DETERMINING THE IMPACTS OF CATTLE ORIGIN AND OWNERSHIP CHARACTERISTICS ON FEEDLOT PERFORMANCE AND ECONOMIC RETURNS

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With sincere gratitude,

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Abstract:

The U.S. beef cattle industry is segmented into two broad categories, feeder cattle production and feedlot finishing. In 2016 cattle on feed totaled 10.5 million head, making feedlots an integral step in American beef production (Jones & Edwards 2016). During the transition from feeder production to the feedlot, background information concerning the quality and potential of individual animals is often lost. The lack of information limits the potential to optimize feedlot management strategies.

Using data from a large commercial feedlot in the Southern Plains region of the U.S., this research analyzes the impacts of background characteristics on feedlot performance. The background characteristics include origin and ownership status. Results from Mixed Linear Models indicate the custom fed pens perform better than pens owned by the feedlot at times. Differences in origin have a notable impact on the health of cattle on feed. To evaluate economic effects, an Ordered Logit Model estimates the probability that a pen will achieve a defined level of return. Cattle sourced from the country that are custom fed have a higher probability of achieving higher returns.

The background characteristics and pen-level observations allow the data to be categorized in distinct groups. Descriptive analysis of close-out pen means confirms general expectations about feedlot performance. Variations of the means offer a unique opportunity to study the volatility of performance across distinct categories.

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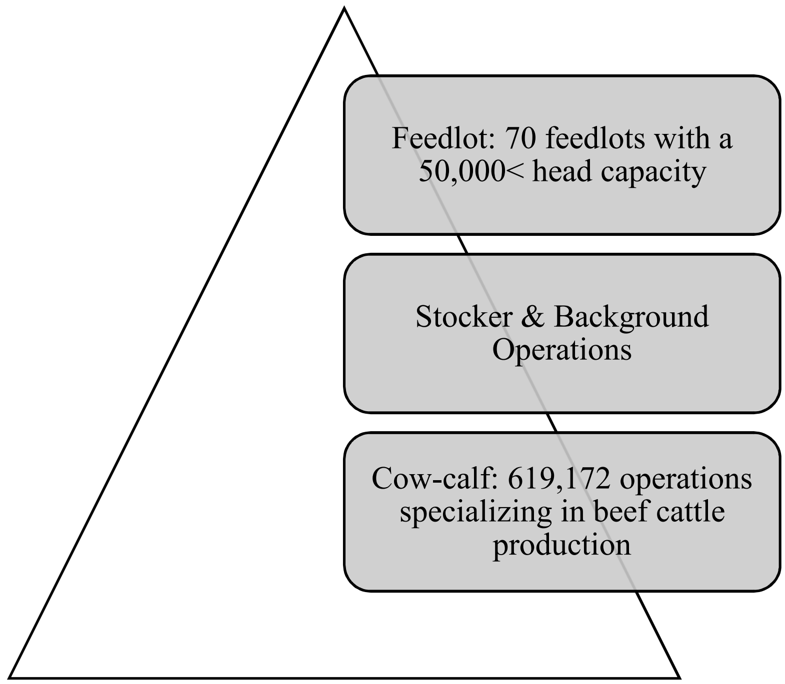
CHAPTER I

INTRODUCTION

The beef production chain functions as a collective of distinct phases, starting with the cow-calf sector and finishing at the packer stage. Unlike poultry or pork production, which have two primary production phases that can occur in one location over a relatively short period, raising beef requires large acreage inputs and typically 18 to 22 months to produce a viable carcass (Ward 1997, NCBA 2009). These constraints have caused the cattle industry to become segmented into three principal phases: cow-calf, backgrounding/stocker and feedlot operations. Cow-calf producers concentrate on producing a calf crop for input into the beef supply chain. Second, stocker operators focus on growing calves to add weight and maturity to feeder cattle. Feedlots concentrate on adding additional weight and finishing cattle that will produce a carcass with acceptable yield and marbling characteristics. Finished cattle are then processed by beef packing firms for wholesale and retail distribution and consumption.

In the United States, approximately 619,172 operations are dedicated to producing beef cattle (NCBA 2015). This estimate includes cow-calf, stocker and feedlot operations. The cattle industry is the highest grossing agricultural sector with $88.25 billion in farm gate receipts in 2014 (NCBA 2015). Cow-calf producers form the broad base of the beef industry and operate throughout the country from Florida to Alaska. As

Figure 1. U.S. Beef Cattle Industry Structure



cattle progress toward the feedlot and packer levels the number of operations narrows. Approximately 85% of cattle on feed are placed in feedlots with a capacity of 1,000 head or more (USDA 2016). There are approximately 72,000 feedlots with less than 1,000 head in the U.S., but the feedlot sector is dominated by large-capacity feedlots (LMIC 2015). Seventy feedlots in the U.S. have an operating capacity greater than 50,000 head and about 40% of fed cattle are marketed from feedlots with a capacity of at least 32,000 head (LMIC 2015, Jones and Edwards 2016). U.S. feedlot operations are generally concentrated in the central region of the country with Texas, Nebraska, Kansas, Colorado and Iowa accounting for 71% of the cattle on feed inventory (USDA 2015). Nearly 80% of commercial beef produced in the US is grain-finished in feedlots, hence feedlots are an integral part of the beef production process (Mathews and Johnson 2013).

The broad cow-calf industry produces calf inputs that vary in quality. While the poultry, pork and dairy industries produce livestock from a narrow genetic base, genetics in the beef cattle industry are expansive due to many diverse breeds and crossbreeding programs (Ward 1997). The wide range of genetics, environment and herd management practices makes it difficult to accurately forecast feedlot performance and carcass grading. Furthermore, as cattle are marketed through narrowing channels, the individual animal's background information is often not transferred from the seller to buyer. Background information includes details such as birth and weaning weights, genetic composition, vaccination history, weaning protocol, implant schedule and treatment records. An animal's background impacts feeding efficiency, carcass quality and potential for economic returns. A study conducted by Oklahoma State University (OSU) found that calves treated for bovine rhinotracheitis virus more than twice produced carcasses that graded lower than calves that are never treated or treated only once. Performance translates to economic returns and research has shown that compared to calves that were never treated, calves that were treated once, twice and more than three times returned $40.64, $58.53 and $291.93 per head less, respectively (Fulton et. al 2002).

Gaining insight to previous management and potential quality is possible with certified beef-quality programs that specify a list of required management practices. When producers implement the required practices, their cattle are recognized as preconditioned and can qualify for exclusive marketing opportunities. The Oklahoma Quality Beef Network (OQBN) Vac-45 program requires producers to castrate bull calves, dehorn, wean calves for at least 45 days prior to the OQBN auction and follow a defined vaccination program (Mourer 2016). In 2012, 7.3% of calves available for market in Oklahoma were enrolled in a value-added program (Mourer 2014). The benefits of preconditioning calves include stronger immune systems, higher stress tolerance and improved feed efficiency (Lalman and Mourer 2014). Proper preconditioning also improves economic gains. Avent, Ward and Lalman (2004) found that feedlot managers perceive a $5.25/cwt premium in value to calves that are preconditioned prior to marketing. Lalman and Mourer (2014) cite that a 45-day weaning and preconditioning program increased the net value by $55.93/head at the feedlot level (Cravey 1996).

Programs such as OQBN Vac-45 provide buyers with background information and lend insight to the quality of marketed calves. Without a certified marketing program, background information can be lost or misrepresented in the market. When a seller knows more about the background and quality of a product than the buyer, an asymmetrical relationship develops and causes negative market externalities. Without third-party verification, producers with preconditioned, higher quality cattle receive the average, pooled price and miss opportunities to receive premium prices (Chymis et al. 2007).

CHAPTER II

IMPACTS OF ORIGIN AND OWNERSHIP CHARACTERISTICS ON FEEDLOT PERFORMANCE

PROBLEM STATEMENT

The challenge of optimizing feedlot programs and perceiving cattle quality persists due to the lack of accurate and verified background information. Background and previous herd management influences the feeding efficiency and economic potential of each pen in a feedlot. One method to preserve background information is retaining ownership during the feedlot phase. Retained ownership allows feedlot managers and customers to exchange information concerning a cattle pen's quality, previous management and feeding potential (Barnhart 2011). While ownership status may influence feedlot management and outcomes, previous research suggests the source of pens can also affect feedlot results. Research from the animal science field suggests that calves sourced directly from ranches have a greater yield grade and higher average daily gain rates compared to calves marketed through sale barns (Step et al. 2008). Ownership and origin characteristics offer insight into the background of cattle placed on feed. This research will evaluate the influence of origin and ownership on feeding efficiency, health and economic returns. How does origin influence feedlot performance and are particular performance variables impacted more than others? Do customers retain cattle that perform better than average? Is it possible to identify changes in cattle quality due to the exchange of information between the feedlot and customer? Understanding the influence of background characteristics can assist feedlot managers to optimize feeding programs and anticipate the maximum potential of a specific pen.

OBJECTIVES

The overall objective of this research is to understand how origin and ownership impact commercial feedlot performance. Identifying the interactions between background and performance can reveal the value of retaining background information throughout the stages of the beef supply chain. Specific research objectives include:

1. Determine feed efficiency differences between pens with differing origin and ownership characteristics. Feed efficiency will be measured by Average Daily Gain and Feed-Gain Ratio variables.
2. Determine the influence of origin on health performance by evaluating sickness and death loss rates.
3. Determine how background characteristics affect economic returns.

LITERATURE REVIEW

The dissemination of information across stages in the beef cattle industry has been a notable research topic for years. Tracing individual animals through the supply chain can maintain useful information for production and trade purposes but traceability systems are complex and often raise concerns about privacy and liability (Hobbs 2004). Discussions of traceability systems principally focus on methods to verify production qualities and coordinate responses to animal disease outbreaks. The expected payoffs and regulations differs between preventative and quality assurance traceability systems. A study conducted by Hobbs (2004) concluded that a voluntary, food quality verification system is cost effective, can be adapted to address the needs of a specific industry and can satisfy traceability requirements for food contamination cases.

To understand how a traceability system would function for the beef supply chain, the University of California (UC) Davis Extension Center implemented an integrated cattle-identification system that synced cow-calf, feedlot and processor activities to track performance and carcass traits (Van Eenennaam et al. 2010). Using radio-frequency identification technology and a centralized database, data for each animal is tracked and made available in real time to managers throughout the production chain. The UC livestock farm coordinators noted the potential to identify animals with high feed efficiency, disease resistance and improve herd management with individual identification technology and systems.

The U.S. Department of Agriculture (USDA) attempted to establish a national traceability program in 2002 with the National Animal Identification System (NAIS). The main objectives of NAIS are to organize animal disease outbreak responses and to verify food safety standards for animal product exports (USDA 2006). To satisfy quality and safety standards set by trade partners, agricultural industries are implementing traceable production chains. Major beef producing countries including Australia, Brazil, Argentina, Canada and the European Union have already established animal traceability programs to verify the age and source of cattle (Van Eenennaam et al. 2010). The U.S. continues to struggle with establishing a national, traceable beef production system. NAIS encourages livestock producers to register their farm premises and track the movement of livestock for disease control. By April 2006, 235,000 premises were registered and the USDA hoped to achieve full participation by 2009 (Loyd and Redding 2006). Cattle producers expressed resistance and only 18% of cattle operations registered themselves by 2008 (Greene 2010). The low participation rate of cattle producers caused the USDA to declare that NAIS was ineffective for disease control in the cattle industry (Greene 2010). Convincing beef producers to voluntarily participate in the program is clearly a challenge for NAIS. Research conducted by Schulz and Tonsor (2010) examined producer willingness to participate in a voluntary traceability system by surveying cow-calf producers throughout the U.S. Results indicated that producers who had previously registered with NAIS would pay up to $2.96/head to participate in the traceability program. Producers without NAIS registration would need to receive a discount of $118.52/head before adopting the NAIS system (Schulz and Tonsor 2010). The study also ranked the willingness to provide certain types of background information. Producers are most willing to provide production practice information followed by performance and genetic information. Age verification and health records are least likely to be shared.

While producers may be wary of traceability programs, research has shown that quality verification programs are increasing in popularity and can provide opportunities to receive price premiums in auction settings (Lalman and Mourer 2014). Voluntary, quality assurance systems, such as the Iowa-Missouri Beef Improvement Organization (IMBIO), set management requirements to verify the source and quality of feeder cattle. Cattle raised by IMBIO producers are marketed in an exclusive sale, which was studied by Lawrence and Yeboah (2002) who collected price premium data during IMBIO auctions. Their analysis indicates that lightweight IMBIO calves received a statistically significant premium. Lightweight, young calves are often a risky purchase but the standardized health program certifies they have received the proper vaccination protocol, resulting in the price premium. The study concluded that buyers value the source and management information that certifies the quality of cattle and justifies premium prices. Research of the OQBN sales identified premiums ranging from $3.94/cwt to $14.33/cwt for preconditioned calves. The research also found that feedlot managers valued preconditioned calves at a $5.25/cwt premium (Ward and Lalman 2003). Quality assurance programs are a proven method to pass on background information from cow-calf producer to stocker or feedlot operator while providing economic benefits to cow-calf producers with high quality calves. Programs such as OQBN are marketed towards cow-calf producers and help to transfer information from the first to second stage of the beef supply chain. The transfer of background information can still be disrupted in subsequent production stages prior to the feedlot.

While establishing an official cattle traceability system in the U.S. continues to be a challenge, producers can track the feedlot performance of their cattle by extending their ownership through successive production phases. Retained ownership facilitates traceability by maintaining the connections between the prior producer and feedlot. Benefits of retained ownership include expanding marketing opportunities, enabling producers to receive performance feedback and providing the feedlot an opportunity to use background information to evaluate feeding expectations for the pen. Retaining ownership is not an option or useful strategy for all cattle producers. Franken et al. (2010) identified producer characteristics that influence interest in retained ownership based on survey responses from Missouri beef producers. The results showed that raising registered cattle and interest in performance-based management variables have a significant, positive relationship to retained ownership interest. Variables including the producer's age, percentage of black-hided calves and prevalence of purebred cattle in the herd lowers the producer's interest in retaining ownership. Risk tolerance also influences the adoption of retained ownership. Pope et al. (2011) studied the tolerance of risk and retained ownership using survey data from cow-calf producers in Kansas and their financial records provided by the Kansas Farm Management Association. Variables including producer age, financial leverage and farm liquidity reduced the frequency of retaining ownership. Producers who strive to minimize risk show a 60% probability of selling calves at weaning to avoid additional production and marketing risks (Pope et al. 2011).

A producer's risk aversion influences the decision to retain cattle along with the current market environment and perceptions of future production, prices and opportunity costs. Using a discrete stochastic programming model, Schroeder and Featherstone (1990) examined optimal retention strategies for cow-calf producers with market data from 1976 to 1988. After considering risk aversion and market price volatility, the model recommends that producers with low risk aversion who are also in the upper 30% of profit return distribution retain 49% of steer calves (Schroeder and Featherstone 1990). The research found that heifers were better to retain than steers, which was most likely due to the heifer price discounts associated with herd liquidation from 1976 to 1988.

