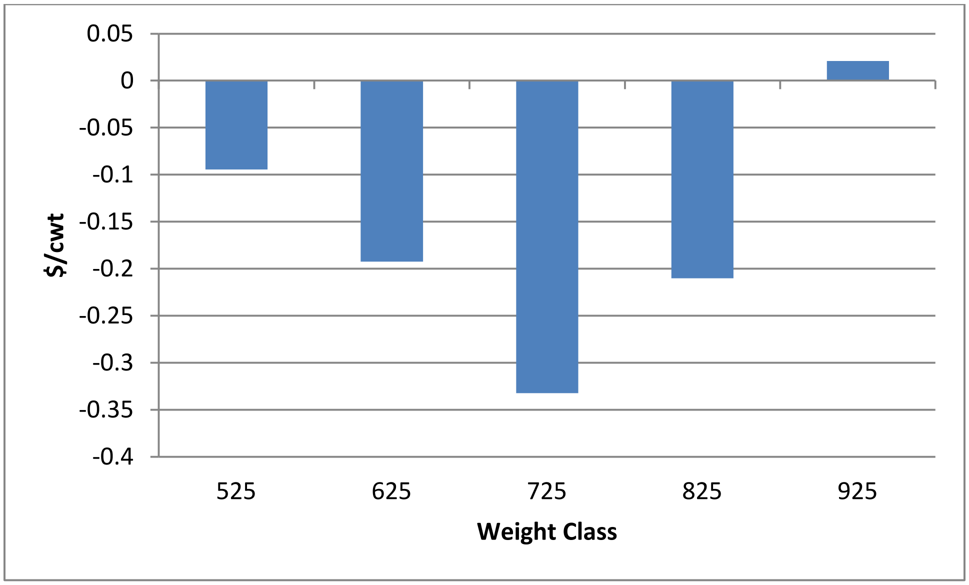
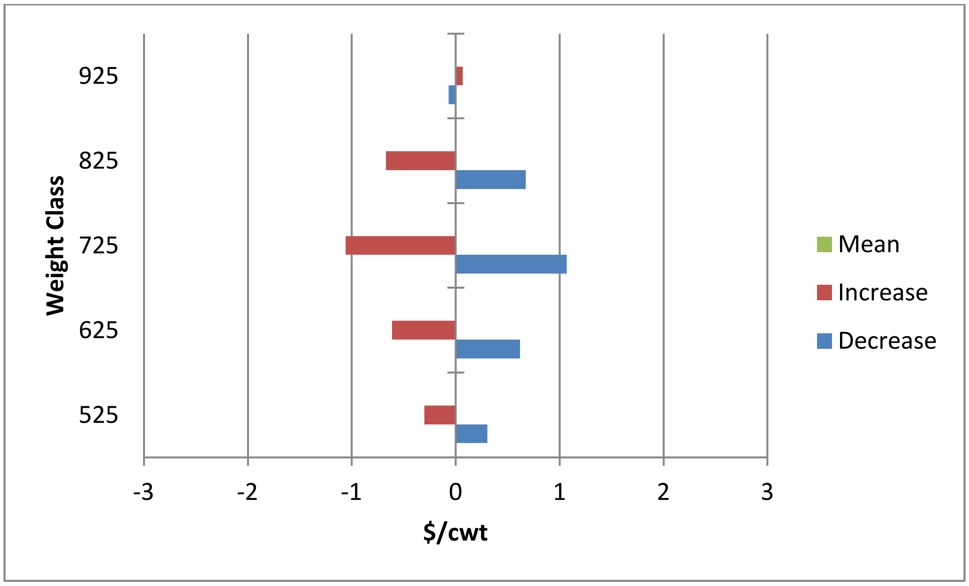


Figure 4-10 Effect of a One-Standard Deviation Change in Utilization on Feeder Steer Price



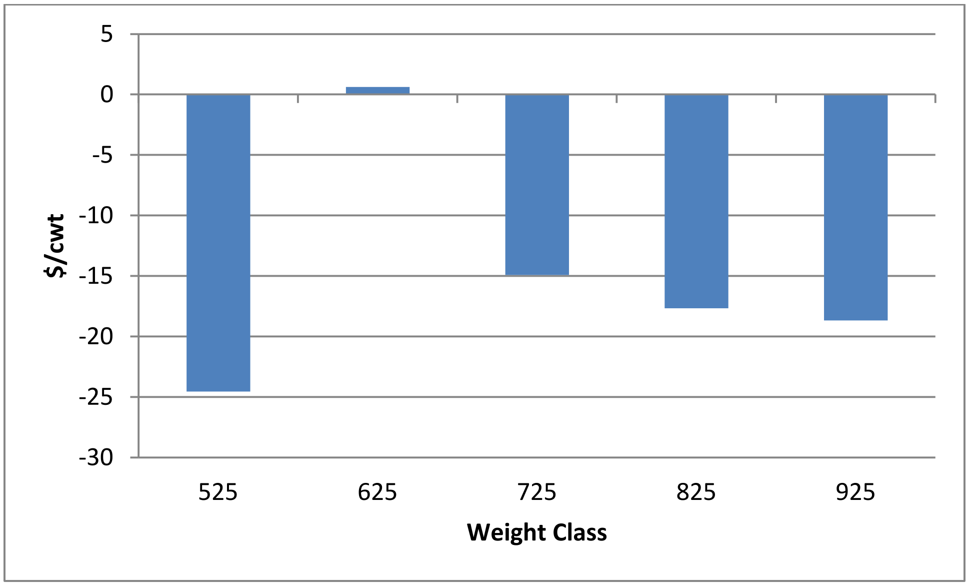
The trend among weight classes in feedlot utilization is that the coefficient is most negative in the 725 pound weight class and approaches zero as weights move toward either extreme. The values are not significantly different from zero in the very light weight and very heavy weight classes of steers. Thus the largest impact occurs in the middle of our weight spectrum,.

The rate of decline is faster numerically for heavier weights compared to lighter weights, however, they both approach values which are not statistically different from zero. One would expect heavier weight calves to be more affected. This would indicate that when utilization is increasing, heavy discounting of light steers occurs by the feedlots that would prefer to bring in heavier cattle which can be finished faster. In contrast, when utilization is decreasing, the feedlots would begin to incentivize lighter placements which will fill pen space for longer periods of time.

An explanation for the fact that lightweight steers are less negatively affected than middleweight steers involves the ability to grow lightweight calves on forage based feed. This creates a stocker/backgrounder demand for lightweight feeder cattle that offsets part of the decrease in feedlot demand for the same. Middle to heavyweight calves are not as heavily impacted by demand from stocker/backgrounder operations because they are reaching weights where feeding concentrate diets are more cost effective than grazing. Either way, this factor indicates that a high percentage of feedlot capacity utilization incentivizes heavier feedlot placements, which in turn creates incentives for cattle producers to keep cattle on grass until they reach these heavier weights.

The variable for cost of gain in steers shows a slightly decreasing trend, though the most negative value occurs in the lightest weight class. A decreasing trend is the opposite of what was expected and seen in previous research such as Dhuyvetter and Schroeder (2000). However, since much of the previous research is based on older samples with a much different set of feed prices, and since this study includes a measurement of the period’s feed efficiency, it is possible that the trend could be correct. However, since the trend is only slightly decreasing in the heaviest weight classes, and since the 625 pound weight class seems to be an outlier, it is possible that the increasing trend has not reversed at all and this model are showing a spurious downward trend in heavyweight cattle. The differences in the effects of a cost of gain increase can be observed in Figure 4.11.

Figure 4-11 Effect of a $1/Pound Increase in Steer Cost of Gain on Feeder Steer Price

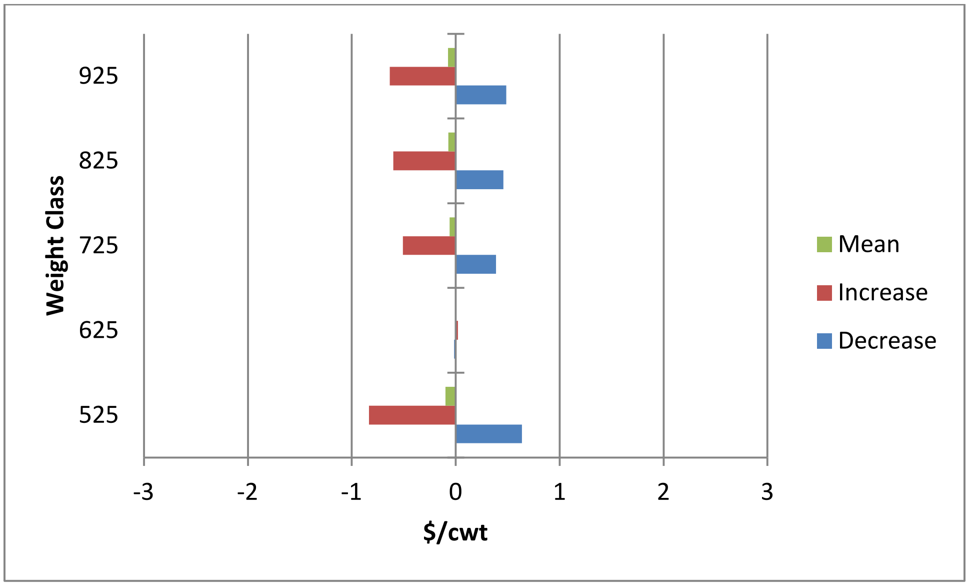


It is also possible that a combination of the two is true. The overall effect of cost of gain may decrease in absolute value as weights increase because of feedlot demand. Perhaps there is also a stocker/backgrounder demand which is caused by the demand of feedlots for heavier weight calves and compensates for portions of the feedlot effect. This substitute use of feeder cattle decreases in feasibility as weights become heavier. It is possible that at the heavier weights this decrease is greater than the increase in demand by the feeders.

An exception to any trend observed in this variable is the value which is statistically zero, and numerically positive in the 625 pound weight class. There is not a clear economic rationale to cause any expectation of this weight class to be different. It is possible that differences in state level data are causing an unusual response in this weight class, but the fact that the value is not significant in any of the four states alone (See Appendix) and that heifers also show a value which is statistically zero for this weight class makes it difficult to dismiss this as a data irregularity. This exception to the trend may be caused by relatively thin markets in this weight class, though each of the states have a full set of monthly observations for the time series, or perhaps this is a further reflection of the weaknesses of this model in lightweight steers relative to their heavyweight counterparts.

Except for the 625 pound weight class, all weights of steers have the expected negative coefficient, are statistically significant at the 90 or 95% confidence level and affect the price of feeder cattle by over $0.50/cwt with a one standard deviation change. This is a large enough change to conclude that a change in feed costs is economically relevant to the feeder cattle price. By far the largest impact of a change in cost of gain occurs in the lightest weight class, where it approaches $1/cwt. This is in line with previous economic reasoning as the amount of gain necessary for these calves to reach a finishing weight is longest. Additional evidence for the previous research's findings of an increasing effect in heavier weight classes is shown by the small difference in the heavier weight classes where the decreasing trend is observed. Only a $0.12/cwt difference is shown between the 725 and 925 weight classes. Figure 4.12 illustrates the economic impacts of this variable.

Figure 4-12 Effect of a One-Standard Deviation Change in Cost of Gain on Feeder Steer Price



The final variable included in the analysis of steer price was the percent of pasture stressed. For the lowest four weight classes the factor shows the expected negative coefficient. This is thought to be due to a surplus of cattle being offered for sale at these weights since availability of pasture for them to graze is limited. The variable is only significant for the lowest two weight classes. A decrease in feeder cattle price of $0.90/cwt is seen in the 525 pound range and a decrease of $0.70/cwt is shown in the 625 range with a one standard deviation increase in pasture stress. These are the only weight classes where the economic effects are above $0.50/cwt. This variable was expected to affect lightweight calves more significantly than middle to heavyweight calves since they are more likely to be on pasture. Figure 4.13 demonstrates the effects of a 1% increase in pasture stress and Figure 4.14 shows the effects of a change which is one standard deviation above or below the mean.

