ECONOMIC ANALYSIS OF BACKGROUNDING AND STOCKING INDUSTRIES IN THE FLINT HILLS OF KANSAS

by

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Abstract

The purpose of our analysis was to examine production strategies in the backgrounder and stocker segments of the beef industry within the Flint Hills region of Kansas. The time period analyzed encompassed 1996-2015. September and November placements of steers in the backgrounding sector of the industry were analyzed with an intended March sale date. Placements considered included 425, 500, and 575 pound steers. April and May placements of steers were analyzed for the industry's stocking sector with an intended July sale date. Placements considered included 450, 600, and 750 pound steers.

Within our analysis historical ex-post net incomes were analyzed, prediction errors were calculated (net income, revenue, and cost of gain), and market incentives/signals were analyzed.

While for our historical ex-post net income analysis we did not identify one of the four placement strategies as superior in all 20 years of our analysis, we did find scenarios that were typically superior to others. In terms of backgrounding, November placements were typically superior to September placements, in terms of stocking April placements were typically superior to May placements, and when comparing backgrounding and stocking scenarios stocking scenarios were typically superior. In terms of prediction errors, we found that revenue errors are the main drivers of net income error. In general, within the backgrounding scenarios typical producers who are representative of our model assumptions generally overestimate net incomes which is detrimental to them (make lower profits than they anticipate making), while in stocking scenarios producers underestimate net incomes which is generally beneficial to them (make larger profits than they anticipate making). Market signal/incentive and ex-post net income analysis both indicated that steer weight at time of sale was a large factor influencing backgrounder profitability and decision making, and that pasture rents were a large factor

influencing stocker profitability and decision making. In all four scenarios it proved economically beneficial to place lighter steer rather than heavy steers.

Further research may include, but is not limited to; adding bulls and heifers to our model, analyzing different placement weights within our model, and allowing for animal performance variability within our model.

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I would also like to thank my fellow graduate students for their friendship and help throughout graduate school. I would like to thank my dad, mom, and grandma for encouraging me through this process and for pushing me to be the best I can be, and additionally thank you to dad for helping me understand the intricacies of the backgrounder/stocker segment of the beef industry. Lastly, I would like to thank God for giving me the patience and perseverance to complete this project.

Chapter 1 - Overview of the Stocker/Backgrounder Industries and Review of Previous Literature

Figure 1.1 Flint Hills Grass and Cattle

(Leiker, 2016)

Research within this report focuses on the stocker and backgrounder sections of the beef industry. These two operations are often referred to as the grower segment of industry. Research within the grower segment of the beef industry has historically been minimal relative to research concerning the cow-calf and feedlot segments of the industry. Knowing this, we believe the research within this report adds value to the beef industry as a whole.

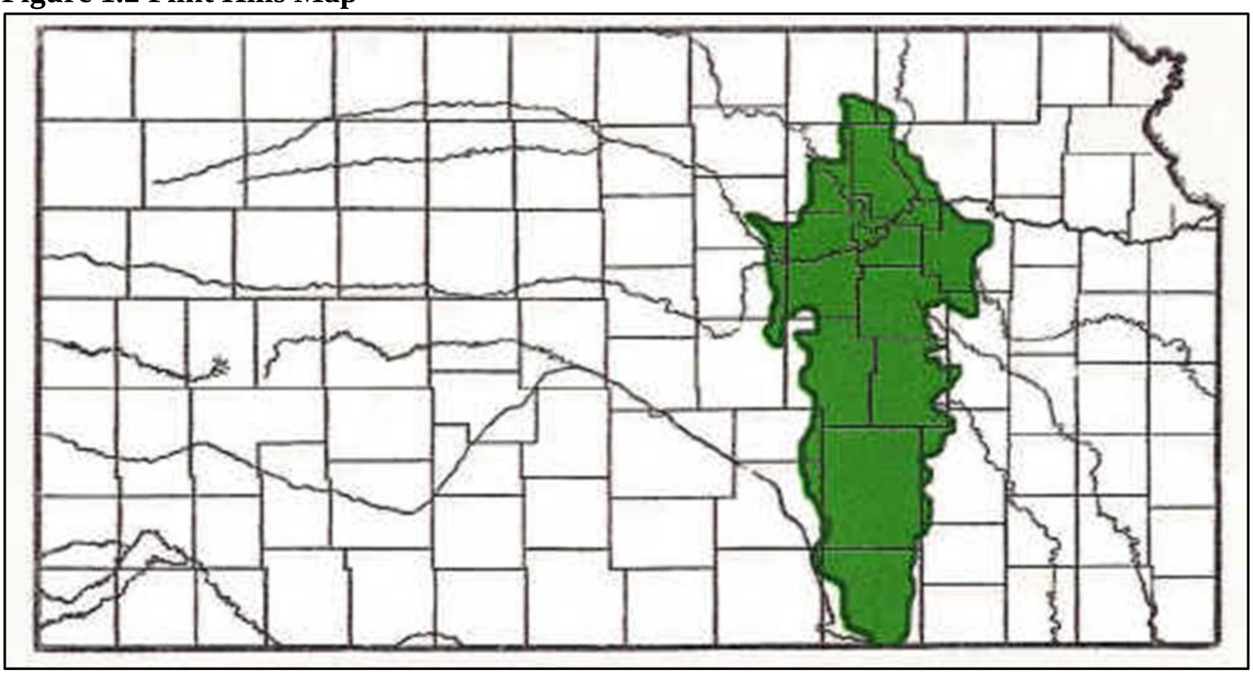
1.1 Beef Supply Chain Overview

The beef industry supply chain begins with seedstock producers who supply genetics to the industry and ends with beef on consumer's plates. Intermediate steps between seedstock producers and consumers include: cow-calf producers, stockers/backgrounders, feedlots, and packers/processors/distributers (Mollohan, 2014). Seedstock producers raise bulls and replacement heifers that they sell to cow-calf producers to utilize in their operations as means of improving herd genetics. Cow-calf producers are responsible for producing calves that will be sent to either stocker/backgrounder operations or sent directly to feedlot operations. Spring calving cows and fall calving cows are utilized in the cow-calf segment of the industry to ensure a year round supply of beef, with the majority of cows calving in the spring. Some cow-calf producers will choose to background their calves themselves while some will sell their calves post weaning. Some of the benefits of cow-calf producers retaining ownership of calves beyond weaning include: increased value of animals from added weight, acquiring post-weaning performance information, and capitalizing on rewards associated with superior genetics within their own herd (White, et al., 2007). An increased level of price risk is a con associated with retaining calves beyond weaning. Expected premiums and discounts often factor into cow-calf producers retain/sell decision and this decision is often producer dependent and not uniform across the industry for any given year. For example, calves that are weaned in the early fall may be sold immediately following weaning, may be conditioned and marketed in the late fall or early winter, may be held throughout the winter with modest rates of gain before being placed on grass in the spring (capitalizing on compensatory gain), or may be fed to achieve greater rates of gain and sold in the winter as feeder cattle (Marsh, 1985).

Stocker/backgrounder operations purchase cattle post weaning with the intention of growing these animals cheaply on low cost forages before selling them to feedlot operations to be finished. Stocker/backgrounder operations typically purchase cattle weighing approximately 500-600 pounds with the goal of adding 200-300 pounds of gain to the animal before selling them as 700-800 pound feeder animal to feedlot operations. In our analysis we are viewing backgrounding operations as ones who grow cattle in a drylot setting with higher energy based rations. Stocking operations are viewed as ones who run calves or yearlings on grass with no additional carbohydrate or protein supplementation. Feedlot operations procure cattle from either cow-calf producers or stocker/backgrounders and typically feed them to a finished weight of 1,200-1,500 pounds. Feedlots then sell finished cattle to packers who will process the animals and distribute them to stores and dining establishments who will then sell beef products directly to the end consumer.

1.2 Kansas Flint Hills Overview

Figure 1.2 Flint Hills Map



(Mason, 2016)

In our analysis of stocker/backgrounder operations we focused our attention on the Flint Hills region of Kansas. This region is located in the eastern third of Kansas and stretches from roughly 50 miles south of the Kansas-Nebraska border down to the Kansas-Oklahoma boarder. This region is a high, wide, gently rolling landscape blanketed with the largest continuous area of tallgrass prairie left in the world (Kansas Department of Wildlife, Parks & Tourism, 2011). The predominant forages in this region consist of Big and Little Bluestem, Switchgrass, and Indian grass. The four million acres that are called the Flint Hills account for nearly 80% of what's left of the world's tallgrass prairie and only 4% of the original prairie remains intact today (The Nature Conservancy, 2016). The primary reason that this region has remained undisturbed until today is the rocky soils (flint, limestone, and shale) that are prevalent in the area. In contrast, much of the prairies of Iowa, Nebraska, Missouri, and Illinois have been plowed under for farming purposes due to the rich and productive soils there.

Ranching is the primary agricultural enterprise within the Flint Hills region of Kansas. Each year thousands of cattle from all over the United States (primarily the southeast) are transported to this region to be placed on pasture. Grass within this region is known for its high forage quality and its ability to generate large average daily gains (up to three pounds/day under ideal conditions) and is widely considered to be the best grass in the United States if not the world. Flint Hills veteran custom grazer and rancher Wayne Bailey states, "When we have water, this is the best grass in the world. We can add pounds cheaper and more efficiently here than anywhere. We have to make a profit anytime we can and we can add a lot of value to those yearlings in the summer" (Mitchell, 2013). Although this region is primarily used for stocker cattle in order to generate cheap gains, some cow-calf operations also exist which produce calves that are then ran on pasture within the region.

Grazing strategies within the region have evolved over time. As time has gone by, burning pasture yearly has grown in popularity and cattle are typically intensively stocked as opposed to being ran in accordance with a season long grazing strategy. Prior to the mid 1970's season long grazing was the norm with cattle being placed on pasture following spring green up in mid to late April and then being pulled from pasture in late September or early October. In the 1970's, researchers at Kansas State University developed what is commonly known as intensive early stocking (also known as double stocking). Intensive early stocking calls for twice the number of cattle to be placed on pasture for solely the first half of the grazing season (Owensby and Fick, 2015). Researchers noticed that cattle gained the same in the first 90-120 day period on grass regardless of whether pastures were lightly stocked, moderately stocked, or heavily stocked. As the grazing season progresses forages become more mature and have lower forage quality which results in decreased gains (Owensby and Fick, 2015). Rather than utilizing 4 acres/head for a 180 day grazing period producers can achieve similar gains (and thus increased gains/acre) by placing twice the number of cattle at 2-2.5 acres/head for half the time. Additionally, researchers have found that stockers placed in feedlots in mid-July have a 15% increase in feed efficiency relative to those entering the feedlot in October. When pulling calves early in mid-July regrowth of forage results in greater volumes of fuel for spring burning which has helped with improving pasture conditions. Burning is an integral piece of stocker operations as late spring burning on average results in an additional 32 pounds of gain/head versus not burning (Owensby and Fick, 2015).

1.3 Previous Literature

Within the stocking/backgrounding segments of the beef industry producers face significant price risk. The ability to accurately forecast prices is critical in the development of marketing plans by producers. Multiple theories exist in regards to the optimal forecasting method for cattle markets. Lawrence and Hoffman's (2009) paper titled "Cattle Price Forecast Errors: Live Cattle Futures & Seasonal Index" analyzed fed cattle markets from both a futures market perspective and a seasonality perspective. In their Live Cattle Futures Market forecast they use the closing futures price one week from the Cattle on Feed report for January, April, July, and October and adjust predictions using a 5-year average basis. Forecasts for three month intervals were then averaged to create quarterly forecasts. In their Seasonal Index approach they use the monthly average price following the January report to forecast prices for each of the next 12 months. Months were then averaged to create quarterly indexes as with the Futures method. These were then compared to actual quarterly prices from 1990-2008. Forecast error in their model was defined as actual price minus forecast price. They found that on average both methods forecasted future price very well with the Seasonal Index being slightly more accurate (Lawrence and Hoffman, 2009).