Retained ownership maintains the ability to exchange information between producers and feedlots. Producers have insight into the genetic composition, health and weaning management of that cattle they raise and retain. Genetic composition influences feeding efficiency and development of external fat. For example, Black Angus cattle typically have higher average daily gain rates and fat thickness compared to Red Angus, Brangus and Polled Hereford breeds (Parish et al. 2014). When marketing fed cattle, feedlot managers often determine the finishing date based on gain rates and visual estimation of fat cover. Therefore, knowing the animal's genetic composition can improve the estimation of the ideal feeding end point. Genetic background data can be considered while sorting pens based on expected end points and feeding efficiency rates. Feeder cattle can also be sorted by health background to reduce the exposure of sick pens. Cattle origin has a notable impact on the health and performance of pens placed on feed. Comparing ranch-direct and auction barn steers, Step et al. (2008) found that sale barn-sourced steers were treated more often for bovine respiratory disease and had a higher death loss rate compared to ranch sourced steers. Calves that were weaned and immediately shipped from a ranch exhibited heavier weights and higher average daily gain during the first 42 days in the feedlot compared to calves sourced from a sale barn. Differences between ranch and sale barn sourced steers persisted in carcass yields with ranch steers obtaining a higher yield grade. The performance differences between pens of different origins reflect the importance of background information and potential to optimize the management strategy on a pen-by-pen basis.

While previous research confirms the value of performance and management data, it is still unclear how to utilize background information to improve commercial feedlot management. Often it is not economical to tailor feeding programs to a highly individualized level. Furthermore, it is difficult to sort pens that vary in ownership status since retained cattle could become mixed with feedlot-owned cattle. Previous research has examined sorting cattle by general characteristics and expectations in an effort to improve feedlot efficiency. Thompson et al. (2014) assessed the value of knowing the genetic background and molecular breeding values (MBV) of an individual animal to determine optimal days on feed. The MBV market for average daily gain is valued at $22.21 per head and can potentially raise expected profits to $168.35 per head (Thompson et al. 2014). Average daily gain is the highest valued genetic marker for selection. Combining average daily gain with marbling MBV markers for selection, the expected profits can potentially reach $176.57 per head. The value of using average daily gain and marbling MBV is estimated to be $0.47 per head. The results from the study indicate that sorting cattle based on MBV traits can increase feedlot profitability. In addition to genetic background knowledge, feedlot managers can sort cattle based on health history if they can attain vaccination records. Chymis et al. (2007) discussed the problem of asymmetric information that causes inefficient revaccination practices. Buyers are inclined to revaccinate cattle if the cost of vaccination is lower than the costs associated with sickness, treatments and death loss. Even though vaccination doses are relatively inexpensive, costs can accumulate quickly as the feedlot's volume of cattle increases. Accurate background information can eliminate revaccinations and allow feedlot managers to sort cattle according to health history and identify high-risk animals.

Previous research is limited by the availability of data that span from the cow-calf to the commercial feedlot stage for individual animals. Using pen-level data for origin and ownership status allows this research to organize and test for differences between pens with distinct backgrounds. Understanding the value of background information can assist producers and feedlot managers to distinguish cattle quality and optimize feeding plans that maximize the potential of fed cattle and economic returns.

CONCEPTUAL FRAMEWORK

Determining performance differences between pens from varied and distinct backgrounds helps to reveal the value of background information for cattle placed on feed. The background variables include origin and ownership, which are both class variables with three levels. Origin is classified as either Country, Salebarn or Other. Country pens were sourced directly from a ranch, Sale Barn pens were marketed through an auction facility prior to the feedlot and Other pens were either from wheat pasture, a growing yard or a backgrounding program. Ownership is defined as either Returning Customer who has retained cattle in the feedlot for four or more years; an Occasional Customer who has retained pens for three or fewer years; or Feedlot-owned.

The research hypotheses focus on origin and ownership variables and the associated influence on feedlot performance and economic outcomes. The first hypothesis states:

H1: Customer cattle will exhibit higher average daily gain rates and a lower feed-to-gain ratio compared to cattle owned by the feedlot.

Custom feeding extends the ownership period and consequentially extends production and market risks. To overcome the additional risk it is expected that customer cattle perform above average and attain strong returns in the fed market. Performance can be measured by feeding efficiency as well as carcass qualities if the fed cattle are marketed on a grid system. When custom feeding costs are based on dry matter intake and grain price, cattle with above average feeding efficiency can improve chances for positive returns (Comerford). A pen's feeding efficiency can be impacted by sickness and death loss, which leads to the second hypothesis relating to animal health:

H2: Pens originating from the country will experience a lower rate of sickness and death loss compared to pens sourced from a sale barn.

Transitioning between production stages and locations induces stress and exposes comingled cattle to sickness, causing adverse health impacts (Grandin 1997, Chymis et al. 2007). Cattle sourced from the country are transported directly to the feedlot and avoid extended transportation and handling stress. Meanwhile, sale barn sourced cattle come into contact with animals from various operations and can be potentially exposed to animals with compromised health.

In addition to extending their marketing options, producers who retain ownership can access feedlot performance reports of their pens. The transmission of background information to and from the feedlot can influence management strategies in the stages prior to the feedlot. The third hypothesis addresses the information exchange for customer cattle:

H3: Feedlot performance improves over time for producers who consistently retain ownership at the feedlot stage.

Feedlot performance reports provide information about feed efficiency and overall quality of cattle. Carcass data, which is crucial to grid-based marketing, can provide producers with an evaluation of their herd's genetic potential and opportunities for improvement (Crawford 2010).

Evaluating each hypothesis will guide the research and provide insight to the connections between background and performance in a commercial feedlot.

METHODS AND PROCEDURES

The research utilizes data provided by a commercial feedlot in the U.S. Southern Plains region with an operating capacity greater than 50,000 head. For clarity, “Feedlot” will be used in the thesis to distinguish the particular feedlot used for research from the broader industry. Data was collected between January 2009 and December 2015. Each observation is pen-level with values averaged among the animals fed in each specific pen. Upon arrival at the Feedlot each pen is weighed and each animal receives a round of vaccinations, an implant and ID tag in the ear. The pens are not resorted during the feeding process. If an animal is determined to be sick it is moved to the hospital pen, treated and returned to the original pen once they are deemed healthy again. If an animal exhibits buller behavior, repeated mounting of other animals in the pen, they are removed from the pen and kept in the buller pen until marketing. Pens containing Holsteins, heifer and steer mixes, cull cows and pens with missing data were removed, leaving 4,648 useable observations. The close out head count totaled 519,985 head. Close out head count is the number of animals that were marketed by the feedlot to the packer. Table 1-A in the Appendix lists the data variables.

The origin and ownership class variables make this dataset unique. The Owner variable has three distinct classifications. Returning Customers retain pens in the feedlot at least four of the seven years captured in the dataset. Occasional Customers retained lots for less than three years and often only retained cattle once. The remaining lots are owned by the Feedlot. Customer cattle can be either fully owned by the customer or in a partnership between the customer and the Feedlot.

Origin is classified as either Country, Salebarn or Other. Country origin signals that the pen was sourced directly from one ranch and was not exposed to a sale barn setting. Sale Barn origin indicates the pen was marketed at an auction facility and was commingled with pens from various operations. Other is the smallest origin category and combines pens originating from wheat pasture, a growing yard or a backgrounding program. For clarity, 125 pens were sourced from video auctions. All video auction pens are owned by the Feedlot and 91% are classified as country origin and the remaining 9% are classified as sale barn origin.

Pen-level observations are useful to examine the variability of animal performance. Constraints of pen-level observations include identifying seasonal trends and benchmarking the Feedlot with the broader feedlot industry. The pen-level data was converted to monthly averages by averaging the values of pens that closed out each month. The averages were weighted by close out head count to account for variations in pen size. To benchmark with the feedlot industry the Feedlot's monthly averages were compared to averages published by the Kansas State University Focus on Feedlot program (FOF). Every month, the FOF program collects and publishes monthly close-out data from nine Kansas feedlots including the number of head, in and final weights, days on feed, average daily gain, dry matter feed conversion, death loss and cost of gain variables for steers and heifers. To test the strength of comparison, correlations between the FOF and monthly Feedlot data were calculated. The correlations are listed in Appendix Table 2-A. The strongest correlations include the cost of gain for both steers and heifers as well as final weight, average daily gain and dry matter feed conversion variables for steers. The weakest correlations are in-weight, days on feed and final weight variables for heifers. The FOF program provides a robust industry comparison for the monthly values of the Feedlot data.

To evaluate the economic significance of the performance and background variables, market information was collected from USDA reports that were compiled by the Livestock Marketing Information Center (LMIC). Feeder prices were sourced from the Combined Auction for Oklahoma Feeder Cattle report (KO_LS794). Monthly averages are calculated by LMIC staff in 100 pound increments for Medium and Large Frame 1 steers and heifers. The generalized use of prices for medium and large framed No. 1 cattle creates a bias in the feeder price estimate. Some pens may qualify for lower thickness standards, which would cause the estimate to overstate the feeder price for the pen. The lack of grading data limits the ability to correctly estimate feeder prices and may cause returns to be understated for some pens. Feeder prices were assigned to each pen based on gender, placement month and purchase weight. Live prices were obtained from the Negotiated Texas, Oklahoma, New Mexico report (LM_CT181) and were also compiled by LMIC. Live prices are an average across all carcass grades. The averaged live price estimate may cause return estimates to be under or over stated since carcass grading percentages are unknown. It is also important to note that feedlots often sell pens on a grid, which reflects yield and carcass quality. Returns should be analyzed with caution due to the unavoidable use of averaged feeder and live cattle prices.

The Cost of Gain (COG) estimate, expressed as dollars per hundredweight gained, includes data concerning the ration composition, dry matter intake (DMI), pounds gained, days on feed, head count, bunk fee and USDA market report data provided by LMIC. Two COG estimates are calculated, a Dynamic COG that uses concurrent commodity prices and a Set COG that uses a set ration price to control for feedstuff market influences. Further differences between the Dynamic and Set COG estimates are discussed later. According to ration data provided by the Feedlot, corn accounts for 73.7% of the ration on average. Dry distiller grains (DDG) are the second largest component and comprise an average of 6.7% of the ration. Since corn and DDGs compose 80.4% of the ration, prices for these two commodities are strong proxies for estimating the total cost of the ration. Monthly grain prices are available from USDA market reports through LMIC. Corn prices are based on the #2 Yellow Corn market in the "Area North of the Canadian River" from the AM_GR110 report. DDG price is based on reports from plants in Kansas and is published in the SJ_GR225 report. Equation 1 expresses the monthly ration cost expressed as dollars per ton.

$$Ration_i = (0.917P_{i,corn} + 0.083P_{i,DDG}) \tag{1}$$

Equation 1 is used to estimate the ration cost with the assumption that corn and DDGs represent 100 percent of the ration rather than the actual ration composition of 80.4 percent. Accounting for additional ration inputs is discussed below. The ration cost is integral to estimate COG on a pen-level and monthly basis. To estimate the ration cost for each pen the monthly ration costs were averaged over the months that the pen was on feed. Additional COG variables include pounds of DMI, days on feed, bunk fee, close out head count and pounds gained by each pen. The bunk fee, set by the actual feedlot, is $0.05 per day per head. The monthly COG estimate aggregated DMI pounds, head count and pounds gained for each month based on close out pens. Equation 2 states the monthly COG calculation, expressed as dollars per hundredweight gained.

$$COG_i = \frac{(Ration_i \times DMI_i) + (0.05 \times DOF_i \times Head_i)}{Pounds\ Gained_i} \tag{2}$$

Since the ration calculation does not include the prices of all ingredients, feedlot mark-ups and related costs the Dynamic COG estimates calculated with Equation 2 do not align with current market levels. To account for the omissions the monthly, Dynamic COG estimate is scaled against the monthly COG values published by the FOF program. The FOF and estimated Feedlot COG values hold a 95.17% correlation. The average difference between the values is 1.73, which is set as the scalar value for the Feedlot COG estimates. The scaled Feedlot COG averages $96.69 per month, while the FOF COG averages $94.25 per month. To calculate Dynamic COG for each pen, the monthly Feedlot COG estimates are averaged over the months that the pen is on feed. Equation 3 expresses the pen-level estimates for COG, expressed as dollars per hundredweight gained.

$$COG_p = \frac{[(\sum Ration_i / MOF_p) \times DMI_p] + (0.05 \times DOF_p \times Head_p)}{Pounds\ Gained_p} \tag{3}$$

Where:

COG_p = Pen-level Cost of Gain
$Ration_i$ = Monthly Ration Cost
MOF_p = Pen-level Months on Feed
DMI_p = Pen-level Dry Matter Intake
DOF_p = Pen-level Days on Feed
$Head_p$ = Pen-level Close Out Head Count
$Pounds\ Gained_p$ = Pen-Level Weight Gained

Between 2009 and 2015 the cattle feeding sector experienced volatility and record high prices for feedstuffs. Corn prices averaged $5.24/bushel but varied from $3.24/bushel to $8.41/bushel over the studied timeframe. The highest corn price occurred in August 2012 and the lowest price occurred in August 2009. DDG prices varied from

$320.63/ton in August 2012 to a low of $92.00/ton in August 2009 and averaged $186.91 overall. To control for the influence of fluctuating corn and DDG prices, a set ration cost was developed in order to calculate a Set COG estimate. Corn price was set $3.47/bushel, which is the average of prices between January 1991 and December 2015. The 300-month span captures periods of price stability as well as intense volatility, generating a robust corn price estimate. DDG prices from Kansas were first reported in January 2006 and the average DDG price between January 2006 and December 2015 was $170.52/ton. A price ratio was used to set corn and DDG prices. From January 2006 to December 2015, the DDG to corn ratio was 49.1:1. Using the long-term corn price average and price ratio the set prices for corn and DDGs are $3.47/bushel and $122.11/ton, respectively. Using these prices, the Set ration cost equals $246.02/ton and the Set COG for each pen differed due to the variance in DMI and yardage costs. The Set COG estimate averaged $70.79 per hundredweight per month and was not scaled against the FOF COG data. The Set COG calculation removes feed market influences and emphasizes variation in performance due to dry matter intake, days on feed and close out head count. Therefore, the Set COG estimate is an additional feeding efficiency variable. The Set COG was not used to calculate pen returns nor is it used in the Mixed Linear or Ordered Logit regressions. The Dynamic COG estimate, calculated with concurrent ration estimates, was used to calculate returns since cattle prices were not set and reflected market behavior. The pen-level Dynamic COG estimates are used to calculate returns for each pen. Equation 4 expresses the estimated returns for each pen, in dollars, using concurrent cattle prices and the Dynamic COG estimate:

$$Return_p = \left[Price_l \times \left(\frac{Pounds_s}{100}\right)\right] - \left[Price_f \times \left(\frac{Pounds_b}{100}\right)\right] - COG_p \qquad (4)$$

Where:

$Price_l$ = Live Cattle Price ($/cwt)
$Pounds_s$ = Pounds Sold (lbs.)
$Price_f$ = Feeder Cattle Price ($/cwt)
$Pounds_b$ = Pounds Purchased (lbs.)
COG_p = Pen-level Cost of Gain

The average return across all pens is $-45.05 per head over the data period. USDA publications indicate that the average returns to cattle feeders in the Southern Plains between January 2009 and December 2015 equaled -$97.22 (LMIC 2016).