Figure 4-13 Effect of a 1% Increase in Pasture Stress on Feeder Steer Price

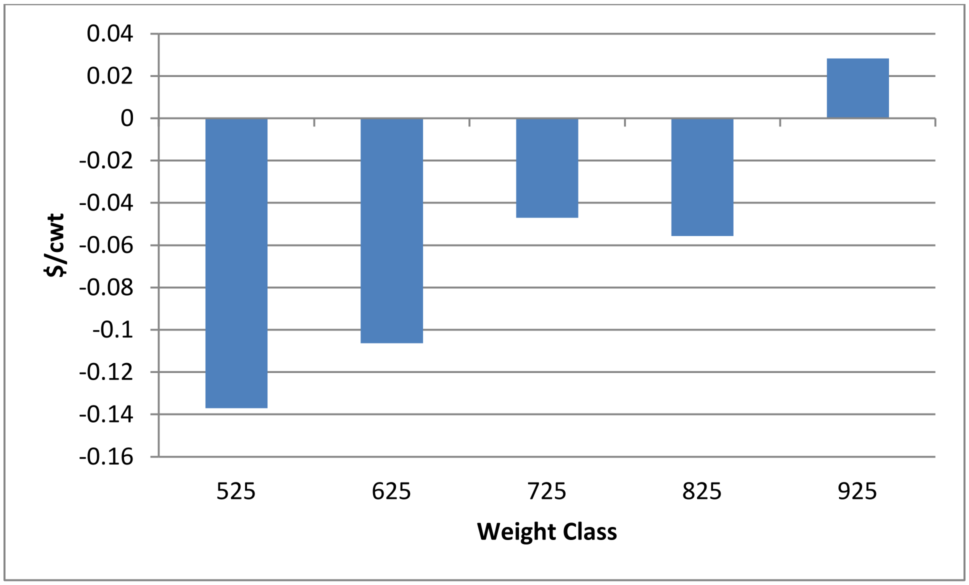
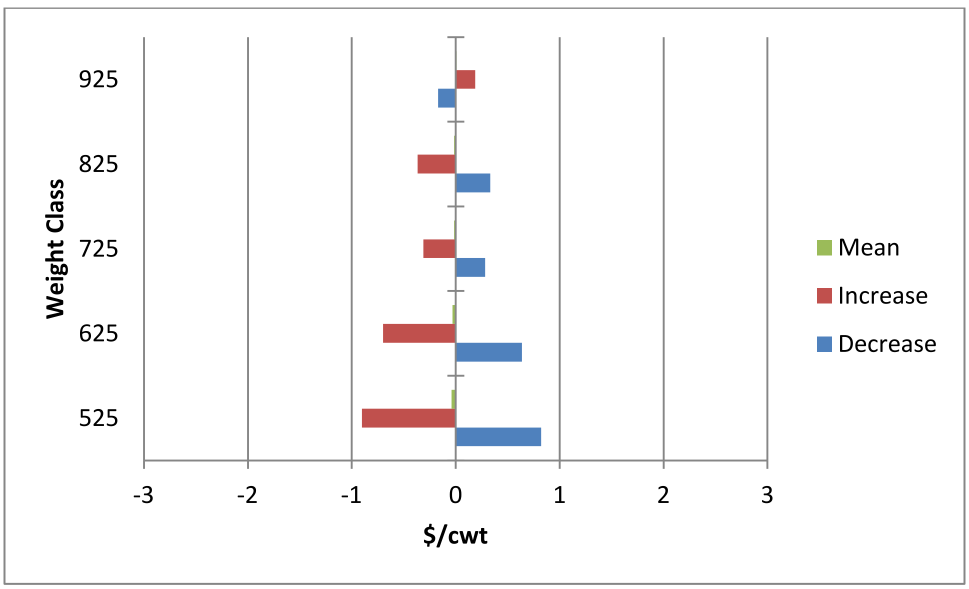


Figure 4-14 Effect of a One-Standard Deviation Change in Pasture Stress on Feeder Steer Price



At heavy weights, estimates of pasture's effect on price become less relevant. Furthermore, thinner markets associated with heavier weights may cause this variable to be less relevant in heavyweight steers, especially in periods of pasture stress when feeder cattle have been placed into feedlots at lighter weights and are therefore unavailable for sale at these heavier weights.

4.2 Feeder Heifer Results

Data from heifers were also analyzed for the same five weight ranges used in steers. Again these weight classes will be referred to by the median weight in the 50-pound ranges. The weight ranges centered on 575, 675, 775, 875 and 975 were omitted from this analysis but exhibited similar trends. The results of this regression analysis are reported in Table 4.3.

Table 4-3 Regression Parameter Estimates for First-Differenced Feeder Heifer Models for Selected Weight Ranges, Monthly Data, January 2000 to July 2013

Median Weight	525		625		725		825		925	
	Estimate	p-value	Estimate	p-value	Estimate	p-value	Estimate	p-value	Estimate	p-value
Intercept	0.28451	0.2764	0.35415	0.1405	0.26388	0.1995	0.17834	0.3677	0.19766	0.4477
dfedfuture	0.77935	0.0001	0.44546	0.0003	0.58582	0.0001	0.72452	0.0001	0.57186	0.0001
dhreturn	0.03388	0.0001	0.03445	0.0001	0.02826	0.0001	0.02076	0.0001	0.02194	0.0002
dHfr	0.00188	0.034	-0.00057784	0.4691	-0.00012002	0.8623	0.00083607	0.2072	-0.00299	0.0008
dInterest	0.69406	0.6639	2.75611	0.0573	1.80688	0.1462	0.86026	0.477	1.29627	0.4115
dUtilization12	-0.25685	0.007	-0.2561	0.0066	-0.37929	0.0001	-0.19562	0.0061	-0.01986	0.8334
dhCostofGain	-21.538	0.0337	-7.92576	0.366	-9.89311	0.1794	-16.48593	0.0173	-18.93265	0.036
dpasture	-0.1524	0.0004	-0.07168	0.0695	-0.04351	0.2004	-0.06355	0.0561	-0.00497	0.9069
Adj R2	0.519		0.5066		0.5956		0.6203		0.4332	
RMSE	3.08617		2.83117		2.43327		2.32838		3.14671	
n	151		151		151		151		151	

In the analysis of heifers it is more difficult to find a general trend of fit between the regressions. The highest adjusted R squared values are seen in one of the heavier weight ranges, but it appears that the models fit about equally well for heifers in adjacent weight ranges of 525 and 625 and for the adjacent weight ranges 725 and 825. This indicates that the model fits better for heifers in the 700-850 pound range than those outside of it.

Again, changes in a variable of one standard deviation are used to measure if a variable has noticeable economic impacts. These economic effects tend to follow the trends expressed in the regression analyses as to which factors effect heavyweight or lightweight heifers.

Table 4-4 Estimated Impacts on Feeder Heifer Price of a One Standard Deviation Increase in Variables

Median Weight	One Standard Deviation Above Mean	525	625	725	825	925
dfedfuture	$3.10-3.69/cwt*	$ 2.88	$ 1.53	$ 1.87	$ 2.27	$ 1.77
dhreturn	$47.23/hd	$ 1.60	$ 1.63	$ 1.33	$ 0.98	$ 1.04
dHfr	329,000 hd	$ 0.62	$(0.19)	$(0.04)	$ 0.28	$(0.98)
dInterest	0.13 % APR	$ 0.09	$ 0.36	$ 0.23	$ 0.11	$ 0.17
dUtilization12	3.19%	$(0.74)	$(0.74)	$(1.10)	$(0.57)	$(0.06)
dhCostofGain	$.0344/lb gain	$(0.74)	$(0.27)	$(0.34)	$(0.57)	$(0.65)
dpasture	6.59 % stressed	$(1.00)	$(0.47)	$(0.29)	$(0.42)	$(0.03)

*The live cattle futures contract of interest varies across weight classes, therefore means and standard deviations also vary. The value of this movement for 525, 625, 725, 825 and 925 pound weight classes are $3.69, $3.43, $3.20, $3.14 and $3.10 per hundred pounds, respectively.

The heaviest weight class seems to be the least consistent with trends from the other classes. The lightweight class also exhibits some irregularities but less so than the heaviest weight class. Differences in the heavyweight heifer market from the other markets are attributed to the shorter time frame and the absence of options for heavyweight heifers which causes many to have already been placed on feed, making the market thin. In this rationale the market for heifers is similar to that for steers.

The lightweight heifer market may be rationalized in a similar fashion, but has at least one aspect which is much different than steers. Feedlot placements of light heifers should not be much more common than those of steers, so the explanation of a thin market that only thickens under certain market conditions remains. However, since heifers are sexually intact, and since lighter weight heifers are may not yet have been given growth treatments which consequently decrease their reproductive abilities, lightweight heifers can fairly easily become replacement heifers in cow/calf operations.

Even as heifers grow, they remain substitutes, though less effective, for breeding cows. Therefore, even if the data collected are specific to non-replacement heifers, situations exist where heifers from this category could be pulled into the breeding herd. Alternatively, heifers considered as replacements may for one reason or another be cut from the pool of replacements and marketed in this category. This substitutability is likely to be the source of many of the differences in the steer and heifer markets. Other potential sources of discrepancy should be controlled for by the adjusted model, since differences in feedlot profit potential, domestic inventory and feed efficiency are accounted for.

The futures price has a significant effect on the price of feeder heifers at every weight. It also shows the expected positive sign. When the three middle weight classes are considered, it can be seen that the effect of futures price increases at heavier weights. This again indicates that as heifers become heavier the futures price, which becomes a more certain indicator of the actual price received for the shorter time period until harvest, has a greater impact on the price of feeder heifers. A one standard deviation increase in the futures contract value results in a noticeable increase between $1.50/cwt and $3.00/cwt. Figures 4.15 and 4.16 present the effects of a $1/cwt increase and a one standard deviation increase or decrease from the mean.