Wilson (1993) specifically analyzed the prediction of feeder cattle prices in her paper titled "Feeder Cattle Forecasting Models: An Econometric Study of Development and Performance". The objective of the study was to identify whether an intricate forecasting model which took into account variables such as seasonality, cost of gain, and output price would forecast quarterly feeder cattle prices more accurately than a simpler model based solely on feeder cattle futures prices. In other terms, she wanted to know if more complex forecasting models had the ability to outperform the market. The findings did show that the more complex model forecasted feeder cattle prices more accurately than the futures market alone, but that both models performed well in the test (Wilson, 1993).

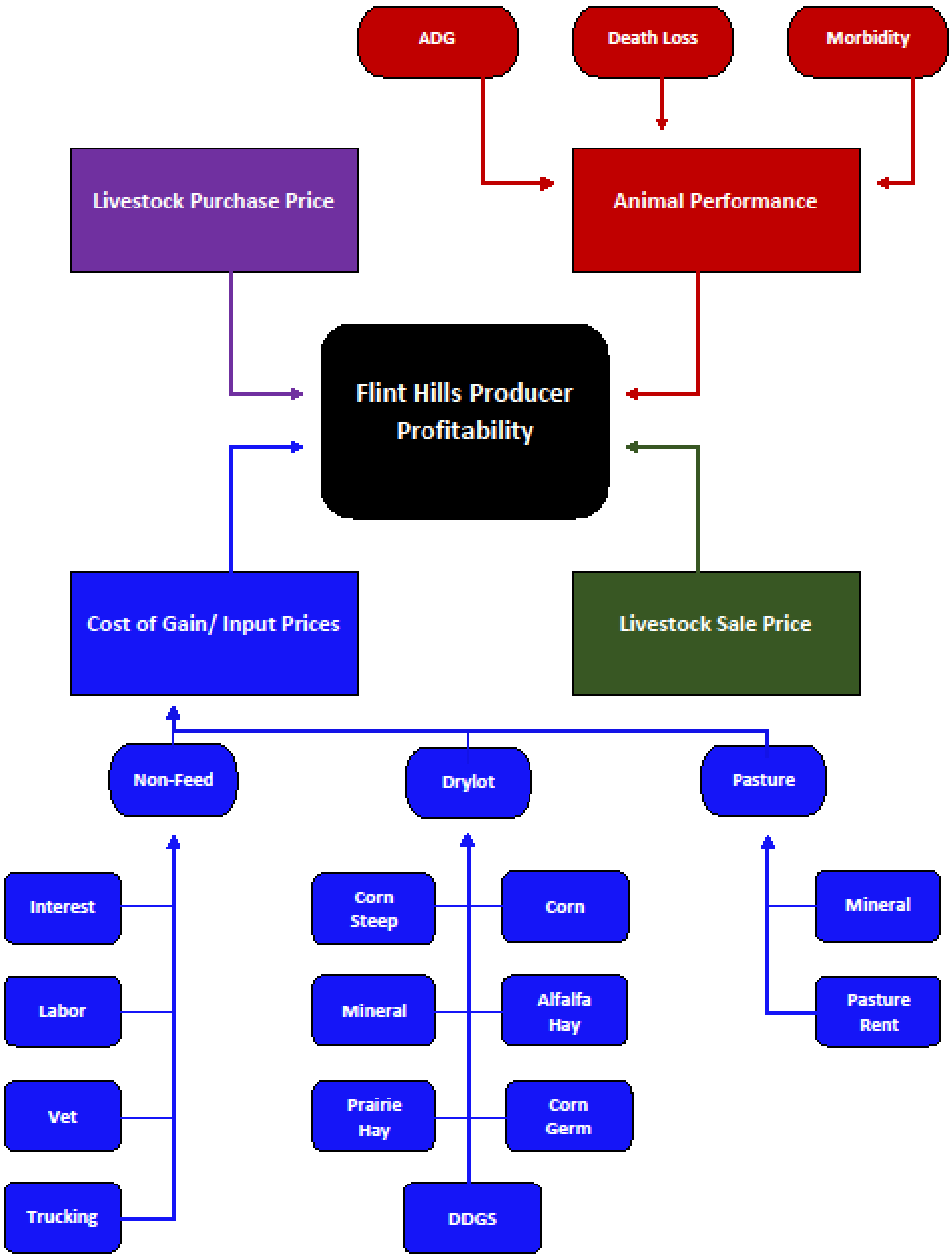
The ability to accurately forecast basis is also an integral piece of predicting both purchase and sale prices for stocker/backgrounder operations. Futures market implied basis-adjusted forecasts have been used over a long period of time by producers when making marketing decisions. This is highlighted in Tonsor, Dhuyvetter, and Mintert's (2004) paper titled "Improving Cattle Basis Forecasting". In this paper they analyze whether or not a time-to-expiration basis prediction approach would be optimal compared to the more common calendar approach, what is the optimal number of years to include in historical average calendar based approach, and if the supplementation of historical basis information with current basis information will increase basis forecasting accuracy. Their first finding was that the time-to-expiration method had little statistical effect on the accuracy of basis projects for the duration of the study. Their second finding was that the optimal number of years to include in historical basis predictions for feeder cattle is three years and the optimal number to include for live cattle forecasts is four years. Lastly, they found that it was beneficial to supplement historical basis information with current basis information when making basis forecasts (Tonsor, et al., 2004).

Another factor affecting stocker/backgrounder profitability relates to price differences between calves and yearlings. Since calves are often brought into stocker/backgrounder operations and then sold as yearlings it is important to understand the factors affecting price differences between the two categories of cattle. In Marsh's (1985) paper titled "Monthly Price Premiums and Discounts between Steer Calves and Yearlings" he focused on how changes in cost of gain, slaughter prices, and seasonality effect calf and yearling prices. In the study he found that increases in cost of gain decreased the price of both calves and yearlings. This results from a decrease in feeding margins which causes decreases in the derived demand of both calves and yearling. However, the price decrease was more significant for calves as feedlots must put more pounds on calves to get them to a finished weight as opposed to yearlings. This narrows the price difference between calves and yearlings. Moreover, Marsh found that increases in the price of slaughter steers leads to increases in both calf and yearling prices, but more so for calves, widening the margin between calves and yearlings (Marsh, 1985). In 2014, Mollohan updated and revised Marsh's 1985 paper in her paper titled "Price Analysis in the Stocker Industry" to include heavier weight cattle (reflecting improved genetics within the beef industry) and corn price variability as factors influencing price differences for calves and yearlings. Mollohan's results generally align with those reported by Marsh. The results of her study showed that as corn price (proxy for cost of gain) increases, calf and yearling prices decrease, and that calves are affected to a greater degree than yearlings. The study also showed that as the price of slaughter cattle increases, calf and yearling prices also increase. However, contrary to Marsh's findings, yearlings were affected to a greater degree than calves with regards to changes in slaughter cattle price (Mollohan, 2014).

Our research analyzed profitability within the stocker/backgrounder segments of the beef industry within the Flint Hills region of Kansas. Emphasis was placed on historically optimal production decisions, prediction errors with regards to revenue, cost of gain, and net income, and market signals/incentives within the industry. In regards to our forecasting method, for prices we used the futures market prediction adjusted for basis differences. We forecasted basis utilizing a three-year historical basis following Tonsor, Dhuyvetter, and Minter's work (Tonsor, et al., 2004). In this study we did not make an attempt to disseminate between calves or yearlings, viewing them as being the same within this paper.

Chapter 2 - Model

Figure 2.1 Flint Hills Producer Profitability Flowchart



Profitability of backgrounder and stocker producers in the Flint Hills region of Kansas is dependent on four main factors. These factors include livestock purchase cost, livestock sale revenue, animal performance, and cost of gain. These factors and their individual components can be visualized above in figure (2.1) and are utilized within the first stage of model analysis and are built upon in later stages.

Our model analyzes profitability, prediction errors, and market signals within the stocker and backgrounder segments of the beef industry for the Flint Hills region of Kansas between 1995 and 2015. The model provides insights into optimal ex-post production strategies, prediction errors (net income, revenue, and cost of gain), and market signals/incentives for steers on a per head basis. Analysis is conducted on the first day of each month with production decisions being updated on the first day within each month livestock are owned. The initial scenario the model considered is a September placement of steers with a planned March sale date. Steer calves and yearlings are both incorporated into the model, thus from this point on both calves and yearlings will be referred to as steers to avoid confusion.

The model was built in five distinct stages. In the first stage of the model, ex-post net incomes for each month between the placement date and planned sale date are predicted. The second stage of the model brings into account prediction errors for net income, revenues, and cost of gain. Within the second stage net incomes, revenues, and COG expectations for the planned sale date (March in our initial scenario) are calculated at the date of placement (September in our initial scenario). These expectations are then compared to actual predicted (what our model estimates to really have happened historically) net incomes, revenues, and COG's that were derived in the first stage of the model in order to generate prediction errors. The third stage of the model expands upon the second stage by updating expectations for net incomes, revenues, and COG's each month cattle are owned. These updated expectations are compared with monthly sales predictions generated in the first stage of the model to calculate prediction errors. The fourth stage of the model examines market signals in a real-time sense by comparing net incomes attainable from selling steers before the planned sale date with expected net incomes from holding steers through the planned sale date. The final stage of the model analyzes changes in placement dates from the base scenario of a September placement.

2.1 Model Stage 1

This stage addresses ex-post optimal production strategies (based on net income) and is driven by the factors in figure (2.1) above. This approach takes prices as given and provides an initial historical assessment of profitability. Within this stage livestock purchase cost, livestock sales revenue, components of COG, and components of animal performance are used to predict ex-post net incomes for each subsequent month between livestock purchase and planned livestock sale. For example, in the initial September purchase/planned March sale scenario the model provides predicted ex-post net incomes for September placed steers that are sold in October, November, December, January, February, and March. Factors that influence net incomes will be described below for the initial September purchase/planned March sale scenario.

2.1a Livestock Purchase Cost (Purple Box Figure 2.1)

In the initial scenario steers are purchased on September 1st. The model analyzes placing three weight classes of steers. These weight classes include 425 pound steers, 500 pound steers, and 575 pound steers. These weights were chosen to describe light weight, average weight, and heavy weight steers. Livestock purchase price is calculated as historical price ($/cwt) on September 1st of the placement year, multiplied by steer weight (in cwt.) at placement. In the first stage of the model historical sale prices are used so basis expectations are not needed.

2.1b Livestock Sale Revenue (Green Box Figure 2.1)

In the initial scenario livestock sale revenues are calculated for the October, November, December, January, February, and March sales of September placed steers. Livestock sale revenues are calculated as historical price ($/cwt) on the date of sale in the specified year, multiplied by steer weight (in cwt.) at the time of sale. Steer weights are shrunk three percent on the date of sale. For calves and feeder cattle it is common for shrinks to be penciled in at 2-3% of weight on the hoof. Livestock sale revenue calculations are made on the first day of each respective potential sale month. Once again, as mentioned in the Livestock Purchase Cost section above, in the first stage of the model historical sale prices are used so basis expectations are not needed.

2.1c Animal Performance (Red Box Figure 2.1)

Animal performance can be broken into three primary components. These components include average daily gain, death loss, and morbidity. In the model average daily gain and death loss contribute directly towards animal performance and indirectly towards producer profitability. Morbidity is not directly included in the model, but indirectly is included as it factors into average daily gain and death loss statistics. Cattle that are morbid are likely to gain less efficiently and also are more likely to die than cattle that are non-morbid. Average daily gain and death loss statistics are representative of animal performance at the Kansas State University Beef Stocker Unit. This facility is located in the Flint Hills region of Kansas and is a good representation of typical stocking and backgrounding operations.

