UTILIZING LIFETIME PERFORMANCE MEASURES ON FED CATTLE TO EVALUATE MANAGEMENT STRATEGIES FOR THE COW-CALF PRODUCER

by

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Abstract

Newer marketing techniques and production technologies have made large amounts of data available in fed cattle production that previously were not available to the cow-calf producer. The application of this data in breeding and management practices has only begun to be evaluated.

This research used individual records, taken from birth to slaughter, on 6,360 calves from a single cow-calf producer who retained ownership of the calves through a custom feed yard and marketed them in a grid system. Using this information, four major topics were analyzed; identifying profitability drivers among animal characteristics, assessing weaning weight as a predictor of finished performance, utilizing lifetime performance of calves to evaluate cow productivity, and quantifying the effects of illness on cattle efficiency and carcass quality.

The main profitability driver was hot carcass weight, while avoiding quality and yield grade discounts was also imperative to returns. Weaning weight did not prove to be a highly accurate tool to predict the finished quality and profitability of an animal. Evaluations of cow performance based on calf productivity were accomplished, accounting for all variation possible, however since sires were not known these performance evaluations may not be capturing an accurate picture of maternal influence on calf genetics. Performance evaluations can still be useful, but it is suggested that they not be the basis for all culling and replacement decisions. Evaluating calves based on the age of their dam highlights a peak in performance in most all measures when a cow is 7 years old. Illness in the feedlot linearly affected Net Return in a negative fashion and also negatively influenced Return to Ranch. This was mostly related to losses in efficiency, but also losses in hot carcass weight and dressing percentage in highly treated animals.

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Chapter 1 – Introduction

1.1. Background

A new age of technology in fed cattle production has created enormous amounts of data on individual animals, pioneering an analytical approach to cattle management. Grid marketing has generated several measures of quality on fed cattle previously not available in traditional marketing systems. Feed yards are utilizing ultrasound and electronic data tracking technologies to measure and manage cattle to optimal performance and to meet the demands of an ever changing beef market. Even at a cow-calf producer level, individual animal management is becoming increasingly popular (NAHMS 2008). All of these changes have produced a wealth of information on cattle growth and development among different stages of production and brought about new opportunities for improvements in genetics and management that were not previously feasible. While data collection and tracking has shadowed the progress of technology, application of the information has not been fully analyzed or understood.

The purpose of this study is to identify quality and efficiency relationships in fed cattle production, utilizing a chain of measurements taken from birth to slaughter, and suggest ideas for enhancing cattle evaluation and management. The framework for measuring and tracking cattle data will include the following broad management practices: individual animal identification, grid market pricing, and retained ownership. While other methods can capture information equally well, these three methods coupled together produce a direct flow of data that the producer can easily ascertain for management purposes. To understand this framework, how it came about, and why it is advantageous to individual data tracking, background on each issue is discussed.

1.1.1. Grid Marketing

The beef industry in the United States has a long rich history; from the time the first cattle ranches began in California and Texas in the 1500's, to the highly industrialized industry of today. The beef industry has experienced many changes in production practices, transportation and marketing, and consumer preferences. Cattle producers have faced many adversities, but most recently losses in market shares have raised concern and brought about the need for re-evaluation of marketing practices. During the period of 1979 to 1998, a 33 percent loss was seen in beef market shares to the pork and poultry industries, which caused a decline in the nation's cattle numbers and forced many producers to exit the industry (Mintert 2009; Purcell 1998; Fausti, Qasmi, and Diersen 2008). These losses are commonly attributed to changes in consumer preferences due to inconsistencies in beef quality, caused by a number of factors. With cattle production occurring in many regions of the United States, production methods are variable, genetic diversity in the nation's cowherd is high, and the current marketing system has multiple pricing channels (Fausti, Qasmi, and Diersen 2008). This has caused beef to become a less consistent product than alternative protein forms and contributed to market share losses.

The most highly addressed of these issues is the marketing system of fed cattle. Traditionally, cattle are sold on a pen basis, with all animals receiving the same price per hundred weight (live or dressed) regardless of carcass quality attributes. This has led to above and below average quality cattle receiving the same price, and thus only transmitting a marketing signal to the producer to increase weight to receive more revenue. However, with the consumer demanding a more consistent and higher quality product, a system was needed to transmit more accurate value signals to the producer. This system is known as value based marketing, which is designed to capture the "true value of the product based on product characteristics" (Fausti, Qasmi, and Diersen 2008). Within the beef cattle industry, value based marketing is commonly achieved through grid pricing, where each carcass is priced individually based on quality attributes. In theory, the system should replace average pricing and encourage producers to raise a higher quality and more uniform product, however widespread adoption of grid pricing has not yet occurred. Fausti, Quami, and Diersen (2008) quote Cattle-Fax for the current industry estimation of 50% of all fed cattle being marketed on a grid system, which is a large increase in adoption since the early 1990's but not enough to achieve product quality goals. Many producers are reluctant to use the system since discounts are large for undesirable characteristics and revenue variability increases relative to average pricing (Fausti, Qasmi, and Diersen 2008).

Many studies have been conducted as to which marketing channel (out of live weight, dressed weight, or grid pricing) would provide the most revenue to a producer based on the anticipated quality of cattle being marketed, but this solution is only short term. As more cattle are sorted before marketing and better quality cattle priced on a grid and poorer quality cattle priced live or dressed weight, it is likely the system will adjust for this exploitation (Koontz et al. 2008). Thus, in the long run, improvements in cattle quality will be needed to increase producer revenue if grid marketing continues to be used.

One of the benefits of the grid marketing system, besides increasing revenue for higher quality cattle, is the detailed information generated on individual animals. Traditionally, when cattle in a pen were sold for the same price per hundred weight, little information was known about individual animals unless each was weighed separately. Even then, a weight measurement provides little information to improve herd genetics. Most packers that price cattle using a grid marketing system allow information about quality characteristics, as well as weight measurements, to flow back to the cattle producer. This system is most advantageous in a retained ownership situation, where the owner of the marketed cattle is the same owner of the cows.

1.1.2. Retained Ownership

Retained ownership for cow-calf producers is a value added process that has the potential to enhance profits by holding ownership of calves after weaning. Operational benefits include increasing the size and diversity of the farm through additional enterprises and gaining marketing flexibility which spreads production and marketing risk over time (Lawrence 2005). Calves may be backgrounded and even finished at the current operation, or sent to a custom feed yard while ownership is still maintained. On-farm backgrounding can make use of excess pasture and crops at a low cost to the producer, turning “lower value calves and feedstuffs into higher value animals” (Lawrence 2005). Custom feedlots can also be a profitable option since a large number of calves are pooled together and become more cost efficient to feed. In addition, commercial feedlots allow specialization and state-of-the-art equipment which would otherwise be costly to invest in and offer potential for increased returns (Lawrence 2005).

Along with operational benefits, retaining ownership increases informational flow of calf performance throughout the entire production process. When calves are sold at weaning, little or no information is known about performance past that point. Retaining ownership through slaughter allows the cow-calf producer to be directly compensated for superior genetics, nutritional practices, and overall management of the herd (Lawrence 2005; Feuz and Wagner 2008). Grid marketing is especially beneficial in a retained ownership situation since animals are individually priced and quality information is known. This transmits consumer preferences through marketing signals directly to the source of production, which creates incentive for producers to increase the quality and consistency of their calves and work towards the industry goal of a more uniform beef product.

1.1.3. Individual Animal Identification

Informational flow is truly beneficial in both grid marketing and retained ownership when individual animal identification is used. Since individual data are generated in the grid marketing system, it makes sense to track individuals at the ranch level. Selecting for superior genetics by utilizing fed cattle performance information can only occur with individual animal tracking. Individual ID and supporting technologies are becoming increasingly available to cow-calf producers. USDA NAHMS 2008 Beef Cow-Calf Report shows that 79.1% of cows have some form of individual ID, which is up from 69.8% in 1997. Computer record keeping systems on the cow-calf operations have seen an increase in use from 10.2% in 1997 to 17% in 2008, while the use of handwritten records decreased. The use of electronic ID has also increased in both cows and calves (NAHMS 2008). These data show the trend towards a more technological age of cow-calf production driven by increased data availability through individual marketing systems. Cow-calf producers who retain ownership through slaughter are likely to capture these benefits.

1.2. Objectives

The broad objective of this research is to analyze aspects of cattle quality and consistency by studying a retained ownership situation where cattle are custom fed at a commercial feed yard and priced through a grid marketing system. Individual animal identification is preserved throughout the entire process and a series of measurements are taken at each level of production. Information flow is maintained so that the cow-calf producer knows performance traits of each animal produced for every level of production. With this information, management strategies can be analyzed. While numerous issues challenge cattle producers, four common topics of interest are considered as objectives for this study.

Specific research objectives are to:

1) Identify cattle growth, efficiency, and quality characteristics as profitability drivers, thus discerning potential areas of genetic and management improvements for a producer.
2) Assess the use of weaning weight as a calf performance measure and determine if it is an accurate tool to provide information on finishing performance and carcass quality.
3) Utilize informational flow from all production phases of cow offspring to evaluate performance of individuals in the cow herd and suggest culling and replacement strategies.
4) Quantify the effects of cattle illness in the feedlot and quantify observable impacts in finishing performance and carcass quality.

While many other areas of cattle production could be studied, these topics were chosen due to data availability and perceived value to cattle producers. By identifying drivers of profitability, producers have a clearer picture of what characteristics to focus on and what improvements would have the most potential impact on returns. Also, identifying these drivers will reveal which marketing signals producers are receiving through the marketing chain.

Weaning weight has commonly been the measurement of choice to evaluate calf performance (and also for cow performance evaluations), so performance of that animal in the finished phase is of interest. If genetic improvement attempts are made to the herd based on weaning weight, which is common when retained ownership is not practiced, and weaning weight is not related to actual finished performance, this could hinder improvement of cattle quality. Related to this issue is cow performance evaluation based on efficiency, growth, and quality of offspring. If weaning weight is not a good measure of finished performance, what decisions can be made about cow genetics using actual calf finishing performance data? While there are no standard procedures to make these evaluations, there is certainly value in knowing the information.

Illness is another issue than can decrease fed cattle returns, especially in commercial feedlots where animals from different sources are comingled and illness risk is high. There is no question that illness will decrease returns, but which determinants of returns that are most highly affected have not been studied in detail.

While these are four areas of interest, it is recognized that the full value of individual animal identification through grid marketing and retained ownership is not completely captured. There are too many exploratory parts in data tracking evaluation of fed cattle that cannot begin to be addressed in a single paper. This evaluation will be a starting point to display the potential of what can be accomplished by knowing lifetime performance information of cattle.

1.3. Overview of Thesis

Each of the subsequent chapters will study these four objectives in detail. Chapter 2 will give a brief overview of past research that has studied areas of fed cattle productivity, fed cattle quality, and cattle genetics. Chapter 3 will give an overview of the data that were used and what specific management practices allowed these data to be generated. Objective 1 will be addressed in Chapter 4 using two different modeling procedures to study consistency of results and applications to cattle management. Weaning weight will be studied in Chapter 5 to meet objective 2. Objective 3 will be studied at an individual cow level and a grouped level in Chapter 6 and Chapter 7 so different relationships can be identified. Chapter 8 will address illness in feedlots and the implications of treatment cost to meet objective 4. Each chapter will go through a brief background, description of procedures used, and discussions and implications of results. Finally, Chapter 9 will summarize findings from all previous discussions and make suggestions for further research.

Chapter 2 -Literature Review

2.1. Introduction

Marketing fed cattle on an individual basis through a grid system is a relatively new form of marketing. Therefore, research on utilizing the information gained through grid pricing has not been studied to the extent that other aspects of beef production have; especially when it comes to evaluating the cow herd based on carcass information of the offspring. The following articles provide background for this research and highlight earlier findings.

2.2. Determining Sources of Variability in Fed Cattle Profits

Fed cattle marketing can take many forms, but in general cattle are either sold on a live weight basis, dressed weight basis, or through a grid pricing system. Knowing which marketing channel is most appropriate for a pen of cattle can be challenging. A study by Feuz titled "Live, In-the-Beef, or Formula: Is there a "Best" Method for Selling Fed Cattle?" was presented at the Western Agricultural Economics Association Annual Meeting in 1997. Feuz studied these different methods of pricing fed cattle and the benefits and problems associated with them. In the initial part of the study, three hypothetical pens of cattle were constructed to represent cattle that were identical in additive live weight, but were considered above average, average, and below average in quality (quality being defined by differences in dressing percentage, quality grade, yield grade, and light and heavy carcasses). The pens were priced using live weight, dressed weight, and two different formula prices. Formula grid pricing in this study works the same as negotiated grid pricing except that the base price is tied to averages of the plant along with the cash market, where as grid pricing base price is usually taken directly from the cash market. Variability in revenue increased substantially when going from a live weight to a dressed weight to a formula pricing system, which is a source of risk to fed cattle producers. Data on 42 pens of steers were then used to confirm the simulated findings. Dressed pricing had the highest average revenue, followed by live price and then formula prices, when all pens were considered. Live price had the lowest variability with increases seen when going to dressed price and formula grid pricing. An earlier study by Fausti, Feuz, and Wagner found similar results and concluded that "the expected return from a grid or formula will not be sufficiently higher than the expected return from live weight pricing to offset the additional variability in revenue" (Fausti, Feuz, and Wagner 1995, p. 22). It was recognized by Feuz, however, that if the quality or primary breed of cattle was known beforehand, there were advantages to selling on a formula or grid. Feuz concluded that some pens of cattle will always be better off sold at live weight and that pens sold with a grid or formula should be sorted and any "out" cattle that would receive large discounts removed and sold at a live price. Although this seems like a logical solution, it also brings to attention long run implications. If all poorer quality cattle are sold in the live market and better cattle sold on a grid basis, changes in the fed cattle market would be expected to occur.

Results from Feuz's study shed light on how variability in revenue is higher for cattle marketed in a grid system, but the reason for what drives this to occur is a different matter. There are many different components to cattle quality, which in turn all play a role in cattle feeding profitability. In 1999, Lawrence, Wang and Loy, published a study titled "Elements of Cattle Feeding Profitability in Midwestern Feedlots." It was an expansion of an earlier study, which evaluated profitability from data on two western Kansas feedlots (Langemeier, Schroeder, and Mintert, 1992). The purpose of both studies was to predict profitability in fed cattle using market and cattle quality data. The more recent study by Lawrence, Wang, and Loy also took the analysis a step further in looking at profitability of heifers versus steers, the effect of placement weight on profitability, seasonality effects, and feeding facility effects.

An ordinary least squares regression was used to regress profit on fed cattle price, feeder price, corn price, feed efficiency, average daily gain, and interest rate. The model was estimated a number of ways to incorporate sex of the cattle, four placement weight categories, and dummy variables to examine facility type and placement season. Evaluations were conducted on 1,626 pens of cattle that were fed between January 1987 and December 1996 (individual animal data were not used).

The coefficients of the models were analyzed using a coefficient of separate determination procedure to isolate the proportion of variation on the dependent variable coming from each independent variable. The model showed that fed cattle price explained roughly 50% of the variation in cattle feeding returns for most pens. Feeder price also was important by explaining around 20% of the variability in cattle feeding returns. Other factors such as feed efficiency and average daily gain showed some contribution to variation, while corn price and interest rate had small impacts unless cattle were light weight when placed into the feedlot. Placement season showed less significance than other variables in the model, but it was noted that seasonal effects may already be captured in the price and performance variables to some extent. Also, heifers were $12.30 per head less profitable than steers, and a total confinement facility had disadvantages to return compared to partial or open lots.

A paper presented in 2000 at the Western Agricultural Economics Association Annual Meeting reported similar results (McDonald and Schroeder 2000). This study also used pen level data to determine the relative impacts of price and performance factors on fed cattle profits when a grid system was used. An ordinary least squares regression was used to study how profit per head was explained by the base grid price, quality grades, yield grades, miscellaneous and condemned carcasses, light or heavy weight carcasses, corn price, average daily gain, feed conversion, hot yield, and days on feed. Standardized beta coefficients were calculated and compared to determine relative effects.

The regression was estimated using two different packer grids; one that used a weighted plant average base price and paid premiums and discounts on an individual basis, and one that used a USDA weekly average slaughter price as the base and only paid premiums and discounts if the total of the pen was above or below certain thresholds.

In both situations, the base price and the feeder cattle purchase price had the largest impact on variability of net return per head. Smaller influences were seen in corn price, average daily gain, and feed conversion. When looking at the first grid, quality and yield factors had very small standardized betas; enough that when the absolute values were summed together, they equaled almost the same as the effect of corn price as a whole. This confirms what Lawrence, Wang, and Loy found earlier in that managing prices would have more influence on net return than managing cattle quality.

2.3. Decomposing Fed Cattle Price into Cattle Quality Components

As noted above, market factors play such a large role in cattle feeding profitability that the actual quality of the cattle seems unimportant when looking at pen level profitability. For a cattle producer, however, cattle characteristics may be easier to manage than market fluctuations. The following studies look at individual animal profitability and remove the influence of a changing cattle market to focus on the impact of cattle quality.

Johnson and Ward (2006) identified and compared market signals sent by grid pricing regarding carcass quality and quantified the incentives to improve quality of cattle sold on a grid system. It was assumed that the more influence a carcass characteristic had on the animal's grid value, the stronger the market signal would be for that trait. A two-stage coefficients of separate determination procedure was used to isolate the proportion of variation in animal value explained by hot carcass weight, yield grade, and quality grade, on data from 18,267 cattle from Iowa, Kansas, Oklahoma, and Nebraska. Cattle were sorted by grid value and by better or poorer quality classification (better being Choice and YG 3 or better), and the top 1/3 was compared to the bottom 1/3 in each of the two sorted groups.

Hot carcass weight explained most of the variation in the top third of the cattle for both sorted groups (79% on average for grid value sorted and 97% for quality sorted cattle). This is consistent with an earlier study by Feuz (1999). In the bottom third of the cattle, hot carcass weight explained 50% of the variation for the grid value sorted group, implying that quality grade and yield grade were more influential to the value of the animal. Because of this, it was concluded that avoiding discounts is more important than receiving premiums. Johnson and Ward also found that an average of $31 to $71 per head could be gained by selling lower valued cattle on a live or dressed weight basis, therefore showing that sorting cattle before marketing could increase revenue (if lower value cattle could be identified pre-slaughter). Overall, the study found that under the current marketing channels and grid pricing structure, increasing the weight on lower valued cattle provides a less risky, higher potential return than trying to improve animal quality.

Like Johnson and Ward, Forristall, May, and Lawrence also studied carcass characteristics and animal performance measures that influence profitability in the feedlot. Data from the Tri-County Steer Carcass Futurity Program in southwest Iowa was used from 1,147 steers marketed between 1996 and 1999. Net returns for each steer were calculated using a standardized base price and marketing grid, standardized feed costs, and standardized animal cost. Then net return was regressed as a function of feed efficiency, hot carcass weight, fat cover, rib-eye area, kidney, pelvic, and heart (KPH), marbling, and dummy variables for the year the steer was marketed. This relationship was examined using different Choice-Select spreads and feed costs.

Results indicated that at a small Choice-Select spread, hot carcass weight and marbling were equally important in explaining variation in net return. Also creating variation in net return was feed efficiency and rib-eye area. Fat cover had a small and negative standardized beta, implying a small relationship in a higher back fat animal receiving a smaller net return, which makes sense since they would receive a higher yield grade. When a higher Choice-Select spread was analyzed, marbling became most important in explaining net return variation and hot carcass weight less important. This is contradictory to Johnson and Ward who found hot carcass weight explained at least 50% of the variation in all but one situation tested, yet they did not account for costs in the feedlot, so the two studies may not be directly comparable. Forristall, May, and Lawrence concluded that marbling, hot carcass weight, feed efficiency, and rib-eye area all had important impacts on net return. Fat cover and KPH were less important.

2.4. Using Genetic Relations to Predict Cattle Quality

Forristall, May, and Lawrence extended their research into comparing feedlot profitability to cow characteristics and maintenance costs. Parentage information was known on 267 of the steers since these steers were raised in a retained ownership setting. Cow feed costs for the corresponding steers were estimated using cow weight, frame score, and body condition score. A Retained Ownership Return was calculated as total revenue subtracting feedlot cost and stored feed cost for the cow.

The study found that most feedlot traits, such as marbling score, average daily gain, and feed efficiency, were lowly correlated (0.17 or less) with cow traits, such as cow age, cow weight, cow body condition score, and cow stored feed cost. However, cows that were ranked as "low cost" produced more "high return" steers and cows ranked as "high cost" produced more "low return" steers, suggesting lower feed cost cows tend to produce high profitability calves. The study suggests the explanation of this may lie in the negative correlation between cow size and marbling score; smaller cow size with therefore smaller feed costs tend to have calves with better marbling scores. While this study provides a good framework for looking at feedlot profitability linked to cow characteristics, it acknowledges that more research is needed in examining this relationship.

Another study used carcass data even more fully in predicting future cattle performance. Walburger and Crews (2004) introduced two models to predict cattle quality on an individual level. The first model used birth weight, age of cow, weaning weight, slaughter weight, sex, and ultrasound measurements for rib-eye area and back fat (taken at three different points in the animal's life). The second model used the same measurements as the first, except that ultrasound measurements were replaced with measurements of related cattle to the animal the model was predicting. Related cattle were defined as an average of at least 15 other cattle coming from the same sire, which all had previously been slaughtered and values were known. Both models were regressed to predict hot carcass weight, rib-eye area, back fat, marbling, and pre-slaughter weight using three years of data on 674 animals. A combined model of all variables and a model to predict most profitable marketing channel (between live, dressed, or grid pricing) was also estimated.

Results showed that the ultrasound measurements could predict values of carcass characteristics with the exception of marbling. This confirms earlier studies that ultrasound can predict rib-eye area and back fat relatively accurately, but does not do as well when predicting marbling (Herring et al. 1998). However, the relations model was also not able to predict marbling to a high degree (R^2=0.28), suggesting marbling may be a more fluctuating measure. In general, the relations models had lower R-squares than the ultrasound models, but they still had some predictability. When studying which marketing channel between live, dressed, or grid pricing would be most profitable, knowing sire relations alone to sort cattle could bring returns of $23.30 per head, $27.26 per head, and $10.61 per head, respectively, over marketing all animals to any one of the three channels. Also, a model that uses ultrasound measurements could increase gross value of cattle by $9.04 to $16.75 per head by marketing them in appropriate channels, but using ultrasound *and* relations data could increase gross value by $11.27 to $27.93 per head. The results of this study show great potential for revenue to be gained when utilizing both ultrasound and relations data.

Clearly, there is value in knowing an animal's parentage and the performance of related calves, but accuracy and actual genetic relations behind this are still uncertain. Herring and Bertrand (2002) looked at heritability of efficiency traits in the feedlot and how these traits are related to important carcass traits. In the feedlot, efficiency is typically measured as feed conversion or feed efficiency and can be affected by elements such as age, diet, temperature, breed, implants, and many more. To take out the dependency on growth and weight traits, this study measured efficiency as "residual feed intake" which is calculated by regressing intake on growth rate and average body weight. The residuals (observed values minus predicted regression equation values) then reflect how much more or less an animal's intake was relative to what the equation predicts. Data used in this study were from the Angus Steer Alliance, which has facilities to collect individual daily dry matter intake values using Calan Broadbent Feeding Gates. After data were collected, an average information REML algorithm was used to estimate environmental and genetic covariance among measured traits.

Results showed that intake, and residual feed intake were moderately heritable (0.44 and 0.50, respectively). Also, fat thickness and marbling of the carcass were heritable (0.40 and 0.44), all suggesting that selection for these characteristics could improve cattle quality. Additionally, the study found that fat thickness and residual intake are correlated at 0.46 which means that cattle with a lower residual feed intake would be leaner at harvest, thus more likely to achieve a better yield grade. Other relationships showed residual feed intake was correlated with feed conversion (0.65), intake was highly correlated with residual feed intake (0.92), and therefore intake and feed conversion were also correlated (0.55). All three of these relationships suggest that selecting for more efficient cattle, measured by intake and residual intake, could decrease overall feed consumption and reduce feedlot costs. While this study shows interesting relationships between efficiency and other feedlot variables, the authors point out that their results are preliminary and that more research is needed in this area. It is recognized that feed efficiency is one of the harder components of cattle genetics to study since obtaining individual feed intake records is difficult and costly. Also, having complete records of parentage information is not likely in commercial feedlot operations, so feed efficiency selection at this time would be difficult to attain.

Other studies have looked at carcass quality relationships in more detail. One of these was conducted at the U.S. Meat Animal Research Center in Clay Center, Nebraska (Rios-Utrera et al. 2005). The objective of this study was to estimate heritability, genetic variance, and genetic correlations among 14 carcass traits when endpoints are determined by different measures. Purebred and composite steers were the basis for measurements and calculated values on hot carcass weight, dressing percent, fat thickness, rib-eye area, KPH, marbling score, yield grade, predicted percent retail product, retail product weight, fat weight, bone weight, actual retail product, fat as a percent of carcass weight, and bone as a percent of carcass weight. A single trait animal model was constructed and estimated where fixed effects and genetic effects were included so that heritability and variance could be estimated for each carcass trait. A bivariate model was used to examine correlations between traits.

The results of this modeling showed that total maternal effects of the dam were very small, therefore not explaining much of the variation in carcass traits. Traits that involved fat were generally higher relative to muscle measurement traits in explained variation by maternal effects, but still not very large. The strongest relationship showed that 19% of the total variance in fat thickness could be explained by maternal effects, yet this was not constant over all adjusted endpoints. Heritability values, in general, varied tremendously across the different endpoints. Most heritable across all measures were marbling score, retail product weight, bone weight, and actual percent retail product. Hot carcass weight, yield grade, and other measures were moderately heritable depending on the endpoint that was used. The study concluded that there was enough variation in carcass traits that carcass quality could be improved through selection. Many carcass traits were highly correlated, but the magnitude and even the sign of correlation differed across endpoints. To sum up the findings, measureable relationships do exist in carcass quality traits, but complications exist in selecting for them when management decisions are not constant.

2.5. Summary

There are many factors that affect cattle quality and overall profitability in producing fed cattle, but relationships among these factors are complicated and in many cases difficult to study. Research has found genetic selection can be useful in achieving better quality cattle, however the effect to which management and environment plays a role in feeding cattle can be confounding. The market has long since been based on cattle weight and selling cattle on the average for a pen, but consumer demands have driven the market into a more individual value based approach. Knowledge of cattle quality relationships can aid in production decisions but managers must take into account the price fluctuations and inconsistencies in the market before focusing on just cattle quality traits. It has been documented in numerous studies, along with those discussed above, that in today's market mixed signals are still being sent to producers. Ward and Lee (1999, p. 91) concluded "Examining live weight and dressed weight pricing reveals one reason both feeders and packers continue to use them. Price variability is low and poorer quality cattle bring almost as much as better quality cattle, even across sales lots." Schroeder and Graff (1999) also back this up by their findings that value-based pricing has small rewards for good quality cattle, but large negative impacts for poorer quality cattle. Even with these problems with the market, it can be concluded that there is value to producers in knowing the quality of the cattle they are producing. Whether that knowledge is utilized for marketing tactics or for selection to improve quality traits, gains are possible.

Chapter 3 - Overview of Data Set

3.1. Data Source

Data used in this study were from a single ranch in the high plains of Wyoming. The ranch grazes year round and typically maintains around 1,300 cows. Data collection on lifetime performance of cattle began in 1998 and continues today. Since research for this study concluded in the summer of 2009, only records up through the 2008 production cycle were used. This produced lifetime performance records on 6,360 animals of which 4,191 were known offspring of cows on the ranch. The remaining 2,169 were purchased heifers that failed to breed, or calves that failed to be matched with their dam. The ranch only maintains cows on its property; all calves are shipped into feedlots at weaning. Ownership is maintained through all phases of production so revenue received through grid marketing of the finished animal is revenue that is received by the producer.

Obtaining and maintaining records from the time a calf was born to the finished carcass is a cumbersome and time consuming task. While computer software is currently developing and in practice, obstacles still exist to having comparable measures that can be directly used in cattle management. Many producers do not want to deal with the headache of the task and prefer traditional forms of cattle evaluation, however judgments made with limited information are difficult and potentially inaccurate.

The data in this study are unique in the detail of information gathered over many years, providing means for comparative analysis. While information is not perfect, it represents what is obtainable when animals are tracked from birth to slaughter and how newer evaluation methods can be developed using this information. Specific management procedures are outlined below to demonstrate how individual animal measurements are collected and lifetime performance records developed.

3.2. Data Collection Procedure

From the time a calf is born, measurements are started to quantify its qualities and potential. Birth date and weight are recorded as accurately as possible, even in the vast pastures and rough environments of a high plains cattle ranch. At birth or branding, calves receive a unique tag number which is then matched to the dam's number. This is a tedious task that requires time and resources, which discourages adoption of these information systems by many cattle ranches. The mothering behavior of each cow needs to be observed to be sure the correct calf is matched to the cow. With a herd size of 1,000+ cows, it is easy to see why many producers choose not to perform this step in data collection and tracking. For calf-to-cow matching to be worth the time and resources, the producer must be sure the information that is gathered will be beneficial enough to cover the costs of data collection.

Cow-calf pairs are pasture grazed until the fall, when calves are weaned and sent to a local feedlot where a forage and grain ration is provided. At this time, calves are separated by sex and an individual weaning weight is taken. Around late November to early December, steer calves are shipped to a custom feed yard for growing and finishing. Heifer calves are kept in the local feedlot over the winter and following spring, when they are bred by artificial insemination and then exposed to a clean-up bull. If heifers fail to breed, they are sent to a custom feed yard to finish for slaughter, typically in July.