Figure 4-15 Effect of a $1/cwt Increase in Futures Price on Feeder Heifer Price

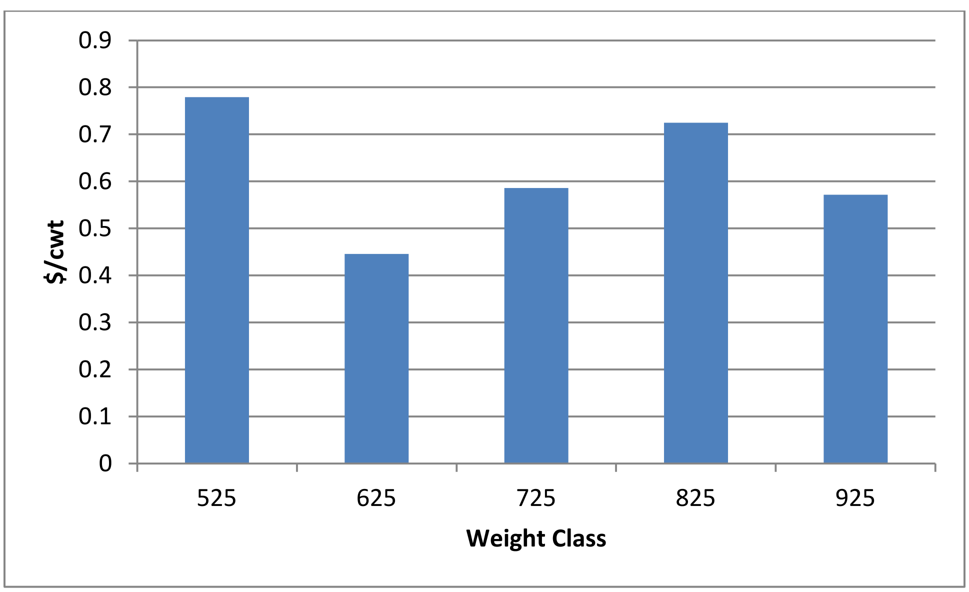
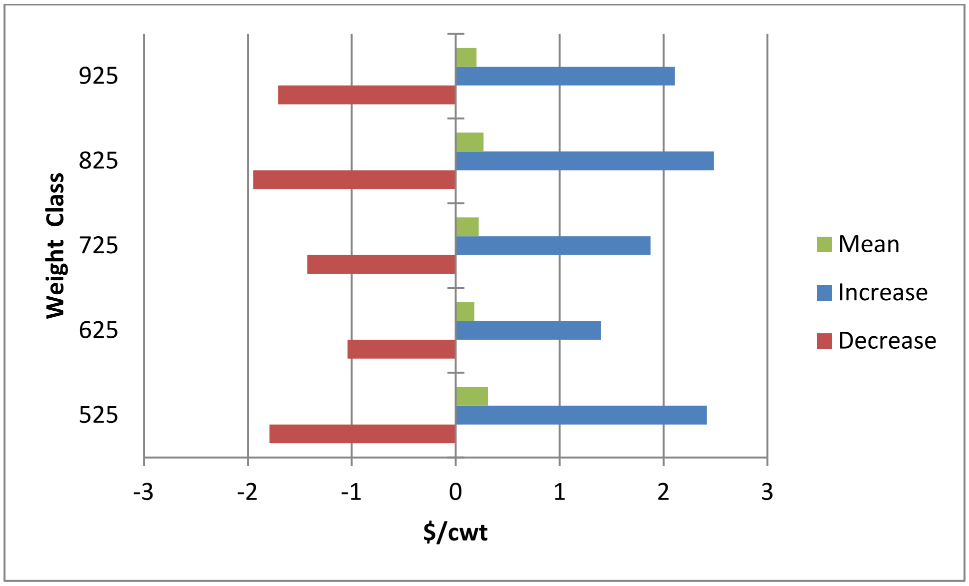


Figure 4-16 Effect of a One-Standard Deviation Change in Futures Price on Feeder Heifer Price



The estimates for historical feedlot return are also positive and significant at the 99 percent confidence level for each weight class. This value shows a decreasing effect as weights increase amongst the three middle weight classes. Additionally this trend seems to plateau rather than reverse in the very light weight and very heavy weight heifer classes as shown in Figure 4.17. This indicates that the naïve expectations of future profits are important, but less important for heavier weights. An increase in returns one standard deviation above the mean results in an increase greater than $1.00/cwt for all weights except 825, in which the increase is $0.98/cwt. Figure 4.18 presents the economic impacts of common changes in returns.

Figure 4-17 Effect of a $1/Head Increase in Previous Feedlot Returns on Feeder Heifer Price

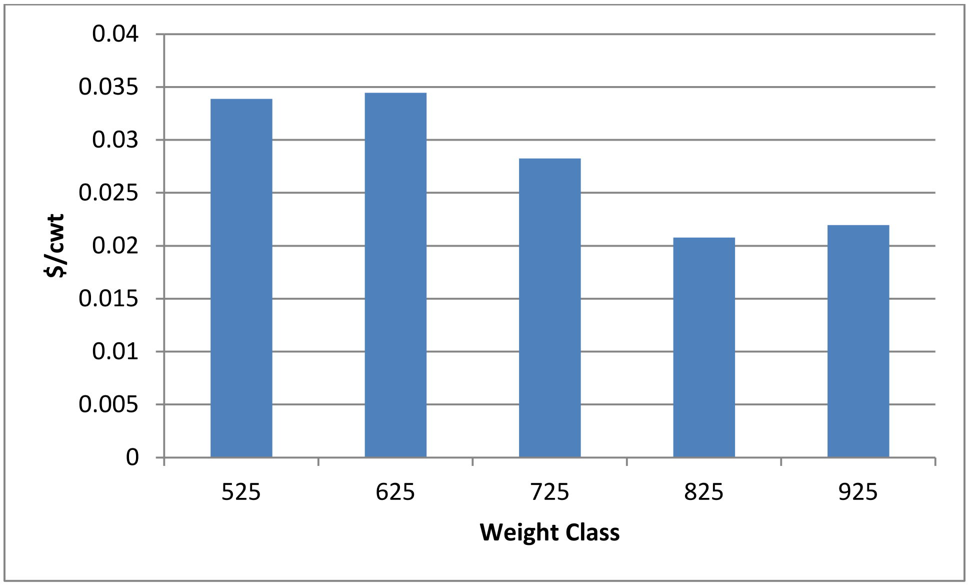
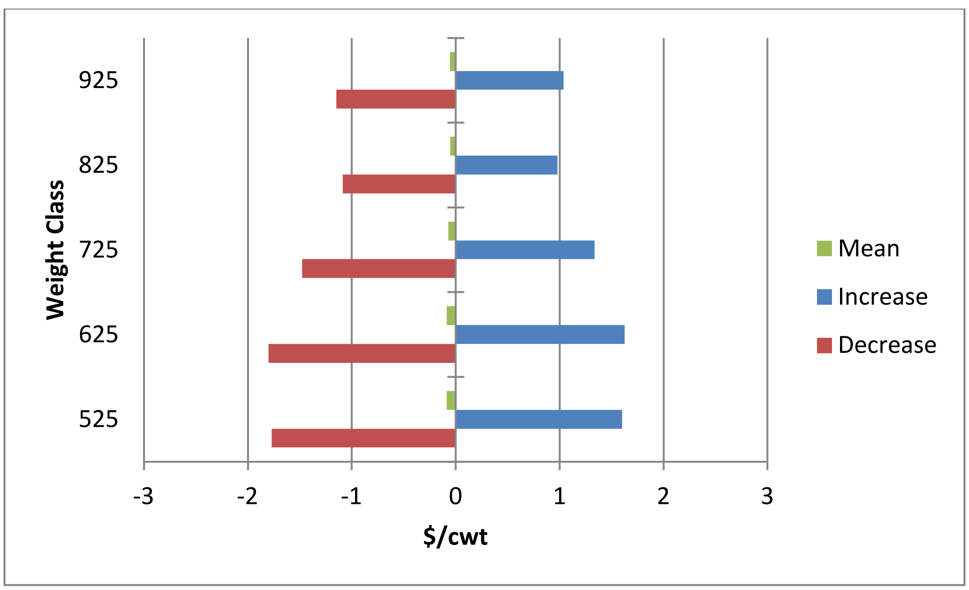


Figure 4-18 Effect of a One Standard Deviation Change in Historical Return on Feeder Heifer Price



These two variables again seem to support the theory that naïve profit expectations and rational price expectations both combine to form producer's expectations of future price. The impact of naïve profit expectations, both in coefficient estimates and economic impact, is reduced as the impact of the rational price expectations rises. Again, this is contrary to economic theory particularly the Efficient Market Hypothesis, which would indicate that the futures market should reflect all existing knowledge and expectations of the actual future price. Although this futures market is less predictable over longer time frames, it should still be a producer's best indication of future price if markets are efficient. Since evidence suggests this is not the case it may indicate that producers believe there is a bias in the futures market or, perhaps a more benign explanation, that historical returns account for other factors apart from the wealth effect it represents.

A notable exception from the above trend is the lightweight heifer market (525 pounds). This market seems to be largely affected by both the rational expectations of price and naïve expectations of profits. This can possibly be explained similarly to the lightweight steer market in that feedlot placements at this weight are less common than the other weight classes and decisions to market or procure 525 weight heifers require more producer confidence in price expectations than the futures market alone can provide. An additional, though less likely explanation is that futures prices may help cow/calf producers decide on the size of cow herd they would like to maintain and consequently the number of breeding heifers they wish to hold back. Therefore, high prices in this weight class signal a demand which can be met by producers retaining fewer heifers, a decision that requires a larger confidence in the price expectation at time of finishing and beyond than other placement decisions.

The domestic inventory of nonreplacement heifers has an impact that generally decreases as weights increase. The value in the lightweight class is significantly positive at a 95 percent confidence level. The three middleweight classes vary in sign and are not significantly different from zero. The heavyweight class is significantly negative at a 99 percent confidence level.

Additionally, the economic effect of an increase is over $0.50/cwt for the lightest heifers and approaches $1/cwt for the heaviest heifers. Figures 4.19 and 4.20 illustrate this trend.

Figure 4-19 Effect of a 1,000 Head Increase in Heifer Inventory on Feeder Heifer Price

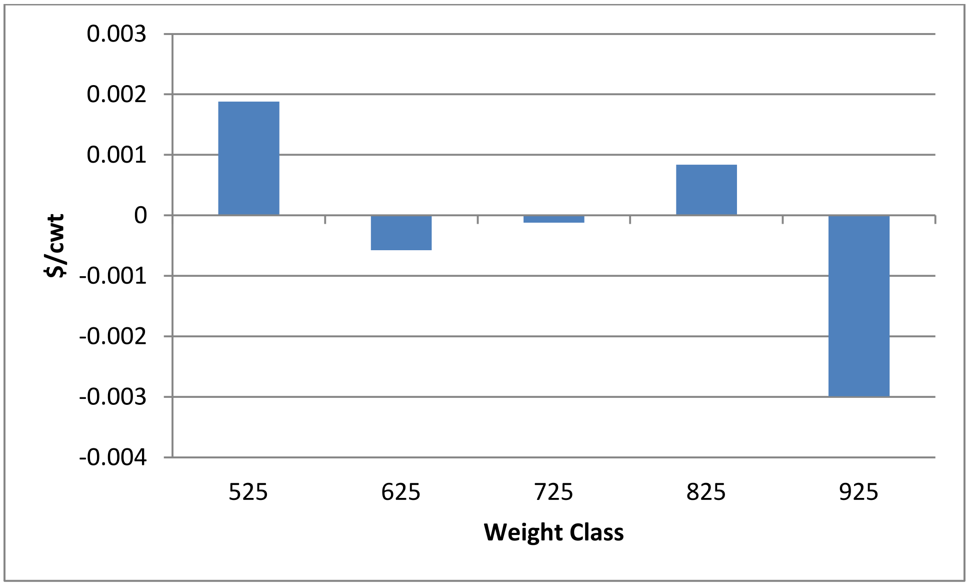
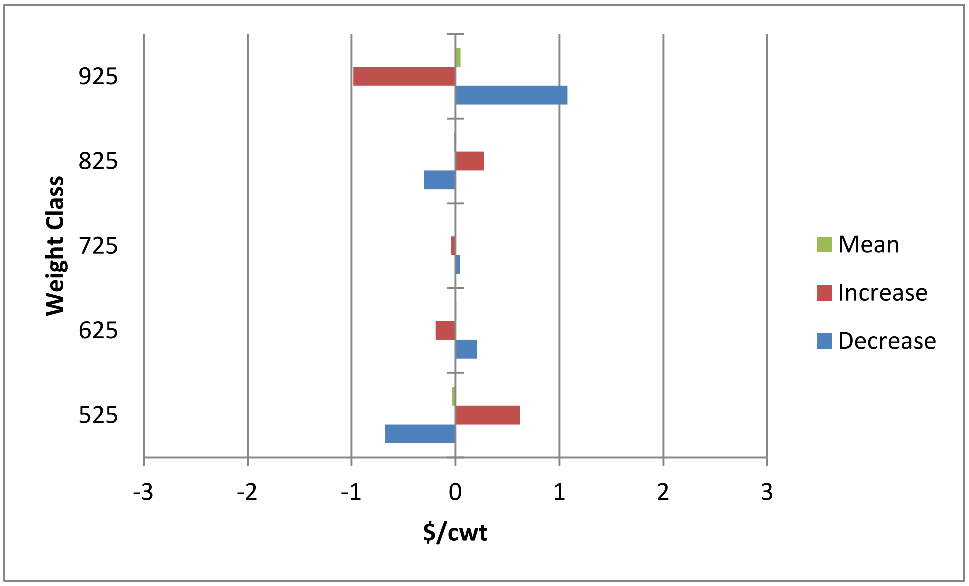


Figure 4-20 Effect of a One Standard Deviation Change in Inventory on Feeder Heifer Price



Similar to the effect of steer inventory on the price of feeder steers, it appears that in the market for feeder heifers, the changes in inventory have little to no effect on the price. Again this can be attributed to inelastic supply of feeder heifers due to biological production constraints. Although there is more substitutability for heifers since they could in theory be put in the cow herd, the primary alternative to placing a feeder heifer on feed now is placing it on feed in the future at a heavier weight. Once again, significant values occur where this substitutability is at its highest and lowest.