In the model animal performance is treated as a known fixed parameter when in reality it is not known with certainty. In reality there can be significant variability in both average daily gain and death loss, some of which can be contributed to controllable management factors and some of which is rather random. For instance, in the backgrounding scenario producers can choose to limit feed intake to achieve lower average daily gains while attempting to capitalize on compensatory gain or minimized feed costs. Alternatively, they can make an attempt to increase feed intake to achieve greater average daily gains when feed costs are low. Additionally, prompt identification and treatment of sick animals can lead to reduced levels of death loss. However, some factors are out of a producer’s control. Some cattle will naturally gain more efficiently than other cattle, some cattle may get hit by lightning, etc. Needless to say, some animal performance factors are out of the producer’s control and can lead to significant levels of variability in animal performance. In this model we are masking this variability which will simplify our predictions and expectations.

We identify average daily gain values and death loss estimates on the date of placement. These estimates are used for the following three-month period after which the estimates are updated (this is due to the structure of the data that we used to generate average daily gain and death loss predictions). Estimated average daily gain and death loss figures are functions of the placement month, animal gender (steer, bull, heifer), and animal weight. For example, in our initial scenario we estimate average daily gain and death loss values for the first three months of ownership on September 1st. On January 1st we then again estimate new average daily gain and death loss values for the next three months using January as the placement date and the animal weight on January 1st as the new animal weight. In an effort to keep our predictions on the conservative side we place death loss at the end of each month within the model. This forces livestock owners to pay feed costs for the entire month for animals that may die in the beginning or middle of the month. If we were to place death loss at the beginning of each month we wouldn't be accounting for the feed that an animal that died in the middle or end of the month would have consumed and that the producer would have had to realistically pay for.

2.1d Cost of Gain (Blue Box Figure 2.1)

Cost of gain represents the expenses that are incurred throughout animal ownership. Cost of gain excludes initial purchase cost. Components that make up cost of gain in our model can be divided into two groups. These groups include non-feed costs and feed costs. Feed costs can be further broken down into feed costs associated with backgrounding (drylot) rations and those associated with stocker (pasture) rations.

Non-feed costs represented in the model include interest expenses (interest), labor expenses (labor), veterinary expenses (vet), and transportation expenses (trucking). These expenses apply to both backgrounding and stocker segments of the beef industry. In the model, 50% of the purchase price of the animal is purchased on credit, whereas 100% of feed is purchased on credit (including pasture rent).

Interest expenses are incurred at the beginning of each month. In the model future interest rates, animal weights, and feed consumption are assumed to be known with certainty on the date of purchase. Therefore, forward looking interest expenses only vary from realized predicted interest expenses due to differences in realized verses expected feed cost. Labor expenses are incurred at the beginning of each month and are assumed to be known with certainty on the date of purchase. The labor rate ($/hour) on the date of purchase is used as the labor rate throughout ownership. It is assumed within the model that it requires .208333 hours of labor/month/animal. Veterinary expenses are assumed to be $5/head and are incurred on the date of purchase within the model. By forcing these expenses to the date of purchase we are ensuring that all animals sold early still face a veterinary expense. This is representative of most operations where a majority of veterinary related expenses are incurred within the first month of animal ownership. All transportation expenses are incurred on the date of livestock purchase. Livestock are assumed to be transported 50 miles from the sale barn to the farm (receiving) and 50 miles from the farm back to the sale barn (shipping). Receiving costs are calculated using placement weights and trucking rates at the time of purchase, while shipping costs are calculated using unshrunk animal weights and trucking rates at the time of the planned sale (March in the initial scenario). Cattle are assumed to shrink during transportation, thus the unshrunk animal weight is used to calculate shipping expenses.

Drylot feed costs for backgrounding scenarios in the model include expenses for corn, alfalfa hay, prairie hay, distillers grains with solubles (DDGS), corn steep liquor (corn steep), corn germ meal (corn germ), and supplement (mineral). This ration is representative of the backgrounding ration used at the Kansas State University Beef Stocker Unit (D. Blasi, personal communication, 2015). Individual operators will adjust rations in response to ration component price changes, but this ration is representative of a typical Flint Hills ration in terms of its nutritional composition. Feed is assumed to be purchased on the first day of each month that cattle are owned. Unlike non-feed costs (excluding interest), drylot feed costs are not assumed to be known with certainty at the date of purchase due to the fact that feed prices aren't constant throughout ownership. In the model historical cash prices are updated each time feed is purchased.

Pasture feed costs for stocking scenarios include grass costs (pasture rent) and supplement expenses (mineral). Due to the fact that within our model we make decisions on the first day of each month, we assume that short season Flint Hills pasture leases run from April 1st through July 1st. In reality, a majority of Flint Hills short season pasture lease agreements begin in the middle of April and run through the middle of July. Pasture rent expenses are incurred on April 1st in the model. The full cost of pasture rent is incurred regardless of whether cattle are pulled off of grass prior to the end of the lease agreement or whether cattle go to grass after the lease agreement starts. Mineral expenses are assumed to be known with certainty on the date of purchase.

2.2 Model Stage 2

The second stage of the model computes expectations for net income, revenue, and COG for the planned date of sale on the date of purchase. For example, in the September purchase/planned March sale scenario the model calculates an expected net income from owning cattle through March on the day the animals are purchased in September. It is important to start bringing expectations into our model at this point due to the fact that producers are making decisions based on their expectations, not on what will actually play out in the market. This results from prices being unknown and animal performance being unknown with certainty. The model also calculates the expected total cost of gain incurred from owning cattle through March and the expected revenue from selling them in March. To generate expectations of net income, revenue, and COG it is necessary to bring basis predictions and current futures market prices into the equation. Basis is equivalent to the spot cash price minus relevant futures contract price (Investopedia, 2016). When calculating ex-post net incomes and revenues historical sale prices are used for the purchase price and sale price. However, when dealing with expectations an estimation of what the price will be at the time of sale is required. In order to generate this expectation an expected basis value for the sale date is combined with a representative futures contract price at the time of analysis to generate an expected sale price for the date of sale. A three-year historical average basis is used as a proxy for expected basis for cattle and corn prices.

These expectations are compared with predicted ex-post net income, revenues, and costs of gain from the first stage of the model to generate prediction errors.

Expected net income incorporates expected revenue and expected cost of gain. Using this information, the model calculates net income prediction error, revenue prediction error, and cost of gain prediction error. In the model we are treating animal performance as a known fixed parameter so our prediction errors aren't representative of variability in animal performance. In reality, animal performance isn't known with certainty and likely varies from expectations, thus animal performance plays a role in prediction error. In our model prediction errors are functions of errors in sale price expectations and errors in feed cost expectations. Errors in sale price are incorporated into revenue prediction error and errors in feed costs are incorporated into cost of gain prediction error.

Positive revenue prediction errors are characterized as detrimental errors to producers (expected revenue is greater than predicted revenue) due to the fact that they receive lower levels of revenue than they expected to receive. Negative cost of gain prediction errors are characterized as detrimental errors to producers (expected cost of gain is lower than predicted cost of gain) due to the fact that their costs are actually larger than what they expected them to be. Positive net income prediction errors are characterized as detrimental errors to producers (expected net income is greater than predicted net income) due to the fact that they receive lower levels of revenue than they expected to receive.

2.3 Model Stage 3

The third stage of the model is an extension of the second stage of the model. In the third stage expectations for net income, revenue, and COG for the planned date of sale are updated for each subsequent month the animal is owned. Combining these expected values with predicted ex-post values generated in the first stage of the model we are able to generate month by month prediction errors for net income, revenue, and COG for each subsequent month that animals are owned.

2.4 Model Stage 4

Using the expected net incomes from holding cattle through the planned sale date generated in model stages 2 and 3, along with the ex-post net incomes generated in model stage 1 from selling cattle in the current month as opposed to selling them in the planned sale month we can gain insights into market signals and incentives. Each month the model calculates the incentive to retaining steers in a real-time sense by subtracting the obtainable net income from selling steers at that time from the expected net income obtained from retaining steers through the planned sale date. Each scenario has two decision criterions for weather the market suggests a retention of steers or a sale of steers. The first decision criterion states that if the net income from selling steers at the current point in time is larger than the expected net income from retaining steers through the planned sale date we should sell steers today as opposed to retaining them. The second decision criterion states that if the net income from selling steers at the current time is at least $25 larger than the expected net income from retaining steers through the planned sale date we should go ahead and sell steers today as opposed to retaining them. The reason for setting two decision criterion was to account for differences in producers desired returns and to show that relatively minimal changes in the return threshold can alter a producers sell-retain decision.

Producers are not likely to deviate from their pre-established plans unless the incentive to selling steers early is above some specified threshold, likely set somewhere above $0. Producers place value on sticking to an existing plan and the relationships with other stakeholders that are dependent on sticking to an existing plan. A majority of producers aren't likely to deviate from their pre-established plan just because the market is telling them that it will give them $1.00 to sell steers today as opposed to retaining them. The decision to sell or retain calves another month is a decision most producers make each day/week/month and is very important within their livestock marketing efforts. In some circumstances it makes sense to hold steers through a pre-established sale date, but in many instances the market incentivizes steer sales prior to the pre-established sale date. Producers react to market signals and this piece of analysis in stage four of the model delves into the decisions that producers face on a daily basis. As opposed to our ex-post optimal net income analysis in model stage 1, this analysis is conducted at the time the producer would have historically made the decision. It is important to note that the optimal decision from an ex-post perspective won't necessarily be the same decision that the market suggested when placed in the real-time scenario.

2.5 Model Stage 5

The last stage of the model analyzes the economic effects of differing placement dates. Two placement scenarios are analyzed for both backgrounding and stocking segments of the beef industry. Analyzing varying situations will allow for comparisons of strategies within the specific segments of the beef industry and will also allow for comparisons between the background and stocking segments of the beef industry.

For the backgrounding segment the first scenario is a September steer placement with a planned March sale, and the second scenario is a November steer placement with a planned March sale. Comparing these two scenarios will provide insights into how variations in purchase price, feed costs, animal sale weights, etc. factor into optimal ex-post production decisions, prediction accuracy, and market signals/incentives. Both backgrounding scenarios will look at steers weighing 425 pounds, 500 pounds, and 575 pounds on the date of placement.

The first scenario for the stocking situations analyzed is an April steer placement with a planned July sale, and the second scenario is a May steer placement with a planned July sale. In the Flint Hills region of Kansas cattle sometimes go to grass later than the expected placement date due to lack of grass availability at the time of the start of the lease agreement. Lease arrangements are typically negotiated in March or prior. A cold spring or lack of rain can limit grass availability at the start of the pre-established lease, thus delaying placement. For this reason, we decided to analyze how delayed placement affected optimal ex-post production decisions and prediction accuracy. Both stocking scenarios analyze steers weighing 450 pounds, 600 pounds, and 750 pounds on the date of placement. Within the stocking industry it is becoming increasingly common to see heavier steer calves and yearlings. This is partially due to increased weaning weights resulting from improved genetics and partially due to feedlots desiring heavier weight feeder cattle.

Chapter 3 - Data

As previously mentioned, factors affecting profitability within the backgrounding and stocking segments of the beef industry can be lumped into four distinct groups. These groups include livestock purchase cost, livestock sale revenue, animal performance, and cost of gain. Data for livestock purchase cost and livestock sale revenue is relatively available, while data on animal performance and cost of gain is more difficult to find. Data for livestock purchase cost and livestock sale revenue is gathered from the Livestock Marketing Information Center (LMIC) in Denver, Colorado. Their data was compiled from USDA sources. Data for animal performance was gathered from the Beef Stocker Unit at Kansas State University. The backgrounding ration from the Beef Stocker Unit was used for the backgrounding portions of the model. Individual components of the cost of gain section of the model were gathered from many different individual sources. The specific pieces of our data sources and data manipulations are described below.