In addition to feedstuff prices, cattle prices also experienced extreme volatility. Cyclical herd downsizing was exacerbated by severe drought conditions in the southern plans, causing the U.S. national beef cattle herd to shrink to 88,526,000 head in 2014 (LMIC 2016). The limited supply contributed to record high feeder prices in 2014, which reached $244.56/cwt for medium and large 1 framed steers weighing 700-750 pounds in October 2014. The lowest feeder price in the dataset was $93.67 per hundredweight in February 2009. Large variations also occurred in the live cattle market. Live prices for steers varied from a low of $81.97/cwt in June 2009 to a maximum of $169.65/cwt in November 2014. Heifers varied from a low of $82.00/cwt in June 2009 to a maximum of $169.54/cwt in November 2014. It is important to note the unique market circumstances and volatility captured in the dataset timeframe.

To evaluate the research objectives and hypotheses, Mixed Linear Models (MLM) are developed to determine the effects of origin and ownership on feedlot performance and economic returns. Additionally, an Ordered Logit Model (OLM) estimates the probability of returns and the impact of factors on the probability of achieving various levels of returns. Both models are calculated using SAS Enterprise Guide 6.1 with the PROC MIXED and PROC LOGISTIC procedures. PROC MIXED is a generalized linear model that can correct heteroscedasticity. When error variances are not homogeneous the estimate values and standard deviations can be misstated (Ayyangar 2007). Heteroscedasticity in the Return per Head, Average Daily Gain (ADG) and Death Loss models was detected by using the White Test with PROC REG procedures. The p-value for the White Test in all regressions is <0.0001, which rejects the null hypothesis that the variances are homogeneous. The PROC MIXED procedure can handle data with inconsistent variability, identify class variables and calculate parameter estimates (SAS 1999). Parameter estimates and standard deviations that are corrected for heteroscedasticity are obtained with the maximum likelihood method. The MLM procedure includes a class statement that defines the base for comparison. The base for all MLM models is *OWNER* = Feedlot, *ORIGIN* = Sale Barn, *GENDER* = Steers and *CLOSE OUT MONTH* = September. Independent variables differ for each of the models. Equation 5 outlines the MLM regression for Returns per head ($/head) on a pen-level basis.

$$R_i = \beta_0 + \sum_{n=1}^{2} \beta_{1n} OWNER_{in} + \sum_{n=1}^{2} \beta_{2n} ORIGIN_{in} + \sum_{n=1}^{11} \beta_{3n} MONTH_{in} + \sum_{n=1}^{1} \beta_{4n} GENDER_{in} + \beta_5 COG_i + \beta_6 FP_i + \beta_7 LP_i + \beta_8 DOF_i + \beta_9 INWT_i + \beta_{10} INWT_i^2 + \beta_{11} SALEWT_i + \beta_{12} SALEWT_i^2 + \beta_{13} S_i + \beta_{14} DL_i + \beta_{15} ADG_i + \varepsilon_i \quad (5)$$

To study the relationship between background and feedlot efficiency a MLM regression is calculated for Average Daily Gain. Equation (6) states the model for ADG.

$$ADG_i = \beta_0 + \sum_{n=1}^{2} \beta_{1n} OWNER_{in} + \sum_{n=1}^{2} \beta_{2n} ORIGIN_{in} + \sum_{n=1}^{11} \beta_{3n} MONTH_{in} + \sum_{n=1}^{1} \beta_{4n} GENDER_{in} + \beta_5 DOF_i + \beta_6 INWT_i + \beta_7 INWT_i^2 + \beta_8 SALEWT_i + \beta_9 SALEWT_i^2 + \beta_{10} S_i + \beta_{11} FG_i + \beta_{12} FG_i^2 + \beta_{13} SHD_i + \beta_{14} DL_i + \varepsilon_i \quad (6)$$

A MLM regression for Death Loss is calculated to examine the influence of background on animal health. Equation 7 outlines the regression for death loss, expressed as a percentage of head placed in the feedlot.

$$DL_i = \beta_0 + \sum_{n=1}^{2} \beta_{1n} OWNER_{in} + \sum_{n=1}^{2} \beta_{2n} ORIGIN_{in} + \sum_{n=1}^{11} \beta_{3n} MONTH_{in} + \sum_{n=1}^{1} \beta_{4n} GENDER_{in} + \beta_5 DOF_i + \beta_6 INWT_i + \beta_7 INWT_i^2 + \beta_8 SALEWT_i + \beta_9 SALEWT_i^2 + \beta_{10} S_i + \beta_{11} FG_i + \beta_{12} FG_i^2 + \beta_{13} ADG_i + \beta_{14} SHD_i + \varepsilon_i \quad (7)$$

The MLM procedure generates estimates for the covariance of the class parameters and estimates for each parameters, referred to as the Solution for Fixed Effects. The covariance parameters helps to control for the correlations between observations caused by the nested structure of the data (SAS 1999). For example pens can be classified by Country origin and within that subset pens are categorized by either

Customer or Feedlot ownership. The grouping of data based on background creates variability and correlations that are addressed with the PROC MIXED procedure to generate accurate parameter estimates.

The OLM regression estimates the probability of obtaining a defined value for Y, which is set as Returns per Head. In an OLM regression there are defined thresholds that are set by the continuous latent variable Y*, which is directly related to Y, the observed ordinal variable. The model's thresholds, κ_j, are defined as:

$Y_i = 1$ if $Y^*_i \geq -300.00$

$Y_i = 2$ if $-200.00 \geq Y^*_i > -299.99$

$Y_i = 3$ if $-100.00 \geq Y^*_i > -199.99$

$Y_i = 4$ if $0.00 \geq Y^*_i > -99.99$

$Y_i = 5$ if $0.00 < Y^*_i \leq 99.99$

$Y_i = 6$ if $100.00 < Y^*_i \leq 199.99$

$Y_i = 7$ if $200.00 < Y^*_i \leq 299.99$

$Y_i = 8$ if $300.00 < Y^*_i$

The procedure descends from threshold 1 to threshold 8. Threshold 1 is set as the base, meaning estimates either have a high or low probability of moving away from threshold 1 and towards threshold 8. Returns per head improve as the estimate moves away from the base threshold. Equation 8 estimates the value of Z.

$$Z_i = \sum_{n=1}^{2} \beta_{1n} OWNER_{in} + \sum_{n=1}^{2} \beta_{2n} ORIGIN_{in} + \sum_{n=1}^{11} \beta_{3n} MONTH_{in} + \sum_{n=1}^{1} \beta_{4n} GENDER_{in} + \beta_5 COG_i + \beta_6 FP_i + \beta_7 LP_i + \beta_8 DOF_i + \beta_9 INWT_i + \beta_{10} INWT_i^2 + \beta_{11} SALEWT_i + \beta_{12} SALEWT_i^2 + \beta_{13} S_i + \beta_{14} ADG_i + \beta_{15} FG_i + \beta_{16} FG_i^2 + \beta_{17} DL_i + \varepsilon_i \quad (8)$$

Once Z is estimated it is used to calculate the probability that Y will fall within one of the defined ranges. The parameter estimates indicate the parameters' effect on the probability that the pen will achieve a higher threshold.

RESULTS

Pen-level observations with origin and ownership variables allows the data to be categorized into distinct categories based on background factors. Before dissecting the data by background characteristics, Feedlot averages were compared to industry averages published by the FOF program. Comparing means between all Feedlot pens and the FOF dataset provides a baseline for assessment. Table 1 summarizes the means for steers and heifers from the Feedlot and FOF program.

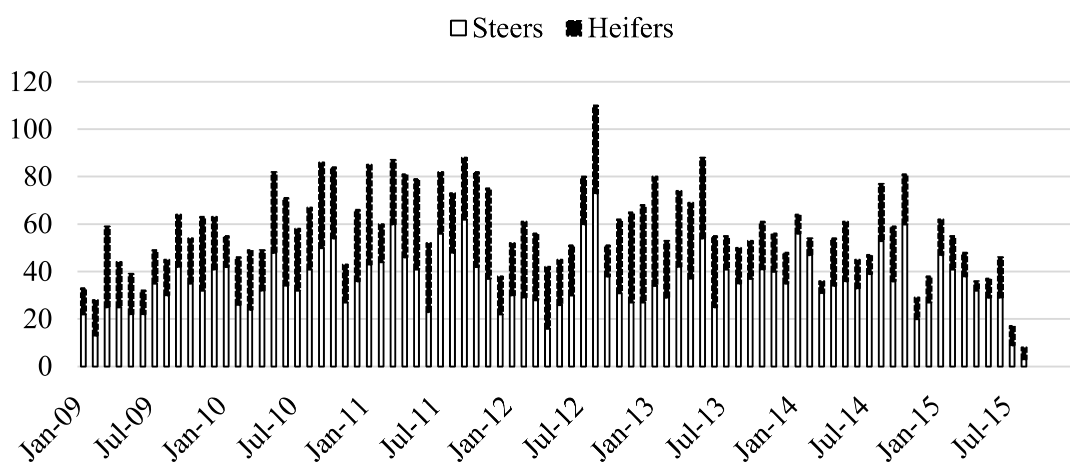
Table 1. Firm and KSU Focus on Feedlots Mean Values, Jan. 2009 – Dec. 2015

Variable	Unit	Steers		Heifers	
		Firm	KSU	Firm	KSU
In-Weight	lbs.	724.93	804.08	722.03	735.18
Final Weight	lbs.	1342.53	1367.98	1254.99	1233
Days on Feed	days	167	154	151	151
Average Daily Gain	lbs.	3.77	3.62	3.61	3.24
Dry Matter Feed Conversion	lbs.	5.97	6.00	6.54	6.26
Death Loss	%	1.86	1.35	2.46	1.46
Cost of Gain	$	99.59	93.87	112.08	98.91

With the exception of end weights for Feedlot-owned heifers, cattle from the FOF program weigh heavier. Feedlot-owned steers are fed nearly two weeks longer while heifers in both programs average the same length on feed. ADG and Feed-Gain are more efficient for Feedlot-owned cattle than FOF lots, except for the heifer Feed-Gain ratio. The Feedlot experiences a higher rate of death loss and average COG compared to the pens reported in the FOF program.

The timeframe of the data captures shifting market conditions that influences feedlot placements and returns. Placements at the Feedlot generally follow an annual, cyclical pattern that peaks during the fall season. Figure 2 tracks feedlot placements by gender. The placement pattern shows anomalies that correspond with herd downsizing spurred by the severe drought in the Southern Plains region from 2010 to 2013 as well as subsequent herd rebuilding. Feedlot placements peaked in August 2012, when approximately 47% of the southern region of the U.S. was experiencing severe to exceptional drought conditions and producers had limited availability to grazing (USDM

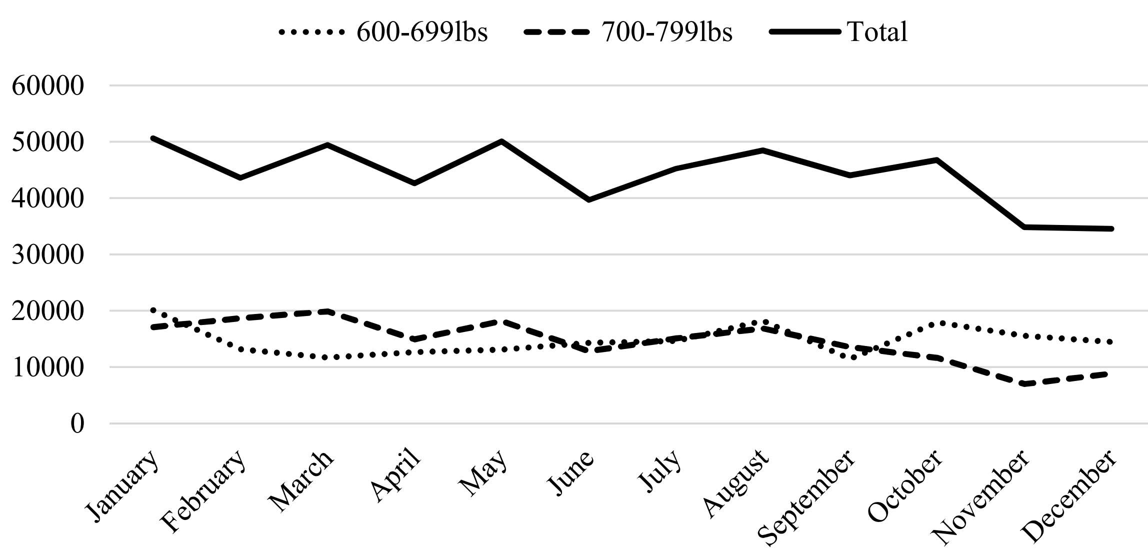
Figure 2. Placements by Month and Gender



2016). Placement of heifers exhibits a strong cyclical pattern but in mid-2013 heifer placements decreased. The decline in heifer Feedlot placements suggests that the cattle cycle entered the herd rebuilding stage. After years of decline the national cattle herd grew by 0.7% and replacement heifer numbers increased by 9.6% in 2015 (USDA 2015). Heifer replacements started to increase in 2012, after multiple years of declining numbers.

Feedlot placements are influenced by seasonal cycles. Monthly placements were further broken down by weight categories to better understand feedlot performance and placement timing. Figure 3 shows a seasonal pattern between the six-hundred and seven-hundred pound placements at the Feedlot. Heavier cattle are placed in the first six months of the year and the lighter cattle are more common placements during the last three months of the year. The same trend is seen in USDA data covering monthly placements during the same months (USDA 2016). Heavier cattle in the spring have most likely been backgrounded since the previous fall before being placed on feed. Lighter placed pens in the fall are most likely composed of the year's weaned calf crop.

Figure 3. Average Monthly Firm Placements by Weight Category



Seasonality effects are also expressed in feed efficiency variables. Based on placement month, average Feed-Gain and ADG rates are calculated for heifers placed at 600-699 pounds and steers placed at 700-799 pounds. The Feed-Gain ratio is higher during the late summer and autumn while higher rates of ADG are seen during the first half of the year. The pattern is confirmed by averages published by KSU research (Langemeier et al., Mark, Jones and Mintert). The monthly averages for feeding efficiency are available in Table 2.

Organizing pens by placement month helps to develop expectations of the pen's performance in the feedlot. In contrast, organizing pens by close out month provides a comprehensive review of feedlot performance. Table 3 organizes the means by close out month for steers and heifers. The heaviest close out weights occur later in the year. Between September and January, ADG has the highest rates. Feed-Gain ratio declines in the summer and peaks in February and March. The higher rates of feed efficiency correspond with the heavier end weights, demonstrating the connection between feed efficiency and finishing weight. Monthly sickness and death loss rates are highly

Table 2. Monthly Mean Comparison for Feeding Efficiency, Jan. 2009 – Dec. 2015

	Steers, 700-799 lbs.				Heifers, 600-699 lbs.			
	Firm		KSU		Firm		KSU	
Placement Month	Feed-Gain	Avg. Daily Gain	Feed-Gain	Avg. Daily Gain	Feed-Gain	Avg. Daily Gain	Feed-Gain	Avg. Daily Gain
January	5.82	3.85	8.39	3.11	5.99	3.34	8.44	2.82
February	5.87	3.87	7.98	3.29	5.99	3.46	8.41	2.86
March	5.83	3.87	7.96	3.31	5.96	3.46	8.34	2.91
April	5.85	3.94	7.83	3.34	6.00	3.41	8.32	2.94
May	5.91	3.87	7.92	3.26	5.98	3.43	8.37	2.87
June	5.89	3.96	8.02	3.29	6.10	3.44	8.33	2.94

Table 2 continued on next page

Table 2 continued

July	5.95	4.02	7.92	3.37	6.08	3.36	8.21	3.07
August	6.06	3.90	8.27	3.25	6.24	3.35	8.63	2.91
September	6.18	3.73	8.8	3.05	6.43	3.20	9.04	2.76
October	6.32	3.53	8.94	2.99	6.41	3.18	9.35	2.63
November	6.11	3.65	8.83	2.98	6.19	3.20	9.12	2.63
December	6.07	3.72	8.74	3.00	6.04	3.31	9.07	2.65

Firm/KSU Correlations, Steers: ADG = 0.91, FG = 0.84, Heifers: ADG = 0.73, FG = 0.75

correlated, ρ = 0.96 for steers and ρ = 0.89 for heifers. Sickness rates peak in April and May while death loss peaks in the same or following month. The highest death loss rate for steers occurs in April and in June for heifers. Seasonal patterns are caused by multiple interactions due to weather, cattle origin, health and management. The monthly averages for market variables including COG and returns provide a baseline for further analysis as the pens are separated into distinct background categories.