The unexpected positive sign on the inventory of lightweight heifers is potentially due to stocker/backgrounder demand increasing when overall cattle numbers are high. This would again be the result of stocker/backgrounder operations expecting to take advantage of increasing prices in the future by utilizing the slower growth rates associated with their production method. This demand would be the highest among lightweight heifers since they have the greatest amount of time before they have to be placed on feed. This demand essentially disappears for the heaviest weight class, as there is very little ability to hold these heifers for longer periods of time. If the high inventory of heifers results in too many heavyweight heifers, it gives an advantageous negotiating position to the cattle feeders over the cow/calf or stocker/backgrounder producers.

The interest rate is shown to have a significant effect at a 90 percent confidence interval on 625 pound heifers and is insignificant elsewhere. All weight classes show a positive estimate, which is opposite of the expected effect of cost of capital. The economic impact of an increase is small, resulting in less than $0.50/cwt change in feeder cattle price in all weight classes. Like in the steer analysis, the interest rate is included because it can be justified theoretically, and may add value to future models in the area. The effects of a one 1% increase and a one standard deviation change above or below the mean are presented in Figures 4.21 and 4.22.

Figure 4-21 Effect of a 1% APR Increase in Interest Rate on Feeder Heifer Price

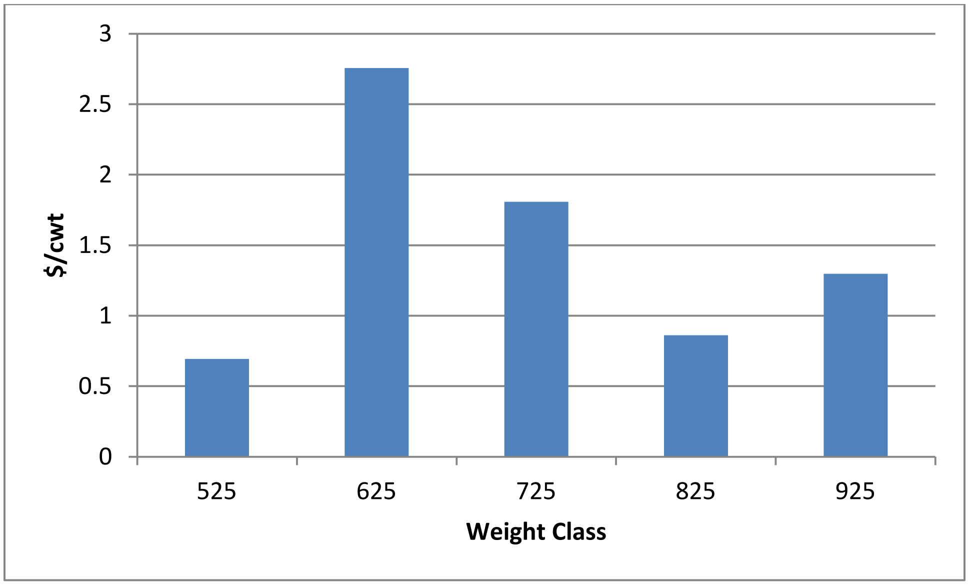
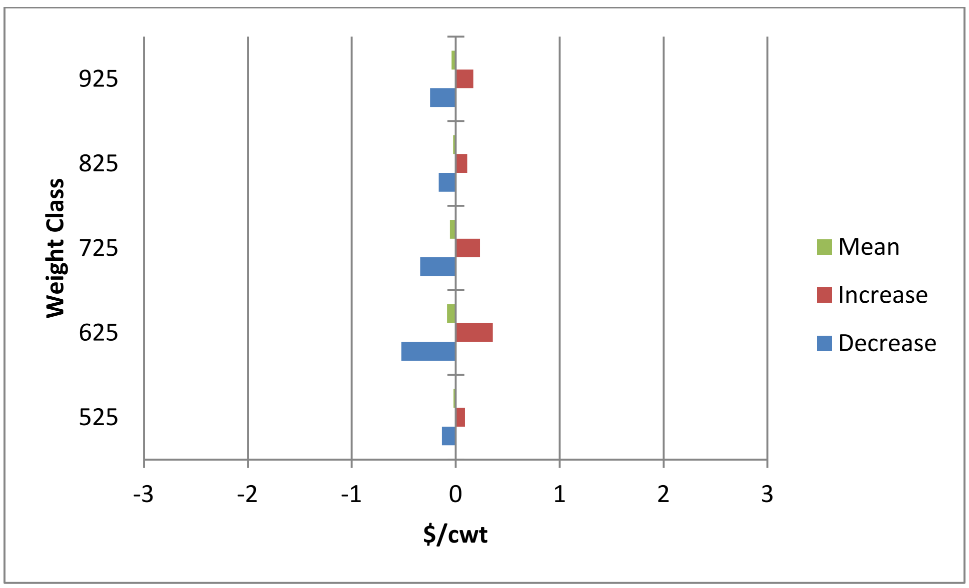


Figure 4-22 Effect of a One Standard Deviation Change in Interest Rate on Feeder Heifer Price



Feedlot capacity utilization has a significant negative effect on all but the heaviest weight class of feeder heifers, indicating that a decrease in feedlot utilization increases the price of feeder heifers. The most negative value is shown to be in the middle weight class (725 pounds). From this weight the impact approaches zero as weight is increased or decreased, though it approaches much faster when weights are increased than when they are decreased as shown in

Figure 4.23. This effect is also seen in the economic impacts as an increase in feedlot utilization changes the price of the middle weight class by over $1/cwt a value which decreases when weights are lighter, and decreases even faster when weights are heavier. Figure 4.24 shows the economic impact of common changes.

Figure 4-23 Effect of a 1% Increase in Feedlot Utilization on Feeder Heifer Price

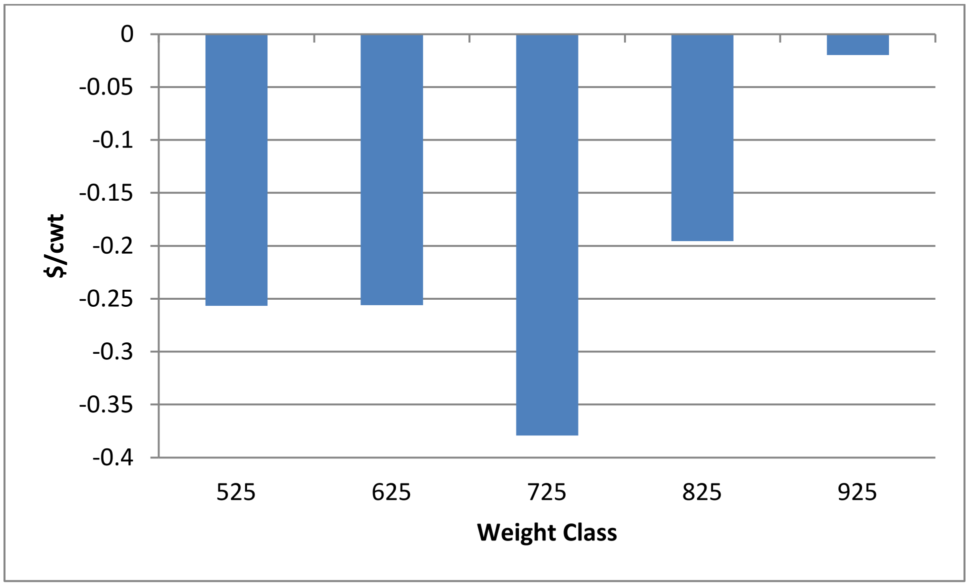
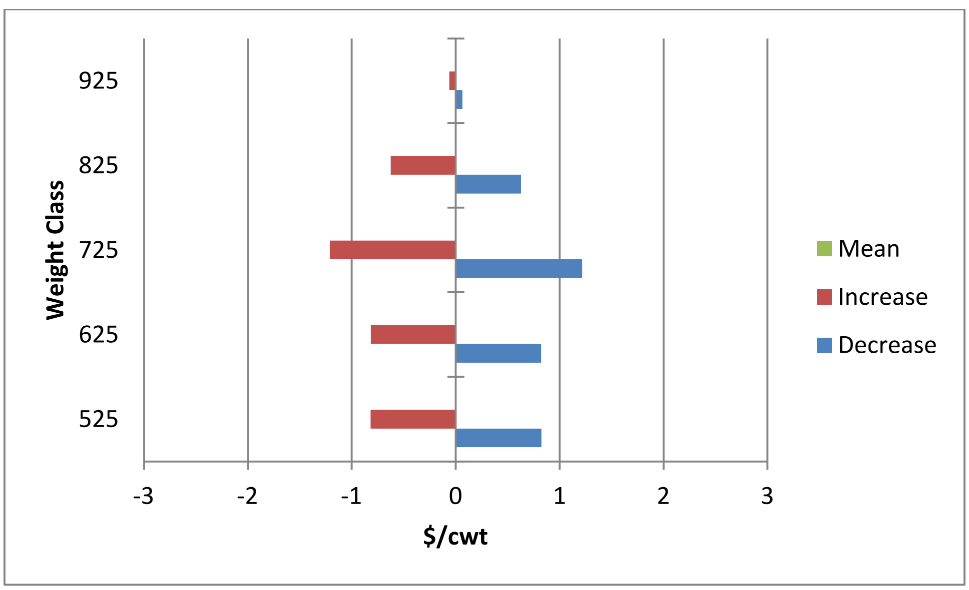


Figure 4-24 Effect of a One Standard Deviation Change in Utilization on Feeder Heifer Price



The most negative impact occurring in the middle of the weight spectrum is expected because feeder heifers are most likely to be placed on feed in this weight range. Lighter weight heifers have different uses such as being held on forage for a longer period of time or being retained for breeding, making the somewhat decreased impact of this factor expected since producers have more control over the timing of their marketing decisions of lightweight heifers than for heavyweight heifers. This reduction is less extreme for lightweight heifers than it was for lightweight steers. This may indicate that placement of heifers at lighter weights is more common or that stocker/backgrounder producers prefer to buy lightweight steers over lightweight heifers, decreasing the alternative demand for light heifers relative to steers.