Upon feed yard receiving, cattle are individually weighed and frame scored using electronic scales and video imaging cameras. An electronic and visual ear tag is applied for management purposes in the feed yard, which also is tied to the ranch identification number so the chain of information is maintained. Cattle are also assigned a lot number, which identifies the group of cattle that was received on the same day from the same source. Cattle are sorted and comingled with other cattle in the feed yard, but individual and group identification is preserved. Electric scales, ultrasound, and video imaging are used at least twice more during the feeding process to measure growth progress and to determine the optimal finishing date for the animal. Variables recorded during processing include weight, ultrasound estimated rib-eye area, and ultrasound estimated backfat. By using previously recorded information, average daily gain, days on feed, and feed conversion (using the Cornell Net Carbohydrate and Protein System model) are calculated. Factors that determine the optimal marketing date include achieving a heavy weight where discounts may be received in the marketing grid, depositing too much back fat that could lead to yield grade discounts, or when the cost of gain exceeds the revenue associated with gain. By closely monitoring these measurements, each animal has the opportunity to reach its highest potential, therefore reducing variability in carcass quality relative to having one marketing date for all cattle in a lot.

When all animals in a lot group have been marketed, the producer receives a “closeout”, which is an informational summary of how the animals performed in the feed yard and slaughtering facility. Feed yard measurements include those discussed above, and reported carcass measurements include quality grade, yield grade, rib-eye area, and hot carcass weight. Feedlot costs include processing, treatment, other costs (alliance fees, dues, etc.), and a total cost of gain. Also included are calculations for the animal’s value as a feeder when it entered the feedlot based on current market values, an estimated live price at slaughter based on market conditions at the time of sale, and the actual grid price that was received. Reported profitability measures include Return to Ranch which is calculated by taking the animal's revenue minus feedlot costs, Net Return which is the Return to Ranch value minus the animal's estimated value at time of entering the feedlot, and Carcass Value over Live Price which reflects what the animal gained or lost in revenue by being priced on a grid relative to the live price. Market Adjusted Net Return is also included so cattle can be compared to one another without the changes in market prices over different time periods affecting the comparison. It is calculated based on average market values from 1997 to 2003 broken up into monthly prices to capture seasonality in the cattle market. Cattle closeouts are organized to show the top 20%, middle 60%, and bottom 20% of cattle profits based on Market Adjusted Net Return.

All of these measurements and calculations, along with earlier data that collected on the ranch, enter an electronic data bank (managed by *CowSense Herd Management Software* in this study) which provides an organized way to study and compare performance. While other methods of data tracking are available, having one program to store all records is advantageous for analysis.

This seems like a fairly easy process, but keep in mind it is relatively new and continues to be developed. Collecting and keeping track of data is costly while analysis of it continues to be lacking, therefore benefits obtained are not to their fullest potential. These data collection practices will likely be adopted further if benefits from acquired data are captured.

3.3. Data Summary and Statistics

Data used for this study were comprised of feedlot closeout information and ranch records on 6,360 head of cattle from 29 pens, marketed between 1998 and 2008. All steer calves from the ranch were placed in the feedlot every year, usually between the months of November and December, after they were backgrounded an average of 80 days. Heifers also entered the feedlot, but typically not until the following summer after they were bred and if they came up open. Therefore, heifers were an average of 200 pounds heavier and 193 days older when they entered the feedlot. As discussed, every group of cattle that entered the feedlot together was given a lot number. Each lot is comprised of either heifers or steers and can have as few as 30 cattle up to more than 600 cattle. Summary statistics for the cattle lots used in this study are reported in Table 3-1.

Table 3-1 Lot Summary Statistics

Lot Number	Number of Animals	Marketing Year	Sex	Avg. Receiving Weight (lbs.)
988155	60	1998	Heifers	813.03
998305	624	1998	Steers	594.06
912999	95	1999	Heifers	803.06
15300	180	2000	Heifers	719.96
912400	124	2000	Heifers	759.02
934500	674	2000	Steers	636.97
17001	76	2001	Heifers	798.83
29701	70	2001	Steers	556.96
34701	664	2001	Steers	593.81
106402	27	2002	Heifers	588.30
212802	64	2002	Heifers	695.80
225502	162	2002	Heifers	949.80
243803	504	2003	Steers	641.06
319504	84	2004	Heifers	812.58
408704	63	2004	Heifers	667.89
422905	71	2004	Heifers	887.46
347404	356	2004	Steers	636.23
405604	33	2004	Steers	926.91
523506	90	2005	Heifers	913.99
453605	506	2005	Steers	682.47
615306	141	2006	Heifers	770.91
622406	52	2006	Heifers	914.42
625006	59	2006	Heifers	917.42
555406	444	2006	Steers	651.92
712307	60	2007	Heifers	733.53
722507	124	2007	Heifers	878.44
819008	50	2007	Heifers	873.74
652107	467	2007	Steers	627.75
729607	436	2008	Steers	499.99

Each lot group is ranked by the Market Adjusted Net Return and then sorted into the top 20%, middle 60%, and bottom 20% classes. Looking at historical distributions of these values, it is easily identifiable why cattle quality inconsistencies are important. Figure 3-1 and Figure 3-2 show the average Return to Ranch and Net Return per Head, respectively, over the 29 cattle lots broken into the Market Adjusted Net Return classes. Average return values are organized by chronological marketing year, which is the year in which the cattle were slaughtered.

Figure 3-1 Average Actual Return to Ranch

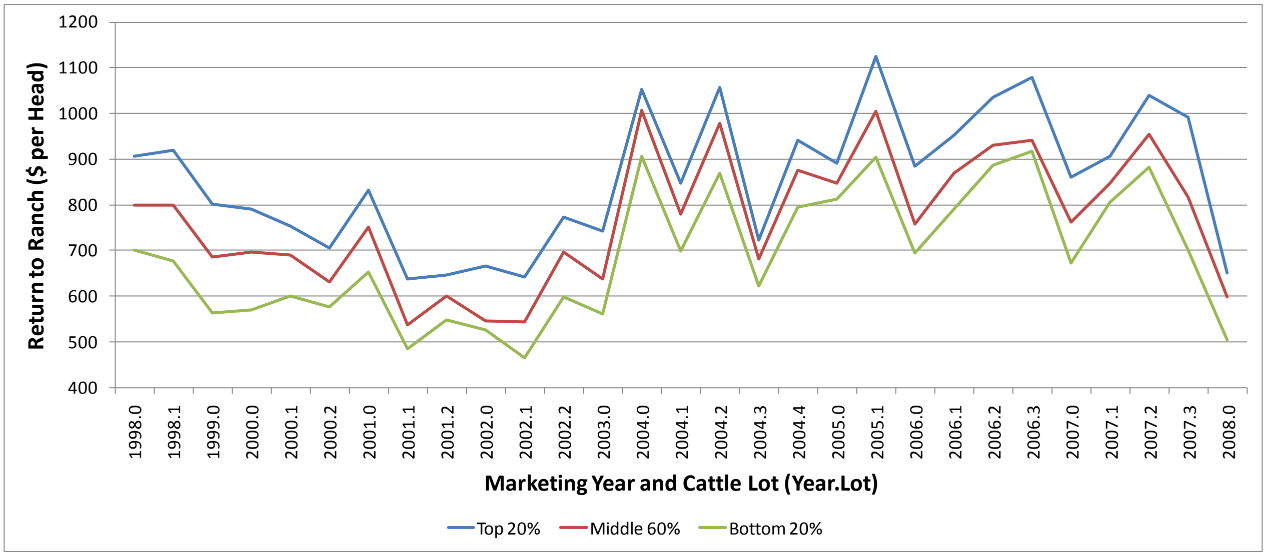
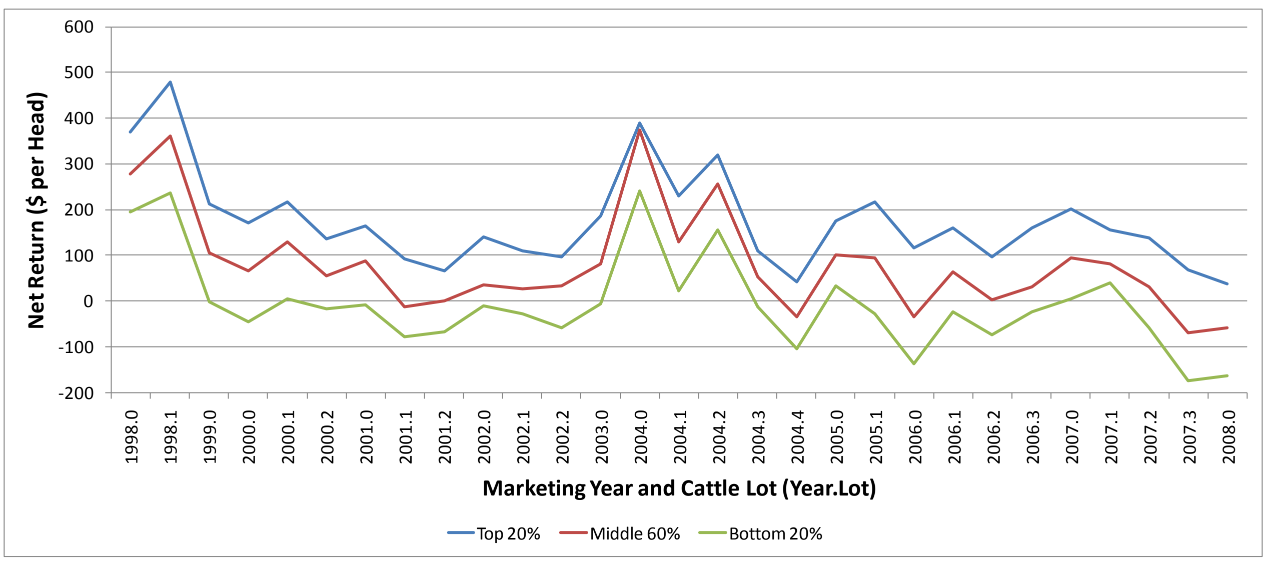


Figure 3-2 Average Actual Net Return



The first thing to acknowledge is that cattle profitability has fluctuated tremendously over the last 10 years. This can be attributed to a number of different causes; mostly changes in the market but also differences in management decisions, environmental factors, and cattle quality. Since this study is focusing on cattle quality, the major points to pull out of these graphs are the differences in returns produced by the top 20%, middle 60%, and bottom 20% of cattle in each lot. When looking at Net Return, with the exception of a few years, the bottom 20% bring negative returns. If the producer were able to identify these animals before placement into the feedlot, it would be more profitable to sell them as feeders on the live market (in current marketing conditions). The Return to Ranch graph appears to not have as large of a magnitude of difference in the return classes, but this also may be because the magnitude of the measure is larger.

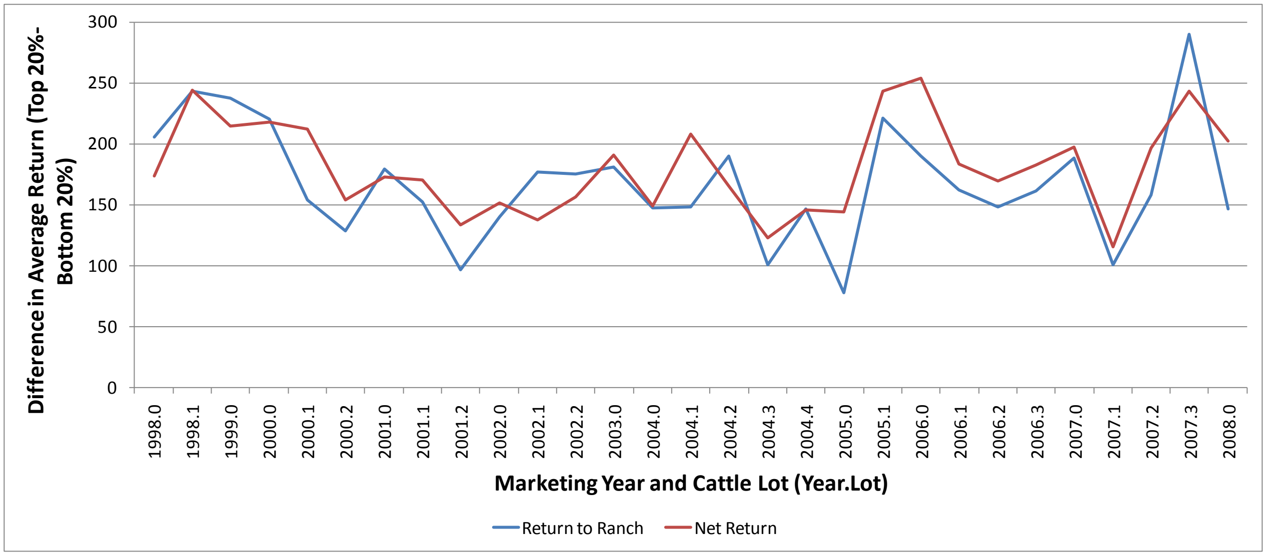
Table **3-2** and Figure **3-3** analyzes the "spread" between the classes further. Spread is defined as the difference between the average Return to Ranch (or Net Return) for the top 20% and the bottom 20% Market Adjusted Net Return class, as defined by the closeout. The spread represents the average dollar return difference between the high and the low Market Adjusted Net Return classes.

The spread of average profitability from the top 20% of the cattle to the bottom 20% has been as high as $253 per head when looking at Net Return, with an average near $181 per head. This is a huge difference in an industry where long run profits average less than $20 per head. Spread in Return to Ranch profitability can also exceed $290 per head, but typically is around $168 per head. Both measures show that fed cattle returns vary across time periods, which explains why improvement in uniformity could potentially increase profitability. In many cases, higher profits of the top 20% are offset by losses of the bottom 20%. Reasons for this large spread in profitability will be discussed in more detail later in this study and suggestions for improvement will be explored.

Table 3-2 Spread Between Top 20% and Bottom 20% of Return Classes

Slaughter Year	Lot Number	Return to Ranch Spread	Net Return Spread
1998	988155	205.42	173.58
1998	988305	242.82	243.99
1999	912999	237.53	214.68
2000	15300	219.78	217.36
2000	912400	153.76	212.16
2000	934500	128.13	153.79
2001	17001	179.33	172.73
2001	29701	152.57	170.00
2001	34701	96.76	133.05
2002	106402	140.00	151.00
2002	212802	177.15	137.31
2002	225502	175.19	156.16
2003	243803	180.55	191.03
2004	319504	147.45	149.30
2004	347404	148.32	207.62
2004	405604	189.57	165.00
2004	408704	100.54	122.54
2004	422905	146.50	145.21
2005	453605	78.03	143.76
2005	523506	221.17	243.33
2006	555406	190.19	253.55
2006	615306	161.61	183.14
2006	622406	147.70	169.20
2006	625006	161.59	182.17
2007	652107	188.62	196.92
2007	712307	100.83	115.58
2007	722507	158.24	196.56
2007	819008	290.10	243.30
2008	729607	146.55	202.47
Average		167.79	180.91
Minimum		78.03	115.58
Maximum		290.10	253.55

Figure 3-3 Spread of the Average Return between the Top 20% and the Bottom 20%



3.4. Adjustments to Standardize Market Conditions

Since the main objective of this study is to analyze uses of information to improve cattle quality and ranch profitability, influences of market conditions need to be normalized so that direct comparisons between cattle across years can be made. The marketing grid in Table 3-3 is derived from USDA Market News Service's National Weekly Direct Slaughter Cattle-Premiums and Discounts report for the week of June 1, 2009. All cattle in the study were assumed to be priced based on this grid and a base price of $137.30/cwt. The base price was calculated using October 2009 CME futures price ($86.50 per cwt) taken on June 11, 2009 divided by 63% to get a dressed price per hundredweight.

Grid market pricing works by taking the base price and then adding or subtracting any premiums or discounts an animal receives. The hot carcass weight (HCW) of the animal is multiplied by this established price, which becomes the grid value of the animal (i.e. the revenue received for the animal).

Marketing grids for cattle use yield grade 3, quality grade Choice, and a hot carcass weight between 600 and 900 pounds as the "base" amount, therefore no discount or premium is received at these levels. Any weight outside of the 600 to 900 pound range is discounted. Yield grade (YG) refers to the cutability of the carcass and is graded by evaluating the fat thickness and rib-eye area; anything receiving a yield grade higher than 3 is discounted and anything less than 3 receives a premium (Wagner 1997). Quality grade (QG) reflects the palatability or eating satisfaction of the meat products and is evaluated by the age of the animal and its marbling or intramuscular fat content (Wagner 1997). Quality grades that are discounted because of their inferior characteristics are Select and Standard carcasses, and "out" carcasses such as Hardbone, Bullock/Stag, Dark Cutter, or Over 30 months of Age, are severely discounted. Prime carcasses are given a premium along with Certified Angus Beef. Certified Angus Beef is a program that requires 51% solid black hair or genetic verification of the animal along with stricter meat characteristics than the base amount (Certified Angus Beef). HCW, YG, and QG are the three variables most commonly used to assess an animal's value in the marketing grid. While other characteristics (such as tenderness) can be considered important to cattle quality, they do not usually have an impact on price and are not often recorded, so only HCW, YG, and QG are used for cattle evaluation in this study.

Because QG, YG and HCW premiums and discounts in the marketing grid represent dollars per hundredweight that are added or subtracted to the base price, they are hard to use on a numerical scale. The "price used" in the grid table is an index value that was created by adding the premium or discount to 137.30 (which is the base price), so 137.30 will be the comparative values and anything below will represent a discount and anything above will represent a premium. This way the QG, YG, and HCW can be treated as continuous variables while preserving the magnitudes between measurement classes that premiums and discounts create. If scores were created by simply assigning a value for each class (i.e. Prime-1, CAB-2, Choice-3, Select-4, etc.) the differences in the values would all be the same in calculations, which they clearly should not be when looking at the values of the premiums or discounts. The difference in the Prime to Certified Angus Beef (CAB) is $4.88 per cwt while CAB to Choice is $2.50 per cwt, so they should not be treated as the same value difference. The numerical "price used" makes the measurement possible to use in ratio calculations while preserving the grid relationships. This will become clearer in upcoming calculations.

Table 3-3 summarizes all pricing assumptions described above for the grid marketing of fed cattle in this analysis and the index scores used for analysis purposes.

Table 3-3 Standardized Market Grid and Prices Used for Analysis

Base Price=$137.30/cwt					
Quality Grades:	**Premium or Discount ($ per cwt)**	**Price Used (index)**	**Yield Grades:**	**Premium or Discount ($ per cwt)**	**Price Used (index)**
Prime	7.38	144.68	YG1	3.25	140.55
Certified Angus Beef	2.50	139.80	YG2	1.375	138.68
Choice	0.00	137.30	YG3	0.00	137.30
Select	-5.67	131.63	YG4	-11.40	125.90
Standard	-17.10	120.02	YG5	-19.33	117.97
Over 30 Months Age	-16.27	121.03			
Hardbone	-27.73	109.57	**HC Weight:**		
Bullock/Stag	-30.43	106.87	500-550 lbs.	-15.75	121.55
Dark Cutter	-31.15	106.15	550-600 lbs.	-3.83	133.47
			600-900 lbs.	0.00	137.30
			900-950 lbs.	-2.08	135.22
			950-1000 lbs.	-4.33	132.97

Feeder prices at the time an animal entered the feedlot were calculated using Oklahoma City Medium and Large Feeder steers and heifers on June 3, 2009. The report breaks up feeder calves into 10 different weight ranges and reports the average weight and average price for each of the 10 weight classes. A regression model was estimated using these average values for each weight class so that a continuous equation could predict the price of any weight of animal at time of feedlot entry. The regression was estimated separately for steers and heifers since differences in prices between sexes are relatively large. The empirical form of the regression was as follows:

$$\textit{Feeder Cattle price (cents/lb.)} = \beta_0 + \beta_1\,\textit{Weight} + \beta_2\,\textit{Weight}^2. \qquad (3.1)$$

Estimated regression equations were:

*Steer Price=145.7647+ (-0.06657*Weight)+(0.00000745*Weight2), and* (3.2)

*Heifer Price=85.78253+ (0.089647*Weight)+(-0.00011*Weight2).* (3.3)

Each model had an R-squared over 0.99 with all terms significant using 10 observations, so the models are a very good fit to the price data and should predict the price of any weight animal quite accurately.

Equations *3.2* and *3.3* report a cent per pound price which is then multiplied by the entering weight of the animal and by 0.01 to get a dollar per head price on each animal. Because costs in the feedlot would also vary greatly over 10 years, these must be standardized so direct comparisons can be made. Feed prices were calculated using September 2009 corn futures price (458.2 cents/bushel) taken on June 11, 2009. This was converted to dollars per pound using a conversion of 56 lbs per bushel and then multiplied by a 0.88 dry matter corn conversion value to get dry matter dollars per pound of $0.072. Feed cost for an individual animal was then calculated by multiplying average daily gain, feed conversion, days on feed, and $0.072 corn price. Another feedlot cost included is yardage, which was assessed at $5 per head plus 42 cents per head per day on feed, which is a typical feedlot cost in the Midwest region when feed cost is not marked up (Schroeder). Processing is held constant at $7 per head across all animals.

Treatment cost for illness in the feed yard is another cost that must be charged to the animal. Since data used in this study were from a time span of 10 years, it is expected that antibiotic and other treatment procedures would have inflated in price over that time period. To be able to compare treatment costs on an equal level over these years, consumer price index is used to adjust prices to a common year, as shown in Table 3-4. Data ends in 2008, so this is used as the base year and prior year adjustments are calculated as:

$$Adjustment\ Factor = \frac{(Average\ Annual\ CPI * 100)}{215.30}. \qquad (3.4)$$

Table 3-4 Consumer Price Index Adjustments for Treatment Costs

Year	Annual Avg. CPI	Adjustment
1998	163.00	75.71
1999	166.60	77.38
2000	172.20	79.98
2001	177.10	82.26
2002	179.90	83.56
2003	184.00	85.46
2004	188.90	87.74
2005	195.30	90.71
2006	201.60	93.64
2007	207.34	96.30
2008	215.30	100.00

Using these adjustment factors, treatment costs (reported as dollars per head) over the 10-year span are standardized as follows:

$$\text{Adjusted Treatment Cost} = \frac{\text{Treatment Cost}}{\text{Adjustment Factor}} * 100. \qquad (3.5)$$

Total cost of gain (TCOG) is the sum of feed, yardage, processing, and adjusted treatment costs. Interest, which represents opportunity cost of retaining ownership and feeding out the cattle until slaughter, is calculated at 8% as follows:

Interest= (Feeder Value(DOF/365)*0.08) + (1/2 *0.08 *TCOG*(DOF/365)).* *(3.6)*

Two profitability measures are then calculated with these new standardized values. These are:

*Return to Ranch= (Grid Price*HCW)-TCOG-Interest, and* *(3.7)*

*Net Return= (Grid Price*HCW)-TCOG-Interest-Feeder Price.* *(3.8)*

These two different profitability measures are used for a number of reasons. First, they are similar as to what would be normally reported on the lot closeout information sheet. Thus, results from the study can be interpreted in the same terms as unaltered closeout profitability. Second, the two profitability measures capture different aspects of feeding performance. Net Return shows how the animal performed in the feedlot setting, so that animals that came in large but performed poorly or came in small but performed well could be identified. Return to Ranch encompasses the performance of the animal from the time it was produced until the time it was slaughtered. The dollar return represents the capital that is coming back to the ranch for all of the activities performed to raise that animal before it entered the feedlot. An animal entering the feedlot larger will most likely look more profitable in this setting because days on feed, and in turn feedlot costs, would be smaller. Both Return to Ranch and Net Return are included in the analysis so that conclusions may be drawn from both aspects.

3.5. The Use of Ratios to Compare Performance

Even with prices completely standardized across time periods, conditions in which an animal developed could vary immensely. Because of this variation, there needs to be a way in which animals can be compared with others that were exposed to similar growing conditions. This way, the differences among the calves more closely represent the genetic differences between them (Beef Improvement Federation 2002). The Beef Improvement Federation Guidelines suggest using contemporary grouping to adjust for this problem, which is defined by a group of cattle that are of the same breed composition and sex, are similar in age, and have been raised under the same management conditions (Beef Improvement Federation 2002). For this research, a contemporary group was characterized by the lot number of the animal. All animals in a feedlot group are either steers or heifers (never are they mixed), so checks were only performed on birth dates, weaning dates, and amount of backgrounding days to make sure management was similar in all calves from the group. Outliers, such as a fall born calf, were removed from the data set. Feedlot entering date was the same for each lot group and breed information was not known since it was a commercial herd, so it was assumed all calves were of similar breeding. These lot groups are encompassed into all aspects of the analysis so that all animals are compared among conditions in which they had an "equal opportunity to perform" (Beef Improvement Federation 2002).

All upcoming analysis was conducted using adjusted values and calculations as presented in this chapter. The use of contemporary groups will be defined in more detail as they are utilized for comparisons.

Chapter 4 –Drivers of Feedlot Profitability

4.1. Introduction

As previously established, grid market pricing can increase risks to producers since more variation is seen in returns than if cattle were sold on a live or dressed weight basis (Feuz 1997). To make up for this increased risk, a producer must know that the cattle being produced are of satisfactory quality and will perform well in a grid system, otherwise it would likely be more profitable to sell cattle on a live or dressed weight basis.

Studies have shown that, when market conditions are held constant, differences in revenue received are primarily due to differences in hot carcass weight or caused by an animal receiving quality discounts (Johnson and Ward 2006). Forristall, May, and Lawrence (2002) found that hot carcass weight and marbling were the biggest contributors to variation in net return. While both studies used large amounts of cattle from various producers and regions, their results may not hold for every individual herd since cattle characteristics and management practices can vary immensely.

Carcass closeouts for lot groups in these data were structured so that a producer can identify cattle that performed in the top 20%, middle 60%, and lower 20%, based on market-adjusted Net Return variable (defined in Section 3.3). In most cases, cattle in the lower 20% received negative returns in the feedlot. That is, the producer lost money by feeding the cattle to slaughter rather than selling the cattle at the time they would have entered the feedlot. Also, average Net Return between the top 20% and the bottom 20% could differ by more than $250 per head, which is a huge amount in an industry where margins are small. Clearly, if cattle were more consistent in their performance, profitability risk would decrease for this producer.

The objective of this chapter is to identify the contributing factors that drive profitability of feeding an animal and specifically determine what characteristics contribute to animals being classified into the top 20%, middle 60%, or bottom 20% of the feedlot group. This way the producer will know what improvements in the cattle herd would have the most impact on cattle quality consistency and overall profitability.

4.2. Methods

The entire data set of 6,360 cattle from 29 lot groups was used for this analysis. Input prices and market conditions were standardized as explained in Chapter 3. Return to Ranch and Net Return profitability measures were used separately to rank cattle in their feedlot group into the top 20%, middle 60%, or bottom 20% categories. Differences between characteristics of the cattle in these categories were then studied.

In order to make comparisons and account for differences in environmental and management differences across time periods, each animal's measures were compared to others in their contemporary group (see Section 3.5). The contemporary groups for these animals are defined by their lot number in the feed yard. A comparison for a single animal to its group was accomplished with a ratio for the performance traits and a difference value for the profitability measures. Ratio calculations for hot carcass weight (HCW), hot carcass weight discount (DctHCW), quality grade (QG), yield grade (YG), average daily gain (ADG), feedlot receiving weight (InWt), dressing percentage (DrsPct), and days on feed (DOF) were as follows:

*Ratio = (Individual animal measure/Average for lot group)*100,* *(4.1)* where the numerical prices in Table 3-3 were used for DctHCW, QG, and YG, and the other variables are simply their measured values.

Most of the above traits are measured on a scale where larger values are preferred to lower values, therefore an animal is above average if the ratio is greater than 100 or below average if the ratio is less than 100. Days on feed are an exception to this rule because longer or shorter is not necessarily better or worse. The fewer days an animal is fed, the lower its feedlot costs, so an animal that gains quickly should be more profitable than an animal that gains weight slowly, all else equal. A counter argument can be made that the longer an animal is fed the higher its hot carcass weight will be and therefore, the higher the revenue will be. This is a complicated matter since cattle in this feedlot are sorted using ultrasound and optimal end date calculations. An animal that finishes quickly may have put on backfat early, so it may not be as profitable as an animal that was fed longer and did not gain backfat until later. Also, cost of gain versus the value of that gain is considered in the optimal end date calculation; if an animal is costing more to feed than it is making in gain, it will be sent to slaughter. All of these confounding factors make it difficult to analyze which are better; longer or shorter days until finish. For indexing purposes in this study, a ratio above 100 means longer days to finish than the average and a ratio below 100 means shorter days to finish than the average.

Feed conversion is measured as pounds of feed per pound of gain, so a smaller value means less feed is needed for gain and the animal is more efficient. Because of this relationship, the feed conversion ratio is calculated differently so that the ratio has the same directional scale as the above variables. The calculation is as follows:

$$Ratio= (100-((Individual\ animal\ measure/Average\ for\ lot\ group)*100)) +100, \qquad (4.2)$$

where a ratio above 100 is above average (better feed conversion) and a ratio less than 100 is below average (worse feed conversion).

Treatment costs (as adjusted in Section 3.4) were not converted to a ratio in the same manner as in the above variables because for most lot groups the average treatment costs were zero, or very close to zero. Therefore, to get a treatment cost relative to the average of the lot group, the following calculation is used:

Tcost Difference= (Average AdjTcost of Feedlot Group- Individual animal AdjTcost), *(4.3)*

where AdjTcost represents the adjusted treatment cost value calculated in Section 3.4. To interpret this calculation, a positive value would represent an animal that had less treatment costs relative to the average of the group, and likewise a negative value would show that the animal had higher treatment costs than the group average.