DESCRIPTIVE WEIGHT CATEGORY MEANS

A unique component of the dataset is the pen-level observations. The observations can be organized by placement weight to examine performance variations, which is not possible when aggregated means are reported. Placement weight can alter the influence of select performance variables on finishing profitability. For example, heavier cattle are impacted less by the Feed-Gain ratio and COG since they are fed for relatively shorter periods (Langemeier, Schroeder and Mintert 1992). The placement weight categories start at <550 pounds and increase in 50-pound increments to 950 pounds and above. The tables include means for purchase, in and sale weights, shrink, days on feed, average daily gain, feed-gain ratio, sick head days, death loss, dynamic cost of gain, set cost of gain and estimated returns per head. Due to the variance of pen size the means are weighted by close out head. The weight category tables are useful to compare trends and relationships

Table 3. Means by Close Out Month, Jan. 2009 – Dec. 2015 *(Weighted by Close Out Head Count)*

	Count	Purchase Weight	In Weight	Shrink	Sale Weight	Days on Feed	Avg. Daily Gain	Feed-Gain Ratio	Sick Head Days	Death Loss	Dynamic COG	Set COG	Return
	pens	lbs	lbs	%	lbs	days	lbs/day	DMI/lb	%	%	$/cwt	$/cwt	$/hd
Steers													
January	319	764.10	736.45	3.65	1358.28	160	3.93	6.00	0.52	1.69	106.16	71.69	-63.70
February	236	744.62	720.16	3.41	1313.78	163	3.67	6.16	0.74	1.95	102.77	73.79	-35.18
March	212	719.84	697.90	3.10	1296.75	170	3.54	6.13	0.77	1.93	103.29	73.88	-14.51
April	232	701.53	679.25	3.24	1274.77	170	3.52	6.06	1.04	3.08	104.09	72.87	-39.74
May	233	716.38	695.35	3.02	1298.21	166	3.66	5.86	0.93	2.72	93.76	70.80	-9.25
June	235	743.95	723.92	2.72	1333.40	161	3.79	5.76	0.73	2.10	93.30	69.75	-46.74
July	312	781.58	758.92	2.93	1363.13	156	3.89	5.83	0.57	1.66	98.23	70.20	-35.36
August	236	779.67	758.06	2.82	1356.05	157	3.82	5.94	0.45	1.61	102.18	71.69	-82.17
September	230	798.85	773.82	3.16	1372.96	154	3.90	5.92	0.42	1.24	95.53	70.90	-96.24
October	214	780.33	755.03	3.30	1366.71	156	3.92	5.87	0.50	1.46	95.62	70.39	-49.43
November	198	755.97	731.97	3.23	1359.30	162	3.90	5.86	0.50	1.37	97.24	70.55	-42.35
December	221	782.16	755.50	3.49	1375.02	156	4.01	5.95	0.48	1.39	92.87	71.14	-59.45
Heifers													
January	167	686.77	659.35	4.03	1211.31	160	3.50	6.24	0.79	1.65	104.81	74.13	-7.51
February	109	685.90	658.96	4.00	1190.10	159	3.38	6.31	0.97	1.78	105.70	75.02	-1.96
March	119	652.62	628.68	3.73	1165.31	170	3.18	6.40	1.11	2.26	113.22	76.46	-8.37
April	144	645.88	621.74	3.81	1151.06	168	3.16	6.20	0.91	2.22	108.28	74.19	3.03
May	174	624.58	602.69	3.55	1145.39	172	3.18	6.04	1.25	2.37	105.60	72.75	-10.28
June	138	648.85	626.93	3.45	1173.69	166	3.32	6.00	1.01	2.51	109.41	72.13	-116.94
July	204	681.12	659.88	3.21	1198.53	158	3.43	6.00	0.82	2.01	108.66	72.20	-112.60
August	141	690.64	668.11	3.29	1207.66	157	3.45	6.07	0.73	1.75	104.51	72.85	-76.21
September	169	711.28	688.07	3.31	1217.66	154	3.46	6.11	0.50	1.43	106.74	73.20	-44.80
October	135	692.77	668.50	3.59	1207.57	157	3.45	6.07	0.54	1.36	107.84	72.66	-50.91
November	131	661.85	636.61	3.89	1203.56	165	3.46	6.05	0.58	1.53	98.92	72.42	-12.34
December	139	664.39	638.50	3.99	1213.13	166	3.48	6.10	0.60	1.57	96.53	72.95	-43.73

of feeding performance for lots from varying backgrounds. Table 4 provides the means for all Feedlot pens and confirms expected performance trends across weight categories. As placement weight increases days on feed, sickness and death loss decline while ADG and Feed-Gain ratio increase. Cattle finishing research conducted by Langemeier, Schroeder and Mintert (1992) observed the same relationships between performance variables and weight categories.

When the pens are separated by gender the relationships between weight categories and performance variables shifts. Weighted means for steers and heifers are reported in Table 5. Days on feed continues to decrease as placement weight increases. For all weight categories, steers are fed longer than heifers. Since heifers reach maturity quicker than steers, fewer days on feed are required (Anderson). The overall weighted mean reports that heifers remain on feed for two days longer than steers. The higher frequency of light weight heifer placements influences the overall mean and highlights the fact that heifers are generally placed at lighter weights compared to steers. Sickness and death loss rates decline for steers as weight placement increases. Heifer sickness and death loss rates show the opposite trend. Only 15 heifer pens were placed in the two heaviest categories, which suggests that the relationship is skewed by abnormal sickness and death loss rates displayed in the heavier pens. Overall, steers display better health means than heifers. ADG and the Feed-Gain ratio continue to hold a positive relationship with placement weight for both steers and heifers. Multiple background and management factors can influence ADG rates. Anecdotal information from the Feedlot clarified that implant protocol varies by placement weight. Terminal implants are administered to steers weighting at least 700 pounds and heifers weighing at least 600 pounds. An

Table 4. Means by Weight Category, All Pens, Jan. 2009 – Dec. 2015 *(Weighted by Close Out Head)*

Variable	Units	<550	550-600	600-650	650-700	700-750	750-800	800-850	850-900	900-950	950<	Overall
Purchase Weight	lbs.	513.39	579.76	625.25	675.13	725.76	775.50	822.30	873.27	921.89	979.20	728.73
In Weight	lbs.	494.84	556.17	601.66	650.86	701.92	751.62	800.43	849.06	895.19	943.51	704.99
Shrink	%	-3.61	-4.07	-3.78	-3.59	-3.29	-3.08	-2.66	-2.77	-2.90	-3.63	3.33
Sale Weight	lbs.	1147.45	1172.90	1203.30	1252.51	1301.86	1324.36	1352.30	1390.23	1434.23	1490.06	1290.65
Days on Feed	days	213	189	179	170	161	151	143	137	131	129	161
Avg. Daily Gain	lbs./day	3.07	3.27	3.37	3.55	3.71	3.80	3.85	3.97	4.11	4.25	3.66
Feed-Gain Ratio	lbs.	5.85	5.90	5.93	5.92	5.95	6.04	6.12	6.19	6.20	6.42	6.00
Sick Head Days	%	0.74	0.73	0.94	0.82	0.70	0.59	0.58	0.47	0.33	0.41	0.69
Death Loss	%	2.54	2.56	2.47	2.16	1.89	1.58	1.27	1.10	0.88	0.82	1.84
Dynamic COG	$/cwt	106.48	107.39	105.00	104.00	101.03	97.41	99.04	97.46	95.89	100.73	101.31
Set COG	$/cwt	71.50	71.15	71.42	71.05	71.43	72.38	73.46	73.89	73.62	74.63	72.03
Return	$/hd.	-43.56	-53.55	-47.61	-66.39	-53.24	-39.39	-24.72	-59.54	-0.74	-61.72	-47.32
Count	pens	181	343	609	798	842	788	511	327	192	57	4,648
	head	13,768	35,243	65,927	93,007	99,466	91,248	58,561	36,772	21,749	4,243	519,985

Table 5. Means by Weight Category, All Steers and All Heifers, Jan. 2009 – Dec. 2015 *(Weighted by Close Out Head)*

Variable	Units	<550	550-600	600-650	650-700	700-750	750-800	800-850	850-900	900-950	950<	Overall
Steers												
Purchase Weight	lbs.	507.55	581.98	625.32	677.42	725.92	775.91	822.30	873.89	921.86	979.38	758.33
In Weight	lbs.	489.23	560.38	602.49	653.28	701.84	752.50	800.57	850.11	895.27	943.62	734.64
Shrink	%	-3.60	-3.72	-3.65	-3.56	-3.32	-3.02	-2.65	-2.72	-2.89	-3.64	3.18
Sale Weight	lbs.	1234.46	1251.99	1268.66	1297.05	1328.43	1349.11	1372.15	1397.80	1434.50	1491.12	1341.83
Days on Feed	days	238	200	189	176	166	155	146	138	131	129	160
Avg. Daily Gain	lbs./day	3.14	3.47	3.52	3.66	3.78	3.86	3.91	3.98	4.10	4.24	3.81
Feed-Gain Ratio	lbs.	5.89	5.70	5.73	5.80	5.88	5.97	6.04	6.14	6.18	6.35	5.94
Sick Head Days	%	0.87	0.73	0.90	0.85	0.70	0.57	0.47	0.37	0.31	0.33	0.62
Death Loss	%	2.78	3.04	2.83	2.44	2.05	1.68	1.26	1.06	0.83	0.64	1.83
Dynamic COG	$/cwt	99.35	107.55	102.79	102.29	100.27	96.54	96.78	95.59	95.51	99.27	98.95
Set COG	$/cwt	72.11	69.20	69.31	69.91	70.74	71.67	72.64	73.38	73.46	74.11	71.39
Return	$/hd.	-73.75	-66.29	-41.72	-70.66	-58.73	-40.53	-27.58	-66.60	-0.23	-67.15	-49.08
Count	pens	55	84	218	453	605	571	380	278	183	51	2878
	head	3047	8117	23756	57164	76366	69386	47290	32845	21480	4087	343539
Heifers												
Purchase Weight	lbs.	515.05	579.10	625.21	671.46	725.24	774.19	822.28	868.13	924.13	974.48	671.13
In Weight	lbs.	496.44	554.90	601.19	647.00	702.18	748.83	799.84	840.27	888.93	940.72	647.27
Shrink	%	-3.61	-4.18	-3.85	-3.64	-3.18	-3.27	-2.74	-3.21	-3.81	-3.47	3.62
Sale Weight	lbs.	1122.72	1149.24	1166.47	1181.49	1213.99	1245.81	1269.02	1326.91	1411.92	1462.30	1191.02
Days on Feed	days	206	185	173	159	147	138	131	127	123	119	162
Avg. Daily Gain	lbs./day	3.05	3.21	3.28	3.37	3.50	3.61	3.57	3.83	4.27	4.39	3.38
Feed-Gain Ratio	lbs.	5.85	5.96	6.05	6.10	6.17	6.29	6.45	6.63	7.59	8.29	6.12
Sick Head Days	%	0.70	0.73	0.96	0.76	0.72	0.66	1.02	1.32	1.63	2.52	0.81
Death Loss	%	2.47	2.42	2.27	1.72	1.36	1.23	1.31	1.47	4.86	5.50	1.87
Dynamic COG	$/cwt	108.51	107.35	106.72	106.72	103.57	100.14	108.52	113.10	127.23	138.95	105.90
Set COG	$/cwt	71.32	71.74	72.61	72.88	73.71	74.62	76.86	78.18	86.52	88.37	73.28
Return	$/hd.	-34.97	-49.74	-50.93	-59.59	-35.08	-35.78	-12.70	-0.47	-42.90	80.55	-43.89
Count	pens	126	259	391	345	237	217	131	49	9	6	1770
	head	10721	27126	42171	35843	23100	21862	11271	3927	263	156	176440

implant can increase ADG by 0.35 pound/day for steers and 0.25 pound/day for heifers (Reuter et al.). Another factor to consider is the balance between roughage, energy components and supplements in the feed rations. The Feedlot uses starter and finishing rations that slightly vary in ingredient composition in order to adjust the animal's gastric system to a high energy, corn based ration. Lighter cattle are initially fed a high roughage diet that is adjusted over time to incorporate a higher corn content, which provides a higher energy value. As the pen approaches a finishing weight the ration adds beta-agonist supplements to increase lean muscle production. Beta-agonists are known to impact weight gain and can lead to a 15-25% increase in ADG (Comerford). Varying ration and implant strategies based on placement weight offer a reasonable explanation to the positive relationship between ADG and placement weight. Higher rates of Feed-Gain for heavier placed cattle highlight the balance between energy requirements for body maintenance versus weight gain. As weight increases so do maintenance requirements, resulting in higher dry matter intake. Daily caloric maintenance requirements increase 83.4% between cattle weighing 200 kilograms (440.9 lbs) and 450 kilograms (992.1 lbs) according to animal nutrition research (Chiba 2014).

The variation of means across weight categories shows the changing efficiencies and capabilities of cattle as they are placed on feed. Origin and ownership variables permit the data to be further categorized based on background characteristics. Appendix Table 3-A lists the frequency pens based on ownership, origin and gender characteristics and Appendix Table 4-A lists the frequencies of further, detailed subcategories. The sale barn is the largest origin source and the majority of Sale Barn pens are owned by the Feedlot rather than customers. 64% of customer cattle are sourced directly from the country and 57% of customers are returning, which is defined by feeding cattle for four or more years at the feedlot.

Before examining the differing trends between background categories, two sample t-tests were conducted to determine if the observed differences in the means are statistically significant. Appendix Table 5-A lists the results of the t-tests. Steer pens from the country and sale barn have statistically independent means. Heifer pens differing by origin are independent for most performance variables except for average daily gain, feed-gain and sickness rate variables. Customer and Feedlot pen means are statistically significant for most performance variables except for steer purchase weight and in weight and for heifer days on feed and average daily gain variables. Customer pens that differ by origin are independent of each other for both steers and heifers. Steers of returning and occasional customers are mostly significantly different for each other but there is nearly no independence between heifer pens of returning and occasional customers. Statistically significant means demonstrate that pens placed on feed are truly distinct. Understanding the unique characteristics and potential for each background category can help feedlot managers to optimize feeding plans and potentially improve feedlot returns.

When pens are separated by origin, distinct characteristics emerge for both steers and heifers. Averaged over all weight categories, country-sourced steers outperform Sale Barn steers in all performance measurements. Weighted means are provided in Tables 6 and 7 for steers and heifers sourced from the country and sale barns. Steers sourced from the country are commonly placed 50 pounds heavier and finish at a heavier weight compared to lots from the sale barn. In regard to returns, Country steers have a better rate of return at -$36.49 per head compared to -$53.10 per head for Sale Barn steers. Even though Country steers have better returns their COG is higher, which may be explained by placement timing. Between February 2011 and December 2013, 46% of country steers were placed on feed. During this time frame, COG was consistently above the overall average of $96.69 per hundredweight.