Heavier weights of heifers are less impacted than lightweight heifers. This is likely due to the fact that placing a heavyweight heifer on feed requires less of a commitment of pen space by the feedlot since they can be harvested in a shorter time frame, allowing them to turn the pen faster. The aforementioned potential preference of stocker/backgrounder producers for steers would also explain why the more rapid decline in the absolute value of the effect of utilization for heavyweight heifers as compared to lightweight heifers is observed statistically, as the heaviest weight class reaches a statistical zero value while the lightest weight class does not. This is in contrast to the purely numerical difference observed in steers.

Estimates for the variable cost of gain each exhibit the expected negative sign, indicating that an increase in the cost of this input to cattle feeding decreases demand for feeder heifers. However, only the two heaviest weight classes and the lightest weight class have estimates which are significant at a 95 percent confidence level. These three weight classes are the only ones in which a price increase of one standard deviation causes more than a $0.50/cwt shift in the price of feeder cattle. If the lightest weight class is ignored, this variable shows an increasingly negative impact on feeder cattle price as weights increase. This is similar to the results found for feeder steers, but it is once again different than what previous research has stated. Again, this variable includes adjustment measurement of heifer feed efficiency, which is not included as part of the cost of feed variable in other studies to which this is being compared. The fact that this dataset contains higher feed prices than what was seen in previous studies is also a potential source of the difference. Figures 4.25 and 4.26 present the changes in feeder cattle price from a 1 unit or one standard deviation change in cost of gain, respectively.

Figure 4-25 Effect of a $1/Pound Increase in Heifer Cost of Gain on Feeder Heifer Price

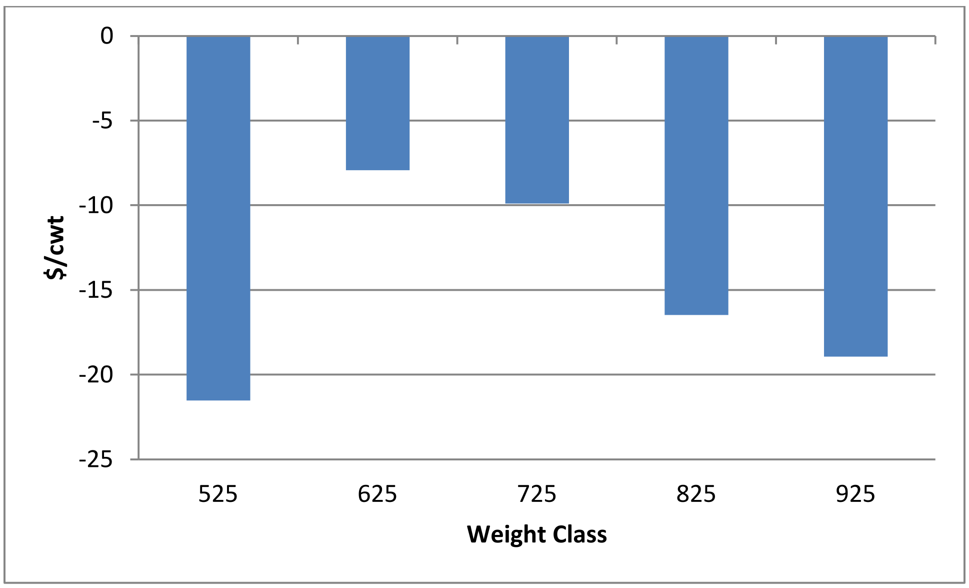
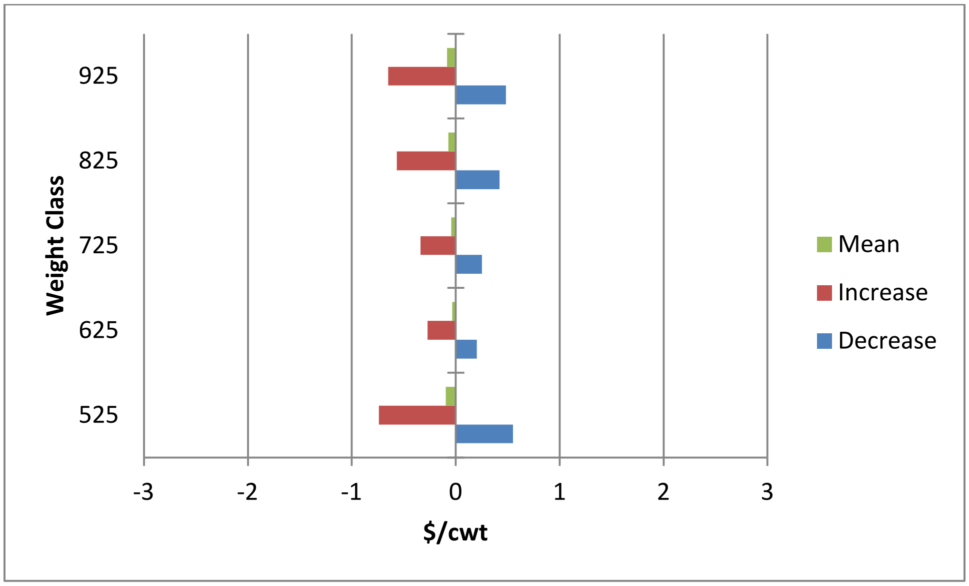


Figure 4-26 Effect of a One Standard Deviation Change in Cost of Gain on Feeder Heifer Price



This research would indicate that heavyweight heifers are more affected by high feed costs than most of the lighter weights. This can be rationalized by the lack of alternative diets which can be fed to heavy heifers, compared to the options for lighter heifers to be fed forages if gain from them is cheaper. When cattle are in the light to middle weight range, they can be held on pasture if the cost of gain is high, allowing for a certain degree of supply response. This ability decreases as heifers reach heavier weights.

The highly negative effect shown on the lightest weight heifers by cost of gain does not follow the above logic. This variable states that the group of cattle most impacted by high cost of gain is the lightweight heifers. This could be seen to contradict the findings of this variable elsewhere in the study, indicating that the previous research holds and that the lightweight calves are indeed the most heavily impacted. However, this negative could also be attributed to the previously discussed idea that heifers at a weight barely over 500 pounds are viewed as interchangeable between cow herd replacements and feeder heifers. In this case, the cost of gain may be viewed as a predictor of the overall profitability of the cattle feeding industry. A high value would therefore indicate that production should be decreased, which can be accomplished by retaining fewer heifers. This could move light heifers from the cow replacement market to the feeder heifer market and cause the supply to increase which would lower price. This explanation is made with less confidence than others, due to the lower predictive power of the lightweight heifer model and the lack of support for this explanation in middle to heavyweight trends.

Pasture conditions are the final variable considered and exhibit the expected negative sign in all weight classes. Figure 4.27 demonstrates that the effect on prices generally approaches zero as heavier weights are considered, though not strictly. Nonetheless, the two lightest weight classes (525 and 625 pounds) are the most negatively impacted, as is expected, and they are significant at the 99 percent and 90 percent confidence intervals, respectively. A significant estimate also appears in the 825 pound group but it does not reach the same negative levels. The lightest weight class shows a pasture condition change affecting prices by more than \$0.50/cwt, reaching \$1/cwt with a one standard deviation increase, though the impact from the other statistically significant classes are much closer than the others. These economic impacts are presented in Figure 4.28.

Figure 4-27 Effect of a 1% Increase in Pasture Stress on Feeder Heifer Price

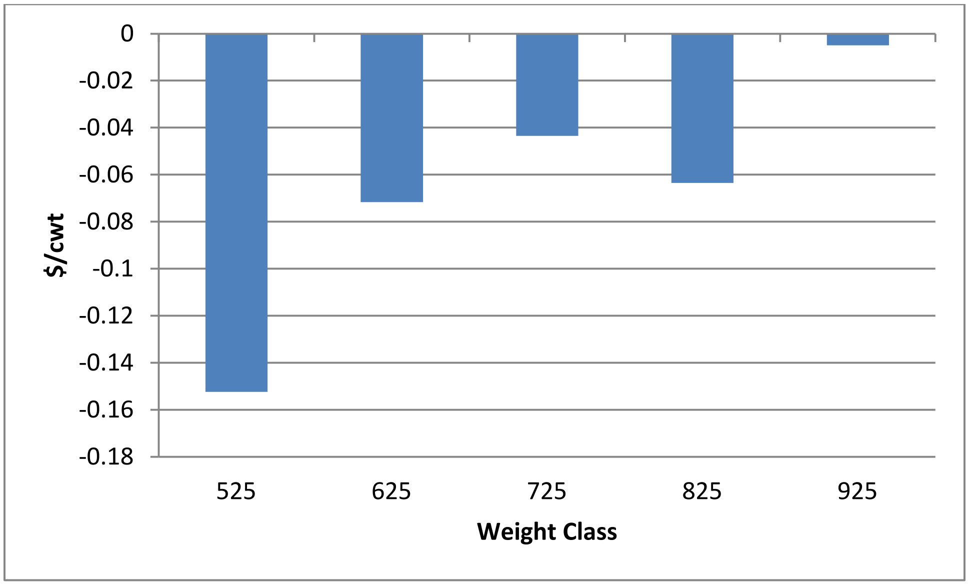
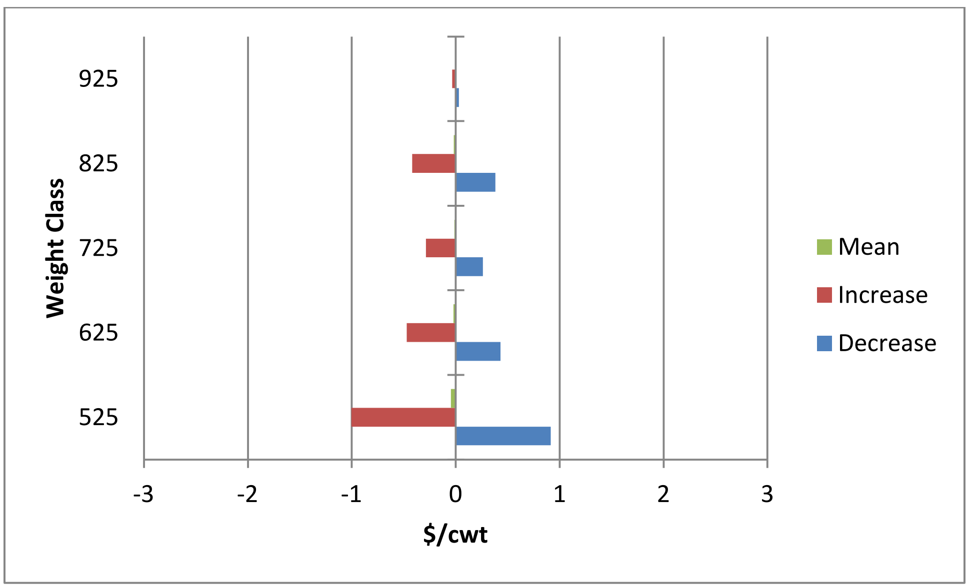


Figure 4-28 Effect of a One Standard Deviation Change in Pasture Stress on Feeder Heifer Price



This variable was expected to have the most negative impact on the lightest weights of heifers because these calves are much more likely to be grazing pastures. Therefore, when pastures are stressed, their grazing capacity is reduced and more of these heifers are likely to be placed on feed, increasing supply in the lightweight heifer market and decreasing the price. This negative impact should diminish as weights increase and the percentage of heifers on pasture decrease.

Chapter 5 - Conclusions

This research has examined the effects of various factors of production on feeder cattle price in 10 market subsets split across weight and gender differences. The purpose of this research was to develop an enhanced understanding of the changing effects of these factors on price across feeder cattle weight. The further development of this understanding can assist cow/calf and stocker/backgrounder producers as well as cattle feeders in understanding price movements and making feedlot placement decisions.