3.1 Livestock Price Data (Purple and Blue Boxes Figure 2.1)

Information regarding cattle prices was gathered from two LMIC data files. The "Weekly and Monthly Dodge City, KS Feeder Cattle Prices" file was used for cash feeder cattle prices. This was the most complete representative feeder cattle cash price data set we had available to us. While this western Kansas data set isn't perfectly representative of Flint Hills regional feeder cattle prices, we believe it provides strong insights into historical prices within the region. It is likely that prices are slightly higher in western Kansas due to relatively close proximity to feedyards and slaughter facilities. The "Daily and Weekly Feeder Futures Prices" file from LMIC was used for feeder cattle futures price data.

In both data sets there were missing values. Multiple steps were taken to fill the missing values.

Three stages were used to fill in values for the missing observations for the western Kansas auction data. Each stage consisted of multiple steps. If there was not missing data in the table, the values remained the same. If a value was missing within the table, the first step in calculating the replacement was to average the cash value from the prior week and the cash value from the following week. A separate process was required for instances in which both the previous and following weeks cash values weren't available. An average value was calculated for the entire data set for each set of weight classes. These values were then used to yield carry values. Yield carry values are the difference between the average of one weight class and the next. The given values from the preceding weight classes were used and the carry values were subtracted to obtain approximated cash values. Cash prices were generated for missing values of cattle weighing from 200-1,100 pounds. Only 21.84% of observations were missing before filling the data set for the weight classes most applicable to our model (400-800 pound animals). After the first stage of filling blanks was completed only 0.89% of observations for the 400-800 pound weight classes were missing and 7.96% of the observations within the entire data set (200-1,100 pound weight classes) were missing.

Although, this first fill adjusted nearly all blanks for the weight classes used in the model, two more steps were taken to fill the remaining blanks within the entire data set. This will allow the model to be expanded to lighter or heavier animals in the future, or for other future research projects. For stage two of imputing missing observations the process was repeated using the data generated in stage one. If a value was available this observation was used. If an observation was missing the value from the prior week was averaged with the value from the following week. If both the prior and following week's values were missing the carry method previously described was applied to the data. Once stage two was completed all missing values for the 400 to 800 pound weight classes were filled. Additionally, only .59% of observations within the data set as a whole were missing. After the process was completed for a third time all missing values within the data set were filled. This concluded all stages of generating values for missing observations and resulted in a data set with no missing data. Following the generation of all missing values within the weekly data, the data was sorted for the first observation within each month. The remaining data that didn't represent the first observation within each month was then deleted.

Data was sorted before missing observations were filled for the feeder cattle futures data file. To do this, daily contract data was sorted to provide the first observations within each month. The remaining data that didn't represent the first observation within each month was then deleted.

One stage was required to fill missing contract values in the feeder cattle futures data. If the contract value was present in the original data set this value was used. If the value was missing, the prior and following week's values were averaged to generate an approximated futures price contract value for the missing observation. When both the prior and following week's values were missing, another step was utilized. Averages were calculated for each futures contract and were then used to yield carry values (difference between average of one contract and the next contract). These generated carry values were then subtracted from given values in the previous contracts to obtain approximate futures contract values. 4.4% of the observations within the feeder futures data set were adjusted.

After filling blanks in both the cash and feeder futures data sets, these data sets were used to generate actual basis values for each weight class of cattle. To do this appropriate futures price values were subtracted from cash prices for each weight class and month. To generate expected basis values a three-year historical average method was used according to Tonsor, Dhuyvetter, and Mintert's paper entitled "Improving Cattle Basis Forecasting" (Tonsor, et al., 2004). For example, if basis values in March of 2000, 2001, and 2002 for 850 pound steers were -$2.00, -$4.00, and -$6.00 the expected basis value for March of 2003 would be -$4.00.

3.2 Animal Performance Data (Red Box Figure 2.1)

Our model focuses on the Flint Hills region of Kansas so we wanted our performance data to be representative of the stocker/backgrounder segment of the beef industry within this region. In order to do this performance data was obtained from the Kansas State University Beef Stocker Unit located in Manhattan KS. The goal of the Beef Stocker Unit is to provide an avenue for backgrounding and stocker cattle research (Kansas State University, 2016). Both native pastures and dry lot systems are available at the Beef Stocker Unit to conduct research studies and trials. In total, the unit consists of 1,120 acres of native pasture, and additionally has 32 receiving pens designed to hold 300 head of 500 lb. cattle (Kansas State University, 2016).

The data we were granted access to contained information on individual cattle performance between 2006 and 2011 at the Beef Stocker Unit (D. Blasi, personal communication, 2015). We had access to data for a total of 5,413 individual head of cattle that were received at the unit in 55 separate lots. Cattle received at the unit included steers, bulls, and heifers. Steers were characterized as being castrated pre-arrival, whereas bulls were characterized as being castrated post-arrival. The 5,413 head of cattle received at the unit consisted of 1,674 steers, 2,509 bulls, and 1,230 heifers (D.Blasi, personal communication, 2015).

Cattle were received at the unit during four time periods throughout the year. These four time periods were designated spring, early summer, late summer, and fall within the data set. Of the total 5,413 head of cattle we had data for, 1,761 were denoted as spring cattle, 1,484 were denoted as early summer cattle, 977 were denoted as late summer cattle, and 1,191 were denoted as fall cattle. Spring cattle were typically received from late February to early March, early summer cattle were received from the middle of May to early June, late summer cattle were received in late August, and fall cattle were received from the middle of October to early November.

Cattle received at the unit were sourced from multiple locations over this six-year period, with a majority of cattle being sourced from Tennessee. Of the 5,413 total head of cattle, 3,208 were sourced from Dickson, TN, 824 were sourced from Waynesboro, TN, 206 were sourced from Guthrie, KY, 702 were sourced from Sweetwater, TN along with additional pickups, and the remaining 473 cattle were from other sources. Incoming calves weighed 318-642 pounds with the average weight being 475 pounds.

The three main animal performance measures we were able to analyze from the Beef Stocker Unit data included average daily gain (ADG), death loss, and morbidity.

3.2a Average Daily Gain

After analyzing the data in regards to ADG our findings were generally as expected with mean ADG across all cattle being slightly above two pounds per day. In regards to gender, steers had the largest ADG's. When looking at ADG in regards to seasonality, calves received in the early summer period had the largest ADG's

ADG values in the data we analyzed had been adjusted for shrink, so the following summary statistics are in terms of shrunk ADG. Cattle from the Beef Stocker Unit were shrunk

3% at time of shipment, so to obtain realized ADG's one may increase shrunk ADG's by 3% to obtain realized ADG's. Realized ADG's will be used and animals will be shrunk at the date of sale in the model. However, summary statistics will be reported here in terms of shrunk ADG's.

ADG statistics were calculated after taking observations for dead animals and animals that were pulled from trials out of the total 5,413 observations. After pulling these cattle from the data 5,309 observations remained. The mean ADG across these 5,309 observations was 2.12 lbs/day, with a standard deviation of .92 lbs/day. The median ADG was 2.23 lbs/day.

Steers had the largest ADG's followed by heifers and bulls in regards to gender. Steers had a mean ADG of 2.39lbs/day, heifers had a mean ADG of 2.20lbs/day, and bulls had a mean ADG of 1.98lbs/day. The difference between mean ADG's for bulls and steers of .41lbs/day was slightly larger than anticipated. The only certain definable difference between steers and bulls was that steers were castrated pre-arrival, whereas bulls were castrated upon arrival. However, it is likely that steers had some prior pre-conditioning and were likely weaned prior to arrival, whereas it is likely that bulls had little prior pre-conditioning and many likely weren't weaned or vaccinated prior to arrival. Overall, it is likely that differences in conditioning prior to arrival played a significant role in the discrepancy between the mean ADG's of steers and bulls at K-State's Beef Stocker Unit.

When analyzing ADG's in terms of seasonality, cattle placed in the early summer had the largest mean ADG's and cattle placed in the late summer had the lowest mean ADG's. Cattle typically struggle the greatest with health issues in late summer and early fall. These health problems, coupled with declining grass conditions and the process of switching cattle from grass to a dry lot based ration, tend to lead to a decline in animal performance. This is particularly observable in declining ADG's. Early summer cattle had a mean ADG of 2.37 lbs/day, spring cattle had a mean ADG of 2.21 lbs/day, fall cattle had a mean ADG of 2.12 lbs/day, and late summer cattle had a mean ADG of 1.79 lbs/day.

Mean ADG's were further calculated for steers, bulls, and heifers within each of the four defined seasons. These results are shown below.

Table 3.1 Average ADG by Sex by Season (K-State Beef Stocker Unit)

Average Daily Gain by Sex by Season (Kansas State University Beef Stocker Unit 2006-2011)		
Sex	Season	ADG
Steers	Spring	2.46
	Early Summer	2.65
	Late Summer	1.68
	Fall	2.44
	AVERAGE	2.39
Bulls	Spring	1.97
	Early Summer	2.18
	Late Summer	1.53
	Fall	2.06
	AVERAGE	1.98
Heifers	Spring	2.43
	Early Summer	2.10
	Late Summer	1.88
	AVERAGE	2.20
AVERAGE ACROSS ALL CATTLE		2.16

It was necessary for our model to generate a regression equation for ADG that would take into account the time of year in which cattle are received, the weight of animals received, and also the gender of the animal. To begin, ADG values were regressed on start weight (placement weight), gender, season, yearly dummies, lot dummies, and source dummies. When running this regression model, problems with collinearity between lot variables existed so the lot variables were dropped from the model. Due to the fact that the source locations were so close to one another a model was re-run without them. Taking these variables out of the model did not significantly affect the predictive power of the model so these variables were also dropped. Given that the data only covered a six-year time period, yearly dummy variables were also dropped. We didn't want to attempt to predict forwards and backwards 10 plus years based solely on the yearly trend from six-years' worth of data. Other models that included exponential variables and interaction terms were also analyzed. However, the final model that appeared to most accurately fit the data represents ADG solely as a function of start weight, gender, and seasonality. The gender dummy variables in the model are in reference to heifers, and the seasonality variables are in reference to fall placed calves. This estimated model is defined as:

(1) Shrunk ADG = 2.8686 + 0.1387(Steer) - 0.2866*(Bull) + 0.0646*(Spring) + 0.2300*(Early Summer) - 0.3557*(Late Summer) - 0.0013*(Start Weight)*

In total, 5,309 observations were included in this analysis. Of the six independent variables in the model, five (Steer, Bull, Early Summer, Late Summer, and Start Weight) were significant at the 99% level. The remaining independent variable (Spring) was significant at the 90% level. The R^2 of equation (1) is .0857. The standard errors for the coefficients within equation (1) are as follows; Steer (.037), Bull (.034), Spring (.034), Early Summer (.035), Late Summer (.039), Start Weight (.000), and Intercept (.140).

For the model to work in the way we desired, it was necessary to not only calculate ADG's seasonally, but also on a monthly basis. To do this, each season was assigned to a specific month of the year. Spring was defined to be March, early summer was defined to be June, late summer was defined to be September, and fall was defined to be December. ADG projections for these months were calculated according to the Shrunk ADG regression equation above. ADG's were then linearly weighted between known months to predict ADG's for unknown months. For example, if the predicted ADG for a 500lb steer in March was 2.00

lbs/day and the predicted ADG for a 500lb steer in June was 2.24 lb/day the predicted ADG's for April and May would be 2.08 lbs/day and 2.16 lbs/day respectively. Once all shrunk ADG's were estimated they were increased by 3% to bring them back to realized ADG's.