For heifers, pens from the country also outperform Sale Barn pens for all performance variables. Country heifers enter and exit the feedlot at heavier weights and are on feed for five fewer days than Sale Barn heifers. ADG and the Feed-Gain ratio means show that Country pens have higher feeding efficiency. The sickness rate and death loss are also lower for country sourced heifers. Country heifers have a lower dynamic price COG but higher set COG average. Placement timing can explain the lower dynamic COG. Between August 2009 and December 2011, 59% of Country heifers were placed in the feedlot. At the same time, COG averaged $84.80/cwt., lower than the overall average of $96.69 per hundredweight. From 2011-2013, 59% of Sale Barn heifers were placed and the average COG at the time was $121.91 per hundredweight. Placement timing and market conditions clearly influence the dynamic COG measurement, further justifying the value of the set COG variable for feeding efficiency comparisons. Origin has a significant impact on the outcomes of feedlot performance. The descriptive mean tables show that country sourced pens outperform Sale Barn pens. Cattle that are sourced from the country avoid additional transportation and experience less stress. Research of cattle handling has shown that longer transportation periods and mixing unfamiliar pens together increases stress. The higher stress not only negatively impacts feedlot performance but it can also cause a higher rate of undesirable dark meat in the carcass

Table 6. Origin Means by Weight Categories, Steers, Jan. 2009 – Dec. 2015 *(Weighted by Close Out Head)*

Variable	Units	<550	550-600	600-650	650-700	700-750	750-800	800-850	850-900	900-950	950<	Overall
Country Origin												
Purchase Weight	lbs.	505.53	583.53	626.44	675.48	727.50	775.93	824.69	872.34	923.99	972.86	776.40
In Weight	lbs.	492.66	566.17	610.67	660.13	711.11	761.49	810.08	854.84	903.83	938.54	759.97
Shrink	%	-2.51	-2.99	-2.52	-2.27	-2.26	-1.86	-1.77	-2.00	-2.18	-3.52	2.18
Sale Weight	lbs.	1269.04	1276.48	1282.99	1298.38	1341.70	1358.91	1374.68	1408.22	1459.21	1505.57	1362.36
Days on Feed	days	235	201	189	177	166	152	144	137	130	129	156
Avg. Daily Gain	lbs./day	3.32	3.55	3.56	3.62	3.81	3.94	3.93	4.05	4.26	4.39	3.89
Feed-Gain Ratio	lbs.	5.65	5.56	5.64	5.80	5.81	5.84	6.00	6.06	6.09	6.29	5.90
Sick Head Days	%	1.08	0.43	0.64	0.67	0.52	0.45	0.40	0.36	0.30	0.32	0.47
Death Loss	%	3.08	1.47	2.43	1.99	1.44	1.20	0.93	0.85	0.68	0.64	1.29
Dynamic COG	$/cwt	96.91	104.86	97.31	108.84	105.31	97.98	102.21	96.89	97.08	106.87	101.20
Set COG	$/cwt	69.78	68.06	69.01	70.94	70.73	71.27	73.13	73.40	73.54	73.87	71.74
Return	$/hd.	-47.89	-28.48	-30.01	-71.69	-56.69	-25.19	-31.74	-41.05	22.12	-66.36	-36.49
Count	pens	25	34	70	97	158	180	153	124	73	32	946
	head	1453	3211	7245	9875	17531	20112	18215	13965	8156	2748	102512
Sale Barn Origin												
Purchase Weight	lbs.	505.19	581.21	624.94	677.82	725.39	775.93	820.67	874.84	920.30	971.76	748.33
In Weight	lbs.	480.19	556.43	598.96	651.76	698.57	748.40	793.50	844.38	888.77	932.21	721.04
Shrink	%	-4.95	-4.26	-4.16	-3.84	-3.70	-3.55	-3.32	-3.48	-3.43	-4.05	3.68
Sale Weight	lbs.	1193.18	1233.09	1262.28	1296.85	1324.64	1345.47	1370.68	1392.08	1420.26	1460.20	1332.22
Days on Feed	days	237	199	189	176	166	156	148	139	132	127	163
Avg. Daily Gain	lbs./day	3.01	3.41	3.52	3.67	3.77	3.83	3.91	3.95	4.03	4.17	3.78
Feed-Gain Ratio	lbs.	5.97	5.80	5.75	5.80	5.91	6.02	6.07	6.21	6.23	6.33	5.96
Sick Head Days	%	0.70	0.93	1.03	0.89	0.76	0.62	0.53	0.39	0.33	0.70	0.70
Death Loss	%	2.32	4.18	3.01	2.54	2.25	1.88	1.47	1.25	0.90	0.79	2.08
Dynamic COG	$/cwt	98.00	109.70	104.89	100.95	98.68	95.59	92.70	93.09	94.47	89.67	97.78
Set COG	$/cwt	72.40	70.03	69.16	69.67	70.75	71.73	72.27	73.27	73.20	72.86	71.12
Return	$/hd.	-98.90	-87.24	-48.88	-69.48	-58.47	-43.75	-20.92	-86.64	-11.10	-115.98	-53.10
Count	pens	29	47	146	353	434	380	216	144	98	11	1858
	head	1431	4722	16271	46999	57597	48251	27842	17442	12194	584	233334

Table 7. Origin Means by Weight Categories, Heifers, Jan. 2009 – Dec. 2015

(Weighted by Close Out Head)

Variable	Units	<550	550-600	600-650	650-700	700-750	750-800	800-850	850-900	900-950	950<	Overall
Country Origin												
Purchase Weight	lbs.	510.21	575.25	629.05	674.08	726.31	773.19	824.99	865.26	916.11	972.95	685.94
In Weight	lbs.	495.10	555.41	612.83	658.69	709.22	754.30	810.43	836.65	890.67	925.62	668.67
Shrink	%	-2.96	-3.46	-2.58	-2.28	-2.36	-2.44	-1.76	-3.31	-2.78	-4.86	2.60
Sale Weight	lbs.	1118.48	1152.53	1174.02	1184.78	1216.95	1262.14	1271.10	1342.17	1340.63	1415.37	1204.58
Days on Feed	days	206	190	172	159	146	138	131	127	125	123	159
Avg. Daily Gain	lbs./day	3.03	3.15	3.28	3.32	3.49	3.68	3.52	3.99	3.60	3.99	3.40
Feed-Gain Ratio	lbs.	5.77	5.86	6.00	6.06	6.14	6.21	6.39	6.66	8.97	11.14	6.10
Sick Head Days	%	0.61	0.78	0.77	0.69	0.72	0.73	0.90	1.09	6.80	4.69	0.76
Death Loss	%	1.91	1.76	1.53	0.94	1.05	0.99	1.22	1.64	11.11	12.61	1.32
Dynamic COG	$/cwt	107.43	103.86	108.88	106.56	103.67	93.44	107.84	108.45	166.92	178.67	104.74
Set COG	$/cwt	70.82	71.11	73.11	73.74	74.31	74.86	77.50	78.58	102.86	108.94	73.95
Return	$/hd.	-9.62	-14.62	-33.03	-33.89	-13.70	-2.76	-20.18	18.88	17.66	-116.68	-17.90
Count	pens	64	60	101	97	110	80	65	27	1	2	607
	head	5455	5177	9209	9124	10550	7451	4738	2231	40	68	54043
Sale Barn Origin												
Purchase Weight	lbs.	519.18	580.16	624.07	670.64	724.21	774.64	819.62	872.47	925.57	975.67	663.23
In Weight	lbs.	495.63	554.70	597.42	642.61	695.69	744.72	789.07	840.55	888.62	952.39	635.77
Shrink	%	-4.54	-4.39	-4.27	-4.18	-3.93	-3.86	-3.73	-3.66	-4.00	-2.39	4.17
Sale Weight	lbs.	1125.38	1148.60	1163.93	1180.47	1211.77	1239.15	1270.67	1316.86	1424.70	1498.56	1184.68
Days on Feed	days	206	184	173	159	147	137	133	128	123	117	164
Avg. Daily Gain	lbs./day	3.07	3.22	3.28	3.39	3.51	3.60	3.63	3.72	4.39	4.69	3.37
Feed-Gain Ratio	lbs.	5.94	5.99	6.05	6.11	6.18	6.30	6.50	6.57	7.34	6.09	6.12
Sick Head Days	%	0.80	0.72	1.03	0.79	0.68	0.61	1.19	1.74	0.70	0.84	0.84
Death Loss	%	3.05	2.56	2.47	2.02	1.58	1.35	1.27	1.35	3.74	0.00	2.12
Dynamic COG	$/cwt	108.33	108.00	105.00	106.89	103.17	102.82	106.80	118.18	120.11	108.26	105.94
Set COG	$/cwt	71.82	71.88	72.33	72.56	73.12	73.96	76.10	76.52	83.59	72.47	72.80
Return	$/hd.	-49.81	-57.24	-53.61	-68.11	-51.85	-52.72	3.59	-52.11	-53.76	232.95	-53.97
Count	pens	58	196	285	241	122	130	59	20	8	4	1123
	head	4870	21685	32443	26174	12275	13691	5884	1428	223	88	118762

Table 8. Ownership Means by Weight Categories, Steers, Jan. 2009 – Dec. 2015 *(Weighted by Close Out Head)*

Variable	Units	<550	550-600	600-650	650-700	700-750	750-800	800-850	850-900	900-950	950<	Overall
Customer Ownership												
Purchase Weight	lbs.	508.71	574.96	624.32	677.34	727.41	777.61	823.69	869.85	925.03	993.29	768.76
In Weight	lbs.	489.82	552.88	604.37	657.63	711.65	760.64	809.45	848.71	907.01	959.91	750.68
Shrink	%	-3.71	-3.84	-3.21	-2.91	-2.17	-2.17	-1.73	-2.43	-1.95	-3.34	2.44
Sale Weight	lbs.	1231.52	1274.07	1276.56	1295.11	1343.57	1364.92	1379.19	1409.09	1437.83	1487.12	1357.83
Days on Feed	days	240	213	198	182	164	153	144	140	132	132	161
Avg. Daily Gain	lbs./day	3.10	3.40	3.42	3.53	3.86	3.96	3.97	4.01	4.02	4.00	3.82
Feed-Gain Ratio	lbs.	5.96	5.84	6.01	6.10	5.90	5.95	6.03	6.18	6.18	6.44	6.03
Sick Head Days	%	0.82	0.81	1.07	1.15	0.72	0.60	0.50	0.51	0.30	0.33	0.66
Death Loss	%	2.71	3.13	3.44	3.36	2.10	1.77	1.30	1.27	0.75	0.65	1.90
Dynamic COG	$/cwt	99.13	105.79	101.19	98.17	98.12	92.82	89.48	86.14	89.62	86.68	93.66
Set COG	$/cwt	72.87	70.86	72.87	73.62	71.57	71.99	73.36	74.18	74.68	75.24	72.93
Return	$/hd.	-74.02	-60.37	-61.11	-71.19	-61.77	-16.56	16.00	-1.04	6.83	-69.01	-28.40
Count	pens	53	33	62	81	124	142	120	83	61	38	797
	head	2842	2064	4031	5035	9736	12362	10429	6451	4863	2186	59999
Firm Ownership												
Purchase Weight	lbs.	491.39	584.37	625.53	677.43	725.70	775.54	821.91	874.88	920.93	963.38	756.12
In Weight	lbs.	481.06	562.94	602.11	652.86	700.41	750.74	798.06	850.45	891.83	924.88	731.24
Shrink	%	-2.07	-3.68	-3.74	-3.62	-3.49	-3.20	-2.90	-2.79	-3.16	-3.99	3.33
Sale Weight	lbs.	1275.26	1244.45	1267.04	1297.23	1326.22	1345.69	1370.16	1395.05	1433.52	1495.71	1338.45
Days on Feed	days	218	195	188	176	166	155	147	137	131	126	160
Avg. Daily Gain	lbs./day	3.65	3.49	3.55	3.67	3.77	3.84	3.90	3.98	4.13	4.52	3.81
Feed-Gain Ratio	lbs.	4.96	5.65	5.67	5.77	5.88	5.97	6.04	6.13	6.18	6.25	5.92
Sick Head Days	%	1.57	0.70	0.87	0.82	0.70	0.56	0.47	0.34	0.31	0.33	0.62
Death Loss	%	3.73	3.01	2.70	2.35	2.04	1.67	1.25	1.01	0.85	0.62	1.81
Dynamic COG	$/cwt	102.32	108.15	103.12	102.69	100.58	97.35	98.85	97.90	97.23	113.74	100.07
Set COG	$/cwt	61.55	68.63	68.59	69.55	70.62	71.60	72.44	73.18	73.11	72.80	71.07
Return	$/hd.	-69.97	-68.31	-37.75	-70.60	-58.29	-45.70	-39.91	-82.63	-2.30	-65.01	-53.46
Count	pens	2	51	156	372	481	429	260	195	122	13	2081
	head	205	6053	19725	52129	66630	57023	36861	26394	16617	1901	283539

Table 9. Ownership Means by Weight Categories, Heifers, Jan. 2009 – Dec. 2015 *(Weighted by Close Out Head)*

Variable	Units	<550	550-600	600-650	650-700	700-750	750-800	800-850	850-900	900-950	950<	Overall
Customer Ownership												
Purchase Weight	lbs.	506.14	576.94	626.33	672.59	727.86	774.31	824.67	872.19	924.13	974.48	686.72
In Weight	lbs.	487.24	554.67	607.61	651.88	708.46	757.60	808.72	850.19	888.93	940.72	667.38
Shrink	%	-3.73	-3.87	-3.00	-3.08	-2.67	-2.16	-1.94	-2.51	-3.81	-3.47	2.91
Sale Weight	lbs.	1127.34	1153.75	1169.28	1180.36	1221.93	1247.70	1276.73	1309.44	1411.92	1462.30	1203.39
Days on Feed	days	215	191	176	162	148	139	131	126	123	119	162
Avg. Daily Gain	lbs./day	2.99	3.15	3.20	3.28	3.47	3.54	3.59	3.63	4.27	4.39	3.34
Feed-Gain Ratio	lbs.	5.97	5.95	6.09	6.25	6.30	6.37	6.40	6.72	7.59	8.29	6.24
Sick Head Days	%	0.76	1.12	1.29	1.24	1.11	0.97	1.19	2.57	1.63	2.52	1.19
Death Loss	%	2.77	2.25	2.42	2.37	1.75	1.65	1.55	2.37	4.86	5.50	2.15
Dynamic COG	$/cwt	104.64	106.61	105.96	104.92	98.87	100.97	103.92	115.83	127.23	138.95	104.27
Set COG	$/cwt	72.76	71.89	73.83	74.98	75.76	76.90	77.44	80.01	86.52	88.37	75.21
Return	$/hd.	-3.82	-38.21	-22.96	-52.89	-11.17	-6.60	-11.54	23.73	-42.90	80.55	-20.57
Count	pens	68	61	97	115	106	80	69	33	9	6	644
	head	4490	4245	7098	8117	7450	5892	4007	1819	263	156	43537
Firm Ownership												
Purchase Weight	lbs.	521.46	579.50	624.98	671.13	723.99	774.14	820.96	864.62			666.02
In Weight	lbs.	503.06	554.95	599.90	645.57	699.19	745.59	794.94	831.71			640.68
Shrink	%	-3.52	-4.23	-4.02	-3.81	-3.43	-3.68	-3.17	-3.82			3.85
Sale Weight	lbs.	1119.39	1148.40	1165.91	1181.82	1210.22	1245.11	1264.77	1341.98			1186.96
Days on Feed	days	199	184	172	158	146	137	132	128			162
Avg. Daily Gain	lbs./day	3.10	3.22	3.30	3.40	3.51	3.64	3.56	4.00			3.39
Feed-Gain Ratio	lbs.	5.76	5.96	6.04	6.05	6.10	6.25	6.48	6.56			6.08
Sick Head Days	%	0.65	0.66	0.90	0.62	0.54	0.54	0.93	0.23			0.69
Death Loss	%	2.26	2.45	2.24	1.53	1.18	1.08	1.18	0.70			1.78
Dynamic COG	$/cwt	111.30	107.48	106.30	107.25	105.80	99.84	111.06	110.74			106.43
Set COG	$/cwt	70.29	71.71	72.36	72.27	72.74	73.79	76.55	76.60			72.64
Return	$/hd.	-57.42	-51.88	-56.59	-61.55	-46.46	-46.54	-13.34	-21.35			-51.53
Count	pens	58	198	294	230	131	137	62	16			1126
	head	6231	22881	35073	27726	15650	15970	7264	2108			132903

(Warriss 1990).