5.1 Overview of Process

A review of previous research highlighted the development of feeder cattle price models over time. Much of the past research has modeled effects of weight as linear or quadratic. Other studies have used interaction terms to attempt to capture the effect of weight on other factors' impact on price. There was not however, a clear method which appeared to fully capture the effects of weight on the behavior of different cattle market subsets.

Research has also documented the effects of feed prices, primarily corn, on feeder cattle price, establishing it as a complementary input to feeder cattle in fed cattle production. The review also revealed that the effects of feed price increases are not static, but that changes in the costs of feed change the demand curve in such a way as to change the preferred placement weight. This phenomenon is difficult to capture using a single variable. The feed-to-gain ratio, which is a measurement of the efficiency of cattle feeders, is not incorporated in much of the past research. A true measurement of the cost of gain, rather than simply feed costs would combine these two variables by multiplication.

The use of rational and naïve expectations is also debated by previous literature. The term "rational expectations" is broadly used to refer to the futures contract price which will be nearby at the expected time of harvest. "Naïve expectations" is the term commonly used to refer to an expectation based upon current or previous prices. Selecting the appropriate expectation model requires a basic understanding of market efficiency. If the market is not at least weak form efficient, then no rational expectations are required, while a strong form efficient market would not require producers to use any naïve expectations. Disagreement on the efficiency of the beef market led to the inclusion of both expectation forms.

The data used in this analysis were publicly available, gathered by the United States Department of Agriculture, the Chicago Mercantile Exchange, Kansas State University and the Federal Reserve Bank of Kansas City. The dependent variables were the aggregation of auction data reported by the Livestock Marketing Information Center. These data were aggregated from four major cattle feeding states Nebraska, Kansas, Oklahoma and Texas for each weight class. Weight classes were 50 pound weight ranges with median weights of 525, 625, 725, 825 and 925 pounds for both steers and heifers. The time series for this analysis ran from January of 2000 until July of 2013 for a total of 151 monthly observations.

An Augmented Dickey Fuller test revealed that the data were nonstationary. This nonstationarity would likely cause spurious results if used for analysis. To correct for nonstationarity, the first difference of the data was taken. Data for December of 1999 was added for this process in order to maintain 151 observations in the data series.

Ordinary Least Squares regressions were used to test for the effects of seven independent variables upon the feeder cattle price of the weight class and gender of interest. These independent variables were the live cattle futures price, past period's feedlot return, feeder cattle inventory, interest rate, percent of feedlot capacity utilized, expected cost of gain, and percent of pastures which were stressed. For each variable, the regression coefficient estimates were reported and compared across weights for the steer market. This process was then repeated for the feeder heifer market. Economic effects of a change one standard deviation above the mean were also included for each variable, weight group and gender. Trends in the effects of these variables were then reported.

5.2 Findings and Implications

Overall, this study supports the concept of considering market subsets as distinct, though equivalence tests between subsets and pooled weight classes would be helpful in lending further support to this concept. Effects of variables tend to differ as the weight of feeder cattle changes. These differences in variables' impact are not always distributed in a way which is easily modeled by a linear, quadratic or polynomial expression. Weight classes of feeder cattle are indeed substitutable, but they are not perfect substitutes. Market conditions, production factors and other influencers can have differing effects between weight classes.

Of these factors, the question of price expectations was considered first. This study included what past research has considered a rational expectation of future price in the live cattle futures contract, along with a naïve profit expectation in the previous period's feedlot returns. Both of these variables had statistically significant and economically significant effects on the steer and heifer markets. This supports the findings of some past research that both rational and naïve expectations influence feeder cattle demand.

The effects of the live cattle futures price tended to increase as weights increased while the effects of previous returns decreased with the same weight increases. This suggests that the importance of rational expectations in making placement decisions is greater for the placement of heavier feeder cattle and that naïve profit expectations, or perhaps a wealth effect similar to naïve price expectations, fill in the information gap which exists for placements of light cattle due to the longer term nature of these futures contracts. This would indicate that cattle feeders believe that the futures market becomes more reliable, and that potential bias is eliminated, as its delivery date approaches. Placements of abnormally lightweight cattle may require additional certainty, as the lightest weight class shows large impacts of both rational price and naïve profit expectations.

The domestic feeder cattle inventory does not have a large effect on prices for most of the weight ranges of feeder cattle; however it has a significant effect on extremely lightweight and heavyweight feeder calves. Effects are positive for light calves and negative for heavy calves. The differences in sign are attributed to stocker/backgrounder demand for lightweight calves.

The interest rate did not have a significant effect on the price of either gender of calves. It does however have a theoretical justification and should still be considered as a potential variable for future studies.

The utilization of existing feedlot capacity is a variable which was uncommon in past research. However, cow/calf producers, stocker/backgrounder producers and cattle feeders alike should be aware of how it affects the demand for, and subsequently the value of, feeder cattle. Capacity utilization is necessary for feeders to be able to allocate fixed costs over a wider base. The actual percent utilization of feedlots is difficult to calculate, since the total feedlot capacity is not known. This study utilizes a percent of the local maximum value in order to estimate capacity utilization. Though more accurate methods of measurement would be useful, this study helped to discover if feedlot capacity could have a significant effect on the cattle market.

This study found significant negative effects of feedlot capacity utilization on the price of feeder cattle. These effects were seen to the largest extent in the middle weight classes, where feedlot placements were likely more common than for light weight classes. Though both lightweight and heavyweight calves were less negatively affected than the middle weight class, it seemed that lightweight cattle were more impacted by feedlot utilization than heavyweights. This could be due to stocker/backgrounder demand changes for lightweight calves offsetting the effect, or it could be an indication that cattle feeders change placement decisions based upon utilization of lot space.

As previously stated in this section, the inclusion of a cost of gain variable rather than a feed price variable is somewhat uncommon for a feeder cattle model. The expectation was that the effect would become less negative as weights increased, as previous research has shown to be the case for the price of feed. However, excluding the lightest weight class this study found effects that tended to become more negative as heavier weight classes were considered.

Two major reasons exist that explain why the findings of this paper could disagree with expectations and still be accurate. The first is that feed prices in this study, especially the cost of corn, were much higher than many of the previous studies. This study could simply be revealing a response to high corn prices which was unobserved in previous research at lower prices. Other recent research does not necessarily confirm this and theoretical justification for this explanation is weak, but it is possible future studies would support this hypothesis.

A second explanation is that the inclusion of the feed-to-gain ratio in this variable makes cost of gain distinct from feed costs. Cost of gain in theory should be a more accurate measure of the prices of complementary inputs to feeder calves in fed cattle production than a simple feed cost variable. This variable should behave differently for each weight class since feed-to-gain ratio is different for each weight; however, feed efficiency was held at a constant value for each weight class in this study (same cost of gain values were used in each weight class). It is possible that enhancements in feed conversion technology and expertise tapered, or even reversed, the effects of feed prices in this study. The true impact of the cost of gain on feeder cattle price warrants further research.

The condition of pasture is shown to have significant negative effects for lightweight cattle, which are more likely to be retained on pasture than their heavier counterparts. The percentage of pasture under stress has a negative effect on the two lightest weight classes of both steers and heifers. These findings are consistent with expectations since a decrease in pasture availability will reduce alternative uses for these lightweight calves and will likely increase the quantity of light cattle supplied to the market.

5.3 Questions for Future Research

This study raises questions for future research to address. The majority of the major questions this research proposes can be grouped into two categories. These categories are feedlot capacity utilization and cost of gain. These two categories are of particular interest since past research shows few attempts to include them in models or to measure their effects on price. This study also contributes to existing research on price-weight relationships and future price expectations, two areas in which research exists but questions remain.

The effects of feedlot utilization on feeder cattle price is one category for future research. This study utilizes a simplified estimation of capacity and finds significant negative effects of utilization on feeder cattle price. Future studies addressing this topic should look for more accurate ways to measure feedlot capacity utilization. A particular topic of interest is measuring the true domestic cattle feeding capacity. A survey of producers, large cattle feeders or other experts in the area may offer substantial assistance in creating more accurate measures of feedlot utilization. Other than finding more accurate measures, the interaction between utilization and other factors, such as cattle inventory, cost of gain, weather patterns and seasonality would increase understanding of this area. Additionally, the effects of utilization on hedonic pricing characteristics could be of interest in determining if capacity utilization affects demand for certain breeds, quality or lot sizes of feeder calves.

The other major category which I believe further research would be of value is in the effects of cost of gain. The use of a cost of gain rather than feed costs variable may be more accurate in future forecasting models. Furthermore, this study seems to suggest that cost of gain, at least as defined in this study, behaves differently than cost of feed in its effect on cattle value. Future research on this topic can help to determine if these findings are a spurious result of data irregularities or thin heavyweight markets, or if they are a true representation of reality. If the latter is true, research to determine if the trend of decreasing effects is due to feed prices, technology advancements or a combination of the two could be of interest.

Other topics which research has already and will undoubtedly continue to address are the effects of weight on feeder cattle price and the use of rational and naïve price and profit expectations in cattle feeding. This research proposes the use of weight class subsets in order to more accurately understand how other variables are influenced by weight. This may be valuable in future studies, including those of a hedonic nature. Additionally, this research supports the idea that both rational price expectations and naïve profit expectations are used in predicting cattle price indicating that producers question the accuracy and efficiency of futures markets, particularly for long term contracts. Research of market bias and methods of correcting it continue to be of value.

Chapter 6 - Bibliography

Anderson, J. D., & Trapp, J. N. (2000a). Corn price effects on cost of gain for feedlot cattle: Implications for breakeven budgeting. *Journal of Agricultural & Resource Economics, 25*(2), 669-679. Retrieved from: http://purl.umn.edu/30896

Anderson, J. D., & Trapp, J. N. (2000b). The dynamics of feeder cattle market responses to corn price change. *Journal of Agricultural and Applied Economics*, *32*(3), 493-506. Retrieved from: http://purl.umn.edu/15311

Buccola, S. (1980). An approach to the analysis of feeder cattle price differentials. *American Journal of Agricultural Economics, 62*(3), 574-580. doi: 10.2307/1240218

Bulut, H., & Lawrence, J. D. (2007). The value of third-party certification of preconditioning claims at Iowa feeder cattle auctions. *Journal of Agricultural and Applied Economics, 39*(3), 625-640. http://ageconsearch.umn.edu/bitstream/18223/1/wp060031.pdf

Burdine, K., Maynard, L. J., & Halich, G. (2013). Factors affecting feeder cattle prices in the southeast. *Southern Agricultural Economics Association Annual Meeting,* Orlando, FL. Retrieved from: http://purl.umn.edu/142976

Dhuyvetter, K. C., & Schroeder, T. C. (2000). Price-weight relationships for feeder cattle. *Canadian Journal of Agricultural Economics, 48*(3), 299-310. doi: 10.1111/j.1744-7976.2000.tb00281.x

Dhuyvetter, K. C., Swanser, K., Kastens, T., Mintert, J., & Crosby, B. (2008). Improving feeder cattle basis forecasts. Paper presented at the *Western Agricultural Economics Association Annual Meeting*, Big Sky, MT. Retrieved from: http://purl.umn.edu/42302

Fama, E. F. (1970). Efficient capital markets: A review of theory and empirical work*. *The Journal of Finance*, *25*(2), 383-417. doi:10.1111/j.1540-6261.1970.tb00518.x

Faminow, M., & Gum, R. (1986). Feeder cattle price differentials in Arizona auction markets. *Western Journal of Agricultural Economics*, *11*(2), 156-163. Retrieved from: http://purl.umn.edu/32255