Below are sample monthly realized average ADG estimates for 500 pound steers, bulls, and heifers:

Table 3.2 Average ADG Estimates for 500lb. Steers, Bulls, and Heifers

Average Daily Gain Estimates for 500 lb. Steers, Bulls, and Heifers (lbs./day) (Kansas State University Beef Stocker Unit 2006-2011)												
Gender	Month											
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Steers	2.43	2.45	2.47	2.53	2.58	2.64	2.44	2.24	2.04	2.16	2.28	2.40
Bulls	1.99	2.01	2.03	2.09	2.15	2.20	2.00	1.80	1.60	1.72	1.84	1.97
Heifers	2.28	2.30	2.33	2.38	2.44	2.50	2.30	2.10	1.89	2.02	2.14	2.26

3.2b Death Loss

The general trends of animal performance for death loss are closely reflected in the trends that were found in our analysis of ADG. In regards to gender, steers had the lowest percent death loss. In regards to seasonality, spring placed cattle had the lowest percent death loss. It was also observed that calves received in the early summer also had low percent death loss.

To begin our analysis of death loss we looked at death loss data at the lot level. Of the 55 total lots in the data, each lot consisting of between 82 and 117 calves, 50.91% had at least one incidence of death loss. The average death loss for an individual lot of cattle was 1.55%, the maximum death loss was 14.29%, the minimum death loss was 0%, and the standard deviation was .27% death loss.

In regards to death loss based on gender, steers had the lowest levels of death loss, followed by heifers and bulls. On average 0.6% of steers died, 1.38% of heifers died, and 2.31% of bulls died. The differences between death loss in steers and bulls is likely due to the factors discussed in the average daily gain section on gender above.

In regards to death loss by season, spring placed calves had the lowest levels of death loss and late summer placed calves had the highest levels of death loss. On average, 0.40% of spring placed cattle died, 0.88% of early summer placed cattle died, 1.51% of fall placed cattle died, and 4.81% of late summer placed cattle died. Large fluctuations in temperature, freshly weaned calves, and the process of switching from grass to dry lot rations are often reasons mentioned as to why late summer placed cattle struggle so greatly.

Death loss percentages were further calculated for steers, bulls, and heifers within each of the four defined seasons. These results are shown below.

Table 3.3 Average Death Loss by Season by Sex (K-State Beef Stocker Unit)

Death Loss by Season by Sex (Kansas State University Beef Stocker Unit 2006-2011)		
Season	Sex	% DL
Spring	Steers	0.12%
	Bulls	0.64%
	AVERAGE	0.40%
Early Summer	Steers	0.66%
	Bulls	1.46%
	Heifers	0.35%
	AVERAGE	0.88%
Late Summer	Steers	2.75%
	Bulls	8.38%
	Heifers	2.39%
	AVERAGE	4.81%
Fall	Steers	0.30%
	Bulls	1.92%
	Heifers	2.11%
	AVERAGE	1.51%
AVERAGE ACROSS ALL CATTLE		1.57%

A regression equation that predicted death loss was required for our model. A probit regression model was first used to estimate lot level death loss percentages. However, after further consideration it was determined that by using lot level data too many individual animal characteristics were being overlooked, and thus it was decided to run the model with each individual animal observation included. As with ADG, gender, seasonality, and start weight were used as independent variables in this model to predict percent death loss. A probit model based on 5,413 individual observations was chosen as the final model. Once again, gender dummy variables are in reference to heifers, and seasonality variables are in reference to fall placed calves. The equation is listed below.

$$(2) \quad Pr(Y=1,X) = \phi(-2.8557 - 0.07776*(Steer) + 0.4377*(Bull) - 0.5182*(Spring) - 0.1866*(Early\ Summer) + 0.5411*(Late\ Summer) + 0.0009*(Start\ Weight))$$

This equation represents the probability of a steer dying over a three-month period and has a pseudo R^2 of .1086. When Y=1, there is a 100% chance that that steer is going to die. ϕ represents the cumulative standard normal distribution. Once again, as with average daily gain, seasons were assigned to the specific months as described above and known months were linearly weighted to find percent death loss estimates for unknown months. The death loss that is predicted for the placement month is the predicted percent death loss over the next three-month time period. This number would be divided by three to obtain each month's predicted death loss.

Below are estimated average three-month death loss estimats for 500 pound steers, bulls, and heifers:

Table 3.4 Average Death Loss Estimates for 500lb. Steers, Bulls, and Heifers

Death Loss Estimates for 500 lb. Steers, Bulls, and Heifers (% per three months) (Kansas State University Beef Stocker Unit 2006-2011)												
Gender	Month											
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Steers	.418	.248	.143	.204	.288	.401	.801	1.517	2.723	1.771	1.119	.686
Bulls	1.694	1.089	.681	.923	1.236	1.637	2.919	4.945	7.961	5.614	3.850	2.566
Heifers	.525	.315	.184	.260	.364	.504	.989	1.840	3.249	2.139	1.369	.850

3.2c Morbidity

The last segment of the Beef Stocker Unit data that we analyzed was morbidity of cattle at the unit. Treatment given to cattle at the unit was broken into six groups. These groups include; no treatment, one treatment for Bovine Respiratory Disease (BRD), two treatments for BRD, three treatments for BRD, BRD treatment along with some other type of treatment, and treatment other than BRD. BRD care and prevention receives a great deal of attention in today's animal health sector and data from the Beef Stocker Unit validates the necessity for this.

Of the 5,413 total head of cattle that went through the unit between 2006 and 2011, 72.63% received no treatment (were non-morbid). 14.45% received one BRD treatment, 7.04% received two BRD treatments, 3.27% received three BRD treatments, 1.18% received a BRD treatment plus other treatment, and 1.44% received only a non BRD treatment. In total, of the 27.38% of the animals that were morbid, 94.74% were treated for BRD. Based on this information it becomes obvious that BRD is a major factor in animal health, and its proper care and prevention can have a significant impact on producer profitability as it affects average daily gain and death loss.

In regards to gender, steers had the lowest likelihood of being morbid while heifers had the greatest likelihood of being morbid. 18.82% of steers were morbid, 29.93% of bulls were morbid, and 33.82% of heifers were morbid. In regards to seasonality, late summer placed calves had the largest likelihood of morbidity, while spring placed calves had the lowest likelihood of morbidity. 10.96% of spring placed calves were morbid, 29.58% of early summer calves were morbid, 33.08% of fall placed calves were morbid, and 46.67% of late summer placed calves were morbid.

Cattle from different sources had differing likelihoods of morbidity. Cattle from Sweetwater, TN along with additional pickups to these loads had the largest likelihood of morbidity, while cattle from Guthrie, KY had the lowest likelihood of morbidity. 6.8% of cattle sourced from Guthrie, KY were morbid, 20.27% of cattle from Waynesboro, TN were morbid, 30.08% of cattle sourced from Dickson, TN were morbid, 40.31% of cattle from Sweetwater, TN along with additional pickups were morbid, and 11.21% of cattle from other sources were morbid.

3.3 Cost of Gain Data (Blue Box Figure 2.1)

Cost of gain data can be divided into two separate groups. These groups include feed expenses and non-feed expenses. Expenses in the model specific to the backgrounding segment include corn, alfalfa hay, prairie hay, dried distillers grains with solubles (DDGS), corn germ meal, corn steep liquor, and supplement. Expenses in the model specific to the stocking segment include pasture rent and mineral. Non-feed expenses include those associated with interest, labor, veterinary, and transportation. These expenses apply to both backgrounding and stocking segments of the beef industry respectively.

3.3a Backgrounding (Dry-Lot) Price Data

Goals of producers in backgrounding dry lot situations can vary greatly. When feed prices are cheap producers may push their cattle hard to achieve higher ADG's, whereas when feed prices are high they may try to creep cattle along in order to minimize their total feed cost bill. Also, compensatory gain (an accelerated growth of an animal following a period of slowed development, particularly as a result of nutrient deprivation) plays a role in how hard producers push their cattle. A common strategy of backgrounder and stocker producers is to limit feed intake when calves are on a dry lot feed ration to slow animal growth, and then put cattle on grass when grass conditions improve in late spring and early summer. By following this strategy producers aim to minimize feed costs and achieve higher ADG's on pasture. The concept of compensatory gain is evident in the fact that cattle buyers will typically pay discounted prices for fleshy calves.

The average daily gain formulas that are used in our model are based on cattle performance at the Kansas State University Beef Stocker Unit. The dry-lot backgrounding ration used at the unit will be used to estimate COG measures within the model. This ration is somewhat more complicated and diverse than many other dry-lot rations that are typically composed of some combination of silage, ground corn, some form of protein, and a salt or mineral supplement. The dry lot ration at the Beef Stocker Unit is composed of dry corn, supplement, corn steep liquor, alfalfa hay, prairie hay, corn germ meal and dried distillers grains with solubles (DDGS). Approximately sixty-three percent of this ration on a dry matter basis is composed of dry corn and hay with the remainder being distributed between supplement, corn steep liquor, corn germ meal, and DDGS. Dry matter and as fed composition of this ration is listed below:

Table 3.5 Beef Stocker Unit Ration

Backgrounding Ration (Kansas State University Beef Stocker Unit 2006-2011)		
Feed Ingredient	**Dry Matter Percentage**	**As Fed Percentage**
Dry Corn	28.13	27.07
Supplement	5.63	5.11
Steep	10.00	16.23
Alfalfa Hay	17.50	16.13
Prairie Hay	17.50	16.03
Corn Germ Meal	11.25	10.23
DDGS	10.00	9.20
Total	**100.00**	**100.00**

Both realized cash prices and expected cash prices for feed inputs were needed to generate expected versus realized returns within our model. While cash price data was available for many feed ingredients, expected cash prices are only available for corn price as no futures contracts are available for the other feed ingredients within the ration. To generate the needed price data predicted corn price values were calculated for the Flint Hills region of Kansas. After these predicted values were calculated a combination of these prices, corn cash prices, and feeder cattle cash prices were utilized to generate price data for the remaining feed ingredients, excluding supplement price data.

Corn Price:

Cash prices and expected cash prices in the model for alfalfa, prairie hay, corn steep liquor, corn germ meal, and DDGS will all be generated directly or indirectly with respect to corn price. Because of this we felt that it would be important to generate historical cash prices that are representative of the Flint Hills region of Kansas.

The first step in calculating cash corn prices for the Flint Hills region of Kansas was to generate historical basis values for Dodge City, Kansas. To calculate these basis values weekly cash corn price data for Dodge City was collected from LMIC. While a majority of weekly cash prices were available between 1992 and 2015, seven weekly cash prices were not available. One stage was required to fill all of the blanks within the cash corn price dataset. If a weekly price was available this price was used. If an observation was missing the process to fill the blank was to average the cash value from the prior week and the cash value from the following week. Once all missing observations were filled the weekly cash corn price data set was sorted for the first observations within each month. Observations not correlated with the first observation within a month were removed from the dataset.

Historical corn futures contract prices were also gathered from LMIC to calculate basis values. This data set also had missing values. However, in total less than 1% of the observations were unavailable. One stage consisting of multiple steps was used to fill the blanks within the corn futures price dataset. If there was not missing data in the table, the values remained the same. If a value was missing within the table, the first step in calculating the replacement was to average the contract value from the prior week and the contract value from the following week. A separate process was required for instances in which both the previous and following weeks contract values weren't available. Averages were calculated for each futures contract and were used to yield carry values (difference between average of one contract and the next month). These generated carry values were then subtracted from given values in the previous contracts to obtain approximate futures contract values. The table with filled observations was then sorted for the first observations of each month. Observations not aligning with the first observation in each month were removed from the dataset.