Ownership status highlights expected and unexpected trends concerning pen performance and customer selection. Tables 8 through 9 list the weighted means for steers and heifers in relation to ownership status. Customer steers and heifers entered and exited the feedlot at heavier weights compared to Feedlot-owned pens. Feedlot-owned steers exhibited lower sickness and death rates. Feed efficiency variables are split, customer steers show a slightly higher ADG and lower dynamic COG. Heifers owned by the Feedlot show higher feeding efficiency and lower sickness and death rates than customer heifers. The set COG measurement for Feedlot-owned heifers is $2.56 lower than customer heifers, further indicating better feed efficiency. Returns for customer pens were better than returns associated with Feedlot-owned pens for both steers and heifers. Trends shown in the descriptive mean tables raises questions about the selection process for customer cattle and a customer's motivation to place cattle on feed.

Origin and ownership characteristics are closely related and often intersect. 61 percent of customer cattle are sourced directly from the country while 78 percent of feedlot-owned cattle are sourced from sale barns. To untangle the interactions between origin and ownership, the customer lots are separated by origin. Means for steers and heifers are listed in Tables 5-A and 6-A in the Appendix. Customer steers sourced from the country outperform customer sale barn-sourced cattle in all feed efficiency and health variables. They also have a significantly better rate of return and lower COG. In contrast, customer Sale Barn steers have worse feedlot performance and returns than all sale barn sourced steers. This observation suggests that customers may purchase low quality cattle from the sale barn in order to fill a pen or feed lower quality animals and attempt to achieve some return in the market. The same trend holds true for heifers, with customer country-sourced pens performing better than customer Sale Barn pens. Customer sale barn heifers perform worse than all heifers sourced from the sale barn, which further suggests that customers purchase poor quality cattle from a sale barn to retain.

The final subcategory examines the performance of lots from returning customers and customers who occasionally retain country-sourced cattle in the feedlot. Appendix tables 7-A and 8-A provide the means for each customer category. Returning customers are defined here as an owner that retains cattle at least four of the seven years in the dataset. Steer pens of returning customers experience lower sickness and death rates and higher feed efficiency than occasional customers. Heifers of occasional customers outperform heifers from returning customers. Steers and heifers of occasional customers have higher returns, suggesting that favorable market conditions may be motivation to opportunistically retain cattle. In addition to the descriptive mean tables, the pens of returning and occasional customers are compared on a monthly basis. The monthly comparison shows any improvement that returning customers experience after considering and adjusting herd management in response to feedlot performance reports. The best improvement was seen in sickness and death loss rates. While overall death loss increased in the feedlot, returning customers saw less death loss in their steer pens. Figures 1-A and 2-A in the Appendix compare the sickness and death loss rates of returning customers and sale barn sourced steers. Steers from the sale barn were chosen as a base for comparison since they represent the largest group in the feedlot. Time trends for sickness and death loss rates for steers show improvement for returning customers over the 84 months of data. Analyzing returning and occasional customer outcomes provides insight to the potential value of exchanging information between the feedlot and producer. Returning customers can adjust herd genetics and management strategies in response to feedlot performance reports. The returning customer pens also allow the Feedlot to benchmark their management and production year after year with cattle that are consistently sourced from one origin.

RESULTS OF MIXED LINEAR MODELS

To understand the impact of background and performance variables three Mixed Linear Models were developed with Returns per Head, ADG and Death Loss set as the dependent variables. The first model, Returns per Head, highlights the influence of background, close out month and performance on the level of return. Parameter estimates, expressed as dollars per head, are listed in Table 10. Ownership status and country origin have a significant impact on returns. Pens of returning customers earn an additional $4.63 per head while occasional customers are discounted $4.13 in reference to pens owned by the Feedlot. Country pens receive a $2.87 per head premium compared to pens sourced from a sale barn. Cattle from the Other origin category receive a premium of $7.18 but the estimate is not significant. Heifers receive a premium of $18.03 over steers, a result that is confirmed by the descriptive mean returns of heifer and steer pens. The average return for heifers in the dataset is -$43.89/head compared to the average return of -$49.08 for steers. As expected COG and Feeder price have a negative estimate since higher input prices reduce returns. The Live price estimate is highly significant and positive. Performance variables such as days on feed, in weight, sale weight and ADG have positive estimates Positive performance estimates suggests that heavier animals receive higher returns. In weight and sale weight have squared terms to correct for the non-linearity of animal weight, which eventually plateaus rather than continue in a linear fashion. The sale weight squared term is extremely small due to the small range of finished weights. The parameter estimate for ADG is fairly large due to the difficulty of increasing the rate of daily gain by an entire pound. The Feed-Gain ratio was not included in the model since factors of the ratio are already incorporated into other independent variables, therefore confounding the effect of a Feed-Gain estimate.

To evaluate feed efficiency, Average Daily Gain is set as a dependent variable for the second MLM regression. Table 11 lists the parameter estimates for ADG. The estimates for returning and occasional customers are significant. ADG increases by 0.02 lbs. for returning customer pens and by 0.01 lbs. for occasional customer pens compared to Feedlot-owned lots. Origin also has a significant influence on ADG. Compared to pens from a sale barn, Country pens have a higher ADG and pens from Other sources have a lower ADG. Steers exhibit a higher ADG than heifers, a result that is confirmed in the descriptive mean tables. Estimates for the close out months show a slight seasonal pattern. With September as the base month, ADG is lower from February to June, nearly unchanged in the fall and slightly higher during the winter months. Days on feed, the Feed-Gain Ratio and Sick Head Days have significant, negative estimates. The relationship of these variables support expectations of feed efficiency. Cattle with a higher rate of average daily gain can reach the finishing weight faster, require less DMI and are resistant to sickness. In weight and shrink percentage have positive ADG estimates.

To evaluate health performance, the influence of origin, ownership, month and performance on death loss are estimated. Table 12 lists the parameter estimates for death

Table 10. Returns per Head, Mixed Linear Model Parameter Estimates

Parameter	Estimate	Standard Error
Intercept	-782.08***	108.19
Returning Customer	4.63**	2.06
Occasional Customer	-4.13*	2.38
Country Origin	2.87**	1.28
Other Origin	7.18	4.47
Heifers	18.03***	1.93
Close Out Month		
January	-1.62	2.28
February	1.29	2.53
March	-6.30**	2.77
April	5.06*	2.89
May	3.66	3.06
June	5.91**	2.54
July	10.94***	2.22
August	6.47***	2.42
October	0.41	2.63
November	5.84**	2.52
December	5.06*	2.91
Performance		
Cost of Gain	-5.45***	0.02
Feeder Price	-7.50***	0.03
Live Price	12.84***	0.05
Days on Feed	2.10***	0.25
In Weight	0.57***	0.13
In Weight Squared	-3.1E-04***	0.00
Sale Weight	0.18	0.14
Sale Weight Squared	-1.5E-04***	0.00
Shrink	-10.94***	0.36
Death Loss	-3.32***	0.27
Average Daily Gain	64.77***	11.13

Significance at 1% ***, 5% **, 10% *

Parameter estimates weighted by head count at close out

Table 11. Average Daily Gain, Mixed Linear Model Parameter Estimates

Parameter	Estimate	Standard Error
Intercept	6.5236***	0.2163
Returning Customer	0.0509***	0.00981
Occasional Customer	0.0614***	0.01404
Country Origin	0.0251***	0.00872
Other Origin	-0.1425***	0.02798
Heifer	-0.2615***	0.011
Close Out Month		
January	0.0907***	0.0153
February	-0.0299*	0.0159
March	-0.0958***	0.0162
April	-0.1347***	0.0154
May	-0.1125***	0.0151
June	-0.0456***	0.0141
July	0.0025	0.0128
August	0.0032	0.0141
October	0.0234	0.0148
November	0.0621***	0.0143
December	0.1124***	0.0152
Feedlot Performance		
Days on Feed	-0.0055***	0.0004
In Weight	0.0016***	0.0004
In Weight Squared	-2.14E-7***	0.0000
Shrink	0.0482***	0.0023
Feed-Gain Ratio	-0.6328***	0.0186
Feed-Gain Ratio Squared	0.0208***	0.0010
Sick Head Days	-0.0045*	0.0026

Significance at 1% ***, 5% **, 10% *

Parameter estimates weighted by head count at close out

Table 12. Death Loss, Mixed Linear Model Parameter Estimates

Parameter	Estimate	Standard Error
Intercept	-14.1496***	1.5326
Returning Customer	-0.0690	0.0598
Occasional Customer	-0.1062	0.0805
Country Origin	-0.2684***	0.0477
Other Origin	-0.0946	0.1310
Heifer	-1.1767***	0.0753
Close Out Month		
January	-0.5514***	0.0779
February	-0.7313***	0.0981
March	-0.7328***	0.1056
April	0.1491	0.1149
May	0.3293***	0.1253
June	0.5237***	0.0911
July	0.3254***	0.0764
August	0.0639	0.0781
October	-0.0450	0.0796
November	-0.3362***	0.0790
December	-0.4486***	0.0821
Feedlot Performance		
Days on Feed	-0.0078***	0.0025
In Weight	-0.0268***	0.0027
In Weight Squared	7.086E-6***	0.0000
Shrink	-0.2353***	0.0141
Feed-Gain Ratio	5.0043***	0.1521
Feed-Gain Ratio Squared	-0.1198***	0.0085
Average Daily Gain	2.1099***	0.0876
Sick Head Days	0.7317***	0.0235

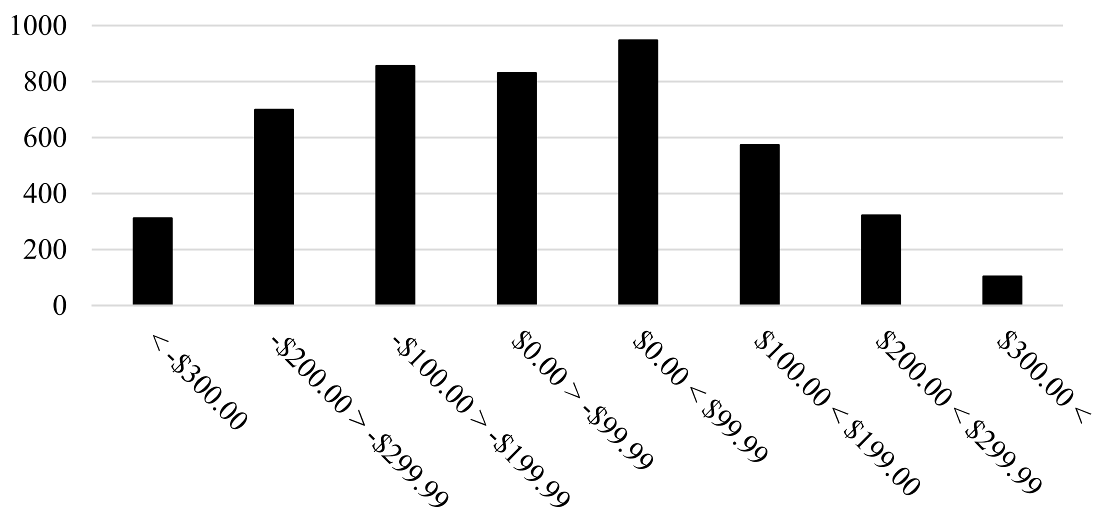
*Significance at 1% ***, 5% **, 10% **

Parameter estimates weighted by head count at close out loss. Country origin is the only significant background characteristic. Pens sourced from the country experience a 0.27% lower death loss rate than sale barn pens. This result is not surprising. Previous research has shown that cattle shipped from a ranch directly to the feedlot experience lower stress and exposure to disease. Estimates for the customer pens indicate a lower death loss rate than firm-owned cattle, but the estimates are not statistically significant. The monthly estimates indicate a seasonal pattern with September serving as the base month. Death loss is lower during the winter months and increases substantially during the summer.

RESULTS OF ORDERED LOGIT MODELS

An Ordered Logit Model (OLM) produces maximum likelihood estimates for a dichotomous dependent variable (Torres-Reyna). The dependent variable for an OLM is not limited to a binary term and it can have multiple, sequential categories. Returns per head is set as the dependent variable and is defined as eight, consecutive return categories. Figure 4 shows the distribution of returns by category.

Figure 4. Frequency of Returns by Category, All Pens



Origin, ownership, gender and close out month are class variables with the same base parameters as the MLM regressions. Feedlot performance and health measurements are included as continuous variables. Table 13 provides the maximum likelihood estimates for the independent variables.

Since the regression is set to descend the parameter estimate relationships are interpreted as either advancing towards or regressing from a higher, more satisfactory, return category. The highest possible return category is Returns/head = $300.00 or greater. Sale Barn Origin is set as the base variable and the estimates for Country and Other sources are in relation to the base variable. If the pen is sourced from the country it has a higher probability of reaching a higher return category than sale barn lots. The inverse is true for lots sourced from Other sources. Pens from Other sources have a slight disadvantage to advance to a higher return level.