A similar procedure to compare how well an animal preformed relative to its feedlot group was completed on profitability measures of Net Return (NR) and Return to Ranch (RTR) (defined in Section 3.4), because both had average values near zero. However, the difference value is reversed because having a positive return is preferred, where in the treatment cost calculation having a higher treatment cost would be bad. Therefore, the calculation is as follows:

RTR Difference= (Individual animal RTR - Average RTR of Feedlot Group), and *(4.4)*

NR Difference= (Individual animal NR - Average NR of Feedlot Group). *(4.5)*

Both RTR and NR are measured in dollars per head, so the difference represents a dollar per head difference from the average of the lot. A positive value means the animal performed better than average, and similarly a negative value indicates the animal performed worse than average.

Using the above calculations, each animal now has a score for each carcass, feedlot, and profitability trait that can be compared across the entire data set. Table 4-1 displays summary statistics of these measures.

Table 4-1 Ratio and Difference Summary Statistics

Variable	Mean	Std Dev	Minimum	Maximum
HCW ratio	100	9.21	63.69	129.28
QG ratio	100	2.75	78.07	107.86
YG ratio	100	2.22	85.91	104.73
Inwt ratio	100	10.23	48.57	144.18
FeedConv ratio	100	10.22	-4.12	182.47
DOF ratio	100	16.47	44.65	180.09
ADG ratio	100	12.85	33.52	171.66
DrsPct ratio	100	3.40	80.77	117.77
DctHCW ratio	100	0.57	88.65	100.71
Tcost difference	0	5.31	-84.20	5.37
NR difference	0	72.26	-421.08	412.38
RTR difference	0	79.30	-416.80	252.22

* Units on difference values are dollars per head
* Number of observations is 6360 animals

Because a ratio of 100 would represent an animal that is exactly at the average for the lot, the mean across all ratios for all animals is 100. The mean profit measures and Tcost are zero since they are difference values; an animal that is exactly the average would have a difference of zero. Ratios all differ in their standard deviations and ranges, with some small, such as DctHCW ratio, and some large, such as FeedConv. The negative minimum value in FeedConv ratio may seem to be an error, but it is actually caused by an animal that had an individual measurement over twice the average for the lot. For example, if the lot average for feed conversion was 5.5 pounds of feed per pound of gain and a single animal had a feed conversion of 12 pounds of feed per pound of gain, the calculation in equation 4.2 would make this animal's ratio negative. Therefore, a negative value for a ratio signifies very poor performance. A negative value in Tcost means that the animal had treatment costs of $84 above the average for the lot group. The positive value in Tcost represents an animal having treatment costs below the lot average. In other words, this animal cost $5.37 less to treat than the average animal in the lot group. Both profitability difference values, NR and RTR, have a wide range suggesting great variation exists in cattle profitability in a grid system, which is consistent with earlier discussions.

These ratio and difference measures were analyzed using two different procedures to quantify their determinants; an ordinary least squares regression model (OLS) and an ordered logit model. Each model captures drivers of the profitability measures among feedlot and carcass characteristics.

4.2.1. OLS Model

The empirical form of an OLS model is for independent variables to explain one dependent variable. The dependent variable in this case was the two profitability measures, NR difference and RTR difference, for which separate equations were estimated. Independent variables were feedlot ratio measures of receiving weight (Inwt), feed conversion (FeedConv), and days of feed (DOF) and carcass ratio measures of hot carcass weight (HCW), hot carcass weight discounts (DctHCW), quality grade (QG), yield grade (YG), dressing percent (DrsPct), and treatment cost difference (Tcost). Average daily gain was not included in the model since it was already captured in Inwt, HCW, DrsPct, and DOF. OLS regression is used in the following two models to identify variation in profits by feedlot and carcass measures:

NR Difference= f(HCW ratio, DctHCW ratio, QG ratio, YG ratio, FeedConv ratio, DOF ratio, Inwt ratio, DrsPct ratio, Tcost difference), and (4.6)

RTR Difference= f(HCW ratio, DctHCW ratio, QG ratio, YG ratio, FeedConv ratio, DOF ratio, Inwt ratio, DrsPct ratio, Tcost difference). (4.7)

The signs on the ratios are expected to be positive in the regression equations since the ratio is calculated in such a way that a value above 100 is above average and a value below 100 is below average. Therefore, the higher the ratio, the better that animal performed relative to the others in the lot, so it would make sense that animals with higher ratios would have higher profitability. Some exceptions to this may be DOF ratio in both models and the Inwt ratio in the Net Return model. As discussed earlier, days on feed is a measure that is not necessary better or worse the longer or shorter it is. Therefore, the sign on this variable could be positive or negative. Because Net Return represents the amount of revenue made or lost in the feedlot over what the animal was worth when it entered the feedlot, a heavier received calf will put downward pressure on its profitability calculation, thus making the regression coefficient sign on receiving weight negative.

Standardized beta coefficients (STB) are calculated so comparisons can be made between variables and to identify the relative contributors among independent variables to the variation in the dependent variable (McDonald and Schroeder 2000). Standardized beta coefficients for each independent variable were calculated by multiplying the beta coefficient, which is the estimated coefficient reported in the OLS regression, by the standard deviation of the variable in question divided by the standard deviation of the independent variable (Greene 1993). For example, the standardized beta coefficient of HCW for the RTR difference model is calculated as:

$$SBC = \beta_{HCW} * \left(\frac{\sigma\ HCW\ ratio}{\sigma\ Return\ to\ Ranch\ Difference}\right). \quad (4.8)$$

The standardized beta coefficient can be interpreted as the increase in the standard deviation of the dependent variable for a one standard deviation increase in the independent variable (McDonald and Schroeder 2000). In the above calculation, if the SBC was calculated to be 0.5, this would mean a one standard deviation increase in the HCW ratio would increase the standard deviation of RTR difference by 0.5. This calculation allows direct comparisons to be made between independent variables since the independent variable that would increase the standard deviation of the dependent variable the most would have the most influence. All independent variables can be "ranked" as to their importance on explaining the variation in the dependent variable based on these standardized beta coefficients.

4.2.2. Ordered Logit Model

The other type of model used to analyze drivers of profitability among feedlot and carcass characteristics is an ordered logit model. This model was chosen because it has the ability to predict probabilities in a categorical dependent variable from numerous continuous independent variables. In the problem being studied, the two profit measures (Net Return and Return to Ranch) are categorical values since they are being studied in the context of the ranking of top 20%, middle 60%, and bottom 20%. The objective is to find the probability of an animal being included in one of those categorical ranks based on the ratios of their carcass and feedlot measurements. By knowing this information, traits can be identified as the drivers of profitability and improvements can be made to cattle quality. As shown earlier, the average Net Return in the bottom 20% of feedlot groups is usually negative. Also, the spread between the top 20% and bottom 20% when looking at the average of either Return to Ranch or Net Return at times exceeds $250 per head. For these reasons, it is important to identify differences between these categories and see where improvements can be made to help cattle uniformity.

This is accomplished by first setting up and estimating the ordered logit model. The empirical form of the ordered logit model is as follows (Greene 1993; Bolte 2007):

$$Y_i^* = x_i' \beta + \varepsilon_i . \qquad (4.9)$$

In this model, ε is the error term which is assumed to be logistically distributed, *i* refers to the individual animal, and *Y** is the unobserved dependent variable. Beta is the parameter to be estimated and *x* is the explanatory variables the model will be evaluated at. The equations to be estimated to study differences in profitability from carcass and feedlot measures in the ordered logit model setting are similar to the OLS regression:

NR = f(HCW ratio, DctHCW ratio, QG ratio, YG ratio, FeedConv ratio, DOF ratio, Inwt ratio, DrsPct ratio, Tcost difference), and *(4.10)*

RTR = f(HCW ratio, DctHCW ratio, QG ratio, YG ratio, FeedConv ratio, DOF ratio, Inwt ratio, DrsPct ratio, Tcost difference). *(4.11)*

However, instead of difference values being estimated, NR and RTR take on values of:

$$Y \begin{cases} 1 \text{ if Bottom } 20\% \\ 2 \text{ if Middle } 60\% \\ 3 \text{ if Top } 20\%. \end{cases} \qquad (4.12)$$

Since the Y* is unobserved in the logit equation, the following technique is used to estimate Y:

$$Y = 1 \text{ if } Y^* \leq 1 \qquad (4.13)$$
$$Y = 2 \text{ if } 1 \leq Y^* < \mu_1$$
$$Y = 3 \text{ if } \mu_1 < Y^* ,$$

where μ_1 is the unknown parameter that is estimated using the beta coefficients in the model. Since this model is logistically distributed, the probabilities of Y=1, 2, or 3 are calculated in the following manner (Greene 1993; Bolte 2007):

$$Prob(Y = 1) = Prob(x_i\,\beta + \varepsilon_i \leq 1) = \frac{1}{1+exp\,(x_i\,\beta)} \tag{4.14}$$

$$Prob(Y = 2) = Prob(x_i\,\beta + \varepsilon_i \leq \mu_1) - Prob(x_i\,\beta + \varepsilon_i \leq 1) = \frac{1}{1+exp\,(x_i\,\beta - \mu_1)} - \frac{1}{1+exp\,(x_i\,\beta)}$$

$$Prob(Y = 3) = 1 - Prob(x_i\,\beta + \varepsilon_i \leq \mu_1) = 1 - \frac{1}{1+exp\,(x_i\,\beta - \mu_1)}.$$

These probabilities are used to study how the feedlot and carcass characteristics influence the chances of an animal being in the top 20%, middle 60%, or bottom 20% of the feedlot groups.

4.3. Results

To understand results and implications of these models, it is first important to recognize the relationships between the carcass, feedlot, and profitability measures. Table 4-2 below displays the correlations between the eight ratio measures and the two profitability difference measures.

Table 4-2 Correlations between Feedlot, Carcass, and Profit Measures

	HCW ratio	QG ratio	YG ratio	Inwt ratio	FeedConv ratio	DOF ratio	DrsPct ratio	DctHCW ratio	Tcost difference	NR difference	RTR difference
HCW ratio	1.00										
QG ratio	0.09	1.00									
YG ratio	-0.04	-0.09	1.00								
Inwt ratio	0.40	0.04	-0.08	1.00							
FeedConv ratio	-0.06	-0.11	0.02	-0.33	1.00						
DOF ratio	0.46	0.05	0.07	-0.34	-0.19	1.00					
DrsPct ratio	0.51	0.05	-0.07	0.02	-0.06	0.30	1.00				
DctHCW ratio	-0.16	0.00	-0.01	-0.10	-0.01	-0.03	-0.07	1.00			
Tcost difference	0.03	0.03	-0.01	0.02	0.05	-0.07	0.06	0.01	1.00		
NR difference	0.65	0.39	0.26	0.07	0.28	0.15	0.49	-0.10	0.15	1.00	
RTR difference	0.77	0.38	0.20	0.54	0.11	0.01	0.46	-0.10	0.15	0.84	1.00

The highest correlation is between the two profitability difference measures, RTR and NR. This makes sense given that they are calculated similarly and an animal that performs well by one measure should perform relatively well by the other. The next highest correlations are between the profitability measures and HCW ratio, at 0.77 for RTR and 0.65 for NR. This implies that HCW is an important characteristic in determining profitability for an animal and may have more influence in the regression models than any other carcass of feedlot measure. This is expected since previous studies have found HCW to be the most important driver of revenue in the grid system (Johnson and Ward 2006). DrsPct ratio is also notably correlated with NR and RTR showing importance to profitability as well.

InWt ratio is positively correlated with RTR, which makes sense since InWt ratio and HCW ratio are also positively correlated, however, NR's correlation with Inwt ratio is essentially zero. Explaining this relationship, an animal that gained well as a calf and a feeder will have a higher receiving weight and be more likely to finish at a higher weight. Since RTR measures the return to all of the activities in raising the animal prior to the feedlot, a higher return should be received for a larger animal at receiving. NR takes into account the value of the animal at the time it was placed in the feedlot, so it represents the return on how the animal performed in the feedlot setting. It is not surprising to find that NR and Inwt ratio are not highly correlated because Inwt has competing implications for feedlot performance. For example, Inwt ratio is negatively correlated with DOF ratio and positively HCW ratio, meaning a heavier receiving weight animal will finish at a higher HCW with less DOF. However, Inwt ratio and FeedConv ratio are negatively correlated, showing that a heavier animal will take more feed to convert to a pound of gain, which will raise feed cost for that animal and lower NR.

DOF ratio and HCW ratio are positively correlated, implying longer DOF will produce higher HCW. There is also a positive correlation between DOF ratio and DrsPct ratio, showing that the longer the animal is fed, the higher its dressing percent. Together, these relationships show that a longer fed animal will bring more revenue in the marketing grid because of its higher carcass weight characteristics, however the cost to feed that animal longer may be of concern and possibly offset the revenue gained. Negative correlation is seen between DOF ratio and FeedConv ratio, which displays the efficiency loss as animals are fed longer.

QG ratios and YG ratios are both positively correlated with the profitability measures, as expected since they are both contributors to carcass price through the marketing grid. QG ratio is similarly correlated with NR and RTR at 0.39 and 0.38, respectively, while YG ratio is slightly less correlated at 0.26 and 0.20, respectively. Smaller, but noteworthy correlations are seen between Feedconv ratio and profitability measures, showing an animal that is more efficient tends to be more profitable.

To sum up the relationships, it is expected that HCW, QG, YG, Inwt, DrsPct, and FeedConv ratios, will all have impacts on profitability in the models, with HCW ratio being the biggest driver. DOF ratio does not show high correlation with return measures, mostly because a direct relationship is not seen between them, but is expected to be important because of relationships with other measures. Ratios that also have smaller correlations to returns are DctHCW ratio and Tcost difference, and are expected to not be as influential in the models.

4.3.1. OLS Model

Regression results for ordinary least squares model on RTR difference are shown below. The R-squared value for the regression shows that 99% of the variation in RTR difference is explained by the independent variables, which means the model is an excellent fit for the data.

This is expected because the model includes all major relative profit determinants. Also, all coefficients are statistically significantly different from zero at the 0.01 level.

Table 4-3 Return to Ranch Regression Results

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|	SBC
Intercept	-4145.90249	23.74582	-174.60	<.0001	0
HCW ratio	5.73686	0.02559	224.14	<.0001	0.66632
QG ratio	10.38008	0.04478	231.81	<.0001	0.35966
YG ratio	11.15950	0.05539	201.49	<.0001	0.31176
FeedConv ratio	1.87010	0.01525	122.66	<.0001	0.24113
DOF ratio	-1.22053	0.01295	-94.25	<.0001	-0.25354
Inwt ratio	2.14733	0.02164	99.24	<.0001	0.27698
DrsPct ratio	4.90690	0.04371	112.27	<.0001	0.21036
DctHCW ratio	6.47878	0.21565	30.04	<.0001	0.04658
Tcost Difference	1.03792	0.02301	45.11	<.0001	0.06954
# of Observations	6360				
Root MSE	9.66				
R^2	0.9852				

As expected, since all independent variables are ratios of how well an animal performed relative to its lot group, all the beta coefficients have positive signs with the exception of DOF ratio. In this model, longer days to finish in the feedlot will reduce RTR difference (become less positive or more negative), most likely because of the additional costs that are incurred. RTR difference will increase (become more positive or less negative) for an increase in HCW ratio, QG ratio, YG ratio, FeedConv ratio, Inwt ratio, DrsPct ratio, DctHCW ratio, and Tcost difference. For example, if an animal's HCW ratio increased from 100 to 101, RTR profitability difference will increase by $5.74 per head. A one-unit increase in DrsPct ratio will increase Return to Ranch profitability difference by $4.91 per head. While HCW and DrsPct seem like they impact Return to Ranch similarly, their parameter estimates are not directly comparable since the ranges of ratios are not the same for both variables (shown in Table 4-1). Dressing percent has a ratio range of 80.77 to 117.77 while HCW ranges as much as 63.69 to 129.28. Therefore, a one-unit change will be a different magnitude between measurements. The key point to find out is how important an increase in each ratio is on RTR difference relative to one another. In the above example, a one-unit increase in dressing percent ratio is a larger scale change relative to an increase in HCW since dressing percent varies little compared to HCW measurements, however, DrsPct may not be as important to profitability as HCW.

To compare the importance of independent variables on the dependent variable directly, standardized beta coefficients are used. Variability in the HCW ratio explains almost twice as much variation in RTR profitability difference than any other feedlot or carcass measure. QG ratio was the next highest in explaining variation in RTR profit difference. Both of these relationships are expected since previous literature also found HCW to be the main driver of revenue and both HCW and QG to be drivers of profit (Johnson and Ward 2006; Forristall, May, and Lawrence 2002). YG ratio, Inwt ratio, FeedConv ratio, and DrsPct ratio were also important in explaining variation in RTR differences. DOF ratio is equally important, but again the SBC is negative, showing that longer days to finish in the feedlot tends to increase RTR difference. The DctHCW ratio and Tcost difference both have smaller impacts when looking at SBC, although they are still statistically significant. The small impact of treatment cost may be because few animals were treated, but also the reduced performance of the animal being captured in the carcass and feedlot measures. A sick animal will incur costs for treatment, but also is likely to experience reduced performance for a period of time. In general, all of these relationships are consistent with what was expected after studying correlations between the measures.

While RTR and NR profitability measures were highly correlated, there was expected to be slight differences between how the independent variables affect them. Table 4-4 below displays ordinary least squares regression results on the Net Return model.

Table 4-4 Net Return Regression Results

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|	SBC
Intercept	-3066.40965	63.25589	-48.48	<.0001	0
HCW ratio	6.86179	0.06818	100.64	<.0001	0.87460
QG ratio	10.11322	0.11928	84.78	<.0001	0.38454
YG ratio	11.40443	0.14754	77.30	<.0001	0.34963
FeedConv ratio	1.34329	0.04061	33.07	<.0001	0.19007
DOF ratio	-1.85493	0.03450	-53.77	<.0001	-0.42286
Inwt ratio	-2.44681	0.05764	-42.45	<.0001	-0.34634
DrsPct Ratio	4.02576	0.11643	34.58	<.0001	0.18939
DctHCW ratio	1.21735	0.57446	2.12	0.0341	0.00960
Tcost difference	0.97554	0.06129	15.92	<.0001	0.07173
# of Observations	6360				
Root MSE	25.74				
R^2	0.8733				

This model also had a good fit for the data with an R-squared value of 0.87, meaning 87% of the variation in NR difference was explained by the independent variables. All variables were statistically significant (0.01 level) in the model except DctHCW ratio, which is not surprising because it was anticipated to have a very small influence on NR difference judging by correlation coefficients.

The biggest difference between the two models is the negative relationship in Inwt ratio. An animal that has a high Inwt relative to its feedlot group is likely to perform better in RTR profitability, but will perform worse in NR profitability when faced with these marketing conditions. This is possible since the receiving value of the animal is subtracted in the NR calculation, therefore a heavier received animal puts downward pressure on NR. Other ratios have positive signs, as expected, since better performance in these measures will contribute to higher profitability. The exception is again DOF ratio, where it appears in this model that longer days of feed will lower NR.

The standardized beta coefficients also show different relationships than the RTR difference model. HCW ratio again explains over twice the variation in profitability difference than any other carcass or feedlot measure, which is consistent with the RTR model. However, the next most important measure in explaining variation in NR difference is DOF ratio, not QG as in the RTR difference model. The reason for this may be that NR is measuring the animal's performance just in the feedlot setting and not the whole growth period, such as RTR does. Because of this, feedlot measures such as DOF may be more important to return.

QG ratio, YG ratio, and Inwt ratio all explain variation in NR difference which is consistent with the RTR model, however in contrast, Inwt ratio is negative, which reasons for are discussed earlier. FeedConv ratio and DrsPct ratio have smaller STB coefficients relative to the RTR model, meaning they are less important in explaining variation in NR differences than RTR differences. This may be because the difference in the impact of Inwt on the profitability measure. Because higher receiving value decreases NR, it may also capture some of the relationship in feed conversion. Correlation shows that a larger animal will convert feed less efficiently, so the importance of FeedConv may be captured somewhat in the Inwt ratio variable. DrsPct ratio and Inwt ratio are also correlated, so the importance of dressing percent may also be captured somewhat in receiving weight. This would not impact RTR profit as much since Inwt ratio is a positive coefficient.

Both models show that HCW is more important than any other measure in explaining variation in feedlot and overall profit. Other measures show considerable impacts, but are less directly important to profitability. However, as displayed in correlations, many of the measures are related to one another, therefore increasing HCW to improve profitability may have implications for other feedlot and carcass measures.

4.3.2. Ordered Logit Model

The ordered logit models study the same concepts as the OLS regression models in that they are trying to explain what factors drive profitability, however, the difference is that the logit model is examining what drives an animal to be categorized as performing in the top 20%, middle 60%, or lower 20% of the lot group. As previously discussed, an animal was ranked within its respective feedlot group and has separate scores for the category that it performed within for Net Return and Return to Ranch profitability. The results should be similar to the OLS regressions, but recall in the actual data that animals in the bottom 20% of the feedlot group tend to have negative net returns. If improvements could be made to advance the quality of those animals, net revenue to the producer would increase. Therefore, the objective of these models is to identify what drives an animal into the lower 20% or top 20% of the feedlot group. These results could be used to focus on the traits in which improvement would have the most impact on cattle quality and profitability and lower the spread between these groups.

The first issue to discuss is which of these feedlot and carcass measures actually change and by what magnitude, when looking at the different categorical groups. The same ratios and profitability difference values are used as in the previous regression models. Table 4-5 presents the differences in the average feedlot or carcass measures of the top 20% of the feedlot group from the bottom 20% when looking at the two different profitability measures.

Table 4-5 Differences in Feedlot and Carcass Ratios Measures (Top 20% - Bottom 20%)

	Net Return	Return to Ranch
HCW ratio	17.51	19.80
QG ratio	3.01	2.80
YG ratio	1.56	1.26
FeedConv ratio	8.19	3.01
DOF ratio	10.06	1.32
Inwt ratio	1.29	15.46
DrsPct Ratio	4.86	4.46
DctHCW ratio	-0.17	-0.22
Tcost difference	2.12	1.87

HCW ratio is 17.51 to 19.80 units higher for the average of the top 20% than the average of the bottom 20%. To put this in perspective, if the average animal had a HCW of 800 pounds, a ratio difference of 17.51 to 19.80 would be equivalent to a difference of 140.08 to 158.40 pounds, which would have a huge impact on revenue received. The DrsPct ratio is consistently around 4.5 ratio points higher for the top 20% than the bottom 20%, which could lead to higher HCW. Also, YG ratio is around 1.5 units higher and QG ratio is almost 3 units higher for the top 20% than the bottom 20%. Both of these measures significantly impact carcass price received, so will be important to profit. DctHCW ratio is only slightly higher in the bottom 20% relative to the top 20%, suggesting that discounts for overweight animals in the top 20% are almost equivalent to the discounts for underweight animals in the bottom 20%. Tcost difference is around 2 units higher for top 20% compared to the bottom 20% for both return measures, suggesting an average $2 per head difference in treatment costs between the classes.

Some inconsistencies between the profit measures include FeedConv ratio, DOF ratio, and Inwt ratio. Feedconv appears to change much more from top 20% to bottom 20% when looking at NR verses RTR. This implies that feed conversion is more important in explaining variation in NR than it is in explaining variation in RTR when looking at animals ranked into return classes. This is also the case for DOF ratio. When looking at NR, cattle in the top 20% average 10.06 units higher for DOF ratio than cattle in the bottom 20%, meaning they are fed longer. DOF ratio in RTR is slightly higher (1.32 units) for cattle in the top 20% versus the bottom 20%, meaning they are fed only slightly longer. The opposite relationship is seen in Inwt ratio; there is large variation in the top 20% from the bottom 20% when looking at RTR, but only slight variation in Inwt ratio across categories for NR. This reflects the relationship that receiving weight is correlated to RTR but not NR.

To study the probabilities of an animal being classified into one of these groups based on its feedlot and carcass characteristics, the results of the ordered logit models are presented. Table 4-6 and Table 4-7 below show the estimated coefficients and significance values for the RTR and NR models.

Table 4-6 Ordered Logit Model Results for Return to Ranch

Parameter	Estimate	Standard Error	t Value	Pr > |t|
Intercept	-761.02661	30.556287	-24.91	<.0001
HCW ratio	0.953229	0.034888	27.32	<.0001
FeedConv ratio	0.315067	0.012722	24.76	<.0001
DOF ratio	-0.191413	0.009143	-20.94	<.0001
YG ratio	1.842001	0.068019	27.08	<.0001
QG ratio	1.741406	0.062795	27.73	<.0001
Inwt ratio	0.361708	0.015984	22.63	<.0001
DrsPct ratio	0.848595	0.035005	24.24	<.0001
DctHCW ratio	1.847684	0.169914	10.87	<.0001
Tcost difference	0.171409	0.013375	12.82	<.0001
_Limit2	21.98038	0.739616	29.72	<.0001
McFadden’s LRI	.8436			
# of Observations	6360			

Table 4-7 Ordered Logit Model Results for Net Return

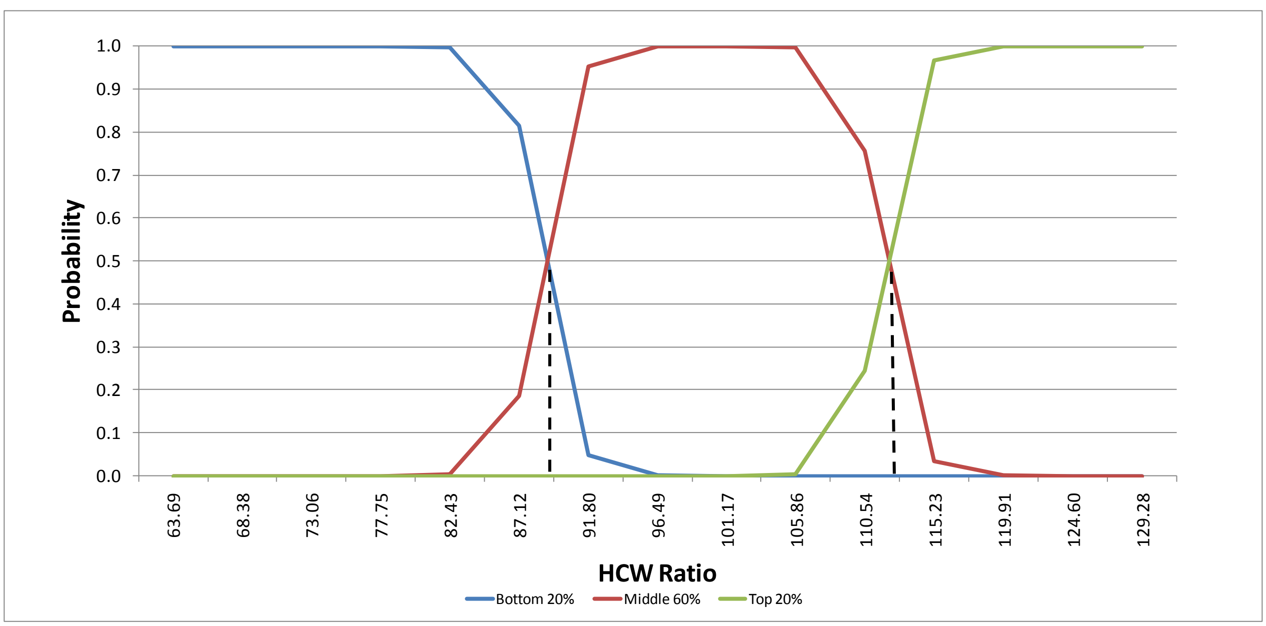
Parameter	Estimate	Standard Error	t Value	Pr > |t|
Intercept	-333.320356	13.537927	-24.62	<.0001
HCW ratio	0.605615	0.016683	36.30	<.0001
FeedConv ratio	0.133184	0.006273	21.23	<.0001
DOF ratio	-0.142557	0.005644	-25.26	<.0001
YG ratio	0.949391	0.030096	31.55	<.0001
QG ratio	0.946350	0.028262	33.49	<.0001
Inwt ratio	-0.210956	0.008924	-23.64	<.0001
DrsPct ratio	0.380148	0.017959	21.17	<.0001
DctHCW ratio	0.723491	0.103005	7.02	<.0001
Tcost difference	0.098854	0.009439	10.47	<.0001
_Limit2	10.582864	0.251363	42.10	<.0001
McFadden’s LRI	.6874			
# of Observations	6360			

All coefficients are statistically significant (0.01 level) in both models and coefficients have the same signs except for the Inwt ratio, which is negative in the NR model. This is expected since it also was in the OLS regression. Both models display adequate fit to the data by looking at McFadden’s LRI. This measure can be treated as a pseudo R-squared since an actual R-squared measure is not possible in a logistic regression (Whitehead 2006). It is generally smaller than an R-squared in a regression model, but in both these models it is relatively high, meaning adequate fit for the data.

To translate these models into probabilities, the procedure outlined in the “Methods” section was completed. Values of 100 were used for comparison values and then the impact of one variable changing while holding the others constant was analyzed. In other words, the marginal effects of the models are presented by changing one variable while holding the others constant. Figure 4-1 through Figure 4-18 show the total range that the ratio measures cover in the actual data and what impact the ratio values have on the predicted probability of the animal being included in the top 20%, middle 60%, or bottom 20% of the feedlot group. The important points on these graphs are the crossovers of the predicted probability lines (shown in dashed black); they are used to estimate the threshold of where probability changes.