After filling blanks in both the Dodge City cash corn and corn futures data sets, these data sets were used to generate actual basis values for Dodge City. To do this appropriate futures contract values were subtracted from cash prices for each month. This resulted in a historical monthly basis value database for Dodge City, Kansas since 1992.

The next step in the process of linking corn prices to the Flint Hills region of Kansas was to define the relationship between basis values in Dodge City and basis values in the Flint Hills region of Kansas. We expected that basis values in Dodge City would be stronger than basis values in the Flint Hills due to the relative close proximity to feedyards and the increased levels of demand that these feedyards provide within the localized corn market.

Data was acquired from the Kansas Farm Management Association (Kansas State University Ag Manager, 2016) to gather basis information for the Flint Hills region. Eight counties within the Flint Hills were identified as counties that were representative of the region and had adequate reporting of corn price data. These counties included Butler, Clay, Dickinson, Geary, Lyon, Pottawatomie, Riley, and Wabaunsee counties. Historical Basis figures were obtained for these counties from 1999-2015. This data originally was organized by county. The data was then sorted by year and week. To obtain the basis values for the first week of each month, in an effort to align our Flint Hills basis values with those of Dodge City, every fourth week was assigned to a subsequent month. For example, week one was defined to be January and week five was defined to be February. If a month consisted of five weeks the fourth and fifth weeks were combined and called the fourth week in the dataset. Therefore, there were 48 observed values per year in the dataset. All observations that weren't assigned to a specific month were then removed from the data set. Average basis values across the eight counties were then calculated for each of the remaining observations in the data set.

The next step in linking corn basis in Dodge City with corn basis in the Flint Hills was to define the relationship between the two values. Our findings on the general basis relationship between the two locations was as expected with Dodge City having the stronger basis. Between January of 1999 and September of 2015 the average monthly basis value at Dodge City was two cents under the relevant board price, whereas the average Flint Hills region basis was twenty-nine cents under the relative board price. In order to obtain a numerical relationship between the two regions Flint Hill's basis values were regressed on Dodge City basis values. This included 201 monthly observations. The relationship between the two regions is defined as follows:

$$(3) \quad \textit{Flint Hills Basis} = -.2848 + .4532*(\textit{Dodge City Basis})$$

Flint Hills Basis and Dodge City Basis are both represented in \$/bushel. The R^2 associated with equation (3) is .2492. The standard error for the Dodge City Basis coefficient is .0151 and was statistically significant at the 99% confidence level. The last step was to calculate historical cash and historical forward looking expected cash prices for the Flint Hills region. Using the equation above, historical monthly basis values were estimated for the Flint Hills region. Next, expected basis values were calculated using the same three-year historical average criterion that was used in calculating expected basis values for feeder cattle. For example, if the realized April basis values for 1992-1994 were 20 cents under the May board price, 30 cents under the May board price, and 40 cents under the May board price, then the expected basis value for April of 1995 would be 30 cents under the May board price. These expected basis values were then combined with historical corn futures contract prices to generate a database of expected forward looking cash prices for each month since 1995. Projections going out 11 months were then calculated for each month. For example, if I was in January of 1995 I would have generated monthly predicted corn prices going out through December of 1995. After these projections were calculated they were adjusted from $/bushel to $/ton, due to the fact that most other feed ingredients in the ration are reported in \$/ton. These projected corn prices were then used to build projections for the other feed ingredients in the ration. This process will now be described.

Alfalfa Hay Price:

Cash prices for alfalfa were obtained from LMIC. Generating projected forward looking alfalfa prices however required the generation of an equation that linked alfalfa price to something we had data for to generate projections, due to the fact that there isn't a futures contract for alfalfa. We felt that alfalfa price was likely correlated with corn price and feeder cattle price, both of which has a futures contract associated with it. Due to the fact that we are desiring cash price projections we decided to regress cash alfalfa price on cash corn price and cash feeder cattle price. The cash alfalfa and corn prices used in the regression are from LMIC. The cash feeder cattle price used in the regression is the 550-600lb steer cash price that was calculated in the livestock price data section above. By regressing monthly alfalfa price on corn and feeder cattle price from 1992-June of 2015 we were able to explain 90.30% of the variability in alfalfa price. The equation resulting from the regression is as follows:

$$\text{(4)} \quad \textit{Alfalfa Hay Price} = 13.0069 + 0.5119*(\textit{Corn Price}) + 0.4245*(\textit{FC Price})$$

In this equation alfalfa price and corn price are in \$/ton and feeder cattle price is in \$/cwt. Feeder Cattle price is representative of the cash price of a 550-600 pound steer. The coefficients on both corn price and feeder cattle price are statistically significant at the 99% confidence level. The standard error of corn price is .017 and the standard error on feeder cattle price is .02.

To generate the table of projected forward looking alfalfa prices, a projected feeder cattle price table was also constructed. This table is representative of a 550-600 pound steer. To construct this table correct futures contracts were pulled for each month as a projection for future feeder cattle price. Following the selection of correct futures contracts, expected basis values which were calculated in the livestock price data section were used in conjunction with futures price data to obtain a projected forward looking feeder cattle price dataset.

Once tables for both projected forward looking corn and feeder cattle prices were completed the alfalfa price equation was applied to these projections to project forward looking alfalfa prices. For example, if in January of 1995 the projected corn price for August was $80.04/ton and the projected feeder cattle price for August was $78.11/cwt, the projected alfalfa price for August would be $87.14/ton.

Prairie Hay Price:

Typically, prairie hay is sold at a discounted rate relative to the price of alfalfa. The nutrient composition in alfalfa, particularly in regards to protein, is much more desirable than that of prairie hay. To determine what the true relationship between alfalfa and prairie hay is, cash alfalfa and cash prairie hay prices were obtained from LMIC. The "alfalfa hay price received by farmers" file was used for alfalfa hay price and for prairie hay price the "other hay price received by farms" file was used. To determine the numerical relationship between the two types of hay monthly prairie hay price was regressed on alfalfa hay price from 1990 through August of 2015. By regressing prairie hay price on alfalfa hay price we were able to explain 92% of the variability in prairie hay price. The equation resulting from the regression is as follows:

$$(5)\quad \textit{Prairie Hay Price} = 15.9763 + .6142*(\textit{Alfalfa Hay Price})$$

In this equation both alfalfa hay price and prairie hay price are represented in $/ton. The coefficient on alfalfa hay price was statistically significant at the 99% confidence level and had a standard error of 1.29. To obtain projected forward looking prairie hay prices equation (5) was applied using the projected forward looking alfalfa hay values generated in the alfalfa hay price section above. For example, if in January of 1995 the projected alfalfa price for August was $87.14/ton, the projected prairie hay price for August would be $69.50/ton.

DDGS Price:

To generate projected forward looking DDGS prices monthly DDGS prices were regressed on weekly corn and feeder cattle prices that had previously been filled for missing observations and sorted to only include the first observation within each month. The DDGS data came from LMIC's weekly DDGS price file and is representative of average monthly DDGS prices in Kansas. The corn price data is from LMIC's cash corn file and is representative of corn prices in Dodge City, Kansas and the feeder cattle price data is from the Dodge City cash file and is representative of western Kansas steers weighing between 550 and 600 pounds. By regressing monthly DDGS prices on corn price and feeder cattle price from 2006 through June of 2015 we were able to explain 85.21% of the variability in DDGS prices. 114 monthly observations were included. The equation resulting from the regression is as follows:

$$(6)\quad \text{DDGS Price} = -13.5799 + 31.7125*(\text{Corn Price}) + .2324*(\text{Feeder Cattle Price})$$

In this equation DDGS price is in $/ton, corn price is in $/bu, and feeder cattle price is in $/cwt. Coefficients on corn price and feeder cattle price are both statistically significant at the 99% confidence level. The standard error for corn price is 1.32 and the standard error for feeder cattle price is .05. To obtain projected forward looking DDGS prices this equation was applied using the projected forward looking corn prices and 550-600lb feeder cattle prices generated in the corn price section above. For example, if in January of 1995 the projected corn price for August was $2.24/bu and the projected feeder cattle price was $78.11/cwt, then the projected DDGS price for August would be $75.65/ton.

Corn Germ Meal Price:

Price data for corn germ meal wasn't readily available so an industry pricing specialist was contacted for information regarding how prices for corn germ meal are determined (Pricing Specialist, personal communication, 2015). According to the pricing specialist, in the current market corn germ meal is typically priced at a $10 discount relative to the price of DDGS. Due to the fact that we were generating price data going backwards upwards of twenty years we decided to find the percent discount at current levels based upon the $10 discount. On the day the pricing specialist was contacted, DDGS prices were at $135/ton which would put corn germ meal prices at $125/ton. At these price levels corn germ meal is being priced at 7.41% discount relative to DDGS. To obtain projected forward looking corn germ meal prices this 7.41% discount was applied using the projected forward looking DDGS prices generated in the DDGS price section above. For example, if in January of 1995 the projected DDGS price for August was $75.65/ton, then the projected corn germ meal price for August would be $70.05/ton.

Corn Steep Liquor Price:

Like with corn germ meal, price data was not readily available for corn steep liquor. To determine how corn steep liquor prices are determined we once again talked to an industry pricing specialist (Pricing Specialist, personal communication, 2015). However, the pricing specialist did not have a general guideline as to how they price their corn steep liquor. The pricing specialist did have a listed corn steep liquor price for their company for that day of $40/ton. Even though DDGS and steep liquor are bi-products of different corn processing techniques (DDDS Dry corn milling: corn steep liquor wet corn milling), we felt that since they were both ingredients in beef rations and are both corn bi-products that it would be acceptable to set corn steep liquor prices as a percentage discount relative to DDGS price. On the day that we contacted the pricing specialist DDGS prices were $135/ton. This means that corn steep liquor is being priced at a 70.37% discount relative to DDGS price. To obtain projected forward looking corn steep liquor prices this 70.37% discount was applied using the projected forward looking DDGS prices generated in the DDGS price section above. For example, if in January of 1995 the projected DDGS price for August was $75.65/ton, then the projected corn steep liquor price for August would be $23.60/ton.

Supplement Price:

The supplement used in the Beef Stocker Unit drylot ration is a Cargill mineral. We did not have historical monthly price data for this mineral or a comparable mineral. This mineral had a relatively high salt content, so we attempted to link mineral prices to historical salt price data. Historical yearly price data was gathered from the U.S. Geological Survey concerning salt statistics (Porter, et al., 2016). Yearly price data was available on salt prices from 1984 through 2013. We chose to use the price data from 1989-2013 as it most represented the time period we attempted to analyze. Year over year percent changes in salt prices were calculated. The mean yearly percent increase in salt prices over the period analyzed was 3.42% per year. In the 18 years analyzed, salt prices increased over the previous year's price in 12 years and in 6 years salt prices decreased over the previous year's price.

When the Beef Stocker Unit purchased supplement in August of 2015 the price of the mineral was $600/ton (D. Blasi, personal communication, 2015). To generate historical yearly mineral price estimates August of 2015 was set as the base time period and 3.42% was taken off this price for each year working backwards in time. For example, the estimated mineral price for August of 2014 was $579.46/ton. This gave us an August price for each year, but did not provide us with prices for each individual month, which was necessary for the model. To generate monthly prices a monthly discount rate was found that allowed the August 2014 price to be $579.46/ton. This avoided compounding issues that occur if the yearly rate is divided by 12 to generate a monthly discount rate. The rate found was .2899%/month. This rate can be applied going forward in time as well to generate future prices. In the case of supplement, we used the prices generated for both realized and projected cash prices (expected and projected mineral cash prices are equivalent).