Another method to interpret the maximum likelihood estimates are odds ratios, which are the exponential value of the maximum likelihood estimate. Equation 9 explains the relationship between the maximum likelihood estimate and odds ratio.

$$Odds\ Ratio_i = e^{MLE_i} \tag{9}$$

Table 14 lists the odds ratios for the parameters. Point estimates above 1 indicate a higher probability for returns to fall in a higher category, whereas estimates less than 1 decrease the chance for a better return. Customer cattle have better probabilities of higher returns than firm owned pens. The odds for Returning Customers are 1.28:1, meaning that a pen of a Returning Customer is 1.28 times more likely to advance to a higher return level than a pen owned by the firm. Odds between Occasional Customer and Feedlot-

Table 13. Ordered Logit, Analysis of Maximum Likelihood Estimates

Parameter	Estimate	Standard Error
Intercept +300	-24.4872*	6.8614
Intercept +200	-19.7386*	6.8514
Intercept +100	-14.8301*	6.8475
Intercept 0	-9.4881	6.8441
Intercept -100	-4.7579	6.8433
Intercept -200	0.3175	6.8420
Intercept -300	5.5548	6.8408
Country Origin	0.0208	0.0888
Other Origin	-0.0077	0.1571
Returning Customer	0.1502*	0.0668
Occasional Customer	-0.0535	0.0816
Close Out Month: April	0.0837	0.1215
Close Out Month: August	0.1983*	0.1198
Close Out Month: December	0.1645	0.1267
Close Out Month: February	-0.2848*	0.1243
Close Out Month: January	-0.3381*	0.1062
Close Out Month: July	0.3906*	0.1065
Close Out Month: June	0.1150	0.1226
Close Out Month: March	-0.3414*	0.1270
Close Out Month: May	0.0149	0.1165
Close Out Month: November	-0.0167	0.1288
Close Out Month: October	0.0006	0.1250
Heifers	0.2838*	0.0685
COG	-0.2749*	0.0053
Feeder Price	-0.3796*	0.0073
Live Price	0.6466*	0.0124
Days on Feed	0.0401*	0.0142
In Weight	-0.0106	0.0078
In Weight Squared	0.0000	0.0000
Sale Weight	0.0096	0.0091
Sale Weight Squared	0.0000	0.0000
Shrink	-0.5730*	0.0270
Average Daily Gain	1.1963*	0.6321
Feed-Gain Ratio	-0.5193*	0.2094
Feed-Gain Ratio Squared	0.0771*	0.0074
Death Loss	-0.2106*	0.0202

Percent Concordant = 97.8, Descending

** Significant at the 10% level or lower*

Table 14. Returns per Head Ordered Logit, Odds Ratio Estimates

Parameters	Point Estimate	95% Wald Confidence Limits	
Country vs. Sale Barn Origin	1.03	0.86	1.24
Other vs. Sale Barn Origin	1.01	0.63	1.62
Returning Customer vs. Firm Ownership	1.28	1.05	1.56
Occasional Customer vs. Firm Ownership	1.04	0.81	1.34
Heifers vs. Steers	1.76	1.35	2.31
Close Out Month, x vs. September			
January	0.70	0.51	0.98
February	0.74	0.52	1.06
March	0.70	0.49	1.01
April	1.07	0.75	1.53
May	1.00	0.71	1.42
June	1.11	0.78	1.57
July	1.46	1.06	2.00
August	1.20	0.86	1.69
October	0.99	0.70	1.40
November	0.97	0.68	1.39
December	1.16	0.82	1.66
Market Parameters			
Cost of Gain	0.76	0.75	0.77
Feeder Price	0.68	0.67	0.69
Live Price	1.91	1.86	1.96
Feedlot Performance			
Days on Feed	1.04	1.01	1.07
In Weight	0.99	0.98	1.01
Sale Weight	1.01	0.99	1.03
Shrink	0.56	0.54	0.59
Average Daily Gain	3.31	0.96	11.42
Feed-Gain Ratio	0.60	0.40	0.90
Death Loss	0.81	0.78	0.84

owned pens is nearly equal at 1.04:1 odds. The maximum likelihood estimate for Returning Customers is the only background variable that is significant. Heifers have a significantly better odds ratio for higher returns than steers. This observation is supported by results in the weight category tables with heifers receiving returns on average of -$43.89 per head compared to -$49.08 per head for steers. Closing out between April and August or in December gives the pen better return odds than pens closed out in September.

Odds for market parameters follow expectations. Input costs, COG and feeder price, have odds that are less than 1, signaling that higher input prices lower the probability for a higher return. Live price has a 1.91:1 odds ratio. For example, if Lot A sells at a live price that is one unit higher than Lot B, the probability that Lot A achieves a higher return category than Lot B is 1.91 times more likely. Performance variables that improve the odds of a higher return include days on feed, sale weight and most significantly, average daily gain. The greater odds for these variables suggest heavier cattle are more likely to produce better returns. A higher average daily gain combined with a longer feeding period results in heavier cattle and a probability of reaching a more favorable return category. In-weight, shrink, feed-gain and death loss lower the probability of reaching a higher return category. Therefore, returns are penalized by lighter placement cattle, pens that experience increased stress or transportation, pens with high DMI and pens with a high death loss rate. Except for in and sale weights, all performance parameters have significant maximum likelihood estimates.

CONCLUSION

The descriptive mean category tables, MLM estimates and OLM results illustrate the impacts of a pen's background characteristics on feedlot performance and economic returns. Using multiple methods of analysis enriches the ability to evaluate the hypotheses. In regards to the first hypothesis, which expects customer cattle to be more feed efficient than Feedlot-owned cattle, the descriptive means are inconclusive since heifers and steers show contradictory patterns. Feed-Gain descriptive results conclude that Feedlot-owned steers exhibit better feed efficiency than Customer cattle. When Customer cattle are sourced from the country, their feeding efficiency supports the hypothesis but the interactions between origin and ownership confound the conclusion. MLM parameter estimates for ADG suggest that Customer cattle have greater feed-efficiency.

Origin influence on cattle health is the focus of the second hypothesis. The descriptive means support the hypothesis that Country pens will have lower sickness and death rates. The Country parameter MLM estimate for death loss further confirms the hypothesis. Country pens experience a significantly lower death loss than Sale Barn pens. Results of the descriptive means and MLM estimates confirm the second hypothesis, Country cattle exhibit better health than cattle sourced from a sale barn.

The final hypothesis strives to prove the value of sharing information across stages in the cattle supply chain. Customers have access to information about the performance of their cattle during the feeding stage. Information from the feedlot can highlight areas that a producer can improve prior to sending cattle to a feedlot. The MLM estimates for ADG show that Returning Customers have a positive ADG effect but Occasional Customers have an even better effect. This trend does not support the hypothesis that returning customers will have the highest quality of cattle. Death loss estimates show that Occasional Customers have the lowest death loss rates followed by Returning Customers. The Feedlot has the highest death loss rate. In regards to economic returns, lots of Returning Customers receive a $4.63 premium over Feedlot-owned pens and an $8.76 premium over Occasional Customers, according to MLM estimates for Returns per Head. The OLM results confirm this trend with Returning Customers holding a 1.28:1 odds ratio against Feedlot ownership to achieve a better return. Odds for Occasional Customers are nearly equal to odds of the firm. The mixed results for Returning and Occasional Customers demonstrate the difficulty of determining the value of sharing information across stages in the beef supply chain. Even though the performance of Returning Customer pens may not be the best of the three categories, the group achieves the best odds for high economic returns. Therefore, it is reasonable to suggest that the exchange of information between customer and feedlot helps the producer to improve their marketing strategy.

Additional research is recommended to examine trends that appear in the analysis. Studying the motivations to retain cattle in the feedlot can separate the influences caused by market conditions or cattle quality. Furthermore, understanding the cattle selection process could potentially lend insight into a producer's perception of cattle quality. Why do customers purchase poor performing lots to retain and place on feed? The pen-level data exhibited the variability of performance measurements, which raises questions about factors that attribute to performance volatility. Further examination of the connections between background characteristics and feedlot performance would improve the expectations of feeding outcomes and improve feedlot management strategies.

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APPENDIX

Table 1-A. Variable Definitions

Abbreviation	Name	Description
Class Variables		
OWNER	Ownership	1 = Returning Customer, RC 2 = Occasional Customer, OC 3 = Firm Owned, F
ORIGIN	Origin of Pen	1 = Country 2 = Sale Barn 3 = Other
MONTH	Close Out Month	1, 2,… 12 = January, February, March, April, May, June, July, August, September, October, November, December
GENDER	Gender	1 = Steers 2 = Heifers
Continuous Variables		
ADG	Average Daily Gain	Lbs. gained/day
COG	Cost of Gain	$/cwt.
CORN	Corn Price	$/ton
DDG	DDG Price	$/ton
DL	Death Loss	% of head count in
DOF	Days on Feed	days
FG	Feed-Gain Ratio	Dry matter lbs. fed/lb. gained
FP	Feeder Cattle Price	$/cwt.
INWT	In Weight	Lbs.
LP	Live Cattle Price	$/cwt.
PWT	Purchase Weight	Lbs.
SALEWT	Sale Weight	Lbs.
SHD	Sick Head Days	% of DOF
S	Shrink	Δ % PWT and INWT

Table 2-A. Focus on Feedlots and Firm Data Correlations

Variable	Steers	Heifers
In Weight	0.45	0.17
Final Weight	0.77	0.45
Days on Feed	0.19	0.16
Average Daily Gain	0.66	0.49
Feed-Gain Ratio	0.61	0.52
Death Loss	0.57	0.50
Cost of Gain	0.95	0.94

Table 3-A. Pen Frequency

	Customer	Firm	Total
Gender			
Steers	797	2081	2878
Heifers	644	1126	1770
Source			
Country	876	677	1553
Salebarn	495	2486	2981
Other	70	44	114

Count = 4648 pens

Table 4-A. Frequency of Subcategories

Category	Steers	Heifers	Total
All Pens	2,878	1,770	4,648
Country Origin	946	607	1,553
Sale Barn Origin	1,858	1,123	2,981
Customer Ownership	797	644	1,441
Firm Ownership	2,081	1,126	3,207
Country Origin, Returning Customer Ownership	270	267	537
Country Origin, Non-returning Customer Ownership	222	177	399
Customer Ownership, Country Origin	492	384	876
Customer Ownership, Sale Barn Origin	259	236	495

Table 5-A. Two Sample T-Test of Background Subcategories

Variable	Steers v. Heifers	Steers, Country v. Sale Barn	Heifer, Country v. Sale Barn	Steer, Customer v. Feedlot	Heifer, Customer v. Feedlot	Customer Steers, Country v. Sale Barn	Customer Heifers, Country v. Sale Barn	Country Steers, Returning v. Occasional Customers	Country Heifers, Returning v. Occasional Customers
Performance Variables									
Purchase Weight	R	R	R	FTR	R	R	FTR	R	FTR
In Weight	R	R	R	FTR	R	R	R	R	FTR
Shrink	R	R	R	R	R	R	R	FTR	R
Sale Weight	R	R	R	R	R	R	R	R	FTR
Days on Feed	FTR	R	R	R	FTR	R	R	R	FTR
Avg. Daily Gain	R	R	FTR	R	FTR	R	R	FTR	FTR
Feed-Gain Ratio	R	R	FTR	R	R	R	R	R	FTR
Sick Head Days	R	R	FTR	R	R	R	R	FTR	FTR
Death Loss	FTR	R	R	R	R	R	R	FTR	FTR
Estimated Market Variables									
Dynamic COG	R	R	FTR	R	FTR	FTR	R	R	R
Set COG	R	FTR	R	R	R	R	FTR	R	FTR
Return	FTR	R	R	FTR	R	R	R	FTR	FTR

Note: 2-tailed t-test, alpha =0.05, H0 = 0

R = Reject H0, FTR = Fail to Reject H0

Table 6-A. Means by Weight Categories, Customer Steers (*Weighted by Close Out Head*)

Variable	Units	<550	550-600	600-650	650-700	700-750	750-800	800-850	850-900	900-950	950<	Overall
Customer, Country Origin												
Purchase Weight	lbs.	507.85	575.69	624.24	678.85	729.64	777.05	824.16	868.86	924.55	983.51	776.32
In Weight	lbs.	494.57	553.46	610.77	662.02	715.73	765.03	814.35	856.32	912.60	955.65	763.19
Shrink	%	-2.58	-3.88	-2.18	-2.47	-1.91	-1.54	-1.19	-1.44	-1.30	-2.81	1.78
Sale Weight	lbs.	1268.01	1297.82	1302.86	1308.75	1361.10	1373.43	1384.71	1415.34	1449.10	1501.35	1374.08
Days on Feed	days	238	211	193	178	164	151	144	139	131	133	157
Avg. Daily Gain	lbs./day	3.26	3.55	3.60	3.66	3.95	4.03	3.97	4.03	4.09	4.10	3.92
Feed-Gain Ratio	lbs.	5.77	5.68	5.71	5.89	5.79	5.79	5.99	6.07	6.08	6.35	5.90
Sick Head Days	%	1.00	0.45	0.94	0.95	0.52	0.43	0.36	0.41	0.28	0.31	0.50
Death Loss	%	2.97	1.92	3.15	2.30	1.44	1.21	0.96	0.92	0.60	0.63	1.36
Dynamic COG	$/cwt	96.02	111.66	96.17	103.32	100.31	89.03	89.76	87.57	86.99	87.57	93.03
Set COG	$/cwt	71.14	69.03	69.99	71.62	70.55	70.90	73.46	74.19	74.55	75.33	72.06
Return	$/hd.	-44.26	-69.30	-27.27	-53.64	-59.17	29.50	22.88	24.73	43.97	-76.33	-3.85
Count	pens	23	16	32	45	78	100	84	54	38	22	492
	head	1248	1085	2118	2847	6753	9256	7531	3918	3263	1231	39250
Customer, Sale Barn Origin												
Purchase Weight	lbs.	505.19	575.62	625.43	673.55	721.25	780.83	819.97	870.38	920.36	994.12	737.67
In Weight	lbs.	480.19	552.38	597.63	649.33	696.99	745.74	789.92	832.07	888.16	944.52	707.87
Shrink	%	-4.95	-4.02	-4.45	-3.59	-3.37	-4.48	-3.67	-4.41	-3.49	-4.97	4.07
Sale Weight	lbs.	1193.18	1237.61	1244.41	1274.57	1294.27	1343.06	1355.13	1408.38	1427.40	1492.84	1316.75
Days on Feed	days	237	214	198	186	167	158	145	143	131	126	171
Avg. Daily Gain	lbs./day	3.01	3.20	3.28	3.38	3.59	3.79	3.91	4.07	4.14	4.34	3.65
Feed-Gain Ratio	lbs.	5.97	6.07	6.22	6.38	6.27	6.41	6.24	6.33	6.22	6.44	6.27
Sick Head Days	%	0.70	1.23	1.32	1.48	1.42	1.21	1.00	0.70	0.39	1.44	1.10
Death Loss	%	2.32	4.99	3.95	4.97	4.08	3.49	2.43	1.87	1.09	1.32	3.25
Dynamic COG	$/cwt	98.00	99.92	104.00	92.34	96.20	104.58	92.36	83.83	104.76	110.07	96.59
Set COG	$/cwt	72.40	73.43	74.25	76.22	74.91	74.72	73.72	73.39	73.06	72.19	74.18
Return	$/hd.	-98.90	-27.31	-125.65	-78.30	-83.52	-145.38	-10.33	-45.86	-79.82	-162.74	-80.70
Count	pens	29	15	28	35	37	35	31	27	14	8	259
	head	1431	857	1673	2026	2386	2687	2380	2277	893	200	16810

Table 7-A. Means by Weight Categories, Customer Heifers (*Weighted by Close Out Head*)