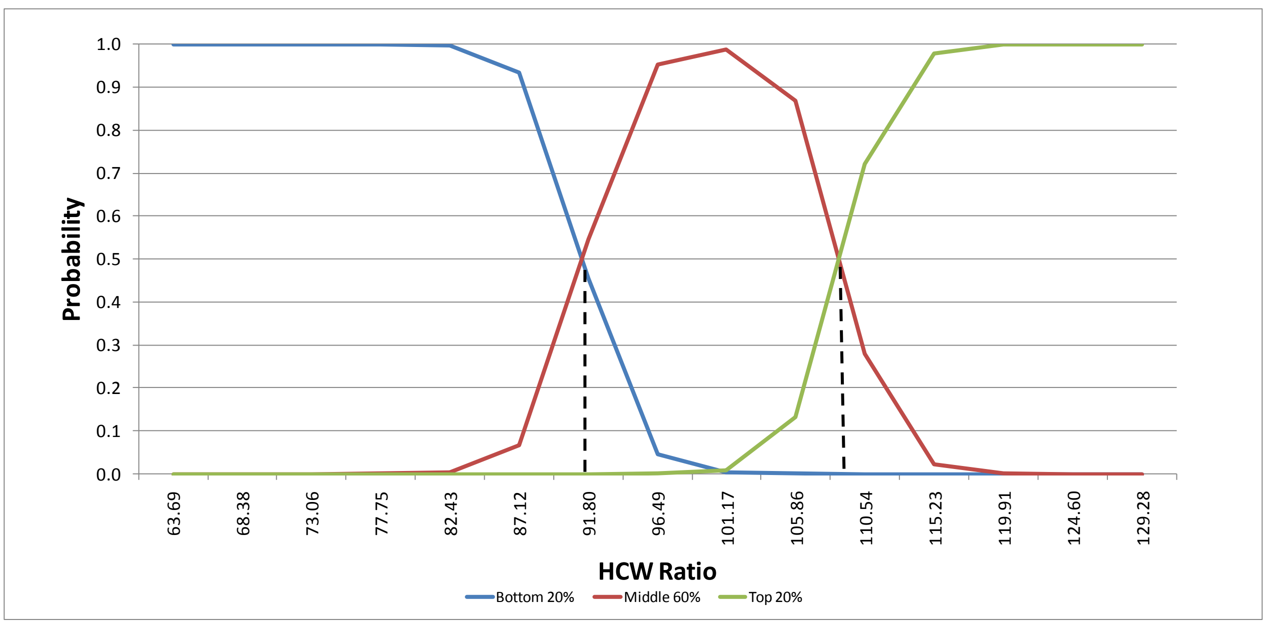
Over the range of ratios that HCW displayed in the actual data, crossover points for RTR are seen at approximately a ratio of 88 for bottom 20% to middle 60%, and a ratio of 112 for middle 60% to top 20%, as seen in Figure 4-1. This shows that an animal with a HCW of 88% of the mean HCW, will most likely be in the bottom 20%. Likewise, if an animal has a HCW of 112% of the mean, it will most likely be in the top 20% of the feedlot group. To give this a pounds perspective, if the average HCW for the lot is 800 pounds, an animal less than 704 pounds will most likely be in the bottom 20% and an animal greater than 896 pounds will most likely be in the top 20%.

Figure 4-1 RTR Probability-HCW Ratio



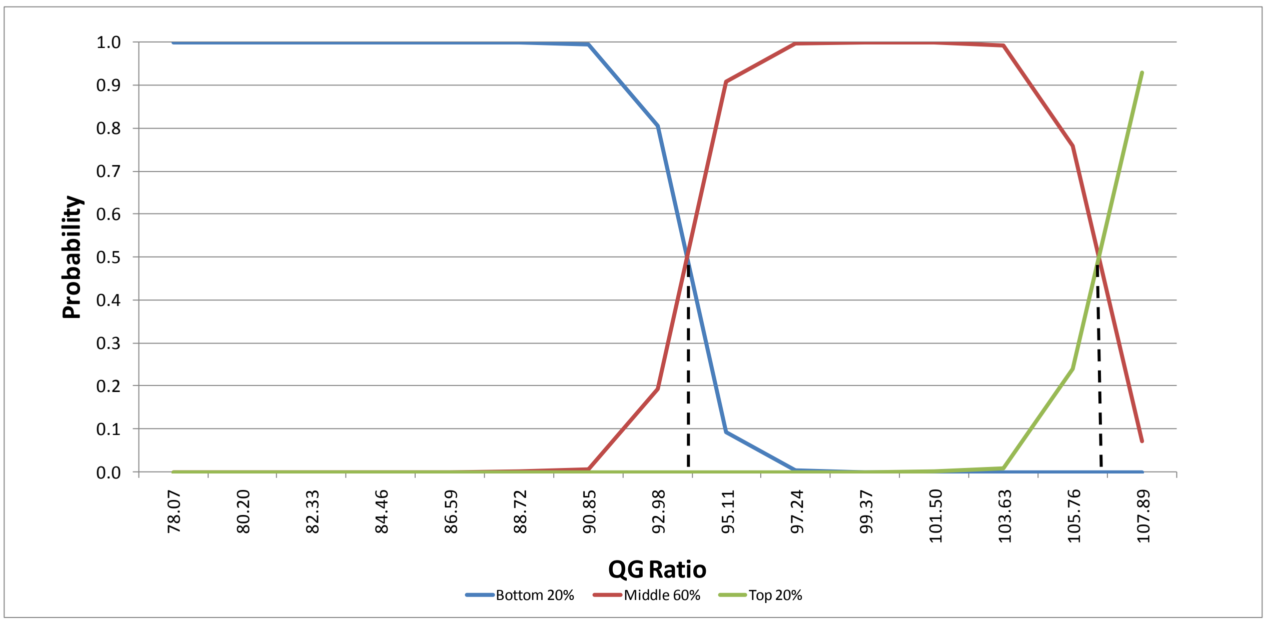
The same relationship is seen in HCW when looking at NR, although the range for the middle 60% is smaller, as seen in Figure 4-2. Crossover values are at ratios of approximately 92 and 109. Compared to the same 800 pound HCW average, an animal with a HCW less than 736 pounds will most likely be in the bottom 20% and an animal with a HCW greater than 872 pounds will most likely be in the top 20%. This is a relatively small range since HCW can be as low as 519 pounds and as high as 1038 pounds. These results suggest that managing for higher HCW can potentially have large impacts on cattle profitability.

Figure 4-2 NR Probability-HCW Ratio



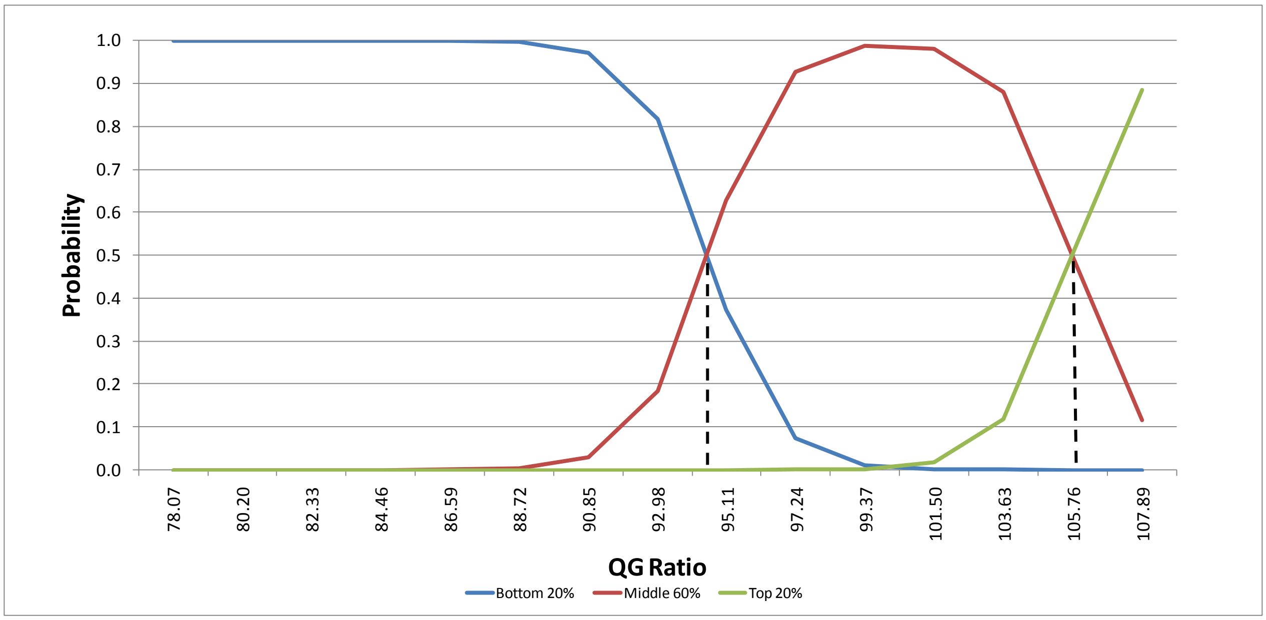
Crossover points for QG probabilities in the NR model occur around a ratio of 94 for bottom to middle and a ratio of 106 for middle to top, as seen in Figure 4-3. If the average for the lot had price index of 137.30, meaning the average is a Choice carcass (see Table 3-3), anything below Select will most likely be in the bottom 20%. This would include Standard, Hardbone, Dark Cutter, Over 30 months of Age, and Bullock/Stag. Also, with an average price index of 137.30 (Choice) a crossover of 106 is not possible, meaning even a Prime carcass is not more likely to be in the top 20% than the middle 60%. (In actual data, a ratio of 106 can occur; the average for the lot must have been lower than 137.30 and at least one animal was Prime.) These results suggest that discounts for Standard and "out" carcass are severe to profitability, while premiums for Prime and Certified Angus Beef are relatively unimportant to achieving the top 20% classification.

Figure 4-3 RTR Probability-QG Ratio



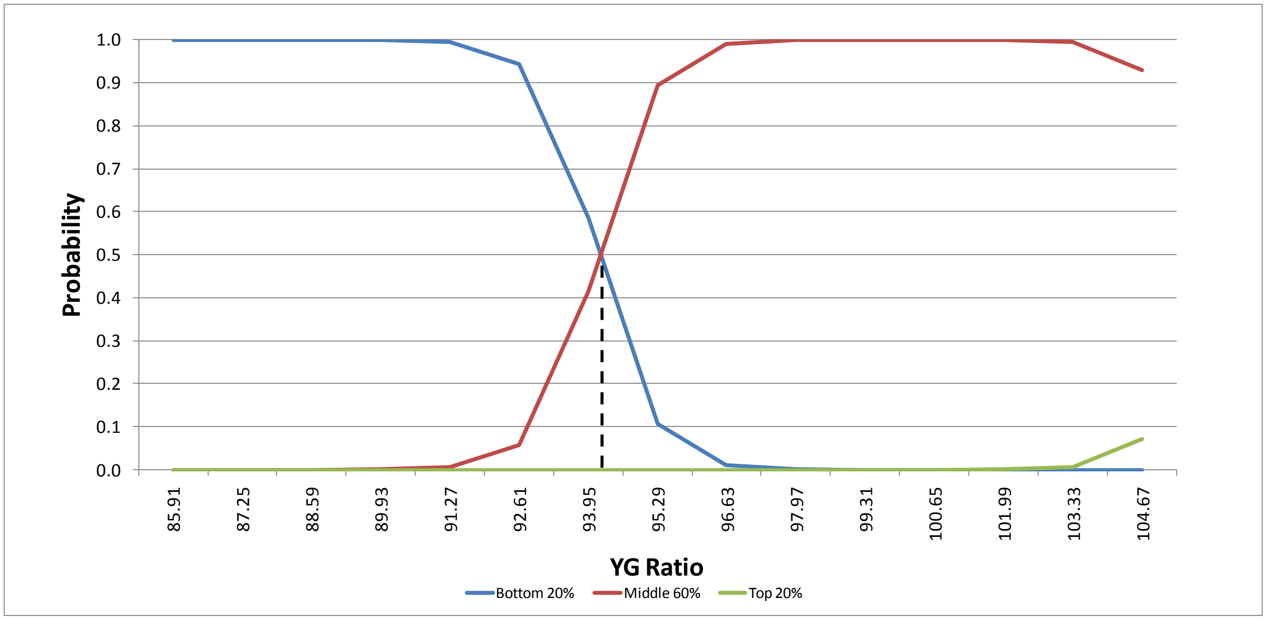
Results for the NR probabilities when looking at QG are similar, as presented in Figure 4-4. Crossover points are approximately 94 and 106, which translates into the comparable results as the RTR model if an average price index of 137.30 is used for assessment. Any carcass that is Standard or "out" will most likely be in the bottom 20% while even Prime carcasses are not more likely to classify the animal into the top 20%. As shown on Figure 4-4 with an extremely high QG ratio, if the average price index for the lot is lower than 137.3 (Choice) there is a better chance that a Prime carcass will be in the top 20%, but this only occurs in rare situations with this data.

Figure 4-4 NR Probability-QG Ratio



As seen in Figure 4-5, YG ratio has only one crossover point going from bottom to middle; approximately a ratio of 94. If comparing to an average price index of 137.30, which is a yield grade 3, anything higher than a yield grade 3 will most likely be in the bottom 20% of the feedlot group. Obtaining yield grades 1 or 2 will only very slightly increase chances of top 20% category. Like QG, this suggests that avoiding discounts is key to staying out of the bottom 20% classification, but premiums do little to drive an animal into the top 20%.

Figure 4-5 RTR Probability-YG Ratio



Results for RTR probabilities based on YG are very similar to NR probabilities based on YG, shown in Figure 4-6, suggesting yield grade affects return classification measures equally.

Figure 4-6 NR Probability-YG Ratio

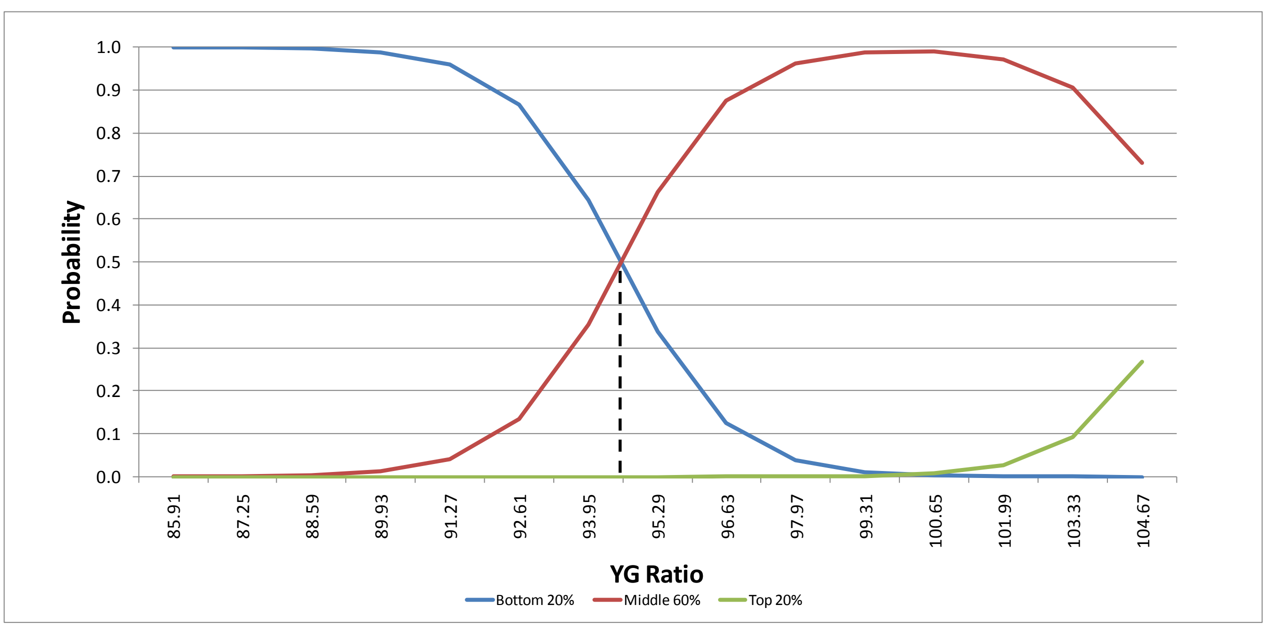
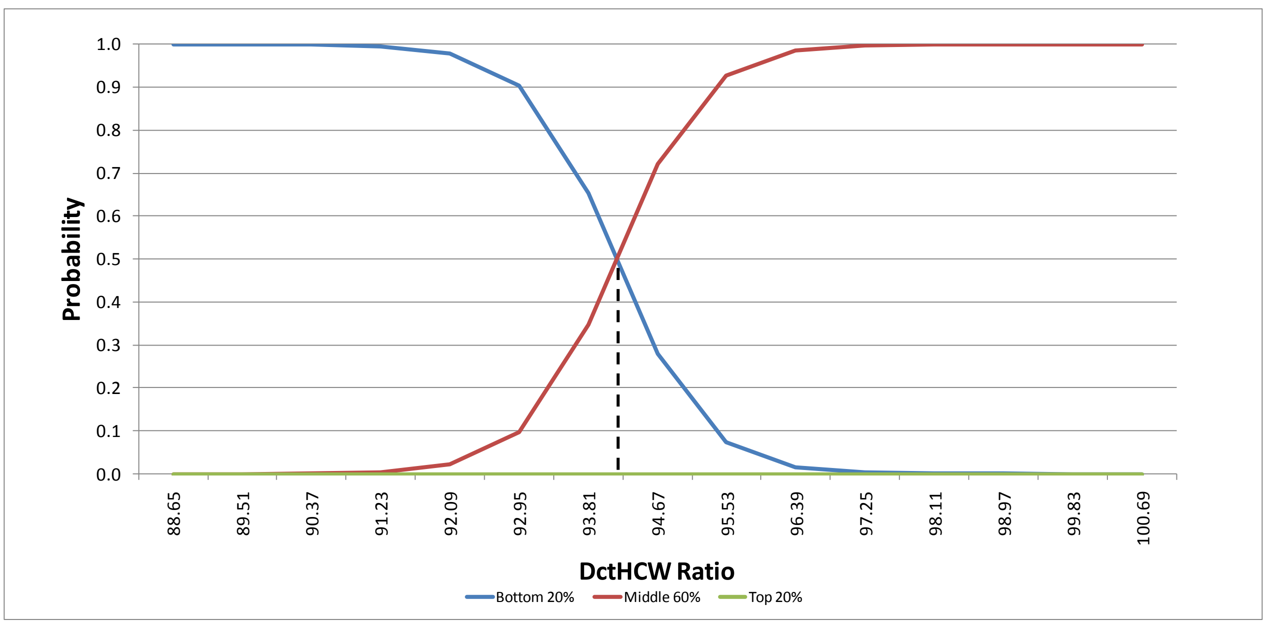


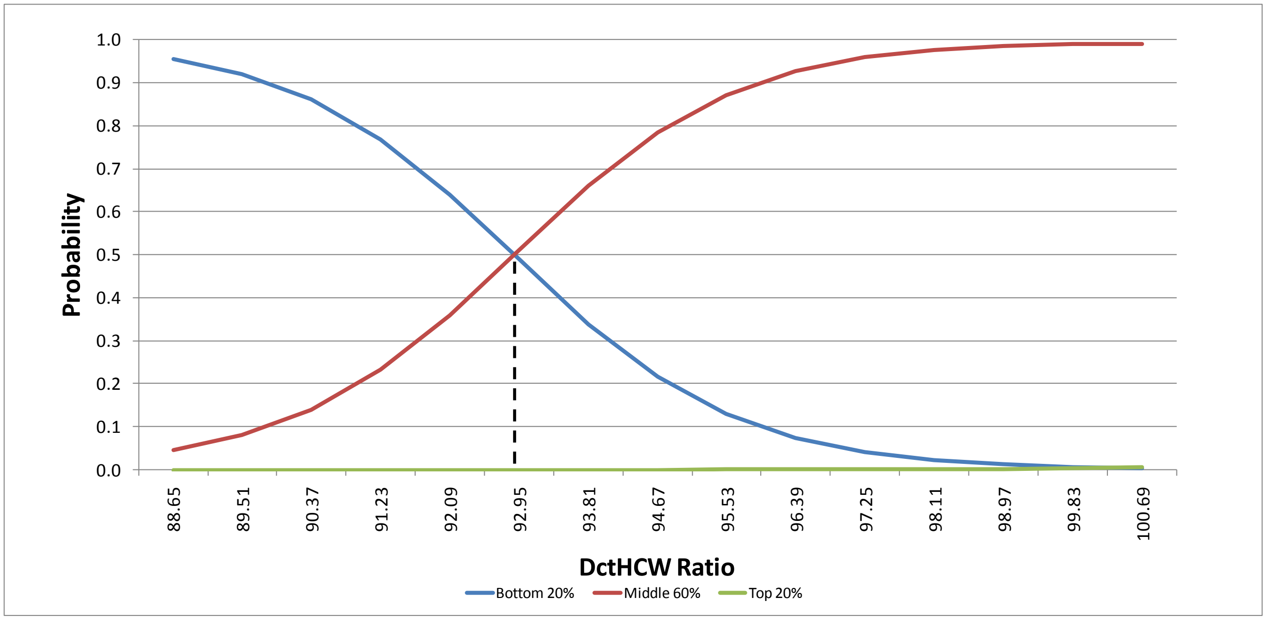
Figure 4-7 shows that the same general conclusion can be drawn when looking at the DctHCW ratio or the HCW ratio (shown in Figure 4-1); that bigger is better. With only one crossover point near a ratio of 94, this shows carcasses that receive discounts for being 550 pounds or less will most likely be in the bottom 20%, if the average animal received no discount (price index value 137.30). A discount for a heavy carcass will not push an animal into the bottom 20%. These results show that the consequences of a light carcass are much more severe than consequences of an overweight carcass.

Figure 4-7 RTR Probability-DctHCW Ratio



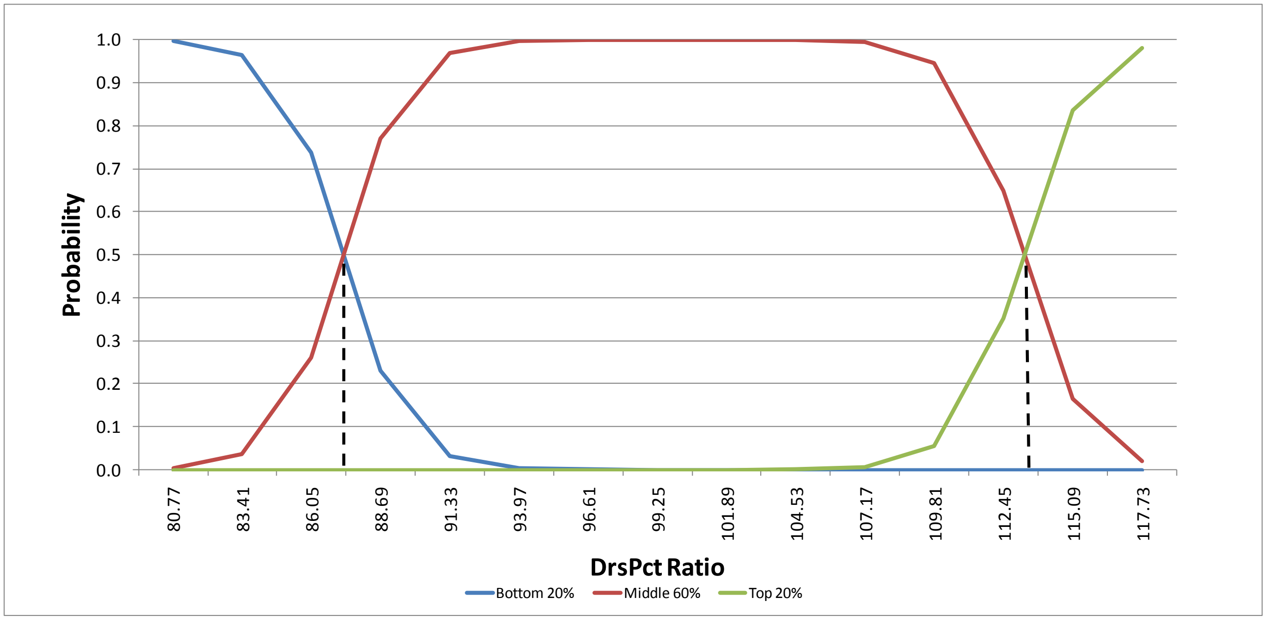
These results are consistent for NR profitability as well, although the crossover is near a ratio of 93 instead of 94, shown in Figure 4-8. With an average price index of 137.30, any carcass below 550 pounds will most likely be in the bottom 20%.

Figure 4-8 NR Probability-DctHCW Ratio



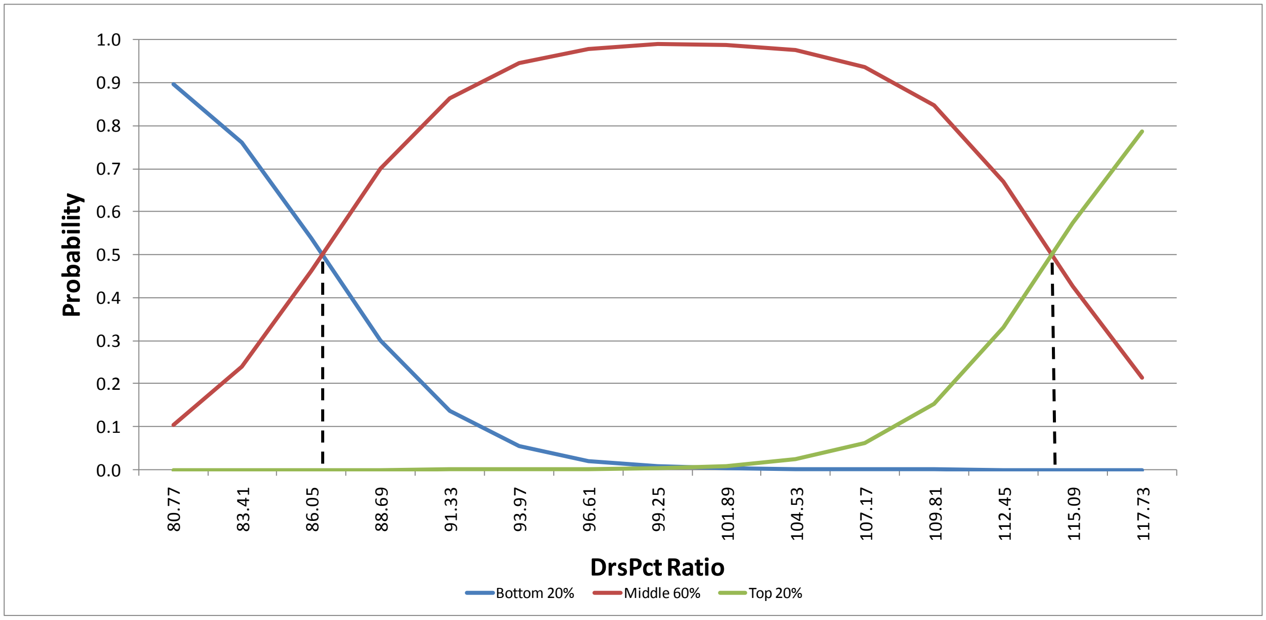
Dressing percentage is a value that does not have a wide range, therefore, only on the extreme ends of the range are animals more likely to be classified as top or bottom 20%. This is displayed in Figure 4-9, where crossover points occur at a ratio of approximately 87 and 113. If an average dressing percent of 63% is used, an animal with a dressing percent of 55.8% or lower would most likely fall into the bottom 20% and an animal with a dressing percent of 71.2% or above would most likely fall into the top 20%. Both of these values are extreme, which leads to the belief that categorical ranking is not impacted strongly by dressing percent for most animals.

Figure 4-9 RTR Probability-DrsPct Ratio



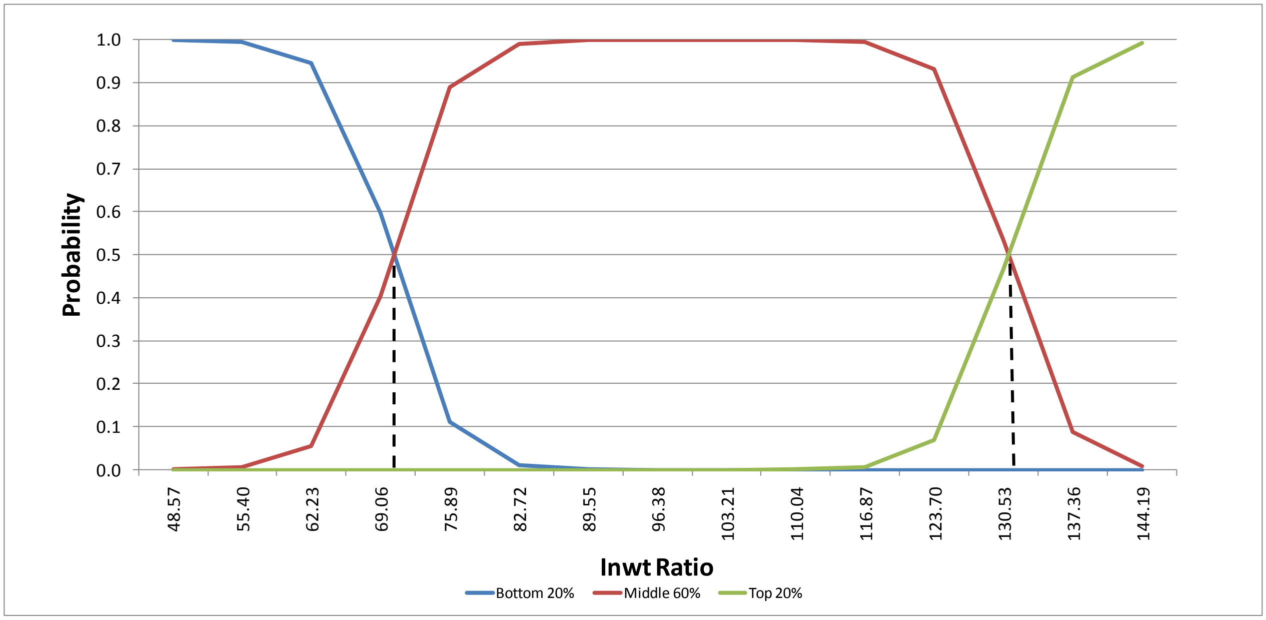
As displayed in Figure 4-10, NR probability with regards to the DrsPct ratio has crossover points are similar to RTR (approximately 86 and 114). This would translate into results like those of the RTR model, so the same conclusion can be drawn that most carcasses will fall into the middle 60% category and only in the extremes be classified top or bottom 20% when using DrsPct ratio probabilities.