Feed Consumption:

Feed consumption estimates were needed for the backgrounding scenarios. Feed consumption levels were calculated for animals weighting from 300-900 pounds using the formula from the NRC for calculating feed intake for growing and finishing cattle published in the 1984 revised sixth edition of the Nutrient Requirements of Beef Cattle (National Research Council, 1984). The formula calculates daily feed intake in kilograms of dry matter. The formula is described as follows:

$$(7)\quad \textit{Daily Feed intake (kg dry matter)} = W * 0.75 * (.1493\ NEm - NEm^2 - .0196)$$

NEm is net energy maintenance in Mcal/kg diet. W is animal weight. For the diet we used the NEm on a Mcal/lb basis as 0.81. This is equivalent to 1.79 Mcal/kg which is what is needed for the daily feed intake calculation. Using this NEm value and each animals starting weight, daily feed intake in kilograms of dry matter was calculated. This feed intake was then converted to daily feed intake in pounds of dry matter. This feed intake in pounds of dry matter was subsequently converted into pounds as fed by multiplying it by 1.22, due to the diet’s composition being 81.8% dry matter.

3.3b Stocker (Grass) Price Data:

It is necessary to determine the cost of renting Flint Hills native pasture to graze cattle for the stocking segment of the feeder cattle industry as this is the largest portion of feed costs and plays a significant role in total cost of gain and thus net profits. The stocker mineral is the same mineral/supplement used in the backgrounder (dry-lot) ration. In order to generate estimates of historical rental rates for short season lease arrangements, models from Dhuyvetter and Tonsor's paper entitled "Determining Pasture Rents in the Flint Hills of Kansas" were used (Dhuyvetter and Tonsor, 2010). In their paper they develop models that predict grass rental rates for the Flint Hills region of Kansas. To do this they used data from the Bluestem Pasture Release, corn futures price data, and feeder cattle futures price data. The Bluestem Pasture Release has historically been released in April and contains surveyed rental rates for the upcoming grazing season. The average of the April and October contracts during March is used for feeder cattle futures price, while for corn futures price the average of the May and December contracts during March is used. It is assumed that negotiations of rental agreements typically occur in March before cattle arrive on grass. In their models they estimate cash rents ($/head) as a function of year of placement, feeder cattle futures price ($/cwt), corn futures price ($/bu), and a binary variable that equals one for years prior to 1986 and 0 otherwise. Data from 1978-2009 was used (Dhuyvetter and Tonsor, 2010).

Two separate equations were estimated for intensive (short-season grazing) stocking lease agreements. One equation was for calves weighing under 500 pounds, while the other was for calves weighing 500-699 pounds. The results of the equations are as follows:

Table 3.6 Pasture Rent Equations

Regression Results for Pastural Rental Rate Short Season Models (Tonsor and Dhuyvetter, 2010)						
	Interept	Year	Feeder Cattle	Corn	Pre1986	R-square
<500 lbs	-1291.01	.6664	.0270	1.9937	3.7060	0.9386
P-Value	(0.000)	(0.000)	(0.394)	(0.000)	(0.004)	
500-699 lbs	-2109.21	1.0766	0.0476	1.1435	8.5753	0.9071
p-Value	0.000	0.000	0.391	0.191	0.0000	

Plugging in historical futures price data for feeder cattle and corn prices, along with survey rental rates from the Bluestem Pasture Release into the two regression equations we were able to obtain $/head cash rent estimates for the two weight classes between 1995 and 2015. We next averaged the predicted cash rent values from the equations for the two weight classes in each year. We further made the assumption that this average $/head cash rent was representative of a 500 pound steer and that the producer was guaranteed 200 lbs/acre. Putting this information together we were able to generate a $/acre estimate for Flint Hills short season lease agreements. Using this $/head estimate we then were able to estimate $/acre estimates for various weights of cattle by again assuming that the producer is guaranteed 200 pounds/acre in the lease agreement. For example, if in 1995 my predicted $/acre cost for a short season lease agreement was $18.02/acre, rent would be equal to $54.06/head for a 600 pound steer.

There is a possibility that for the projections for more recent years (post 2009), we may have undervalued grass leases. The average feeder cattle price from 1978-2009 was $79.39/cwt, while the average feeder cattle price from 2010-2015 was $155.57/cwt. Also, corn prices were on average 87.57% higher after 2009 than before 2009. Additionally, we also saw increasing variability in feeder cattle and corn prices in the later years. Higher prices coupled with increased volatility may potentially lead to our predictions of grass rates for 2010-2015 being lower than they were in reality.

3.3c Non-Feed Cost of Gain Expense Data

Non-feed expenses are applicable to both the backgrounding and stocking segments of the beef industry. Non-feed expenses included in our model are interest, labor, veterinary, and transportation expenses. They are described as follows:

Interest:

Monthly bank prime loan rates from the Federal Reserve were used to calculate interest on cattle and feed (Board of Governors of the Federal Reserve System, 2016). 50% of the animal and 100% of feed costs were purchased on credit within our model.

Labor:

To generate historical estimates of labor costs multiple beef industry sources were contacted to determine an average worker wage for 2015 (Beef Industry Sources, personal communication, 2016). This wage was determined to be $14.50/hour which happened to be twice the federal minimum wage in 2015. We used this rule of hourly wage being twice the federal minimum wage to generate historical wage rates for livestock operations. For example, in 1995 the federal minimum wage was $4.25/hour, so we are assuming the livestock operational wage to be $8.50/hour in 1995.

We also make assumptions about labor requirements/head based on contact with an industry source (Beef Industry Sources, personal communication, 2016). They utilize three workers to care for approximately 800 head of feeder cattle over a 4 month time frame. From this we can infer that three workers can care for 2,400 head of feeder cattle in a one-year time frame. Alternatively, this means that one worker can care for 800 head of feeder cattle over a year long time frame. We further assume that each worker works an average of 40 hours/week for 50 weeks/year, or a total of 2,000 hours/year. Combining these assumptions we can infer that it takes .208333 hours of labor/head/month.

Transportation:

To generate historical trucking rates a beef industry source was contacted to infer about their trucking rates between 2014 and 2016 (Beef Industry Sources, personal communication, 2016). They informed us that in 2016 they had paid an average of $3.25/loaded mile, in 2015 $3.71/loaded mile, and in 2014 $4.00/loaded mile. These trucking rates were then regressed on average yearly diesel fuel rates form the Energy Information Administration for the Midwest Region to generate a schedule of historical trucking rates (Energy Information Administration, 2016). Using this information, we were able to generate an equation that explained 73% of the variability in trucking rates between 2014 and 2016. The equation was then used in correlation with historical monthly Midwest diesel fuel rates to obtain estimates of historical trucking rates. This equation is as follows:

$$(8) \quad \textit{Trucking Rate} = 2.4678 + .4146 * (\textit{Midwest Diesel Fuel Price})$$

In the above equation trucking rate is in $/loaded mile and Midwest Diesel Fuel Price is in $/gallon. The coefficient on Midwest diesel fuel price was only significant at the 75% confidence level. However, transportation expenses play a minimal role in the overall cost structure of our model.

To generate trucking distances sale barn locations within the Flint Hills region were analyzed. Sale barns observed included locations in El Dorado, Emporia, Eureka, Fredonia, Manhattan, and Salina. After analyzing distances from various locations in the Flint Hills region to a representative sale barn it was determined that generally most of the Flint Hills region is within 50 miles of at least one sale barn. Cattle will be assumed to be bought and sold in the Flint Hills region of Kansas at a sale barn 50 miles from the cattle operation.

Cattle pots are assumed to carry 48,000 pounds of live cattle weight. For example, if we assume that we are purchasing 500 pound steers, a cattle pot can carry 96 head. If we further assume that the trucking rate is $4/loaded mile and it is 50 miles from the sale barn to our operation, we can assume the trucking costs of getting cattle back to our operation from the sale barn to be $2.08/head.

Vet Cost:

We are assuming that vet costs are $5/head and costs are incurred at time of placement.

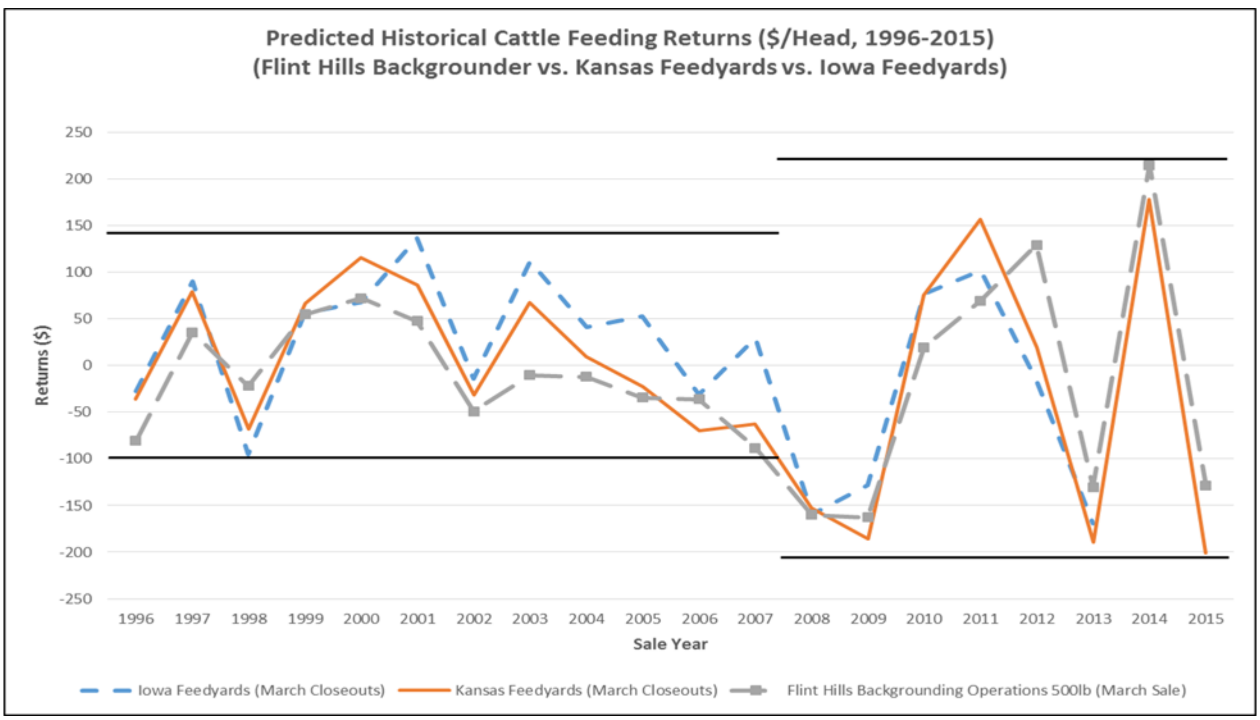
Chapter 4 - Results

Results from our model can be divided into optimal ex-post production strategies in regards to net income, prediction accuracy, and market signals/incentives. It is important at this point to note and reinforce that all results are a representation of a typical producer who adheres to the assumptions within our model. Producers whose production practices differ from the assumptions in our model may have differing results. Prior to reporting these results the validity of the model will be discussed through comparisons with predicted historical fed cattle returns reported by Kansas State University (Kansas State University Ag Manager, 2016) and Iowa State University (Iowa State University Ag Decision Maker, 2016). Stocker results are not compared due the lack of historical stocker cattle return predictions as the majority of historical cattle return information is centered around the feedlot and cow-calf segments of the beef industry. Net income results will be reported scenario by scenario. These results will then be compared across all four scenarios discussed previously in the model section of this paper. Prediction accuracy results for net income will be reported for all four scenarios, while prediction accuracy results for revenue and cost of gain error will be reported solely for the two backgrounding scenarios. Market incentive results will be reported for all four scenarios.