Variable	Units	<550	550-600	600-650	650-700	700-750	750-800	800-850	850-900	900-950	950<	Overall
Country Origin												
Purchase Weight	lbs.	500.79	577.77	627.85	674.79	728.59	772.58	824.27	866.76	916.11	972.95	692.61
In Weight	lbs.	483.23	556.97	610.73	658.18	713.46	760.58	810.99	845.46	890.67	925.62	676.54
Shrink	%	-3.49	-3.61	-2.74	-2.46	-2.09	-1.56	-1.61	-2.45	-2.78	-4.86	2.42
Sale Weight	lbs.	1134.22	1169.76	1191.09	1194.52	1231.00	1258.21	1273.88	1317.28	1340.63	1415.37	1216.62
Days on Feed	days	217	193	176	159	147	139	130	126	125	123	160
Avg. Daily Gain	lbs./day	3.01	3.18	3.31	3.37	3.52	3.59	3.56	3.73	3.60	3.99	3.41
Feed-Gain Ratio	lbs.	5.92	5.89	5.99	6.06	6.22	6.20	6.35	6.87	8.97	11.14	6.15
Sick Head Days	%	0.72	1.14	1.19	1.01	0.90	0.73	1.10	2.54	6.80	4.69	1.04
Death Loss	%	2.32	2.26	1.91	1.28	1.26	1.12	1.20	3.55	11.11	12.61	1.64
Dynamic COG	$/cwt	102.02	100.96	101.24	96.69	95.23	98.63	102.72	110.43	166.92	178.67	99.67
Set COG	$/cwt	72.34	71.44	72.84	73.58	75.53	75.75	77.31	81.96	102.86	108.94	74.68
Return	$/hd.	12.92	11.36	-2.44	0.45	19.67	11.43	-11.27	22.36	17.66	-116.68	6.46
Count	pens	33	35	61	64	70	51	50	17	1	2	384
	head	2219	2357	4504	4696	5459	3701	3045	864	40	68	26953
Sale Barn Origin												
Purchase Weight	lbs.	509.05	575.90	623.54	670.14	725.40	778.07	821.82	880.31	925.57	975.67	669.29
In Weight	lbs.	486.27	551.79	601.47	641.13	692.86	745.98	788.00	848.85	888.62	952.39	641.76
Shrink	%	-4.47	-4.19	-3.53	-4.33	-4.47	-4.13	-4.11	-3.57	-4.00	-2.39	4.13
Sale Weight	lbs.	1117.55	1133.76	1133.54	1162.56	1199.10	1240.59	1295.31	1321.44	1424.70	1498.56	1180.61
Days on Feed	days	215	188	175	164	152	138	133	127	123	117	168
Avg. Daily Gain	lbs./day	2.94	3.10	3.04	3.18	3.33	3.59	3.80	3.71	4.39	4.69	3.26
Feed-Gain Ratio	lbs.	6.05	6.03	6.18	6.56	6.55	6.56	6.53	6.54	7.34	6.09	6.36
Sick Head Days	%	0.82	1.08	1.48	1.71	1.52	1.60	1.82	3.25	0.70	0.84	1.49
Death Loss	%	3.14	2.25	3.24	4.37	3.07	3.05	2.28	1.51	3.74	0.00	3.15
Dynamic COG	$/cwt	104.89	113.66	112.77	119.21	109.38	100.61	93.97	119.14	120.11	108.26	110.85
Set COG	$/cwt	73.26	72.46	74.36	77.15	76.47	75.94	75.75	76.12	83.59	72.47	75.26
Return	$/hd.	0.22	-100.09	-60.22	-133.90	-98.68	-42.70	32.94	-9.60	-53.76	232.95	-66.50
Count	pens	33	26	35	45	32	23	16	14	8	4	236
	head	2015	1888	2526	3016	1835	1602	694	687	223	88	14574

Table 8-A. Means by Weight Categories, Customer Frequency, Country Steers (*Weighted by Close Out Head)*

Variable	Units	<550	550-600	600-650	650-700	700-750	750-800	800-850	850-900	900-950	950<	Overall
Returning Customers												
Purchase Weight	lbs.	511.70	577.20	624.94	677.43	728.48	776.98	822.50	866.04	918.89	985.67	753.80
In Weight	lbs.	496.50	555.40	612.83	659.39	716.32	769.28	813.09	853.07	892.30	956.11	741.24
Shrink	%	-2.96	-3.78	-1.94	-2.65	-1.67	-0.99	-1.14	-1.48	-2.89	-3.01	1.71
Sale Weight	lbs.	1269.43	1286.02	1311.90	1286.02	1371.94	1398.15	1392.97	1435.03	1448.44	1486.90	1373.38
Days on Feed	days	238	212	191	180	164	152	142	141	135	133	162
Avg. Daily Gain	lbs./day	3.25	3.45	3.67	3.49	4.00	4.15	4.10	4.14	4.12	3.96	3.96
Feed-Gain Ratio	lbs.	5.83	5.71	5.68	6.06	5.64	5.65	5.84	5.91	6.13	6.68	5.78
Sick Head Days	%	0.73	0.45	0.77	0.84	0.42	0.37	0.36	0.49	0.25	0.46	0.46
Death Loss	%	2.26	2.21	2.66	2.15	1.20	0.85	0.75	0.60	0.69	1.10	1.21
Dynamic COG	$/cwt	93.45	116.04	101.21	113.03	102.45	93.50	90.96	84.80	94.03	79.66	97.11
Set COG	$/cwt	71.72	69.48	69.75	73.39	69.32	69.78	71.71	72.15	73.20	78.70	70.85
Return	$/hd.	-16.24	-84.80	-65.50	-92.59	-53.19	15.95	53.89	24.96	-41.98	-82.95	-13.87
Count	pens	19	13	18	31	51	53	42	22	15	6	270
	head	1037	945	1179	1779	4466	5694	3976	1465	1141	262	21944
Occasional Customers												
Purchase Weight	lbs.	488.91	565.48	623.36	681.21	731.90	777.15	826.01	870.54	927.59	982.93	804.99
In Weight	lbs.	485.08	540.31	608.18	666.41	714.57	758.24	815.77	858.26	923.52	955.53	791.13
Shrink	%	-0.73	-4.53	-2.48	-2.16	-2.39	-2.42	-1.24	-1.41	-0.44	-2.76	1.86
Sale Weight	lbs.	1261.06	1377.46	1291.52	1346.61	1339.95	1333.90	1375.47	1403.59	1449.46	1505.26	1374.98
Days on Feed	days	233	199	195	174	164	151	147	138	129	133	151
Avg. Daily Gain	lbs./day	3.32	4.23	3.52	3.94	3.84	3.82	3.82	3.96	4.07	4.14	3.88
Feed-Gain Ratio	lbs.	5.46	5.43	5.75	5.60	6.08	6.02	6.16	6.17	6.06	6.26	6.04
Sick Head Days	%	2.34	0.45	1.17	1.14	0.71	0.52	0.36	0.36	0.29	0.27	0.54
Death Loss	%	6.50	0.00	3.78	2.57	1.90	1.77	1.19	1.11	0.56	0.50	1.55
Dynamic COG	$/cwt	108.63	82.11	89.85	87.15	96.12	81.74	88.42	89.23	83.21	89.70	87.83
Set COG	$/cwt	68.28	65.99	70.30	68.68	72.96	72.73	75.41	75.40	75.27	74.41	73.61
Return	$/hd.	-181.98	35.26	20.73	11.25	-70.84	51.57	-11.81	24.59	90.19	-74.54	8.92
Count	pens	4	3	14	14	27	47	42	32	23	16	222
	head	211	140	939	1068	2287	3562	3555	2453	2122	969	17306

Table 9-A. Means by Weight Category, Customer Frequency, Country Heifers (*Weighted by Close Out Head)*

Variable	Units	<550	550-600	600-650	650-700	700-750	750-800	800-850	850-900	900-950	950<	Overall
Returning Customer												
Purchase Weight	lbs.	502.51	577.19	625.59	676.17	727.03	773.05	825.07	865.02	916.11	972.95	689.87
In Weight	lbs.	487.72	557.14	606.26	658.71	715.41	765.97	814.82	843.50	890.67	925.62	675.09
Shrink	%	-2.95	-3.47	-3.10	-2.58	-1.61	-0.92	-1.25	-2.49	-2.78	-4.86	2.24
Sale Weight	lbs.	1149.48	1161.83	1185.01	1193.94	1232.36	1257.07	1274.26	1318.03	1340.63	1415.37	1215.55
Days on Feed	days	219	194	176	159	149	138	130	127	125	123	162
Avg. Daily Gain	lbs./day	3.04	3.12	3.29	3.38	3.47	3.56	3.54	3.73	3.60	3.99	3.38
Feed-Gain Ratio	lbs.	5.94	5.89	5.96	6.02	6.21	6.16	6.33	7.06	8.97	11.14	6.14
Sick Head Days	%	0.59	1.07	1.21	1.01	0.92	0.80	1.04	3.24	6.80	4.69	1.07
Death Loss	%	2.17	2.19	1.82	1.28	1.48	0.99	1.18	4.44	11.11	12.61	1.70
Dynamic COG	$/cwt	98.14	104.15	102.85	101.03	100.93	106.95	108.15	121.28	166.92	178.67	104.07
Set COG	$/cwt	72.95	71.46	72.20	72.91	75.92	76.02	77.66	84.08	102.86	108.94	74.76
Return	$/hd.	28.01	4.53	-4.83	-1.00	16.17	-14.45	-20.74	2.57	17.66	-116.68	0.31
Count	pens	25	23	47	39	49	29	40	12	1	2	267
	head	1682	1739	3389	2820	3522	2141	2429	582	40	68	18412
Occasional Customer												
Purchase Weight	lbs.	495.40	579.39	634.74	672.71	731.43	771.93	821.12	870.34			698.52
In Weight	lbs.	469.17	556.49	624.35	657.39	709.92	753.18	795.88	849.49			679.68
Shrink	%	-5.15	-4.01	-1.66	-2.27	-2.96	-2.45	-3.07	-2.36			2.79
Sale Weight	lbs.	1086.41	1192.09	1209.56	1195.40	1228.52	1259.78	1272.40	1315.74			1218.95
Days on Feed	days	212	188	175	160	143	139	130	125			156
Avg. Daily Gain	lbs./day	2.92	3.38	3.37	3.36	3.62	3.65	3.67	3.73			3.48
Feed-Gain Ratio	lbs.	5.84	5.91	6.07	6.14	6.23	6.25	6.41	6.47			6.17
Sick Head Days	%	1.11	1.36	1.12	1.01	0.86	0.64	1.34	1.10			0.98
Death Loss	%	2.78	2.43	2.20	1.28	0.86	1.31	1.26	1.72			1.50
Dynamic COG	$/cwt	114.15	91.99	96.37	90.17	84.87	87.19	81.31	88.04			90.16
Set COG	$/cwt	70.41	71.39	74.78	74.60	74.81	75.38	75.89	77.61			74.51
Return	$/hd.	-34.34	30.57	4.84	2.61	26.03	46.95	26.05	63.21			19.70
Count	pens	8	12	14	25	21	22	10	5			117
	head	537	618	1115	1876	1937	1560	616	282			8541

Figure 1-A. Sick Head Days (% of DoF), Steers

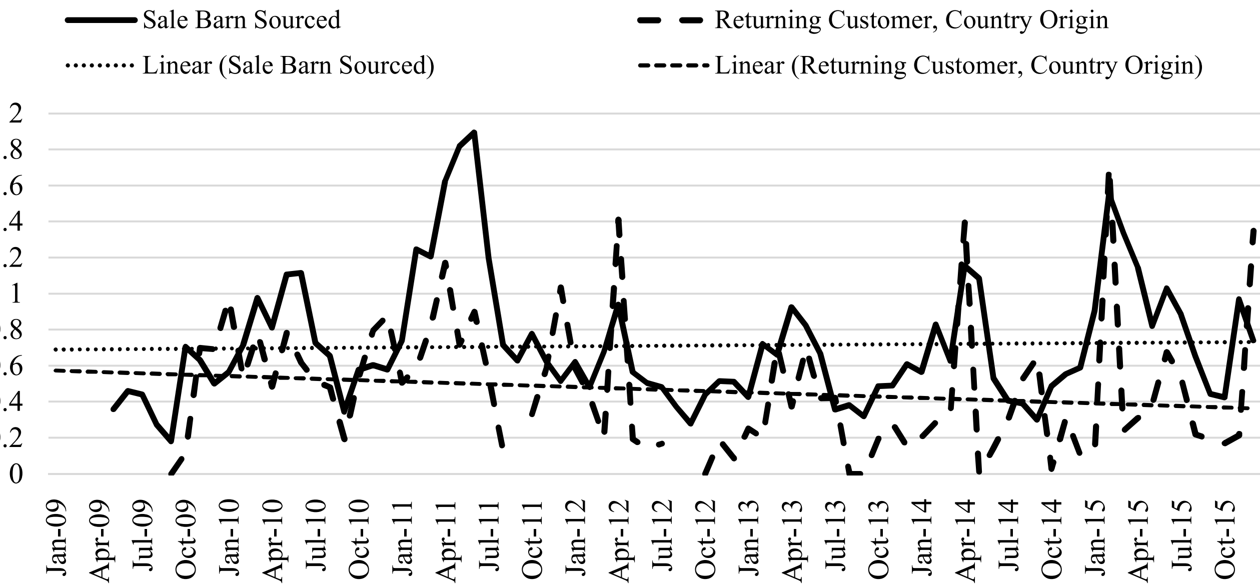
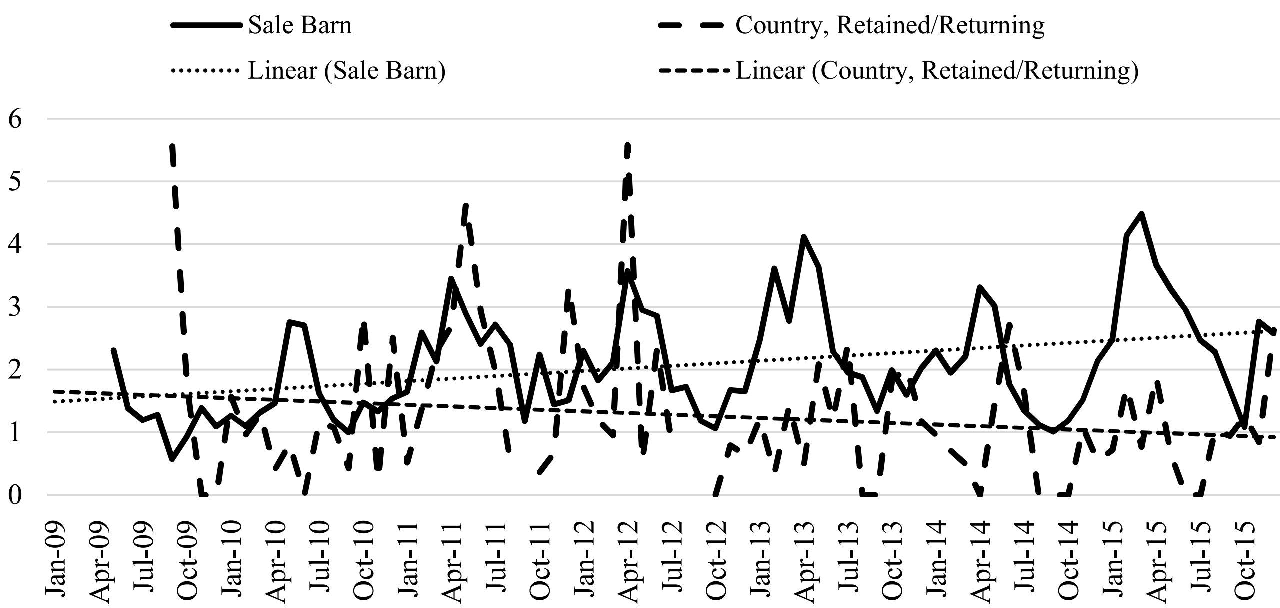


Figure 2-A. Death Loss, Steers (%)



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