Figure 4-10 NR Probability-DrsPct Ratio



Receiving weight is of high importance to RTR profitability because it is the one measure that can be used to predict animal characteristics at an earlier age. Figure 4-11 illustrates crossover points at roughly a ratio of 70 for bottom to middle and 131 for middle to top. If the average for the lot is 600 pounds at receiving, this would mean a 420 pound animal would most likely be in the bottom 20% and a 786 pound animal would most likely be in the top 20%. While this seems like a huge spread for animals that were born at approximately the same time, actual weight values in the data show that it is possible.

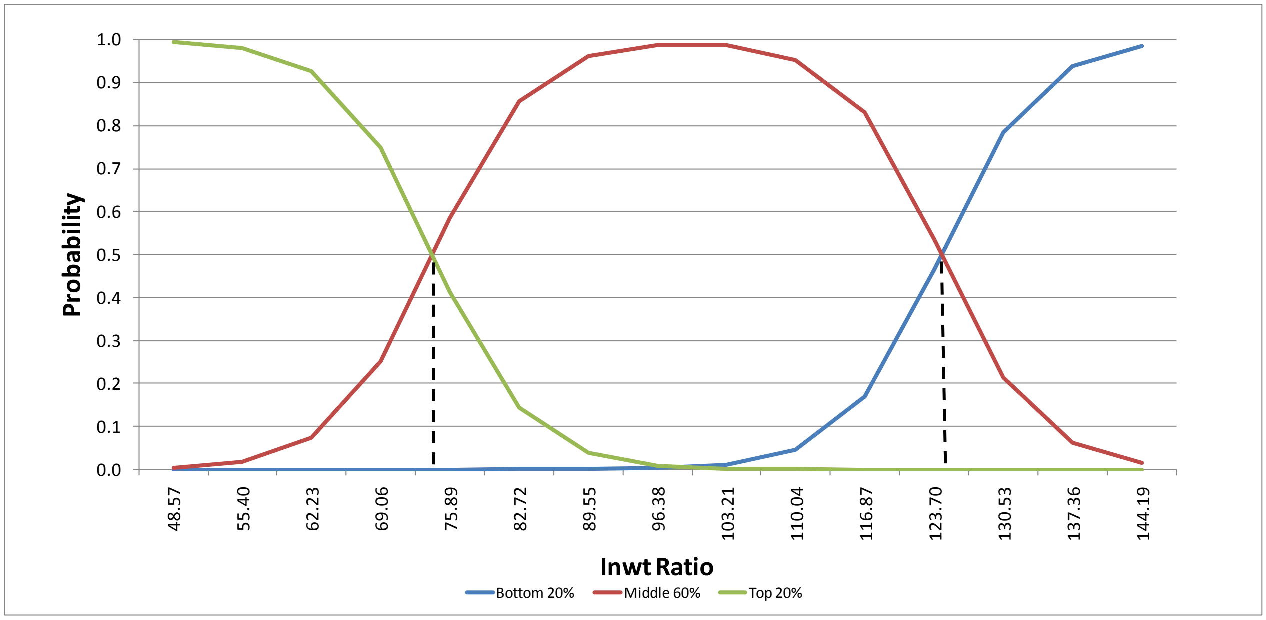
Figure 4-11 RTR Probability-Inwt Ratio



In the NR model, displayed in Figure 4-12, Inwt ratio has a negative coefficient suggesting a higher receiving weight animal will be more likely to receive lower NR. Therefore, probabilities are much different than the RTR model. Crossover points are seen close to 74 for top 20% to middle 60% and 124 for middle 60% to bottom 20%, which means an animal that is 74% of the average will be more likely to be in the top 20% and an animal that is 124% of the average will most likely be in the bottom 20%. If an average of 600 pounds is again compared, an animal more than 744 pounds will most likely be in the bottom 20%. As discussed earlier, a heavier feeder will be worth more at receiving relative to the others in the group, so even if that animal performs equally to the other animals in feedlot and carcass performance, it will have a lower NR. This does not directly mean that heavier calves have worse performance in the feedlot; it suggests that some may be more profitable to sell as live feeders than to finish out. Also, with a 600 pound average, an animal less than 444 pounds will be most likely in the top

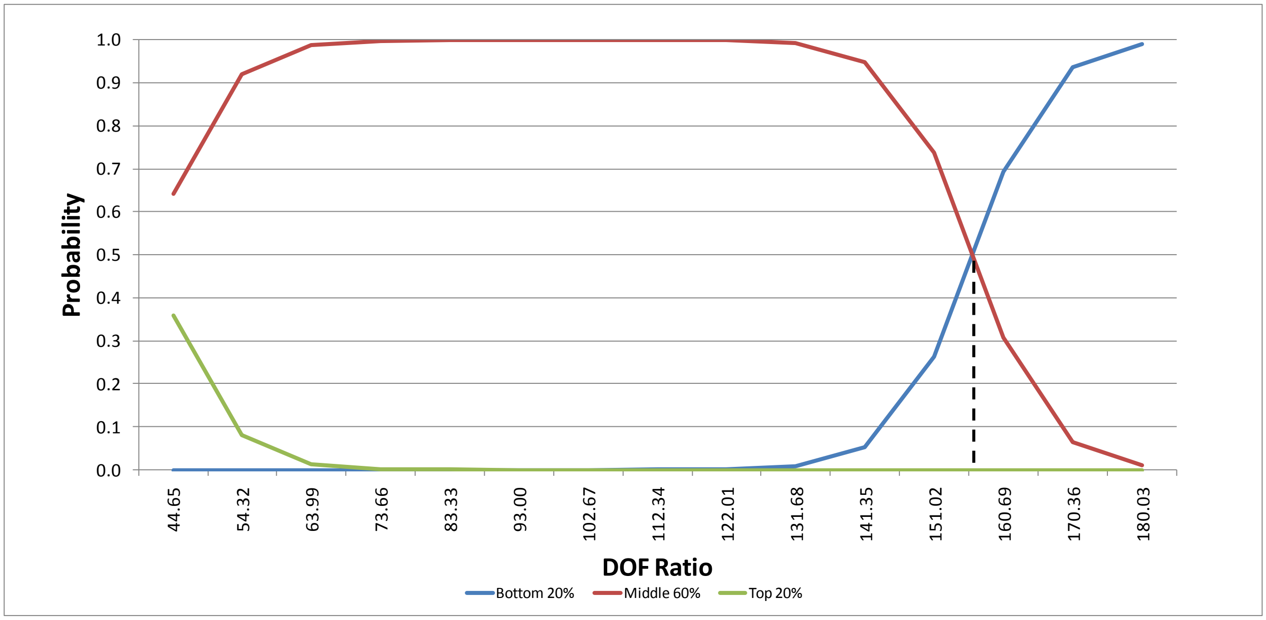
20%, which shows that lower weight feeder calves are likely to add more value in the feedlot and would not be better off sold at a live feeder price.

Figure 4-12 NR Probability-Inwt Ratio



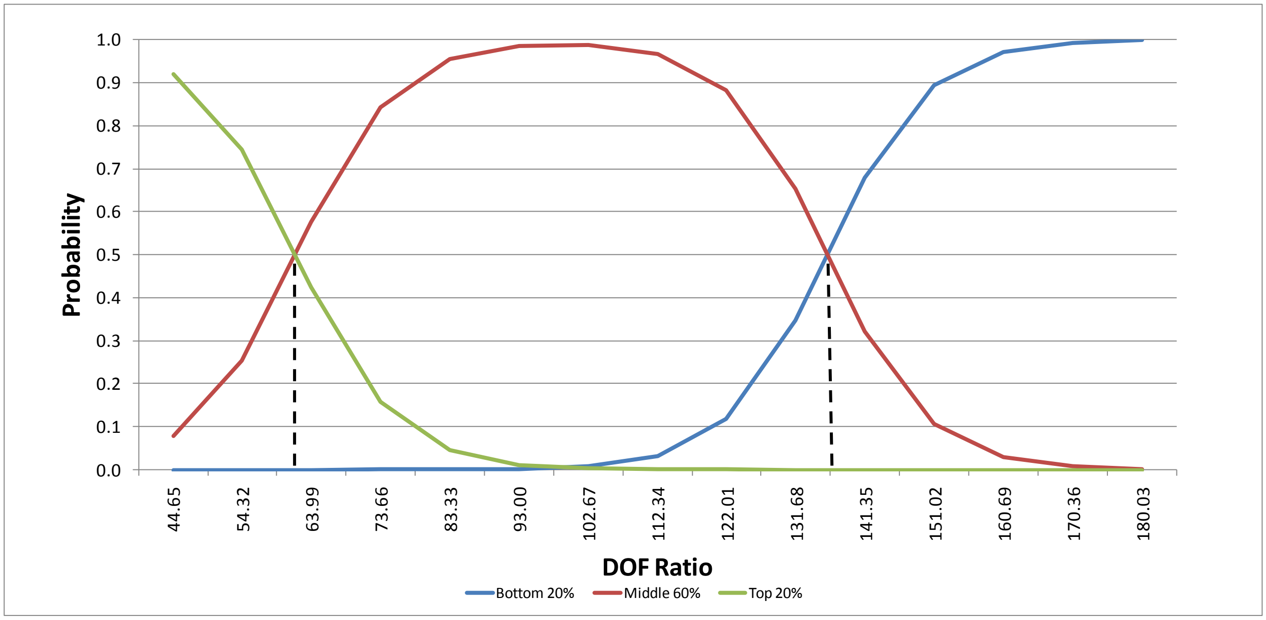
As discussed in Section 4.2, DOF is a measure that is conflicting from the point of longer or shorter being better. Figure 4-13 shows RTR probabilities for DOF ratio, where only one crossover point is seen at around a ratio of 157 between the middle 60% and the bottom 20% categories. If the average animal is fed 160 days, a DOF ratio of 157 would show animals fed fewer than 251 days would most likely to fall into the middle 60% category. This also means an animal fed more than 251 days would most likely be in the bottom 20%. This difference of near three months is very large, suggesting that DOF is not a main driver of animals being classified as top 20%, middle 60%, or bottom 20% for RTR profitability. Results do indicate, however, that shorter days to finish is more profitable than longer days to finish.

Figure 4-13 RTR Probability-DOF Ratio



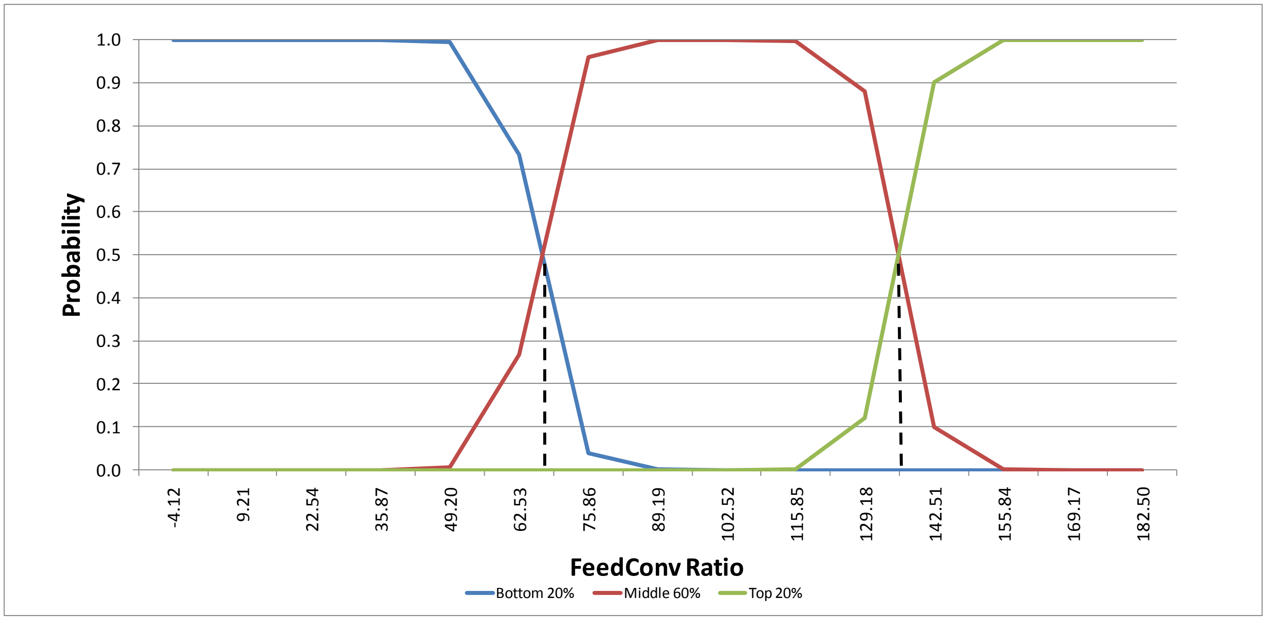
The NR model is affected much differently by DOF ratio than the RTR model, which was also seen in regression results. In the NR profitability graph (Figure 4-14), there are two crossover points near a ratio of 60 for top 20% to middle 60% and a ratio of 136 for middle 60% to top 20%. If 160 days is again used for comparison, an animal fed longer than 218 days will most likely be in the bottom 20% and an animal fed less than 96 days will most likely be in the top 20%. While this is still a large spread, it does suggest that DOF is more influential to NR than for RTR.

Figure 4-14 NR Probability-DOF Ratio



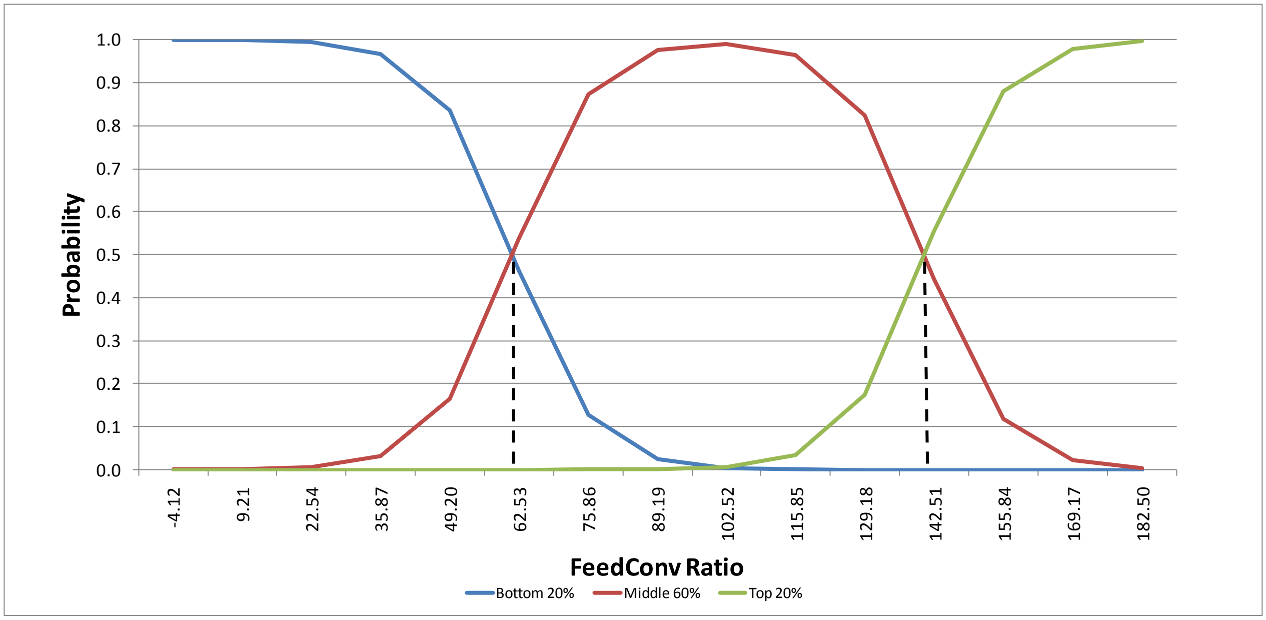
Feed conversion is a measure which appears to have a smaller range for animals to be included into the middle 60% with the RTR model, as shown in Figure 4-15, however extreme values in the data may make the graph appear misleading. Crossover points are approximately at ratios of 65 and 136 for bottom 20% to middle 60% and middle 60% to top 20%, respectively. Therefore, if the lot average is 6 pounds of feed per pound of gain, an animal that needs more than 8.10 pounds of feed to gain one pound will most likely be in the bottom 20%. This is a very large feed conversion and only actually occurs in 31 animals out of 6360 in the data, therefore, it can be concluded that only very poor feed conversion will push the animal into the bottom 20%. Likewise, an animal that needs less than 3.84 pounds of feed per pound of gain will most likely be in the top 20%. Again, this occurs infrequently in the data (16 out of 6360 animals), so only highly superior feed conversion will increase the chances of the animal being classified into the top 20% for RTR.

Figure 4-15 RTR Probability-FeedConv Ratio



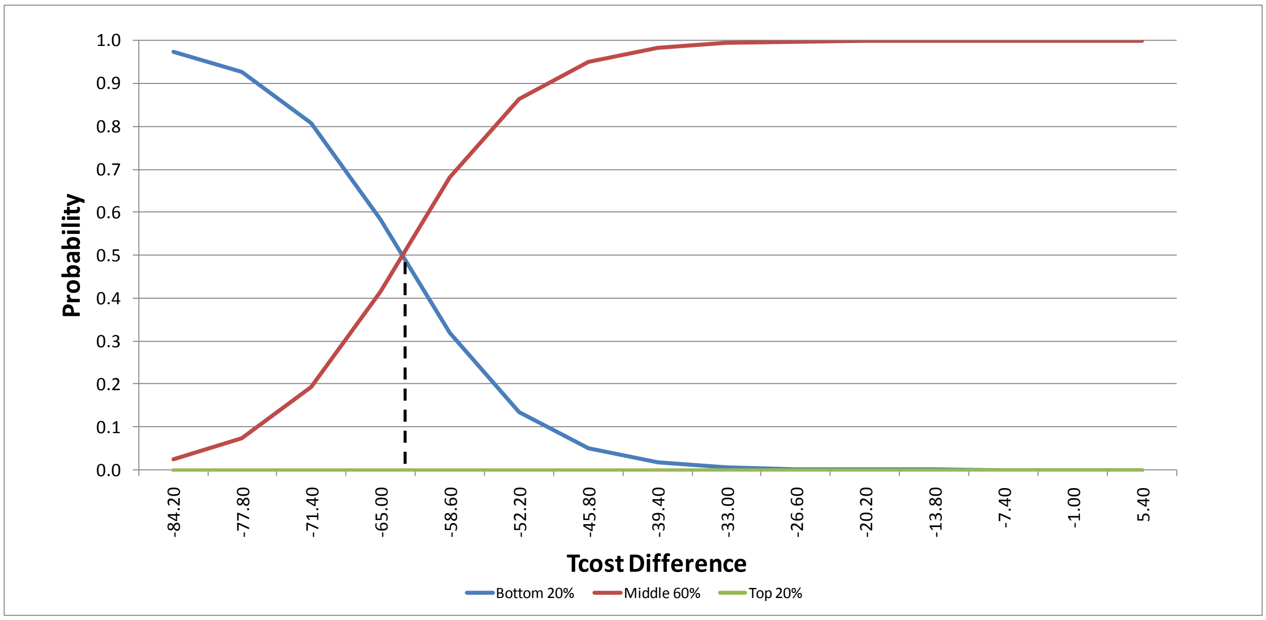
Similar results to the RTR model are seen in the NR model for FeedConv ratio, although the area for the middle 60% is slightly larger (seen in Figure 4-16). The bottom-to-middle crossover ratio is slightly smaller than the RTR model at a ratio of 61, and the middle-to-top crossover point is somewhat higher at a ratio of 141. For an average feed conversion of 6 pounds of feed per pound of gain, an animal that only needs 3.54 pounds or less of feed per pound of gain will most likely be in the top 20%. Likewise, an animal with a feed conversion greater than 8.34 will most likely be in the bottom 20% NR category. Again, there are both extreme values that occur infrequently in data, so like the RTR model, the conclusion is that most animals will not be pushed into the top 20% or bottom 20% because of their feed conversion.

Figure 4-16 NR Probability-FeedConv Ratio



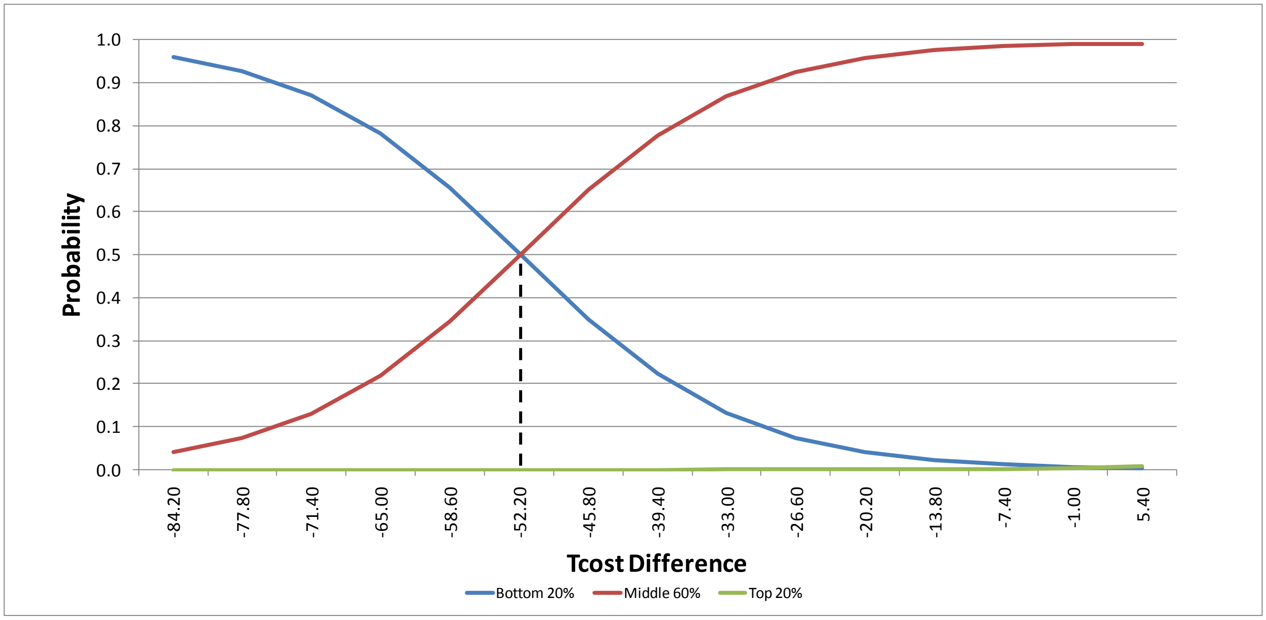
Illness is also of great concern in the feedlot because treatment costs will increase cost of gain and sickness can decrease performance of the animal as measured by other characteristics. Figure 4-17 shows how Tcost difference affects the probability of an animal being classified into the top 20%, middle 60%, and bottom 20% with respect to RTR. To review, tcost difference is calculated by taking the average treatment cost for to the lot group and subtracting the individual animal's treatment cost. Therefore, a positive value shows the animals was treated less than average and a negative value reflects an animal that was treated more than the average in that lot. Figure 4-17 shows only one crossover point at approximately -63 which is between the bottom 20% and the middle 60%. If this is compared to a lot average of zero (no treatment costs) an animals that requires $63 or more of treatment will most likely fall into the bottom 20%. This is a large amount of treatment, but keep in mind that all other characteristics are being held constant in this comparison. In reality, other characteristics such as feed conversion and days on feed would also be effected in an animal was sick, so most likely $63 is a high estimate. The model does show that healthy animals (zero of higher Tcost difference) are not more likely to fall into the top 20%. In the data, very few animals were treated (466 out of 6360), so this may change if illness more prevalent.

Figure 4-17 RTR Probability-Tcost Difference



The NR model shows a slightly smaller crossover point from bottom 20% to middle 60% when looking at Tcost difference (shown in Figure 4-18). This point is near -52, suggesting animals that are treated with costs $52 or more will most likely fall into the bottom 20%, when compared to an average lot where treatment costs are near zero. This again is an extreme value that only occurred in 12 animals out of 6360, but as stated above other characteristics would also be affected when an animal is treated for that severe of an illness.

Figure 4-18 NR Probability-Tcost Difference



4.4. Conclusions

All of these models highlight one measure as more important than anything else to cattle profitability: HCW. In both the RTR and NR regression models, HCW captured twice the variation in profitability difference than any other carcass or feedlot variable. Also, as seen in the ordered logit figures, there is a small range of HCW in which an animal is classified in the middle 60% category. Slightly heavier or lighter carcasses will push the animal into the top or bottom 20%. This suggests HCW is the primary measure of importance when deciding the optimal time to slaughter the animal.

Also in achieving higher HCW, care should be taken to avoid yield grade 4's and 5's or Standard and "out" carcasses. Any of these measures will most likely push the animal into the bottom 20% of the feedlot group and therefore may receive negative feedlot returns. In regression models, YG and QG both exhibit significant influence on the profit variation, so they must not be ignored if profitability is to be improved. Focusing on avoiding discounts is also shown to be more important than receiving premiums for both YG and QG, which is consistent to earlier studies (Johnson and Ward 2006).

Receiving weight has complicated relationships to profitability. RTR models show that animals with a higher InWt ratio will be more likely to finish at a higher HCW ratio and therefore a higher RTR. However, in the NR models, InWt ratio has a negative coefficient, suggesting that the heaviest weight calves when entering the lot may not be the best performers of the lot. What these results suggest is that weight is not a good measurement, by itself, to determine which calves should be sent to the feedlot and which should be sold as feeders.

Days on feed and feed conversion are also variables that have mixed connections to profitability. In regression models, DOF ratio appears to explain more variation in NR than RTR, which is also seen in the probability models, where the interval for middle 60% is smaller for NR than RTR. Feed conversion is more consistent across models and probability measures, and shows significant importance to variation in profitability, but not as much as other measures.

Dressing percent also has similar impacts across all models. DrsPct ratio explains similar variation in NR and RTR when studying regression models and probabilities are almost equal when looking at ordered logit models.

Illness is known to be very important to profitability in the feedlot, however because this producer has controlled illness quite well, treatment costs only affect returns when the animal is very heavily treated. Tcost difference had very small STB coefficients in OLS models and only affected return probabilities when cost exceeded $50. It is expected that illness would have more relative influence on profitability if more animals had gotten ill.

Overall, the findings for this individual herd highlight what previous studies have shown to be true for large numbers of cattle across many herds. HCW is most important to profitability, while avoiding yield grade 4's and 5's, and quality grade Standard and "out" carcasses. Obtaining price premiums enhances revenue, but models show that their relative importance to profitability is low. Feed conversion is also important, but may be a measure harder to study or control since individual feed consumption is difficult to determine before the feedlot stage.

Chapter 5 – Weaning Weight as a Predictor of Profit

5.1. Introduction

Chapter 4 highlights important relationships in feedlot and carcass characteristics that drive profitability, but being able to predict these characteristics before feedlot placement is what would be most advantageous to choosing optimal marketing channels for cattle. Ultrasound technology can be effective in measuring backfat and rib-eye area on an animal starting as early as weaning (Walburger and Crews 2004), but the cost to a ranch of having this technology and training to use it may not be worth the returns that it could potentially generate. Physical measurements, such as weight or frame score, are more commonly used on calves to predict future value.

This chapter will study issues of predicting future value on animals at an early stage of production and compare these measurements to known profitability of the animal after feedlot finishing and slaughter. Specifically, weaning weight of a calf will be compared to Net Return and Return to Ranch, given that weaning weight is the most common measurement taken on calves and most frequently used for evaluation.

5.2. Methods

Because not all calves in this herd have birth and weaning information, not all calves can be used for this analysis. Also, if only some of the calves in a lot group have birth and weaning information, it is not appropriate to make comparisons to the whole group. Therefore, this analysis only used lots with 50 or more calves having birth and weaning information and removed lots that were missing birth and weaning information on a large number of calves. Summary statistics for this subset are shown below:

Table 5-1 Summary Statistics for Data used in Weaning Weight Analysis

Lot Number	# of Animals	Sex	Birth Year	Avg. Birth Wt. (lbs.)	Avg. Adj. 205-Day Wean Wt. (lbs.)
998305	436	Steers	1998	83.73	490.00
934500	498	Steers	1999	85.43	507.56
29701	70	Steers	2000	87.90	411.25
34701	664	Steers	2000	85.31	480.21
212802	64	Heifers	2001	76.16	474.22
243803	504	Steers	2002	85.44	549.07
347404	356	Steers	2003	85.29	513.12
453605	498	Steers	2004	83.88	515.60
555406	440	Steers	2005	83.57	504.72
652107	465	Steers	2006	82.55	500.53
712307	60	Heifers	2006	74.63	529.85
Total	4055	Total Average		83.08	497.83

These restrictions resulted in reducing the data set from 6,360 observations to 4,055 observations. Another modification had to be made to the data to standardize the age at which the calves were weaned because, even if calves were weaned on the same day they may have been born numerous days apart. To accomplish this, an adjusted 205 day weaning weight calculation from the Beef Improvement Federation Guidelines (2002) was used. This equation is as follows:

Adj. 205-Day Weaning Wt. = (5.1)

$$\left[\left(\frac{(Weaning\ \ Wt.-Birth\,Wt.)}{Weaning\ \ Age}\right)*205\right]+Birth\,Wt.+Age\ of\ Dam\ Adjustment.$$

The *Age of Dam Adjustment* is used to standardize for the age of the cow and the sex of the calf. Heifer calves are known to be lighter weight compared to similar aged steers, and dams 2-4 years of age or over 11 years of age are known to have lighter weight calves than middle aged cows, so weight is added to these disadvantaged animals to make up for these issues in a normal situation. Because this analysis is comparing weaning weight performance to end profits, it would not make sense to use this age of cow adjustment. If smaller calves at 205 day weaning actually have decreased performance in the feed yard, this needs to be captured in the analysis, and may not be if age of dam adjustment were included. Heifer and steer calves are not included in the same lot group, so comparisons between sexes are not an issue. Age of dam will be studied separately in Chapter 7, so it is not studied here. The goal is to compare weaning performance to standardized profitability; therefore, using this equation without the age of dam adjustment gives a weaning weight standardized for 205-days. The calculation will still be referred to as the adjusted 205-day weaning weight because it does adjust the weight to a 205-day reference point.