Franzmann, J. R., & Walker, R. L. (1972). Trend models of feeder, slaughter, and wholesale beef cattle prices. *American Journal of Agricultural Economics, 54*(3), 507-512. doi: 10.2307/1239170

Halich, G., & Burdine, K. (2014). Feedlot vs. pasture impacts on feeder cattle prices. *Southern Agricultural Economics Association Annual Meeting,* Dallas, TX. Retrieved from: http://purl.umn.edu/162898

Hampel, F. A., Schroeder, T. C., & Kastens, T. L. (1998). Risk and expected returns in cattle feeding. Paper presented at the *Proceedings of the NCR-134 Conference on Applied Commodity Forecasting and Risk Management,* Chicago, IL. http://www.farmdoc.illinois.edu/nccc134/conf_1998/pdf/confp18-98.pdf

Hirschi, M., & Feuz, D. M. (2010). Does the law of one price hold for feeder cattle purchased in various regions of the US and shipped to one state in the Midwest? Paper presented at the *2010 Annual Meeting, February 6-9, 2010, Orlando, Florida*. Retrieved from: http://purl.umn.edu/56381

Kastens, T. L., & Schroeder, T. C. (1994). Cattle feeder behavior and feeder cattle placements *Journal of Agricultural and Resource Economics*, *19*(02), 337-348. Retrieved from: http://purl.umn.edu/30754

Kastens, T. L., & Schroeder, T. C. (1995). A trading simulation test for weak-form efficiency in live cattle futures. *Journal of Futures Markets*, *15*(6), 649-675. doi: 10.1002/fut.3990150605

Koontz, S. R., Hudson, M. A., & Hughes, M. W. (1992). Livestock futures markets and rational price formation: Evidence for live cattle and live hogs. *Southern Journal of Agricultural Economics, 24*, 233-233. Retrieved from: http://purl.umn.edu/30384

Lambert, C. D., McNulty, M. S., Grunewald, O. C., & Corah, L. R. (1989). An analysis of feeder cattle price differentials. *Agribusiness, 5*(1), 9-23. http://search.proquest.com/docview/223679138?accountid=11789

Langemeier, M., Schroeder, T., & Mintert, J. (1992). Determinants of cattle finishing profitability. *Southern Journal of Agricultural Economics, 24*(2), 41-47. Retrieved from: http://purl.umn.edu/29637

Lawrence, J. D., Wang, Z., & Loy, D. (1999). Elements of cattle feeding profitability in Midwest feedlots. *Journal of Agricultural and Applied Economics*, *31*(2), 349-358. Retrieved from: http://purl.umn.edu/15377

Maki, W. (1962). Decomposition of the beef and pork cycles. *Journal of Farm Economics, 44*(3), 731-743. Doi: 10.2307/1235949

Marsh, J. (1985). Monthly price premiums and discounts between steer calves and yearlings. *American Journal of Agricultural Economics*, *67*(2), 307-314. doi: 10.2307/1240683

McLemore, D. L., Drinnon, D., Rawls, E. L., & Campbell, J. C. (2010). Effects of producer-provided descriptions of feeder cattle and conditions of sale on prices on a Tennessee video board sale. *Southern Agricultural Economics Association Annual Meeting,* Orlando, FL. Retrieved from: http://purl.umn.edu/56263

Menkhaus, D., & Kearl, G. (1976). Influence of breed, sex, lot size and weight on feeder cattle prices. *Journal of Animal Science, 42*(6), 1389-1396. http://www.journalofanimalscience.org/content/42/6/1389.short

O'Byrne, J. C., & Davenport, C. (1988). *Doane's tax guide for farmers* Doane Information Services.

Peel, D. S. (2011). Market coordination in the beef stocker sector: Short and long run implications of higher corn prices. *Southern Agricultural Economics Association Annual Meeting,* Corpus Christi, TX. Retrieved from: http://purl.umn.edu/98826

Purcell, W. D. (1991). IRS Policy on Hedging vs. Speculation: Possible Implications to Market Efficiency and Price Discovery in Cattle Markets. *Pricing and Coordination in the Consolidated Livestock Market* Research Institute on Livestock Pricing, Department of Agricultural Economics, Virginia Tech, Blacksburg, VA.

Schroeder, T. C., Mintert, J. R., Brazle, F., & Grunewald, O. (1988). Factors affecting feeder cattle price differentials. *Western Journal of Agricultural Economics, 13*(1), 71-81. Retrieved from: http://purl.umn.edu/32161

Schulz, L., Dhuyvetter, K., Harborth, K., & Waggoner, J. (2010). *Factors affecting feeder cattle prices in Kansas and Missouri* (Special Report No. 4). Manhattan, KS: Cooperative Extension Service, Kansas State University. http://agmanager.org/livestock/budgets/production/beef/Factors%20Affecting%20Feeder%20Cattle%20Prices%20(Nov2009--RevisedMar2010).pdf

Swanser, K. (2013). Dynamics of feeder cattle basis and price slides. Paper presented at the *2013 Annual Meeting, August 4-6, 2013, Washington, DC.* Retrieved from: http://purl.umn.edu/150249

Tejeda, H. A., & Goodwin, B. K. (2011). Dynamic price relationships in the grain and cattle markets, pre and post-ethanol mandate. *Agricultural & Applied Economics Association*

2011 AAEA &NAREA Joint Annual Meeting, Pittsburgh, PA. Retrieved from: http://purl.umn.edu/103825

Tomek, W. G., & Robinson, K. L. (2003). *Agricultural product prices* (Fourth ed.). Ithaca, New York: Cornell University Press.

Williams, G. S., Raper, K. C., DeVuyst, E. A., Peel, D., & McKinney, D. (2012). Determinants of price differentials in Oklahoma value-added feeder cattle auctions. *Journal of Agricultural & Resource Economics, 37*(1), 114-127. Retrieved from: http://purl.umn.edu/122309

Zhang, F., Epperson, J. E., & Houston, J. E. (2006). Modeling live cattle supply with different price expectations. Paper presented at the *2006 Annual Meeting, February 5-8, 2006, Orlando, Florida.* Retrieved from: http://purl.umn.edu/35447

Zhao, H., Du, X., & Hennessy, D. A. (2009). *Pass-through in United States beef cattle prices* (Center for Agricultural and Rural Development Working Paper Series. Ames, IA: Iowa State University. http://econ2.econ.iastate.edu/research/webpapers/paper_13093.pdf

Zimmerman, L. C., Schroeder, T. C., Dhuyvetter, K. C., Olson, K. C., Stokka, G. L., Seeger, J. T., et al. (2012). The effect of value-added management on calf prices at superior livestock auction video markets. *Journal of Agricultural and Resource Economics, 37*(1), 128-143. Retrieved from: http://purl.umn.edu/122317

Appendix A - Spatial Differences in Price Effects Between States

This appendix presents the results for regression analyses performed for each state independently. These data sets do not always contain the full 151 observations as some states do not have transactions in all months for all weights. Results are presented by weight class and gender. Explanations and trends between states are not described in this section.

A-1 Spatial Differences for 525 Pound Steers

525 Steers								
	NE		KS		OK		TX	
	Estimate	P value	Estimate	P value	Estimate	P value	Estimate	P value
Intercept	0.3866	0.2965	0.2457	0.5020	0.2787	0.4650	0.3460	0.3255
dfatfuture210	0.7967	<.0001	0.7735	<.0001	0.7004	0.0002	0.8376	<.0001
dsreturn	0.0314	<.0001	0.0310	<.0001	0.0286	0.0002	0.0251	0.0003
dStr	0.0037	0.0028	0.0037	0.0025	0.0015	0.2286	0.0030	0.0094
dInterest	1.1231	0.6184	0.8533	0.7021	0.3915	0.8662	0.7661	0.7207
dUtilization12	-0.3099	0.0217	-0.1795	0.1763	0.0972	0.4812	0.0139	0.9127
dsCostofGain	-35.8515	0.0208	-8.6819	0.5681	-26.5186	0.0957	-27.1587	0.0644
dPasture	-0.2187	0.0004	-0.1415	0.0185	-0.1214	0.0518	-0.0664	0.2461
Adj R^2	0.3686		0.3347		0.2605		0.3020	
RMSE	4.3726		4.3264		4.5089		4.1556	
N	151		151		151		151	

A-2 Spatial Differences for 625 Pound Steers

	625 Steers							
	NE		KS		OK		TX	
	Estimate	P value	Estimate	P value	Estimate	P value	Estimate	P value
Intercept	0.3720	0.2700	0.2960	0.4701	0.3343	0.2846	0.4210	0.1875
dfatfuture210	0.3526	0.0371	0.6080	0.0031	0.4333	0.0060	0.4396	0.0063
dsreturn	0.0284	<.0001	0.0360	<.0001	0.0316	<.0001	0.0313	<.0001
dStr	-0.0010	0.3577	0.0002	0.9033	-0.0007	0.5031	0.0010	0.3256
dInterest	2.1490	0.2882	3.1308	0.1960	2.4526	0.1914	3.8554	0.0452
dUtilization12	-0.2780	0.0362	-0.1954	0.2274	-0.1443	0.2383	-0.1729	0.1668
dsCostofGain	0.3506	0.9784	-1.1055	0.9435	-3.1547	0.7927	6.5303	0.5943
dPasture	-0.1993	0.0004	-0.0838	0.2256	-0.0634	0.2175	-0.0986	0.0612
Adj R^2	0.3386		0.3250		0.3519		0.3322	
RMSE	3.9748		4.7430		3.6838		3.7618	
N	151		147		151		151	

A-3 Spatial Differences for 725 Pound Steers

	725 Steers							
	NE		KS		OK		TX	
	Estimate	P value	Estimate	P value	Estimate	P value	Estimate	P value
Intercept	0.3097	0.2133	0.2751	0.2596	0.3073	0.2208	0.3090	0.2822
dfatfuture210	0.6537	<.0001	0.5872	<.0001	0.5611	<.0001	0.5072	<.0001
dsreturn	0.0206	<.0001	0.0288	<.0001	0.0243	<.0001	0.0273	<.0001
dStr	-0.0011	0.1919	-0.0005	0.5642	-0.0005	0.5189	0.0014	0.1292
dInterest	2.5602	0.0884	2.0504	0.1636	3.4464	0.0235	0.9375	0.5876
dUtilization12	-0.3166	0.0004	-0.3397	0.0001	-0.2636	0.0034	-0.4098	<.0001
dsCostofGain	-26.1154	0.0065	-14.5930	0.1182	-11.9485	0.2126	-7.0830	0.5182
dPasture	-0.0697	0.0919	-0.0149	0.7114	-0.0207	0.6178	-0.0832	0.0817
Adj R^2	0.5202		0.5401		0.4736		0.3903	
RMSE	2.9418		2.8864		2.9668		3.3995	
N	151		151		151		151	

A-4 Spatial Differences for 825 Pound Steers

	825 Steers							
	NE		KS		OK		TX	
	Estimate	P value	Estimate	P value	Estimate	P value	Estimate	P value
Intercept	0.2265	0.3427	0.2619	0.2773	0.2534	0.2864	0.2226	0.4129
dfatfuture210	0.8049	<.0001	0.7171	<.0001	0.6667	<.0001	0.4496	<.0001
dsreturn	0.0201	<.0001	0.0231	<.0001	0.0195	<.0001	0.0241	<.0001
dStr	-0.0012	0.1235	-0.0009	0.2255	-0.0007	0.3858	0.0020	0.0259
dInterest	1.4433	0.3212	1.5697	0.2854	1.3415	0.3542	-2.3531	0.1537
dUtilization12	-0.1524	0.0732	-0.0779	0.3623	-0.1155	0.1714	-0.5310	<.0001
dsCostofGain	-26.4272	0.0032	-21.7723	0.0156	-17.1758	0.0521	-4.8504	0.6272
dPasture	-0.0548	0.1719	-0.0480	0.2352	-0.0276	0.4877	-0.0928	0.0418
Adj R^2	0.5887		0.5467		0.5019		0.4176	
RMSE	2.8196		2.8470		2.8068		3.1888	
N	151		151		151		149	