This adjusted 205-day weaning weight can then be converted to a ratio so that calves are compared to their peers in the feedlot group. As discussed earlier, the use of ratios helps to take out influences of weather and management practices across time periods and indexing calves relative to cohorts makes it so calves are being compared against other calves that have equal performance opportunities. The calculation for Adjusted 205-Day Weaning Weight Ratio is (Beef Improvement Federation 2002):

$$\textit{Adj. 205-Day Weaning Wt. Ratio} = \left(\frac{Individual\ \ Adj.205\ Weaning\ \ Wt.}{Group\ \ Average\ \ Adj.205\ Weaning\ \ Wt.}\right) *100. \qquad (5.2)$$

With this adjusted 205-day weaning weight ratio, calves can be ranked into performing in the top 20%, middle 60%, or bottom 20% in their lot group. This ranking is used to compare to Net Return and Return to Ranch ranked measures (as they were computed in Section 4.2) to see what percentage of the time a calf that performs in the top 20% weaning group also performs in the top 20% feedlot group, and vice versa. (Weaning group and Feedlot group would contain the same animals.)

The percentage distributions of top 20%, middle 60%, and bottom 20% are compared between weaning rank and both return rankings and tested for statistical significance using Chi-Square Goodness of Fit. A Chi-Square statistic tests if the observed proportions from the actual data differ from a known proportion (UCLA: Academic Technology Services 2009). In this case, the known proportion would be 20% top, 60% middle, and 20% bottom. If the observed proportion in the data varies significantly from the expected proportions, we can conclude that the weaning weight ranking of a calf provides predictability to future RTR or NR profitability ranking.

To examine relationships between weaning weight and feedlot and carcass measures, correlations are also presented using the weaning weight ratio calculation described in Section 5.2 and ratio calculations for HCW, YG, QG, Inwt, DrsPct, DctHCW, FeedConv, ADG, and DOF as they were calculated in Section 4.2. If weaning weight can predict profit measures, these correlations will explain what components of profitability are driving predictions.

5.3. Results

Tables of Return to Ranch and Net Return categorical distributions for each Adjusted 205-Day Weaning Weight class are shown in Table 5-2 through Table 5-4. Each table presents one weaning weight class and shows the percents of those calves in their RTR and NR class ranks. In each table, if the return distribution is statistically different from the 20%-60%-20% comparison distribution, this indicates the relative weaning weight ratio (as calculated in equation 5.2) provides information useful in predicting relative Return to Ranch or Net Return.

Table 5-2 below presents the RTR and NR class rankings for all of the calves that were categorized into the bottom 20% when evaluated by adjusted 205-day weaning weight ratio. RTR class rankings show that a calf that falls into the bottom 20% of its group when using an adjusted 205-day weaning weight ratio is 13.66% more likely to fall into the bottom 20% of its feedlot group. Likewise, a calf in the bottom 20% of its weaning group is 10.01% less likely to be included in the top 20% and 3.65% less likely to fall into the middle 60% for RTR ranking.

The adjusted 205-day weaning weight class shows a smaller difference from the base distribution for Net Return classes. Compared to a 20% bottom, 60% middle, and 20% top distribution, a calf in the bottom 20% of the weaning group is 1.82% more likely to be in the top 20% of NR profitability group and less likely to be in the middle or bottom group.

Table 5-2 Bottom 20% of Adjusted 205-Day Weaning Weight Class

	Frequency (# of animals)	Observed (%)	Comparison (%)	Difference (Percent-Comparison)
Return to Ranch Class				
Bottom 20%	273	33.66	20	13.66
Middle 60%	457	56.35	60	-3.65
Top 20%	81	9.99	20	-10.01
Net Return Class				
Bottom 20%	158	19.48	20	-0.52
Middle 60%	476	58.69	60	-1.31
Top 20%	177	21.82	20	1.82

As shown by Table 5-3, calves that are included in the middle 60% of their weaning group, determined by adjusted 205-day weaning weight, are 2.80% more likely to be included into the middle 60% of their RTR group. These calves are also less likely to be in the bottom 20% or top 20% of their RTR group at 1.09% and 1.71%, respectively.

NR class differences from the base are small. These percents show that a calf that is in the middle 60% of the weaning group is 0.89% less likely to be in the top 20% of the NR group. Also, animals are almost 0.5% more likely to be in the bottom or middle of their NR group, if they were in the middle 60% of their weaning group.

Table 5-3 Middle 60% of Adjusted 205-Day Weaning Weight Class

	Frequency (# of animals)	Observed (%)	Comparison (%)	Difference (Percent-Comparison)
Return to Ranch Class				
Bottom 20%	460	18.91	20	-1.09
Middle 60%	1528	62.80	60	2.80
Top 20%	445	18.29	20	-1.71
Net Return Class				
Bottom 20%	497	20.43	20	0.43
Middle 60%	1471	60.46	60	0.46
Top 20%	465	19.11	20	-0.89

Table 5-4 reveals that calves classified into the top 20% of their weaning group have a 17.48% increased likelihood of being classified as top 20% for RTR ranking. These calves are also 13.96% less likely to be in the bottom 20% and 3.53% less likely to be in the middle 60% for RTR class ranking.

Differences in NR classes are again small. Calves in the top 20% of their feedlot group are 1.50% less likely to be in the bottom 20% of the NR group and 1.53% more likely to be in the middle NR group. The distribution also shows that calves classified into the bottom 20% of their weaning weight group are 0.02% less likely to be in the top 20% of their NR group ranking. This seems odd, but is not likely a statistically significant relationship.

Table 5-4 Top 20% of Adjusted 205-Day Weaning Weight Class

	Frequency (# of animals)	Observed (%)	Comparison (%)	Difference (Percent-Comparison)
Return to Ranch Class				
Bottom 20%	49	6.04	20	-13.96
Middle 60%	458	56.47	60	-3.53
Top 20%	304	37.48	20	17.48
Net Return Class				
Bottom 20%	150	18.5	20	-1.50
Middle 60%	499	61.53	60	1.53
Top 20%	162	19.98	20	-0.02

Chi-Square goodness of fit tests were computed on these distributions to find statistical significance of weaning weight class differences on Return to Ranch and Net Return classes. The null hypothesis is that return rankings will follow a 20%, 60%, 20% distribution for each adjusted 205-day weaning weight class. Table 5-5 below summarizes these tests.

Table 5-5 Statistics for Weaning Weight Class by Return to Ranch and Net Return Class

	Statistic	Degrees of Freedom	Value	Probability
RTR Class	Chi-Square	4	331.35	<.0001
NR Class	Chi-Square	4	4.04	.4003

* Sample Size= 4,055 animals

Chi-square goodness of fit test shows that the adjusted 205-day weaning weight classification of an animal is statistically significant at the 0.01 level in distributional differences of RTR class from a 20%, 60%, 20% distribution. This means that the null hypothesis is rejected for RTR class and data is significantly different from a 20%, 60%, 20% distribution. Distributional differences in NR class by weaning weight class were not statistically significant according to the Chi-Square test, meaning the null hypothesis is not rejected. This signifies that adjusted 205-day weaning weight could be useful for predicting future RTR but not NR. Since RTR measures the return to all activities prior to feedlot entry, it makes sense that better performing calves on the ranch should receive better returns. NR measures feedlot and carcass performance only, so earlier stages of life appear to be less influential on this return value.

To know what feedlot and carcass measures are most influential on profit predictability by using an adjusted 205-day weaning weight ratio, correlation values are presented in Table 5-6.

Table 5-6 Correlation of Weaning Wt. to Carcass and Feedlot Measures

	HCW ratio	QG ratio	YG ratio	InWt ratio	FeedConv ratio	ADG ratio	DOF ratio	Drspct ratio	DctHCW ratio	Tcost difference
Adj. 205-Day Weaning wt. ratio	0.23	-0.06	-0.04	0.63	-0.10	0.18	-0.28	0.03	-0.06	-0.03

Inwt ratio has the largest correlation with adjusted 205-day weaning weight ratio at 0.63. This is not surprising since calves that are in the same lot group are backgrounded a similar amount of days until entering the feedlot. Unless a calf gains well or poorly during the time period between weaning and entry into the feedlot, the ratio of how well a calf performed relative to the group at weaning should be about the same as how well they performed relative to the group at the time they entered the feedlot. It is not a perfect correlation because feedlot receiving weight does not account for the age of the calf, as adjusted 205-day weaning weight does, so younger calves will be disadvantaged in receiving weight. Other correlations are small. DOF ratio is correlated with adjusted 205-day weaning weight ratio (0.28), which suggests a heavier weaned calf tends to finish with fewer days on feed. This is also seen in the positive correlation of ADG ratio (0.18); a heavier calf at weaning tends to have better ADG in the feedlot. This contrasts earlier findings, but because the correlation is small it may not be accurately capturing the relationship. HCW ratio is correlated with adjusted 205-day weaning weight ratio at 0.23 showing that a heavier weaned calf also tends to finish at a larger weight relative to the group. Since it was previously established that HCW is the biggest driver in profitability, this relationship is important in explaining why a larger calf at weaning would tend to have better RTR profitability.

Other measures are only slightly correlated with adjusted 205-day weaning weight ratio. Both YG and QG ratios display negative correlation but are essentially zero (-0.04 and -0.06, respectively). FeedConv ratio is negatively correlated suggesting that a heavier weaned calf will have worse feed conversion in the feedlot, but again the correlation is small. DrsPct ratio has a positive correlation, though it too is essentially zero (0.03). All of these correlations are very small, so conclusions are that they are not highly related to adjusted weaning weight in pair-wise fashion.

To sum up explanations, the adjusted weaning weight ratio provides predictability in RTR mainly because of relationships with receiving weight, hot carcass weight, and efficiency measures. A relationship between adjusted 205-day weaning weight and NR is not seen most likely because of receiving weight's relationship to NR. Since receiving weight is used to calculate the value of the calf at receiving and this value is then subtracted in the NR calculation, a well performing calf at weaning and feedlot receiving has a tendency to get penalized in NR if it did not continue its superior performance in the feedlot. Even though heavier calves at weaning tend of achieve a higher HCW, the NR is offset by their higher value as feeders.

Therefore, weaning weight can be a predictor for overall profitability, but not feedlot profitability.

5.4. Conclusions

Weaning weight is one of the common individual measurements taken on a calf, and therefore commonly used for evaluation. As discussed in previous chapters, many producers do not retain ownership of their calves, so sale occurs at weaning or after backgrounding. In this situation, calves are usually sold mostly on the basis of weight, so adjusted weaning weight ratio can be a great indicator of calf performance relative to the group. When ownership is carried out until slaughter, evaluations are not so easy. The calf has a much longer time to perform, and characteristics other than weight are also important.

Adjusted 205-day weaning weight shows predictability to Return to Ranch profit, meaning weaning weight can be used to forecast total life cycle profitability, however the relationship is not perfect. Calves that perform in the top 20% when looking at adjusted weaning weight class still fell into the bottom 20% of Return to Ranch class over 5% of the time. Likewise, calves that were classified in the bottom of the group using adjusted weaning weight made the top classification of RTR over 10% of the time. Implications of these results are that adjusted 205-day weaning weight is a useful forecasting tool, but will not predict accurately every time.

Correlation values show that heavier calves at weaning tend to be heavier when entering the feedlot, have less days on feed, and finish at a higher hot carcass weight. These relationships are also not perfect, but do support RTR distributional findings; that larger calves at weaning are generally better in the overall performance.

Carcass quality measurements of YG, QG, and DrsPct do not show strong correlation to adjusted 205-day weaning weight, which highlights a large problem for the beef industry. When producers use weaning weight as the only measure of calf evaluation, quality characteristics are not being captured. Genetics for higher quality animals will not likely improve when weaning weight is used as a selection tool. For cattle producers who are trying to achieve higher hot carcass weights (and increased revenue), using adjusted 205-day weaning weight to evaluate calf productivity can be useful, as long as quality components do not drop so much that large discounts are received in the marketing grid.

The limited accuracy of weaning weight predictions for future profitability suggests that other measures of performance should be explored on weaning age calves to try to forecast profitability more accurately. Using other physical measurements such as frame score or primary breed type may boost predictability along with weaning weight, or ultrasound benefit/cost analysis could be studied at the ranch level. The reality is that, in a situation where weaning weight is the only measure recorded, profit predictability and quality evaluation is difficult.

Chapter 6 –Maternal influence on Profit

6.1. Introduction

There are many studies and guidelines published to help producers make culling decisions based on characteristics of their calves up until weaning. Most popular among these production measures is MPPA, or Most Probable Producing Ability, which is based on adjusted weaning weights of a cow's calves, relative to the other calves produced in a given year. Few studies have evaluated a cow's production when the overall end product is considered and if this information is useful in making management decisions.

One of the main reasons this type of research is not performed is because most producers do not retain ownership of their feeder calves, so tracking where the calves went after they were sold is challenging. Furthermore, the slaughter facility calves eventually end up in may not collect and supply back to the producer individual carcass data. For producers who sell their calves as feeders, the main attribute factored into price is the weight of the calf, so a heavier calf generates more revenue. Sex is also considered in the price, however, quality factors of an animal are based on only visual assessment and may or may not individually influence price. There is a much smaller incentive at this level for a producer to be concerned about cattle quality or probable feeding performance versus weight. As a result, cattle quality in the entire industry will be slow to improve in such a marketing environment.

A manager can use MPPA and other physical measures on a cow to assist them in making culling decisions, but this may not be helping the beef industry as a whole to produce a better meat product. The true potential of the calves may not be realized at weaning. With retained ownership, revenue is determined by weight and quality attributes at the time of slaughter, so knowing and being able to predict these can be advantageous. This incentive to improve quality is what could improve the entire beef market, however since not many producers retain ownership, improvements may be minimal.

Another confounding problem of feedlot and carcass evaluations is that the cow producing the feedlot animal is only a small part in this overall puzzle, and evaluating her performance is hard to do until she is already deep into her useful life. On many ranches, heifers are kept as replacements or sold as replacements in other markets, so by the time a cow has three calves with feedlot and carcass data she might be 7-8 years old (if her first calf was at two years, and her calves were half heifers and half steers). By the time an evaluation can be conducted on this scale, she may be too old to breed again anyway. Along with this is the problem that cows represent only 50% of the genetic make-up of the calf. Unless the same bull or very similar bulls were used across all cows in all years, there will be a lot of unaccounted variation. With this data set herd bulls are used to pasture breed, so the sire of the calves is unknown. The best this evaluation can do is to focus on the cows, but it is not surprising to see inconsistencies in offspring of the same cow across different years because it may be a different bull that she was bred to. In a setting where artificial insemination is used, sire records may be kept and a more accurate evaluation performed. In future research, it would be good to study this issue.

Previous research has shown that the total maternal genetic effect of the cow on its offspring is small when looking at carcass traits (Rios-Utrera et al. 2005). This would imply that decisions to cull cows based on their calves' performance would be erroneous. This seems hard to comprehend, however, since suggests that there is no value in knowing information about a cow's offspring. If this were true, cow evaluation would have to stop at having a live calf, being able to reproduce again, and not have any physical or temperamental problems.

This question of evaluating cow performance based on offspring's whole life cycle performance will be studied in this chapter. Life cycle performance involves incorporating measures of the calf from the ranch all of the way to the rail (slaughter facility) and trying to account for other factors that were due to management and environment, not cattle genetics. The main objective is to come up with a method of cow evaluation based on calculated profitability using feedlot and carcass data, assess the legitimacy of this evaluation, and make recommendations for how the results could be utilized for management decisions.

6.2. Methods

The initial set of 6,360 calves from 29 lot groups were used to evaluate calf performance relative to its feedlot group. A difference calculation between the calf and the average for the lot quantifies how much better or worse a calf performed relative to other calves that were raised in similar management and environmental conditions. This calculation is performed in Section 4.2 on both Return to Ranch (RTR) and Net Return (NR) profitability measures.

Cow production is then evaluated using these values. Since not every calf has data to tie back to the cow, some cows in the herd were young and only had one or two calves, and some calves were retained for replacements and not sent to the feedlot, not all animals can be used in this evaluation. Also, to evaluate consistency, an individual cow has to have enough calves to make meaningful comparisons. Out of 6,360 calves, 1,337 were able to be matched with cows that had three or more calves with feedlot and carcass information, which equated to the evaluation of 391 cows.

For each of the 391 cows, a mean and standard deviation of all calves produced was calculated for both Return to Ranch and Net Return difference measures. Since all cows did not have the same number of calves, standard error is used so cows can be comparable. Standard error was calculated as:

$$SE\ of\ cow = \frac{Standard\ \ Deviation\ \ of\ Calves\ Produced}{Square\ \ Root\ \ of\ Number\ \ of\ Calves}. \qquad (6.1)$$

From this, a 95% confidence interval for each cow was calculated to represent the interval expected to contain the profitability difference values of the cow's calves. This was calculated by:

$$Confidence\ Interval = Calculated\ Mean\ of\ all\ Calves\ \pm (1.96*SE). \qquad (6.2)$$

The average difference value of zero was used to evaluate the performance of a cow based on her confidence interval. Zero is the overall mean of the profitability difference since a difference of zero would represent a calf that is exactly equal to the average for the lot group. Therefore, cows that have confidence intervals above zero, contain zero, or below zero represent cows that are above average, average, or below average, respectively for all of the calves they have produced. For example, if a cow's confidence interval had a minimum value above zero, this would be interpreted as, with 95% confidence, this cow will always produce calves that are above the average for the lot group to which they belonged. By taking a numerical count of all cows above average, average, and below average, the consistency of cow production can be assessed.

Along with this evaluation, the question comes up that even with completely random variation, some cows will always appear above or below average, so how truly meaningful is the discovered relationship? To answer this, a simulation was run to randomly assign the 1,337 calves to the 391 cows and calculate confidence intervals on this simulated data set. The simulation was run one hundred times and corresponding confidence intervals and counts of above average, average, or below average cows were made. The average counts for all 100 trials were used to compare to the actual data. If actual cow production is more consistent than a random situation, there should be more cows that have above or below zero confidence intervals. In other words, cows should be more consistently producing above or below average calves and fewer cows should be producing a mixture of each. This is a way to evaluate how meaningful or accurate cow assessments can be when lifetime performance of calves is used as the appraisal tool.

6.3. Results

In explaining the results of this analysis, first it needs to be pointed out that the actual mean of the profitability differences of the 1,137 calf subset is not zero; it is actually $5.82 per head for Net Return and $11.02 per head for Return to Ranch. This would be interpreted as the average calf in this subset brings a $6.03 per head higher NR (or $11.23 per head higher RTR) than the average of the 6,360 calves. There could be a number of reasons why this is the case. One suggestion may be that the calves that were purchased and backgrounded on the ranch (calves that do not match to the cows) are of a lower quality than the calves that were raised on the ranch. This producer has been purchasing feeder heifers to raise as replacements or to send to the feedlot if they failed to breed. If these heifers were of inferior quality to the raised calves, this would explain why calves that could be tied back to cows are more profitable. Another reason could be that calves from first time heifers and second time cows are not as profitable as calves from older cows (only cows with three or more calves were included, so calves from younger cows are not in the 1,337 subset). This question of cow age influence will be explored in more detail later in the study, but for now it can be considered a possibility. A third option is that this producer is doing a good job of identifying poor producing cows after their second calf and eliminating them before they have a third calf. Whatever the reason, because of this higher mean in the subset, it would make sense that the results show more cows having above average confidence intervals than those that have below average confidence intervals.

This is seen in the results below. Table 6-1 displays data for both profitability difference measures and compares the actual numbers of cows and the percents that fall into each category.

Table 6-1 Cow Confidence Interval Summary

	Return to Ranch		Net Return	
	# of Cows	% of Total	# of Cows	% of Total
Above Zero	69	17.65%	53	13.55%
Contain Zero	297	75.96%	313	80.05%
Below Zero	25	6.39%	25	6.39%
Total	391	100%	391	100%

The distribution of differences for NR and RTR are approximately normal when visually appraising. It would make sense then, that a large number of cows have confidence intervals that contain the mean, since that is where the highest concentration of calves would be. The cows that have confidence intervals on the extreme ends of the spectrum (above or below zero) are the cows that are of most value for genetic improvement of the herd. As mentioned above, for a variety of possible reasons there are more cows that are above the average than below.

The easiest interpretation of the distribution would be to cull cows that always produce below average calves and then to retain replacement heifers from the cows that always produce above average calves. While this seems logical, the relationship is not that direct and conclusive. It would have to be studied in more detail the actual magnitude of the loss of revenue/profit in calves from these below average cows. If these calves are still generating an adequate return for the producer, culling the cows that produce them may not be the most profitable solution. Statistically, there will always be "below average" calves no matter how good the actual quality of the entire herd. Because of this, there will always be cows that produce below average calves, but the losses in profit due to them need to be quantified before direct culling is performed. Also, in deciding what heifers to retain, there must be other considerations made along with the historical production of the dam of the replacement. The physical attributes of the heifer, the reproductive ability, health, and most importantly needs of the ranch all have to be taken into consideration when selecting which heifers and how many heifers to retain. It must be recognized that cows that are producing in the average category are good candidates for heifer retention. Genetics tell us that performance traits are not perfectly heritable, so these average cows could easily produce heifers that would adequately suit the ranch's needs. A manager, however, should question the use of the below average cows as seed stock for replacements.

All of this being said, the question of the accuracy of these assessments does arise. In other words, is cow production consistent enough to make evaluations based on historical calf performance? Table 6-2 and Table 6-3 show distributions of the actual data compared to the averages of 100 simulations in randomly matching the 1,337 calves to the 391 cows. In each table, the sum of the number of cows and the percentage of the total cows (391) are listed for confidence intervals below zero, containing zero, and above zero for the actual data and the average of the simulations.

These results show that the actual data are not largely different from a random generation of matching calves to cows. If cow production was highly consistent, there should be a higher majority of the cows in the above and below categories and fewer in the middle. This relationship is to some extent reflected in the actual data, since more cows that fall into above and below zero categories than the simulation would predict. However, the difference in cows in the above and below average categories is not a large amount, ranging from 0 to 15 cows, or 0.02% to 3.72%, but keeping in mind that studies have previously found maternal effect to be small, so this is not a surprising result. It is clear that factors other than the genetics and mothering ability of the cow are playing a role in determining the profitability of the calf.

Table 6-2 Return to Ranch Simulation Results

	Above Zero	Contain Zero	Below Zero	Total
Actual Data (# of Cows)	69	297	25	391
Actual Data (% of Total)	17.65%	75.96%	6.39%	100%
Avg. of Simulations (# of Cows)	54.46	316.68	19.86	391
Avg. of Simulations (% of total)	13.93%	80.99%	5.08%	100%
Difference* (#of Cows)	14.54	-19.68	5.14	
Difference* (% of total)	3.72%	-5.03%	1.31%	

*Difference is calculated as (Actual data-Simulation data)

Table 6-3 Net Return Simulation Results

	Above Zero	Contain Zero	Below Zero	Total
Actual Data (# of Cows)	53	313	25	391
Actual Data (% of Total)	13.55%	80.05%	6.39%	100%
Avg. of Simulations (# of Cows)	44.67	321.4	24.93	391
Avg. of Simulations (% of total)	11.42%	82.20%	6.38%	100%
Difference* (#of Cows)	8.33	-8.4	0.07	
Difference* (% of total)	2.13%	-2.15%	0.02%	

*Difference is calculated as (Actual data-Simulation data)

6.4. Conclusions

Cattle production is typically an industry where profit margins are small, so magnitude difference in one animal to the average of the lot can become significant to profitability quickly. To improve profitability, two options are logical; reducing variability in cattle quality and increasing overall cattle quality. A method that is used all too readily to try to accomplish this goal is to blame the cow that had the unprofitable calf and get rid of her. However, as these results point out, the cow is only a small part in a great number of factors that determine an animal's profitability.

These data suggest that cow performance is not much different than a totally random distribution of calves matched to cows. Therefore, the validity of using these results to make managerial decisions is an issue. However, it does not seem that these results are totally useless either. Since more cows appear in the above average and below average of the distribution than a random generation, there is some significance as to that actual performance driving them into those categories than just getting lucky to be matched with good calves. A conservative and rational approach would be to use this information as a component in cull and replacement cattle selection; not as a prime factor. In an aggressive culling situation, such as a drought or consolidation of the business, it may make more sense to eliminate the cows that are below average. In the reverse situation, such as a ranch that is wanting to expand quickly and will retain a lot of heifers, a cow that has produced all above average calves or is at the average should be considered a better replacement candidate than a cow that has had all below average calves.

Another suggestion would be to study bulls instead of cows. With this data set, herd bulls were used for live cover, so there was no way of knowing which bull was actually the sire of which calf. In other situations, sire data may be available and stronger relationships could be found in feedlot and carcass data.

Chapter 7 –Age of Dam influence on Calf Performance

7.1. Introduction

Previous literature and Chapter 6 in this study highlight the dam as having a relatively small influence on the lifetime performance of the calf. Forristall, May, and Lawerence (2002) used cow size to estimate stored feed costs and found that cows with smaller feed requirements had more "high return" steers in the feedlot, which was believed to be linked to smaller cows having calves with better marbling scores. Results were preliminary, however. Herring and Bertrand (2002) found that feed intake traits, fat thickness, and marbling were all moderately heritable, therefore these traits could be improved with genetic selection, but studying these traits was costly at the ranch level. Other studies have found total maternal genetic effects to be small, but nevertheless, some variability in traits were explained by heredity from the dam (Rios-Utrera et al. 2005). Chapter 6 found a random assignment of calves to cows produced only a slightly different distribution in cow confidence intervals than real data. All of these results lead to the belief that the dam of the calf is relatively unimportant to the calf's productivity compared to other environmental and management factors.

By knowing that maternal influence on calves' lifetime productivity is small, relationships in performance may only be found on a broad level. For example, calves from cows of different breeds, size, or age could be compared to see if patterns in feedlot or carcass characteristics exist. Also, if a maintenance cost on each cow was known or could be estimated, this could be compared to calf efficiency in the feed yard. All of these are issues that seek more research, but data collection is more difficult and time consuming on a ranch where animals are spread on pastures rather than in a feedlot where animals are confined. The data used in this study did not include cow measurements other than age, so this is the only distinguishable difference in cows to make comparisons of calf performance.

Research has shown that at a 205-day weaning weight, calves from first time heifers are an average of 54-60 pounds less than calves from cows that are 5-10 years old. Calves from cows 3-4 years of age and over 11 years of age also are somewhat smaller in weight at weaning than calves from 5-10 year old cows (Beef Improvement Federation 2002). It would be reasonable to believe then, that calves from these groups do not perform as well in the feedlot compared to their counterparts. This chapter will study age of dam as a factor in calf performance. Specifically, profitability measures and feedlot and carcass traits will be compared between dam age groups to evaluate differences in performance.

7.2. Methods

The original data comprised of 6,360 animals from 29 lot groups, however, maternal data on some calves was unknown and some lots were too small to get a large cow age distribution. Because of these issues, only lots that contained 250+ animals with cow age known were used, creating a subset of 3,665 steers from the original data. Cow age distributions by feedlot number are shown below.

Table 7-1 Age of Dam Distributions for Steer Lots

Lot Number	34701	243803	347404	453605	555406	652107	934500	998305
Age of Cow				*Number of Calves*				
2	114	81	102	157	152	164	143	110
3	147	124	87	136	100	105	115	55
4	140	68	61	76	65	70	75	32
5	74	45	19	53	33	41	57	23
6	50	48	22	25	39	25	31	32
7	28	44	22	23	17	32	30	22
8	45	18	19	28	16	10	29	18
9	33	13	11	1	18	18	17	0
10	16	18	6	0	0	0	0	0
11	17	0	0	0	0	0	0	0
Total	664	459	349	499	440	465	497	292

One concern in performing this analysis was if genetics of the cows had changed over the years of data, a trend may show up in the analysis that was not only due to the age of the cow at the time it has a calf. Table 7-2 below shows statistics for birth years of the cows that were used in this section. There is clearly a trend of earlier birth years for older cows. Throughout time, genetics of sires and dams that produced these cows would have changed, most likely improving, to produce calves that better fit market demands and would generate more revenue. This trend will be kept in mind during analysis and may help to explain observed relationships.

Table 7-2 Summary Statistics for Birth Year by Age of Cow

Age of Cow	# of Cows	Average Birth Year	Standard Deviation	Minimum	Maximum
2	1023	2000	2.81	1996	2004
3	869	1999	2.55	1995	2003
4	587	1998	2.55	1994	2002
5	345	1997	2.62	1993	2001
6	272	1996	2.62	1992	2000
7	218	1995	2.64	1991	1999
8	183	1994	2.48	1990	1998
9	111	1993	2.60	1990	1997
10	40	1991	1.17	1990	1993
11	17	1989	0.00	1989	1989

Ratio and difference measures were calculated on the 3,665 subset of data using the same procedures that were outlined in Section 4.2. Using these methods, each calf has an index value based off of its performance relative to the feedlot group that can be used to compare across all animals being studied. Ratio measures include hot carcass weight (HCW), quality grade (QG), yield grade (YG), receiving weight (Inwt), dressing percentage (DrsPct), feed conversion (FeedConv), average daily gain (ADG), days on feed (DOF), and hot carcass weight discounts (DctHCW). A ratio measure for adjusted 205-day weaning weight (Adj.205WW) was also included (without Age of Dam Adjustment), as computed in Section 5.2. Difference measures were Treatment costs (Tcost), Return to Ranch (RTR), and Net Return (NR) as calculated in Section 4.2.

The means of these ratio and difference measures were computed for all cow age groups and used to compare differences in performance. Average actual age and weight at receiving for the lot groups was also included to help explain relationship trends.

7.3. Results

Summary statistics for ratio and difference measures by cow age group are shown below:

Table 7-3 Averages of Steer Performance Measures by Age of Dam

Age of Cow	2	3	4	5	6	7	8	9	10	11
Adj.205WW ratio	90.93	99.05	103.26	107.49	109.21	110.35	108.07	106.70	103.03	99.05
Inwt ratio	103.94	95.74	99.13	101.62	103.01	103.27	102.05	99.81	97.16	94.37
HCW ratio	101.60	99.74	100.80	99.90	100.64	100.05	99.45	97.11	98.93	95.91
YG ratio	99.84	99.99	100.15	100.04	100.14	100.07	99.99	100.14	99.96	99.92
QG ratio	100.79	99.59	99.67	99.70	99.93	100.04	99.93	100.14	99.88	100.11
DrsPct ratio	99.82	100.21	100.28	100.09	100.02	100.41	99.97	99.94	100.18	98.31
DctHCW ratio	99.99	100.01	100.01	100.03	100.02	99.98	99.97	100.01	99.98	100.02
FeedConv ratio	96.27	102.36	101.40	100.43	99.82	100.07	100.19	99.39	99.28	99.75
ADG ratio	97.97	101.46	101.50	101.06	100.31	100.03	100.05	98.70	101.04	99.93
DOF ratio	101.75	101.94	100.33	96.97	97.86	95.49	96.70	95.62	99.65	101.82
Tcost difference ($ per head)	0.67	-0.06	-0.12	-0.46	-0.06	0.11	-1.45	-0.01	-0.91	0.25
NR difference ($ per head)	-3.08	7.44	7.55	-3.06	-0.21	1.21	-7.80	-9.00	-2.98	-18.97
RTR difference ($ per head)	14.33	-11.60	4.00	4.46	13.40	16.20	1.70	-9.48	-15.60	-45.18
Age at receiving (days)	281.71	252.19	251.63	252.39	251.85	251.91	252.66	250.34	248.90	245.94
Actual weight at receiving (pounds)	660.88	607.96	625.30	642.89	648.86	652.95	642.98	624.45	603.85	560.35

Trends in ratio and difference values are hard to evaluate in table form, so measures are organized into graphs in common groupings.

Figure 7-1 shows the actual calf age and weight at feedlot receiving broken into cow age categories. Age at receiving into the feed yard is equal across cow years except for the 2-year old cow year. First time heifers are calved an average 29 days earlier than older cows because they typically have more calving difficulties and require more supervision. Because of this management difference, it is expected that performance relative to the lot group may show inaccuracies in the 2-year old cow. Actual weight at receiving reflects the age discrepancy in calves from 2-year old cows; these calves are an average 34 pounds heavier at receiving. After this, the trend shows a steady incline until the cow reaches 7 years of age and then a steady decline thereafter.

Figure 7-1 Average Actual Calf Receiving Age and Weight versus Cow Age

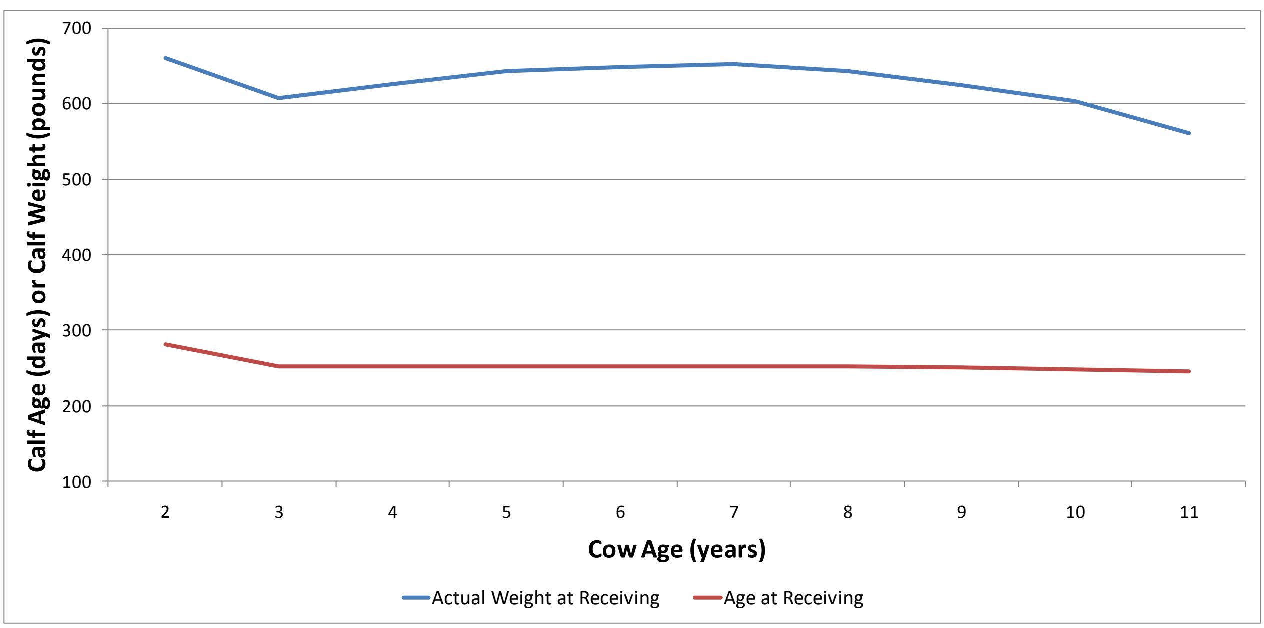


Figure 7-2 shows trends in average steer weight ratios when broken into cow age groups. Adj.205WW ratio displays a trend which does not directly match expectations from Beef Improvement Federation (BIF) guidelines. Adj.205WW ratio increases dramatically after the first calf (2 year old cow), continues increasing and peaks when a cow is 7 years old, and then drops off steadily. BIF adjustments for age of cow factor in weaning weight are in Table 7-4:

Table 7-4 BIF Guidelines for Age of Dam Adjustments to Weaning Weight

Cow Age (years)	Weaning Weight Adjustment (pounds)
2	+60
3	+40
4	+20
5-10	0
11+	+20

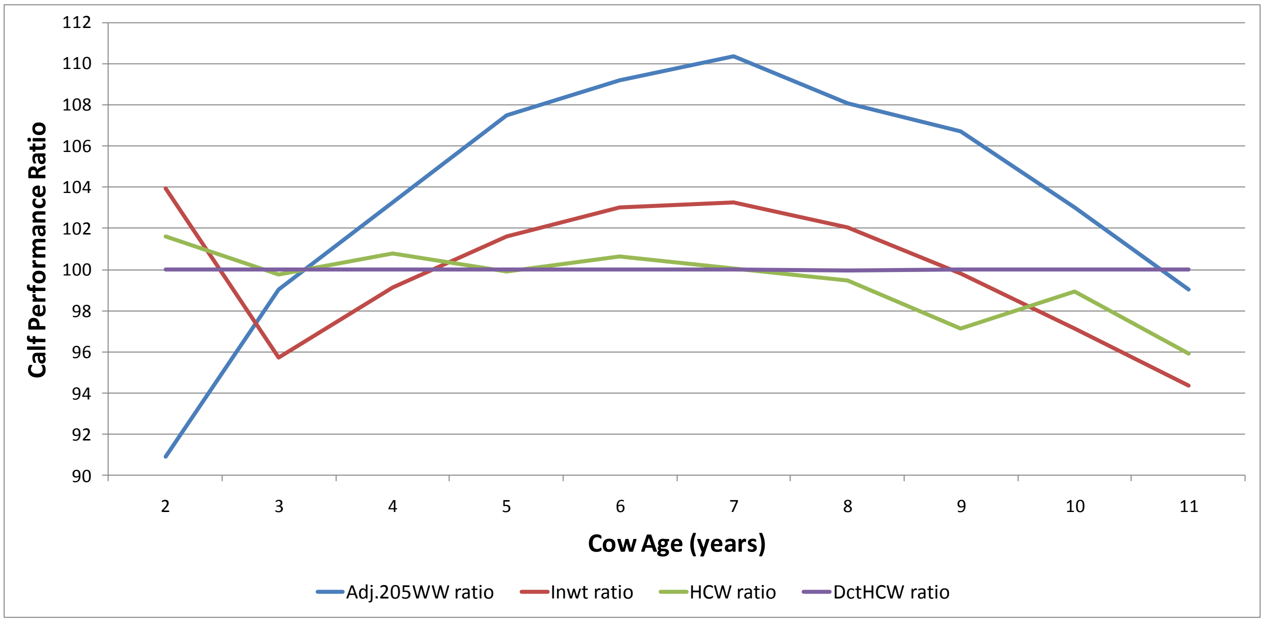
BIF guidelines suggest calf weaning weight should increase at a steady rate from 2-4 years of cow age, have a constant peak from 5-10 years of cow age, and then decrease thereafter. The reason for these differences are unclear, but data for this ranch suggests that a 7-year old cow is where performance peaks, which other studies have also found to be the optimal age to cull a cow (Bentley, Waters, and Shumway 1976; Melton 1980).

Inwt ratios follow a closely related trend with Adj.205WW ratios with the exception of the 2-year old cow. This relationship is expected since calves that are in the same lot group are typically backgrounded the same number of days, so unless a calf gained or lost weight tremendously over this period, they should have approximately the same relative performance as at weaning. Again, the 2-year old cow is an exception because these heifers are typically calved earlier than the cows, leading to calves being an average 29 days older and 34 pounds heavier at receiving into the feedlot. Since Inwt ratio is not standardized for age, these calves appear to perform better, but it is actually due to the slightly higher age and not performance. This is also why Inwt ratio plummets from the 2-year old cow to the 3-year old cow. At 3 years of age, cows are calved at the same time as all older cows and calves do not have the age advantage, so 3-year old cows have relatively smaller calves at receiving.

HCW ratio is highest in the 2-year old cow and declines thereafter. Explanations of this could be tied to the fact that calves come into the feedlot older and heavier when they are from a 2 year old cow. Since it was previously found that Inwt and HCW are correlated (0.40 established in Table 4-2), this could explain why these calves are finishing somewhat heavier. After cow age of 7 years, a decline is seen in HCW ratios, which supports weaning weight and receiving weight findings that peak performance is at 7 years of cow age. Hot carcass weight discounts do not appear to change over cow age, which is probably because of the individual optimal end management style in the feedlot which minimizes the number of steers receiving discounts for being over or under weight.

It also should be recognized, as shown in Table 7-2, that with increasing cow age group average birth year declines. This indicates that older cow age groups tend to have “older genetics”, meaning some of these trends could be due to genetic improvements in the herd over time and not just the age of the mothering cow. It is possible that the declines in performance in older cows could be because they are inferior to “newer” cows. However, because trends are so distinct, the general relationships between cow age and performance should be valid. The trends may be overemphasized, but should still be accurate.

Figure 7-2 Average Calf Weight Ratios versus Cow Age



Quality measures are steadier across cow age groups than weight measures, as shown in Figure 7-3, (notice the scale is smaller than Figure 7-2). YG ratio remains constantly around a ratio of 100 across all years. This is not surprising since backfat is also measured with ultrasound in the feed yard and used in the optimal slaughter date calculation along with weight. Yield grade discounts are mostly avoided by using this management technique and therefore YG should be a steady measure across time. With the exception of 2-year old cows, QG ratio of calves very near an average ratio of 100, suggesting quality grade of calves in not influenced by the age of their dam. The slight quality difference calves from 2-year old cows could be again due to the older age when placed in the feedlot, but also a genetic improvement in the bull being used. Two-year old heifers are bred by artificial insemination, so the genetics of these bulls are different than herd bulls used in all other cow age groups. It is possible that A.I. bulls have slightly better genetics for marbling that may be increasing quality grade performance in calves from 2-year old heifers. DrsPct ratio shows no distinguishable trend over cow years with the exception of the 11-year old cow. This drop could signify a large performance drop, but since there are so few steers that have 11-year old dams, (17 steers total), it should be studied in more detail before conclusions are drawn.

It also can be concluded, since there are no observed trends over the cow years, that genetic improvements in quality grade, yield grade, and dressing percentage, are not being picked up by this analysis. Because older cows have an earlier average birth year and younger cows have a more recent average birth year, a large genetic improvement over time should be displayed. The fact that it is not seen does not mean genetics are not improving, it simply means that genetics improvements are not overweighing the physical influence of cow age.

Figure 7-3 Average Calf Quality Ratios versus Cow Age

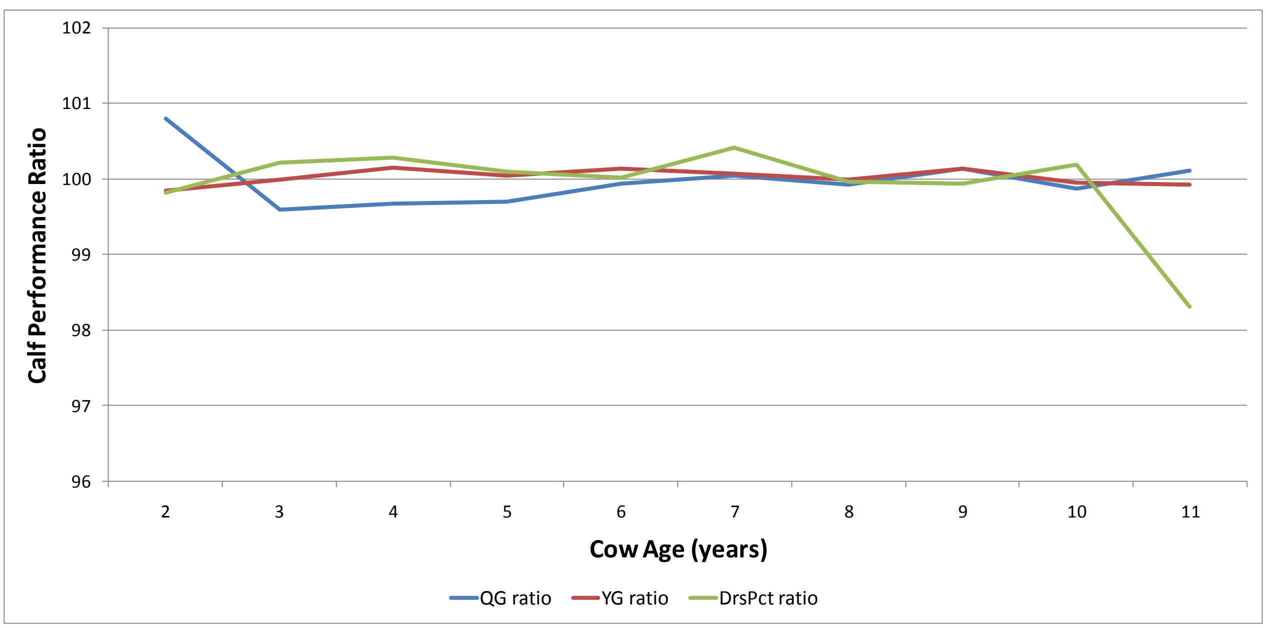
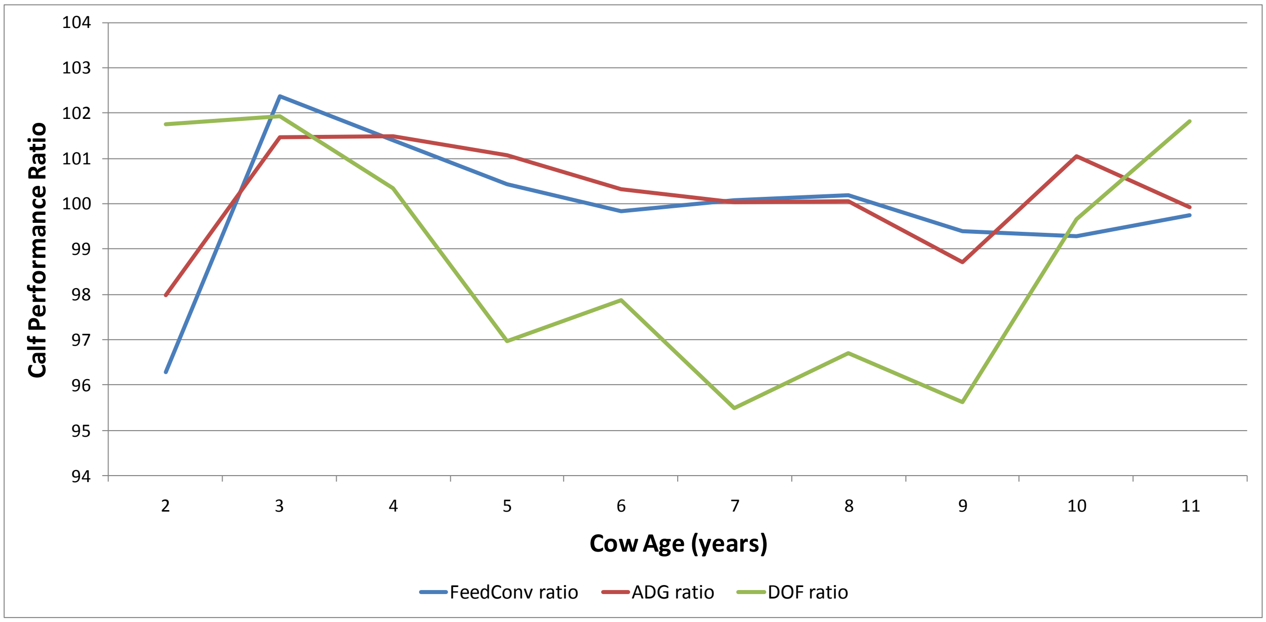


Figure 7-4 displays trends for ratios of ADG, FeedConv, and DOF across cow age groups. It was previously found that ADG and FeedConv ratios had a correlation coefficient of 0.51, so they tend to follow a similar general trend. Both ratios are lowest in the 2-year old cow and then increases dramatically to the 3-year old cow with small declines after this. DOF ratio is high for 2-year old and 3-year old cows, meaning calves from these cows are fed longer than others in the lot (which is interesting especially since calves from 2-year old cows are received at a higher age and weight). Performance related to efficiency and growth may be low in calves from 2-year old cows due to the calf being their first calf and not their genetics. Heifers tend to produce less milk and sometimes have less mothering ability, so calves from them may be disadvantaged. The spike in the 3-year old cows shows that efficiency is improved when a cow has her second calf, so this also reinforces that the main cause of reduced efficiency is likely not genetics. In the 3-year old cows, it is interesting that ADG and FeedConv ratios are high, yet calves from these cows are still fed longer than average. This likely occurs because calves from 3-year old cows are received into the feedlot at a low weight relative to other calves, (see Figure 7-2), so even though they gain efficiently, these calves still require longer days to finish. Calves from cows age 5-9 are typically fed shorter than others in the lot and have average FeedConv and ADG ratios. Again, this occurs because they are received at a higher relative weight, so with average feed and growth efficiency these calves still finish in fewer days. Calves from 10-year old and 11-year old cows are fed longer than average because these calves are received at a lower relative weight.

“Newer genetics” may be contributing slightly to the higher ADG and FeedConv ratios displayed in younger cows. There does not seem to be a physical cow age reasoning of why efficiency would be higher in calves from these cows, so it is possible a genetic improvement is being captured in this trend.

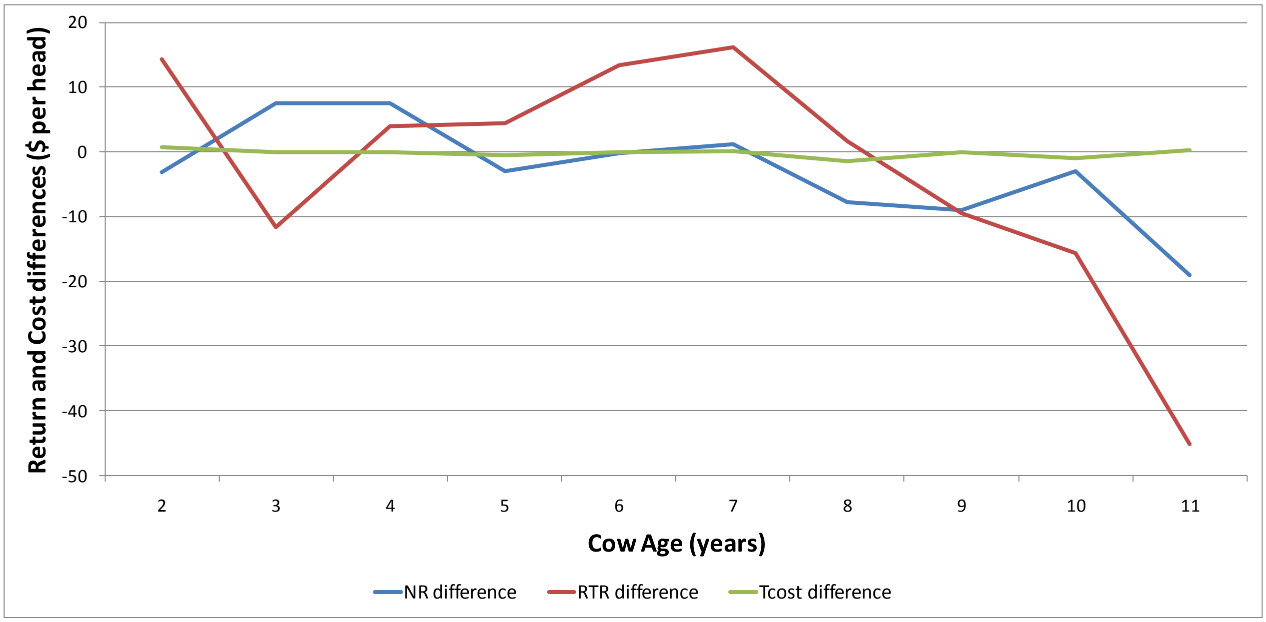
Figure 7-4 Average Calf Efficiency Ratios versus Cow Age



Of most interest in performance is profitability, which combines all of the individual measures that were already discussed. Recall that profitability is measured as the difference from the average profitability of the lot group, so negative numbers signify and animal performing worse than average and a positive number shows better than average performance. Figure 7-5 displays trends in both RTR and NR, and treatment costs, across cow age. NR difference shows that calves from 3-year old and 4-year old cows, on average, outperform all other cow age groups; so much so that all other age groups are close to or slightly below average. While differences from average in most years are small (less than $10 per head), calves from 11-year old cows show a dramatic performance drop. This evidence suggests that cows over 10 years of age should be culled or their calves sold as feeders rather than being finished out. RTR difference displays a different trend line, but it is also measuring a different type of performance. While NR measures feedlot and carcass performance only, RTR measures the revenue going back to the ranch for all activities prior to the feedlot. RTR difference is high in the 2-year old cow because, as discussed earlier, calves from 2-year old cows are older and heavier at receiving, so they would have accrued more costs at the ranch and therefore should have a higher return. The trend really starts in the 3-year old cow year where RTR steadily increases to the 7-year old cow year and then dramatically declines. Tcost difference is very near zero across all cow years, suggesting that the age of the dam does not influence the chances of an animal getting sick.

As mentioned above, there also could be genetic improvements influencing these trends. The average year born becomes more recent for younger cow age groups leading to the belief that younger cows will look superior to older cows because of advances in genetics and not simply age. Therefore, these relationships may be slightly swayed by genetic changes overtime, but overall the trends are reasonable.

Figure 7-5 Average Calf Returns and Treatment Costs versus Cow Age



7.4. Conclusions

Making judgments on cow performance based on offspring's traits are complicated and inaccurate due to environmental factors, management factors, bull genetics, and many other causes. Therefore, studying calf performance on a broad level with defined categories such as cow breed, cow age, or cow size have shown more promise in identifying relationships. In this study, cow age was the only variable available for analysis, so calf groups were divided by the age of their dam.

Trends in performance based on calf weight show an increase up until a cow reaches 7 years of age and then rapid declines are seen. Hot carcass weight, which has a large influence on profitability, remains steady in earlier years but then declines slightly after the cow is 7 years old.

Carcass quality measures are more constant across time when compared to weight measures. Yield grade is not affected by cow age and dressing percent only shows a large deviation from the average in 11-year old cows, where it sharply declines. Quality grade is also constant across cow age with the exception of 2-year old cows. Management practices are slightly different for heifers that are calving for the first time, so these calves typically are received at the feed yard 29 days older and 34 pounds heavier than the other calves in the lot. Because of this difference, calves from 2-year old cows appear to outperform others in some feedlot and carcass measures, but in reality the variation may simply be due to management factors.

Efficiency measures are lower for calves from 2-year old cows, which leads to these calves having more days on feed. Days on feed are less for calves from middle age cows, and then again longer for calves from 10-year old and 11- year old cows. This is most likely due to relationships with feedlot receiving weight.

Net Return in the feedlot is highest for calves from 3-year old to 4-year old cows, but a dramatic drop is not seen until a cow is 11 years of age. Return to Ranch peaks at a 7-year old cow and drops rapidly thereafter.

All of these results suggest that the age of the cow does have some effect on the performance of the calf. If cow age had no effect on calf profitability, averages of feedlot and carcass measures would be more constant across years. Weight measurements are influenced more by age of dam than carcass quality, but all are influencing profit. Most measures show a decline after the cow is 7 years of age, suggesting that culling should be more heavily considered at this point. Genetic improvements may be captured in cow age categories because of younger cows tending to have earlier birthdates. While this may be a source of variation beyond cow age, relationship trends discovered should still be accurate.

One factor that may be slightly misleading in the data is if culling decisions were made based some measure of performance. This would lead to older cows displaying better performance than 2-year old or 3-year old cows because poorly performing animals would have been removed. While this does not seem to be the case, there was one year in the data where a drought occurred and many cows were culled. After the drought was over, the herd was built back up and culling was performed mostly on reproductive and physical problems. Data from cows where no culling occurred would give a more accurate picture, but these results should still be fairly accurate.

Another slight problem is different bulls being used in different years. Two-year old cows are typically artificially inseminated and then pastured with a clean-up bull. The genetics of these A.I. bulls are different than the herd bulls used, so there could be some bias in calves from 2-year old cows. Ideally, the same bulls should be used throughout all years, but since the data are over a time span of 10 years, there were obviously new purchases and retirements of bulls. This may have caused slight inaccuracies, but overall these trends displayed should be reasonable.

Chapter 8 – Analysis of Treatment Costs in the Feedlot

8.1. Introduction

An important component to any stage of beef cattle production is keeping animals healthy. Death losses result in large amounts of foregone income and sickness can reduce production potential and add production costs in medicine and labor of treating a sick animal. In the feedlot setting, animals from many different areas are typically confined within a small vicinity and sickness potential is high. Vaccination precautions are taken to prior to feedlot entry, but animals still get sick.

Treatment costs have already been included in regression and logit models (see Chapter 4), but impact on profitability measures were minimal. This most likely occurred because few animals in these data required treatment for an illness, but it is likely that treatment cost would be more important to profitability if more animals had gotten ill.

This chapter will analyze performance of animals that were treated for an illness in the feedlot and what effect this had on individual feedlot and carcass measurements, and overall profitability.

8.2. Methods

Only 466 animals out of 6,360 had to be treated for an illness in the feedlot. The type of illness was not specified, so the assumption was made that the higher the treatment cost was for the animal, the more severe the illness. After treatment costs were adjusted as in Section 3.4, values for treatment costs ranged from $1.04 to $86.00 per head.

To study how illness affected animal performance in the feedlot and carcass characteristics, treated cattle were broke into groups by dollar amount of treatment and compared to each other and to the untreated group. Treatment cost categories were as reported in Table 8-1:

Table 8-1 Treatment Cost Categories

Adjusted Treatment Cost ($ per Head)	Number of Animals
$0	5894
$0.01-$10	160
$10.01-$20	204
$20.01-$30	48
$30.01+	54

Ratio values for hot carcass weight (HCW), receiving weight (Inwt), hot carcass weight discount (DctHCW), quality grade (QG), yield grade (YG), dressing percentage (DrsPct), average daily gain (ADG), feed conversion (FeedConv), and days on feed (DOF) were used as calculated in Section 4.2. Recall the ratio value gives an index of how well the animal performed relative to the average of the lot group. A ratio above 100 is above average performance and a ratio below 100 is below average performance. When referring to the DOF ratio, a smaller ratio indicates less days on feed compared to the lot average and a larger ratio indicates longer days on feed than average. Difference values for profitability measures, Return to Ranch (RTR) and Net Return (NR), were also calculated in Section 4.2. These values represent the dollar per head return the animal received above or below the average for the lot; therefore a positive number indicates above average profits and a negative number represents below average profits (Refer to Section 4.2 for more explanations). The average for each ratio and difference value was calculated for each treatment cost category so that comparisons could be made in performance and to identify what characteristics illnesses was affecting.