A-5 Spatial Differences for 925 Pound Steers

	925 Steers							
	NE		KS		OK		TX	
	Estimate	P value	Estimate	P value	Estimate	P value	Estimate	P value
Intercept	0.1916	0.4578	0.2240	0.3919	0.2034	0.3716	0.1476	0.7256
dfatfuture210	0.8199	<.0001	0.7145	<.0001	0.6604	<.0001	0.4457	0.0028
dsreturn	0.0153	0.0036	0.0132	0.0134	0.0158	0.0007	0.0271	0.0013
dStr	-0.0041	<.0001	-0.0027	0.0017	-0.0019	0.0101	-0.0015	0.2861
dInterest	1.5731	0.3124	1.7086	0.2805	1.1268	0.4129	2.2354	0.3866
dUtilization12	0.0381	0.6828	0.0487	0.6072	-0.0802	0.3313	-0.1063	0.5117
dsCostofGain	-31.7606	0.0010	-26.9430	0.0058	-11.6293	0.1670	-8.3471	0.5885
dPasture	-0.0354	0.4262	0.0088	0.8376	0.0053	0.8866	0.0601	0.3704
Adj R^2	0.5696		0.4679		0.5238		0.2414	
RMSE	3.0376		3.0940		2.6915		4.3465	
N	149		151		151		119	

A-6 Spatial Differences for 525 Pound Heifers

	525 Heifers							
	NE		KS		OK		TX	
	Estimate	P value	Estimate	P value	Estimate	P value	Estimate	P value
Intercept	0.2060	0.5141	0.3639	0.2494	0.2685	0.3571	0.2914	0.3304
dfatfuture210	0.8528	<.0001	0.7529	<.0001	0.7200	<.0001	0.7718	<.0001
dsreturn	0.0246	0.0004	0.0396	<.0001	0.0379	<.0001	0.0324	<.0001
dStr	0.0022	0.0369	0.0024	0.0251	0.0008	0.4240	0.0015	0.1410
dInterest	-0.1900	0.9213	1.6963	0.3698	0.4097	0.8182	0.4651	0.7994
dUtilization12	-0.3536	0.0022	-0.3160	0.0071	-0.1466	0.1637	-0.2199	0.0427
dsCostofGain	-27.1915	0.0264	-18.6014	0.1235	-22.6873	0.0448	-16.8488	0.1454
dPasture	-0.2401	<.0001	-0.1651	0.0014	-0.1420	0.0031	-0.1170	0.0171
Adj R^2	0.4331		0.4757		0.4604		0.4269	
RMSE	3.7095		3.6459		3.4441		3.5364	
N	149		147		151		151	

A-7 Spatial Differences for 625 Pound Heifers

	625 Heifers							
	NE		KS		OK		TX	
	Estimate	P value	Estimate	P value	Estimate	P value	Estimate	P value
Intercept	0.3287	0.2406	0.3619	0.1936	0.3736	0.1375	0.3524	0.1847
dfatfuture210	0.5011	0.0005	0.2960	0.0367	0.4584	0.0004	0.5263	0.0001
dsreturn	0.0318	<.0001	0.0376	<.0001	0.0370	<.0001	0.0314	<.0001
dStr	-0.0017	0.0637	-0.0008	0.3803	-0.0005	0.5228	0.0008	0.3828
dInterest	2.6414	0.1179	3.7077	0.0278	2.9166	0.0547	1.7588	0.2710
dUtilization12	-0.2547	0.0202	-0.2972	0.0065	-0.2297	0.0196	-0.2428	0.0195
dsCostofGain	-14.0225	0.1715	4.1939	0.6796	-11.4180	0.2141	-10.4565	0.2814
dPasture	-0.1161	0.0122	-0.0179	0.6943	-0.0628	0.1281	-0.0899	0.0399
Adj R^2	0.4653		0.4191		0.4975		0.4302	
RMSE	3.3050		3.2824		2.9635		3.1326	
N	151		151		151		151	

A-8 Spatial Differences for 725 Pound Heifers

725 Heifers								
	NE		KS		OK		TX	
	Estimate	P value	Estimate	P value	Estimate	P value	Estimate	P value
Intercept	0.2108	0.3591	0.2536	0.2538	0.2593	0.2365	0.3318	0.2277
dfatfuture210	0.6812	<.0001	0.6563	<.0001	0.6410	<.0001	0.3648	0.0021
dsreturn	0.0273	<.0001	0.0270	<.0001	0.0239	<.0001	0.0349	<.0001
dStr	-0.0012	0.1379	-0.0001	0.9341	-0.0004	0.5835	0.0011	0.2194
dInterest	1.2345	0.3739	2.8529	0.0346	2.0763	0.1173	1.0639	0.5212
dUtilization12	-0.3432	<.0001	-0.3809	<.0001	-0.3104	0.0001	-0.4827	<.0001
dsCostofGain	-20.5907	0.0132	-12.5345	0.1161	-11.0218	0.1605	4.5746	0.6416
dPasture	-0.0144	0.7042	-0.0567	0.1233	-0.0400	0.2688	-0.0629	0.1664
Adj R^2	0.5792		0.5794		0.5478		0.4182	
RMSE	2.7237		2.6310		2.5926		3.2549	
N	151		151		151		151	

A-9 Spatial Differences for 825 Pound Heifers

825 Heifers								
	NE		KS		OK		TX	
	Estimate	P value	Estimate	P value	Estimate	P value	Estimate	P value
Intercept	0.1247	0.6037	0.2064	0.3303	0.2040	0.3018	0.2853	0.3825
dfatfuture210	0.7926	<.0001	0.7124	<.0001	0.6686	<.0001	0.4042	0.0013
dsreturn	0.0174	0.0011	0.0238	<.0001	0.0210	<.0001	0.0301	<.0001
dStr	-0.0019	0.0169	-0.0003	0.6244	-0.0002	0.7336	0.0015	0.1714
dInterest	-0.1885	0.8978	1.4881	0.2511	1.2813	0.2888	-0.3680	0.8610
dUtilization12	-0.0991	0.2478	-0.2231	0.0035	-0.2647	0.0002	-0.4947	<.0001
dsCostofGain	-24.0675	0.0044	-17.6551	0.0172	-7.7352	0.2591	-4.4035	0.6867
dPasture	-0.0449	0.2645	-0.0753	0.0348	-0.0705	0.0340	-0.0749	0.1716
Adj R^2	0.5396		0.5981		0.6030		0.3520	
RMSE	2.8456		2.5073		2.3361		3.6578	
N	151		151		151		136	

A-10 Spatial Differences for 925 Pound Heifers

925 Heifers								
	NE		KS		OK		TX	
	Estimate	P value	Estimate	P value	Estimate	P value	Estimate	P value
Intercept	0.1304	0.5819	0.2396	0.4770	0.0480	0.8604	0.4334	0.6003
dfatfuture210	0.7273	<.0001	0.5120	<.0001	0.4297	<.0001	0.5253	0.0470
dsreturn	0.0164	0.0020	0.0285	0.0001	0.0327	<.0001	0.0210	0.2270
dStr	-0.0045	<.0001	-0.0013	0.2693	-0.0007	0.4581	-0.0016	0.6044
dInterest	0.6643	0.6436	1.7145	0.4703	-1.4078	0.4382	17.7386	0.0401
dUtilization12	0.0045	0.9581	-0.1546	0.2221	-0.2424	0.0203	0.1563	0.6406
dsCostofGain	-22.0927	0.0075	-16.3118	0.1160	-17.1387	0.0582	-6.2950	0.8167
dPasture	0.0081	0.8334	0.0084	0.8788	-0.0544	0.2147	0.0559	0.6504
Adj R^2	0.5519		0.4472		0.4354		0.2205	
RMSE	2.8071		3.3356		2.9715		5.5982	
N	151		105		130		51	

Appendix B - Results for Unreported Weight Classes

This Appendix presents the results for weight classes with median weights of 575, 675, 775, 875 and 975 for steers and heifers respectively. Explanations and descriptions of trends are not included.

B-1 Regression Parameter Estimates for First-Differenced Feeder Steer Models of Unreported Weight Ranges, Monthly Data, January 2000 to July 2013

	575		675		775		875		975	
	Estimate	P value	Estimate	P value	Estimate	P value	Estimate	P value	Estimate	P value
Intercept	0.2415	0.412	0.33888	0.1907	0.27612	0.2027	0.22513	0.333	0.17597	0.5322
dfedfuture	0.81456	<.0001	0.44669	0.0007	0.66209	<.0001	0.72052	<.0001	0.60695	<.0001
dsreturn	0.02686	<.0001	0.03023	<.0001	0.02343	<.0001	0.01829	<.0001	0.02187	0.0002
dStr	0.00185	0.0554	-0.00041	0.6177	-0.00023	0.7412	-0.00013	0.8656	-0.00232	0.0118
dInterest	0.4772	0.7902	3.0084	0.0538	2.06962	0.1135	0.87486	0.5366	0.85728	0.6147
dUtilization12	-0.15496	0.1468	-0.24498	0.0164	-0.22852	0.0033	-0.14388	0.0824	-0.01521	0.8815
dsCostofGain	-17.8932	0.1447	-3.46478	0.7274	-20.915	0.0122	-18.7506	0.0305	-4.29443	0.6793
dPasture	-0.12265	0.0113	-0.05653	0.1843	-0.01922	0.5918	-0.04791	0.2199	0.05842	0.2058
Adj R^2	0.426		0.464		0.5648		0.5222		0.4255	
RMSE	3.47899		3.05023		2.56217		2.74685		3.33297	

B-2 Regression Parameter Estimates for First-Differenced Feeder Heifer Models of Unreported Weight Ranges, Monthly Data, January 2000 to July 2013

	575		675		775		875		975	
	Estimate	P value	Estimate	P value	Estimate	P value	Estimate	P value	Estimate	P value
Intercept	0.25074	0.3154	0.30662	0.1877	0.2618	0.22	0.21371	0.3082	0.1401	0.6655
dfedfuture	0.75912	<.0001	0.50179	<.0001	0.61959	<.0001	0.63545	<.0001	0.72202	<.0001
dsreturn	0.03317	<.0001	0.03174	<.0001	0.02552	<.0001	0.0196	<.0001	0.00843	0.2387
dStr	0.000638	0.4491	-0.00071	0.3604	0.000309	0.6674	-2E-05	0.9775	-0.00241	0.028
dInterest	0.84079	0.5819	2.37571	0.0906	1.6247	0.2077	1.53475	0.2317	0.45428	0.8171
dUtilization12	-0.25752	0.0047	-0.22853	0.0122	-0.37185	<.0001	-0.24349	0.0013	-0.04761	0.6857
dsCostofGain	-22.8881	0.0184	-8.08662	0.3415	-17.2421	0.025	-12.8206	0.0791	-31.3117	0.0056
dPasture	-0.09218	0.0241	-0.05304	0.1649	-0.05575	0.1146	-0.03976	0.2571	0.000168	0.9975
Adj R^2	0.5351		0.5176		0.561		0.5414		0.3199	
RMSE	2.94958		2.74441		2.52578		2.48059		3.84129	