8.3. Results

Averages for ratio and difference values, by treatment cost category, are presented in Table 8-2:

Table 8-2 Average Performance Ratios and Profit Differences by Treatment Cost Category

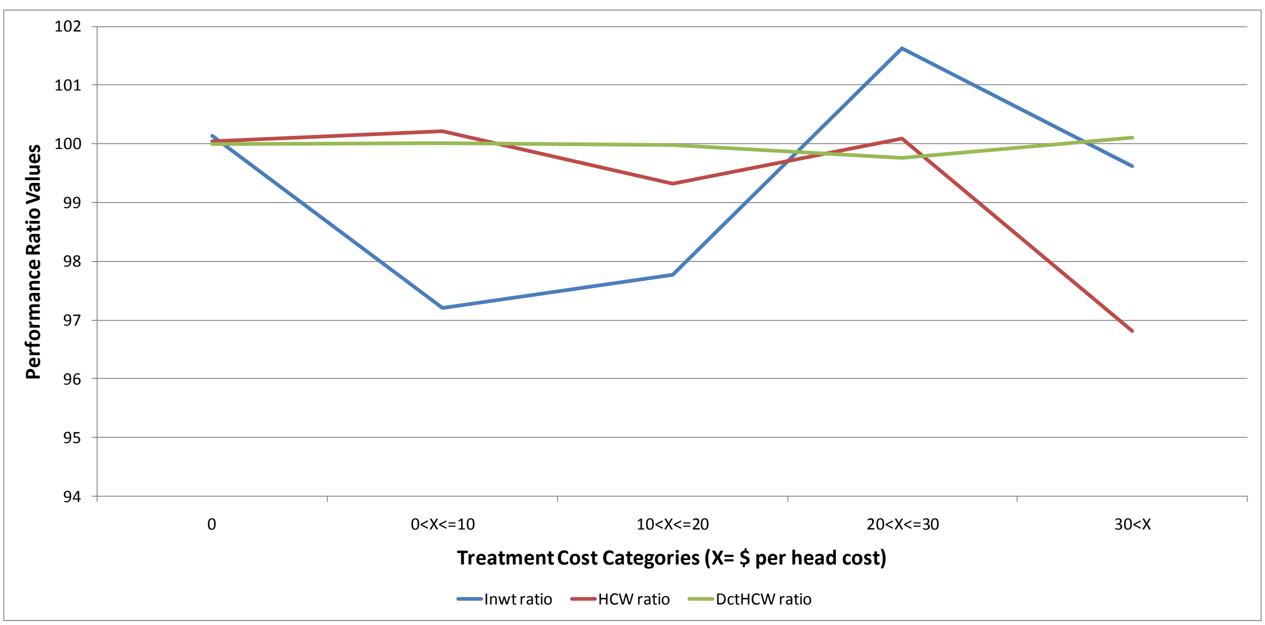
Treatment Cost Category ($ per head)	0	0<X<=10	10<X<=20	20<X<=30	30<X
Inwt ratio	100.14	97.20	97.77	101.63	99.62
HCW ratio	100.05	100.22	99.33	100.09	96.82
DctHCW ratio	100.00	100.00	99.98	99.75	100.10
YG ratio	99.99	100.21	100.05	99.92	100.08
DrsPct ratio	100.01	100.43	100.03	100.11	97.43
QG ratio	100.04	99.50	99.46	99.85	99.64
DOF ratio	99.48	110.29	105.04	100.93	105.99
ADG ratio	100.41	92.86	96.21	96.82	93.79
FeedConv ratio	100.20	95.06	99.37	99.61	95.81
NR difference*	2.41	-16.12	-25.16	-31.75	-91.52
RTR difference*	3.01	-28.55	-34.30	-24.30	-92.56

* differences are in $ per head

To get a better picture of trends in feedlot and carcass measures by treatment cost categories, ratio and difference measures are plotted by treatment cost group in Figure 8-1 through Figure 8-4.

Weight ratios, displayed in Figure 8-1, show inconsistent trends across treatment cost categories. HCW seems relatively unaffected by illness until animals have to be treated over $30 per head, at which point performance drops severely. DctHCW ratios remain close to average for all treatment cost categories, which is expected since animals are not typically marketed at a time where they would receive discounts for weight in the marketing grid. The Inwt ratio trend suggests that animals that were treated at $0.01 to $20 per head were typically animals that were received into the feedlot at a lower weight relative to the lot average. However, this trend does not continue into the higher cost categories. Animals that required $20 per head or more of treatment were received at near the same weight or even larger than the average for their lot groups. These differences could be due to the type of illness that was contracted since smaller calves versus larger calves could have different levels of disease susceptibility. Collecting information on types of illnesses may help to explain this trend.

Figure 8-1 Weight Ratios Averaged by Treatment Cost Category



Carcass quality appears to fluctuate only slightly by the degree to which an animal is treated for an illness, as shown in Figure 8-2. For animals treated up to $30 per head, all three measures are close to a ratio of 100, meaning these characteristics do not seem to be affected if an animal is ill. When an animal is treated with costs exceeding $30 per head DrsPct ratio drops severely, but QG and YG remain close to average. The reason for this related to the drop in HCW, shown in Figure 8-1. Because dressing percentage is calculated as the hot carcass weight divided by the live weight of the animal, and both ratios are dropping to an average ratio of roughly 97 in the $30+ treatment cost category, this indicates that live weight is staying close to the same. So these highly treated animals are carrying more weight in hide, head, feet, and gut and are not achieving fat and muscle composition as other healthier animals in their feedlot group.

Figure 8-2 Quality Ratios Averaged by Treatment Cost Category

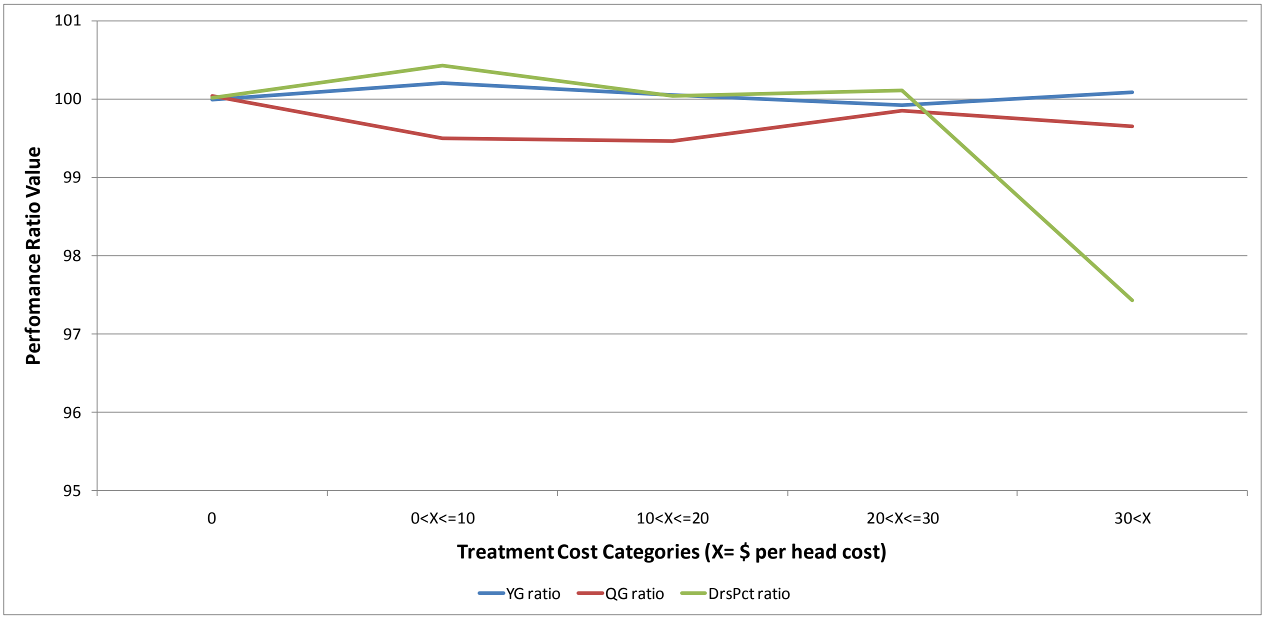
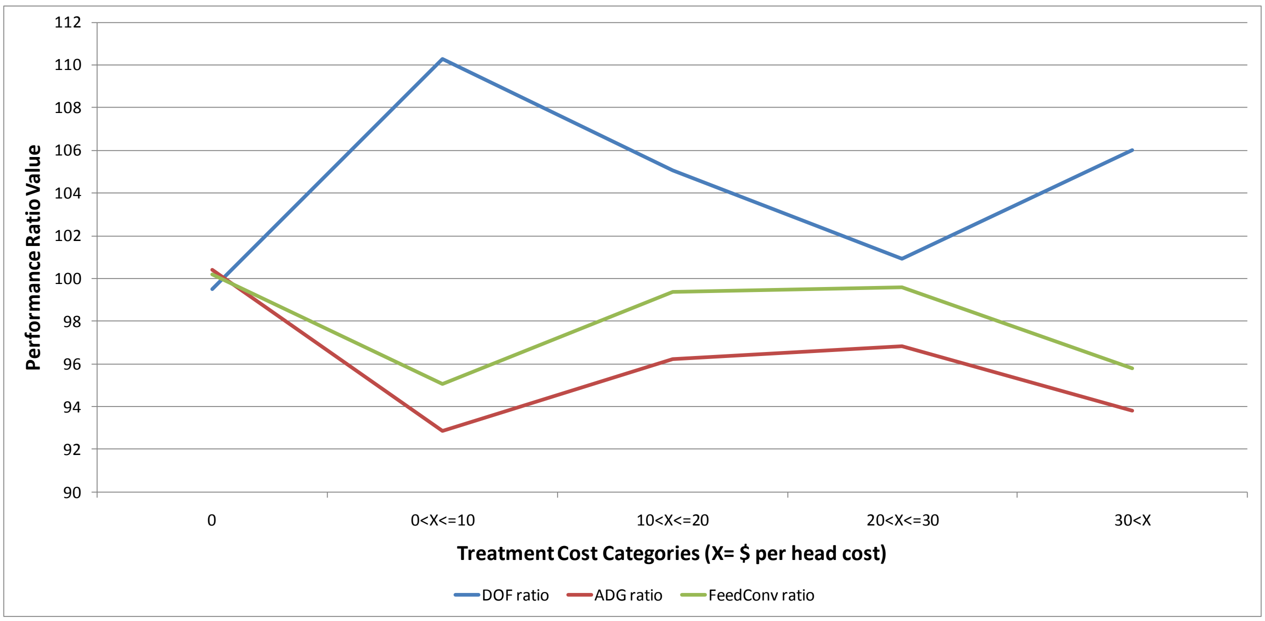


Figure 8-3 demonstrates that efficiency measures are inferior for animals that are treated for illness, but a clear pattern is not displayed. FeedConv ratio (which represents pounds of feed per pound of gain) drops for animals treated up to $10, but returns to near average in the next two higher cost categories. For animals treated with costs over $30 per head, FeedConv ratio is low once more. Reasons for this pattern are unclear, but could again be due to the type of illness that was contracted. ADG ratio follows the same pattern as FeedConv ratio, however the decrease in performance is even greater. This implies that illness does negatively affect ADG, but it is not a perfect inverse relationship where ADG falls as treatment cost increases. Illness will decrease ADG, but the degree of illness, measured by dollar cost of treatment, is not linearly related. DOF ratio increases dramatically from untreated animals to the first treatment category, meaning these animals are fed longer than average. Animals that are treated with cost 10<X<=20 and 30<X are also fed longer than average, but interestingly animals treated with cost

20<X<=30 are fed very near average length. Since ADG and FeedConv ratios decrease in most categories, it would make sense that the animal needs to be fed longer before it finishes. It was also found that animals in the 0<X<=10 and 10<X<=20 treatment cost categories had lower Inwt ratios (see Figure 8-1) so this could also explain longer DOF. It is unclear why DOF is near average for the 20<X<=30 treatment cost category, since ADG is lower, but this again could be due to the type of illness.

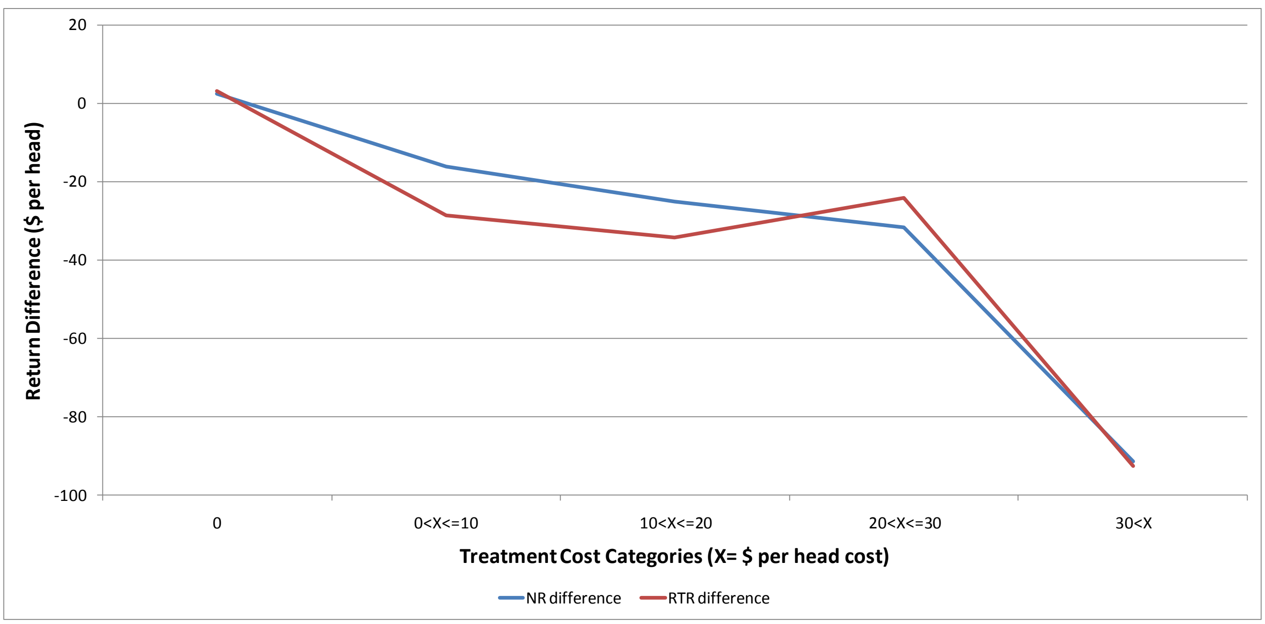
Figure 8-3 Efficiency Ratios Averaged by Treatment Cost Category



Profitability difference measures show a definite decline as treatment cost categories increase, displayed in Figure 8-4. Net Return difference (measured as the individual NR minus the average NR for the lot group) decreases steadily as treatment cost category increases. Animals that were treated with costs exceeding $30 per head had an average net return close to $90 per head less than lot group averages, which is a huge loss in profits. Similarly, RTR difference decreases with increasing treatment cost category, but the relationship is more inconsistent. When treatments costs are less than $30 per head, RTR difference is $20 to $40 per head lower than averages for lot groups, but for treatment cost exceeding $30, RTR difference is near $90 per head less than averages for lot groups.

Decreases in profitability are most likely driven by the reduced efficiency and longer days on feed which would increase feedlot costs. In highest treatment cost category, the lower dressing percentage and hot carcass weight are also likely to be contributing factors. In Chapter 4, HCW was found to be the main driver of both RTR and NR differences, so even a slightly lower ratio for HCW would most likely equate to a negative profitability difference (meaning the animal performed lower than average). Clearly, illness in the feedlot will reduce profitability, not just in added costs but in reduced performance.

Figure 8-4 Return Differences Averaged by Treatment Cost Category



8.4. Conclusions

Animal health is a large task for beef cattle producers over all stages of production. Because of the feedlot environment, cattle have an increased risk of falling ill and requiring additional labor and medicine costs. Along with the importance of added costs is also the reduced performance in animal efficiency and quality measures, thus equating to losses in profit.

Efficiency measures (ADG, FeedConv, and DOF) all are affected if an animal is treated for an illness, but do not seem to vary with the amount of treatment. Any degree of illness decreases feed conversion and average daily gain, thus requiring more days on feed. Carcass quality measures are less variable and do not seem to be greatly affected until treatment costs exceed $30 per head. In highly treated animals, HCW and DrsPct ratios are lower, reflecting a reduction in revenue. For all of these reasons, profitability for treated animals is less, on average, than healthy animals. When measured by NR, which reflects performance in the feedlot and from the carcass, an almost linear negative relationship is seen between NR difference and treatment cost categories. When treatment costs increase, NR difference decreases. RTR difference is also below average for all treated groups, but fluctuates more than NR difference.

These findings indicate that preventing illness is important to increasing profitability and reducing variability. Even with the relatively small number of animals that required treatment in these data, revenue was clearly lost.

This analysis only roughly identified relationships in cattle performance and illness. In future research it would be more insightful to collect data on the type of illness an animal was treated for, and how severe, so more specific relationships can be identified between illnesses and weight, efficiency, and quality characteristics. By knowing how much revenue is typically lost from an illness or more cost incurred, decisions for vaccinations or management changes can be more accurately evaluated.

Chapter 9 – Conclusions and Implications

Technological advances in fed cattle production and marketing have created vast amounts of data on individual animals which provide opportunities for closer scrutiny of cattle genetics and management practices. While it seems that data collection and tracking is developing rapidly, analysis and implications of the information are still deficient. The purpose of this study was to examine lifetime performance of individual beef animals and identify relationships in quality and efficiency characteristics. This provides potential to enhance management practices to allow for a more uniform and better quality beef product, thus bringing higher returns for producers.

Past research along with data in this study have shown cattle quality to be highly variable. This is believed to be caused by the long time practice of average pricing pens of cattle, however, newer marketing systems (such as grid marketing) are attempting to send a more direct signal to the producer for a better quality and consistent product. While the theory behind value-based pricing makes sense, application in the real world is more difficult. Individually pricing fed cattle on a grid has been documented to increase revenue variability to the producer relative to live or dressed weight pricing (Feuz 1999). This discourages many producers from using the system, unless the cattle they are producing are expected to perform well in the marketing grid. Cattle markets also tend to be volatile, and many times market price management seems to overshadow the need for cattle quality concerns.

Even with these problems, cattle quality is essential to increasing returns to the producer. Hot carcass weight and marbling are the most important to variation in fed cattle returns, with efficiency traits also appearing influential (Foristall, May, and Lawrence 2002). Genetic studies have shown these traits can respond to selection, but since most are correlated in some way, selection for improvement to a single trait can be confounding (Rios-Utrera et al. 2005). By knowing all of these difficulties in fed cattle evaluation, four main objectives where developed to isolate areas of improvement potential, utilizing lifetime performance measures of fed cattle.

9.1. Objective #1

The first objective was to identify fed cattle characteristics as profitability drivers. Although this problem has been studied numerous times in the past, of interest here was the application to a single cattle herd, rather than a collection of data, and to the specific management style that was used on the cattle. Regression models indicate that differences in hot carcass weight explain almost twice the variation in both profitability measures (Return to Ranch and Net Return), indicating that increasing cattle finishing size (without excess fat) would increase returns more than improvement in other characteristics. Both models show quality grade, yield grade, dressing percentage, feed conversion, days on feed, and receiving weight as important to returns, with hot carcass weight discounts and treatment costs being the only variables that were marginally significant. The biggest difference between the models was the sign on the receiving weight variable. The Net Return model displays a negative coefficient for receiving weight, which is not surprising since the value of the feeder animal at feedlot entry is subtracted in the Net Return calculation. However in different marketing conditions, the value of feeders may be lower relative to the value of fed cattle, so the receiving weight relationship in the Net Return model may not always be negative. In the Return to Ranch model, receiving weight is positive because a heavier feeder most likely costs more to produce (had larger nutrient requirements) before entering the feedlot, so it should receive a higher return.

This shows that the heaviest calves are not always the best calves to send to the feed yard. A common misconception of producers is to retain ownership of their “best” calves and send them to the feed yard while selling the others at local auction (best calves being defined as heaviest). Results here show that smaller calves tend to gain more value in the feed yard and have a higher return over their feeder price. Larger calves are worth more as feeders, so sending them to the feed yard may not always be the best option in current marketing conditions.

Ordered logit models produce similar results, however, the models also highlight the importance of avoiding discounts over achieving premiums. Yield grades 4 and 5 greatly increases the chance of an animal being ranked in the bottom 20% of its feedlot group, which historically has received returns more than $250 per head lower than top producing cattle and even experiencing negative Net Returns in most years. Cattle that are quality graded as Standard, Over 30 months of Age, Hardbone, Bullock/Stag, or Dark Cutter are also most likely to fall into the bottom 20% of their feedlot group, measured by Return to Ranch and Net Return. In contrast, achieving premiums for yield grades 1 and 2, or quality grades Prime or Certified Angus Beef, do not greatly increase the chances of the animal being included in the top 20% of its feedlot group.

Suggestions for using these results is to increase hot carcass weight of the animals being produced, while still avoiding yield grades 4 and 5’s and quality grades Standard and “out” carcasses. This may be achieved through bull selection, cow replacements, and adjustments in management practices. Since this feed yard uses ultrasound to measure backfat, yield grade is somewhat controlled by management practices. Quality grade is a more difficult trait to measure and predict on the live animal, therefore management practices to control for it may be less effective. Improvements in quality grade may respond better to genetic changes in the bull used or in replacement heifers. In other words, changing genetics may have more impact on quality grade than changing management practices. Hot carcass weight is influenced by the size of the animal, determined by breed type, age, and other factors, and the ability of the animal to convert feed into lean body tissue. Increasing hot carcass weight does not mean directly breeding larger animals. Larger animals will have more feed costs because of increased maintenance requirements and possibly be less efficient in feed conversion. Thus, the gain in revenue from higher hot carcass weight must be weighed against the cost of achieving it. Selecting for animals that convert feed well and add weight without excess body fat is desired.

In summary, increasing hot carcass weight while avoiding high yield grades and low quality grades is desirable, but achieving this may take both genetic and management changes.

9.2. Objective #2

The second objective was to scrutinize the use of weaning weight as a predictor of finished animal performance. Results indicated that weaning weight, adjusted for the number of days of calf age, can be used to predict Return to Ranch profitability, but not Net Return. Since the value of the animal as a feeder is subtracted in the Net Return calculation, and weaning weight performance is correlated with receiving weight performance, heavier calves tend to be worth more at feedlot receiving. Therefore, heavier calves may not always bring the highest return over their receiving value, unless their superior performance is continued throughout the feedlot and carcass measurements. Lighter calves are not worth as much as feeders, but tend to add value in the feedlot, so they can have a Net Return comparable to heavier calves.

Weaning weight showing predictability for Return to Ranch is not surprising. Since Return to Ranch measures the return to all activities prior to feedlot entry, it is expected that a heavier calf should receive a larger return. If more information was known about costs on the ranch, it would be interesting to see if a heavier calf actually costs more to produce than lighter calves. If heavier calves are from larger cows, these cows most likely have greater feed requirements for maintenance, thus having higher feed costs on an annual basis. Therefore, returns on larger calves must be enough to cover additional feed costs for the cow.

Correlations of weaning weight to feedlot and carcass characteristics show that weaning weight is related to receiving weight, days on feed, average daily gain, and hot carcass weight. However, correlations with yield grade, quality grade, dressing percentage, and feed conversion are essentially zero. This highlights that weaning weight cannot be used to measure finished quality. Therefore, it is unlikely that beef quality, measured by quality and yield grade in cattle, will improve as a whole since most feeder calves are priced by weight in the market.

Overall, the implications of these results show that weaning weight is not very accurate to predict future performance. Some predictability is shown in Return to Ranch, but predictions have limited accuracy. Other measures such as frame score, ultrasound estimation of body characteristics, or feed efficiency estimates may be needed to make more accurate predictions of finished quality. These require additional time and resources, however, and will not likely be utilized since weight is still the biggest price determinant in the feeder calf market. Results conclude that when weaning weight is the only information known, future performance is a gamble.

9.3. Objective #3

As shown by objective #2, weaning weight does not appear to be related to carcass quality measures and only slightly related to other performance measures, therefore cow evaluations using MPPA (which is based on weaning weight performance of calves) will not likely improve the quality of beef or the return to the producer in a retained ownership situation.

Therefore, objective #3 was designed to see if performance evaluations on cows could be conducted using lifetime performance of calves, rather than just weaning weight, and how these techniques could be applied to management of cows.

Results show that most cows produce both above and below average calves when the calves are compared to the group they were calved and entered the feedlot with. Only a small number of cows have consistently above or below average calves. When compared to a simulation where calves are randomly assigned to cows, little difference is seen in distributions. This suggests that many other factors, besides the cow, affect the performance of the calf. This is consistent with earlier studies (Rios-Utrera et al. 2005), however, it is recognized that unaccounted error exists in the data. The genetics of the bulls used was not known since cows were pasture bred; therefore, it is expected for performance to fluctuate in different years when looking at the same cow, just because of genetic differences in the bulls. Other problems of this analysis are the length of time needed to collect this amount of data. By the time performance is known on 3 calves from one cow, that cow has already neared the end of her useful life.

Implications of these results are to use lifetime calf performance evaluations on cows as a tool, along with age and physical attributes, to make culling and replacement decisions. Cows that fail reproductively or have physical problems should be culled first, then age and past performance should be considered. When selecting replacement heifers, physical size, growth, and reproductive soundness should be considered as well as genetics of the dam. Heifers from average and above average cows, defined by confidence intervals, could all be good replacement candidates while heifers from below average calves should be more closely scrutinized.

The biggest message to take away from this analysis is to not always blame the cow for the poor performance of a calf. Genetics of the bull or other factors may have played a role in finishing at a low weight, having a low quality grade, or having a high yield grade.

The second part of analyzing objective #3 was to look at cow performance on a broad categorical level. Cow age appears to have an effect on calf performance, even in the finished phase. Measurements of weaning weight and feedlot receiving weight peak when the dam is 7 years old and decline thereafter. Hot carcass weight is steadier across cow age but does fall in older cows. Efficiency measures of the calf increase after a cow is 3 years old, which also leads to shorter days on feed in calves from cows that are 5-9 years old. Carcass measurements of yield grade, quality grade, and dressing percentage appear to fluctuate only slightly over years of cow age. Combining all of these factors together into profit measures, it appears that feedlot and carcass performance (measured by Net Return) is highest in calves from 3-year old to 4-year old cows. Return to Ranch profits, measuring lifetime performance of the calf, are maximized when a cow is 6-7 years old, and sharply decline thereafter.

These results suggest that culling should be more heavily considered after a cow has her fifth calf, at which time she would be 7 years old. While this does not suggest every 7-year old cow should be eliminated, it does highlight that a cow will more likely be dropping in calf performance.

9.4. Objective #4

Objective #4 was to quantify the effects of illness in the feed yard and what impact would be seen in carcass and efficiency traits. While relatively few animals in the data were ill in the feed yard, relationships were still identifiable. Efficiency traits, measured by feed conversion, average daily gain, and days on feed, all decrease in performance when an animal is ill, but not in a linear fashion. Carcass traits of yield grade and quality grade appear less affected by illness in the feed yard, even as dressing percentage and hot carcass weight decrease at higher levels of illness treatment. Net Return decreases steadily with higher levels of treatment, while Return to Ranch also decreases, but with less uniformity.

All of these results highlight that preventing illness in a feedlot animal is critical in achieving higher returns. Since animals from many different areas are comingled in the feed yard, risk of illness is especially high. This producer has had great success in producing healthy animals, judging by the small numbers that were ill. Therefore, treatment costs showed little influence to return fluctuation in regression models, but certainly would be increasingly important if more animals had fallen ill.

9.5. Suggestions for Further Research

This analysis is only the beginning of what is possible with lifetime performance information on individual animals. While relationships were found and quantified, much more areas are open to exploration.

Suggestions to improve this analysis would be to gather more information on the sires of the calves to help eliminate a great deal of error that is present when only half of the genetic composition is known. Even if specific sires are not known, recording the bulls that the cow was exposed to would give some level of assessment. By comparing calves from one group of bulls to another, at least some variation could be accounted for and evaluations on bull performance could be accomplished. In a cow-calf herd, altering genetics is much more readily accomplished by changing the bulls used rather than using cow culling and replacement methods. Therefore, it may be more beneficial to analyze bulls instead of cows.

Another suggestion would be to take some more measurements on the cows and conduct more broad assessments such as was performed in Chapter 7. Breed type and weight could be taken on each cow without a huge amount of additional time and labor if it was conducted at the same time as other procedures when the cow is worked in a chute. Calf breed type could also be recorded to make assessments on both bulls and cows being used.

Other areas of research using lifetime performance information could include analyzing specific management practices. Vaccination programs could be compared in groups of calves and across years. Also, number of days of backgrounding before feedlot entry could be studied as to when the most profitable time would be to ship calves to the custom feed yard. Even new technologies could be evaluated by using individual lifetime performance data. For example, in the fall of 2009, this ranch used "Quiet Wean flaps" on calves to restrict nursing for 7 days before actually removing calves from their dams. Comparing to a control group of directly weaned calves, performance of the two calf groups could be analyzed in various stages of growth after weaning to see if using this management practice actually increases returns. While it initially seemed these calves got up on feed quicker and had less incidences of illness, finished returns will be the most interesting to compare.

Another suggestion closely related to Chapter 8 would be to study specific diseases and their impacts on quality and efficiency. The trends found in Chapter 8 were hard to explain without knowing this information, so this highlights an area of potential research in the future. Evaluating what management practices to use to keep animals healthy would be easier accomplished if costs can be weighed against revenue lost for sick animals.

These are just a few examples of what is possible to accomplish with lifetime performance data. While only some aspects have been studied as of now, there will certainly be potential in the future as data are more readily available and analysis becomes more common.

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