4.1 Model Validity

To validate the results of our model we compared the results from our September purchase/planned March sale scenario with predicted historical March fed cattle closeouts reported by Kansas State University and Iowa State University from 1996-2015 (Livestock sales in March beginning in March of 1996). Results from Kansas State University represent historical average net returns for finishing steers in Kansas feedlots and should be most representative of the area in which our analysis focused, the Flint Hills region of Kansas (Kansas State University Ag Manager, 2016). Results from Iowa State University represent estimated returns for finishing medium #1 yearling steers to a choice slaughter grade in Iowa and Southern Minnesota (Iowa State University Ag Decision Maker, 2016). Our net income predictions for the September placement of 500 pound steers in conjunction with a March sale were plotted relative to Kansas State University and Iowa State Universities' historical estimated predictions of fed cattle March closeouts in figure (4.1) below.

Figure 4.1 Predicted Historical Cattle Feeding Returns (March Closeouts)



It can be seen in Figure 4.1 above that the results of our model generally track closely with the predicted closeouts reported by Kansas State University and Iowa State University from 1996-2015. Our projections are 89.1% correlated with K-State's projections and 72.3% correlated with Iowa State's projections. Correlation with K-State's projections is a good indication that our model is valid, due to the fact that both are estimated feeding returns within the state of Kansas. Livestock prices and feed prices should be similar between the two data sets. Our model does a good job of picking up on extremes and general trends in profitability. For example, the model picks up the corn price spike in 2008 and 2009, large positive returns in 2011 and 2014, and large negative returns in 2013 and 2015.

Since we analyzed two different stages within the beef production cycle we would expect the net returns to follow similar patters since both rations are corn based. However, we did not expect them to be precisely the same. Cattle pricing discount (basis) schedules are different between the two segments of the beef industry (growing vs. finishing), profits are not necessarily distributed evenly within the different segments of the industry (cow-calf vs. grower vs. finisher vs. packer), and during price swings different segments of the industry aren't necessarily affected at the same rate at the same point in time. Our model tends to predict slightly lower returns than the two feedlot closeout predictions from K-State and Iowa State. Across the 20 years of predictions K-State's predicted average March closeout return was -$8.11/head while our models predicted average March sale return for a steer that was placed in September at 500 pounds was -$13.39/head. One plausible explanation for the predicted lower returns is that finish yards were able to capitalize on feed technology advancements to a greater degree than backgrounder yards due to a higher concentration of a growing ration being roughage than that of a finish ration. For example, in the 1990's finish lots were able to capitalize on steam corn flaking technology to a greater degree relative to backgrounder lots. Likewise, in the 2000's finish lots were able to capitalize on the use of distillers grains in their rations to a greater degree than backgrounder lots.

Our model also picked up on the industry adjustment that appears to have taken place in 2008 as a result of the ethanol industry driving up the price of corn, a significant ingredient in cattle feeding rations. It can be seen in Figure 4.1 above that the range of net returns becomes significantly more variable post 2007. In our model the standard deviation of returns between 1996 and 2007 was $52.63/head (COV 5.24), whereas from 2008 to 2015 the standard deviation of returns was $146.97/head (COV 7.98), a significant increase in the variability of returns. Standard deviations from K-State's projections are $68.16/head (COV 5.82) between 1996 and 2007 and $162.82/head (4.36) from 2008-2015, indicating similar levels of return variability as our model predicts. Overall, our model's predictions align well with predictions from other credible sources, thus signifying validity of our model.

4.2 Ex-Post Net Income

Within this section the highlights of the ex-post net income results within each of the four scenarios will be discussed in subsequent order. Following the display of the results for each scenario broad comparisons will be made across four scenarios.

4.2a September/March

This scenario analyzes the placement of steers on September 1st with a planned sale on March 1st. The model looks at placing steers weighing 425 pounds, 500 pounds, and 575 pounds.

Figure 4.2 Average Ex-Post Net Income (September/March)

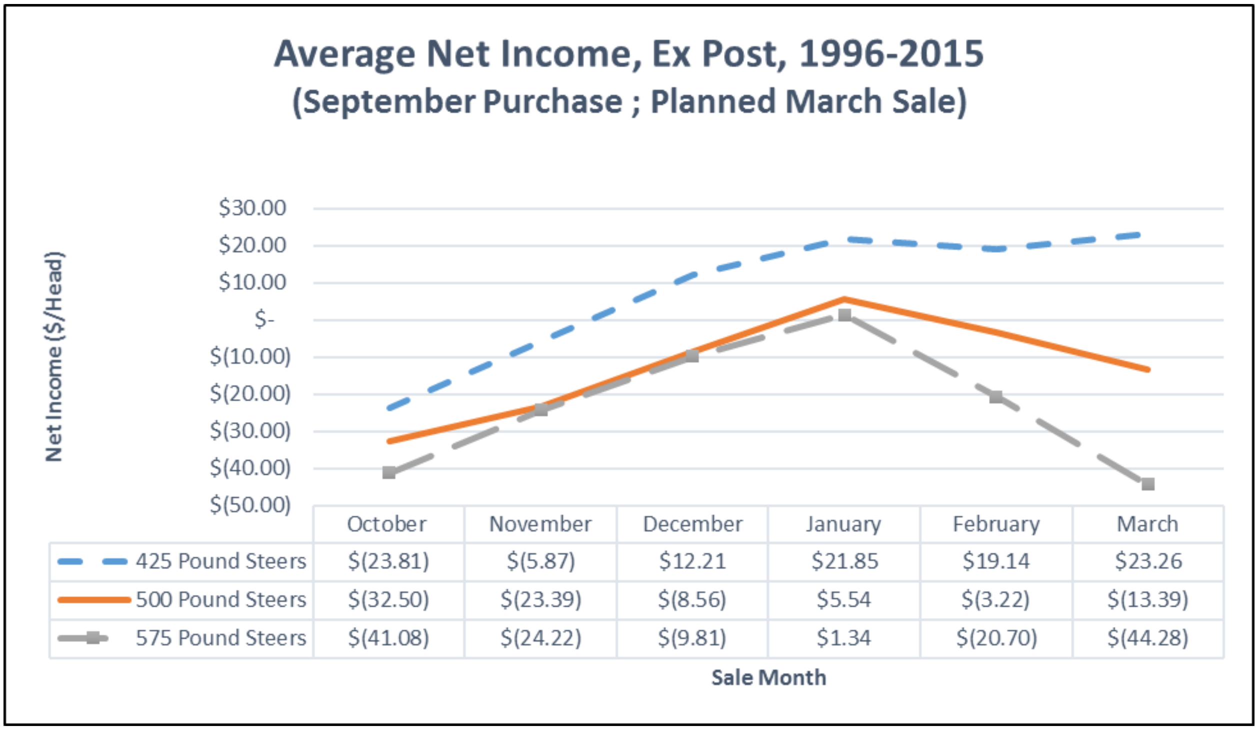


Figure (4.2) above represents the average ex-post net incomes obtainable from selling September placed steers in varying sales months (October, November, December, January, February, and March) between 1996 and 2015. For example, the dashed blue line above represents the average ex-post net income attainable from selling steers that were placed in September weighing 425 pounds. March sales have historically resulted in the largest average net income for 425 pound placed September steers, with an average net income of $23.26/head. Likewise, March sales have historically resulted in the smallest average net income for 575 pound placed September steers, with an average net income of -$44.29/head. Overall, average net incomes obtainable from placing steers in the 425-575 pound weight classes in September appear to be on average relatively low. This however does not mean that large profits have not been obtainable over the time period analyzed, but rather that on average between 1996 and 2015 returns have been relatively low. For 425lb placements four of the potential six sales months have resulted in positive average ex-post net incomes. However, for the 500lb and 575lb placements only one of the six potential sales months (January) resulted in positive average net incomes, and these positive incomes are rather low. The results in figure 4.2 tend to indicate that the largest net incomes have been historically attainable when selling September placed steers in the month of January and additionally that larger average net incomes have been historically realized from the placement of lighter weight steers. The results also tend to suggest that 425 pound steers on average can be economically carried through the planned March sale date, whereas 500 and 575 pound steers get penalized on average for being carried past January.

Table 4.1 Net Income Summary Statistics (September/March)

Net Income Summary Statistics for Varying Sales Months, Ex-Post, 1996-2015 (September Purchase ; Planned March Sale)							
Steer Weight	Statistic	October	November	December	January	February	March
425 Pounds	Average	-$23.81	-$5.87	$12.21	$21.85	$19.14	$23.26
	Maximum	$18.80	$136.85	$157.84	$172.12	$216.57	$272.41
	Minimum	-$105.15	-$101.33	-$119.07	-$107.65	-$140.38	-$125.96
500 Pounds	Average	-$32.50	-$23.39	-$8.56	$5.54	-$3.22	-$13.39
	Maximum	$44.68	$91.70	$103.25	$146.77	$157.16	$215.14
	Minimum	-$115.87	-$132.36	-$160.84	-$133.13	-$129.32	-$162.90
575 Pounds	Average	-$41.08	-$24.22	-$9.81	$1.34	-$20.70	-$44.28
	Maximum	$4.50	$121.88	$122.25	$142.38	$132.36	$125.84
	Minimum	-$126.25	-$98.36	-$166.62	-$128.38	-$144.84	-$188.46

Figure (4.2) above generally indicated that selling September placed steers in January and placing lighter weight steers typically resulted in the largest average net incomes over the past twenty years and that on average it has been difficult to generate positive returns by placing steers in September. Table (4.1) above delves deeper into what the range of the obtainable returns for the same scenario have been over examined time period. For example, while the average return resulting from the January sale of 425 pound placed steers has been $21.85/head, the range has been significantly wider with a maximum net income of $172.12/head and a minimum net income of -$107.65/head. It can be seen that in at least one year over the time period it was possible to generate positive net incomes by selling any of the three weight classes of steers in any of the six potential sales months. It can also be seen that in at least one year over the time period analyzed it was possible to generate negative net incomes be selling any of the three weight classes of steers in any of the six potential sales months. The largest net income attainable over the time period occurred in 2014 ($272.41/head) and was a result of selling a 425 pound September placed steer in March. The smallest net income attainable over the time period occurred in 2008 (-$188.46/head) and was a result of selling a 575 pound September placed steer in March. In summary, table (4.1) indicates the large degree of variability in net incomes from placing steers in September.

Across the six potential sales months the average of the range of average net incomes for 425 pound placed steers was $279.02/head, for 500 pound placed steers the average of the range was $265.52/head, and for 575 pound placed steers the average of the range was $250.35/head. Variability in net incomes across the three weight classes of steers aligns well with the Risk-Return Tradeoff principle that states that to obtain higher returns more risk must be accepted. Figure (4.2) and Table (4.1) both indicate that it has historically been more profitable to place light weight steers and Table (4.1) shows that to be exposed to the potential of these higher returns it is necessary to expose oneself to greater levels of net income variability, a higher degree of risk. It also can be seen that as cattle are held for longer periods of time variability of returns increases. For example, the average of the range of net returns across the weight classes for a December sale of September placed steers was $276.62/head, whereas the average of the range of net returns across the weight classes for a March sale of September placed steers was $363.57/head. Depending on a producer’s risk tolerance this can be viewed as being either good or bad. For producers who are risk loving holding cattle for a longer period allows them to face greater degrees of risk, whereas a risk adverse producer would not be as comfortable facing this risk and would desire to avoid some of this risk if possible.

Table 4.2 Steer Weights by Sale Month (September/March)

Steer Weights (Pounds shrunk 2%) for Varying Sales Months Ex-Post, 1996-2015 (September Purchase ; Planned March Sale)						
Placement Month						
Placement Weight	October	November	December	January	February	March
425	479	540	601	667	733	799
500	549	608	665	728	792	854
575	620	675	729	790	850	910

Table (4.2) above shows the payable sales weights of September placed 425, 500, and 575 pound placed steers for varying potential sales months. For example, in our model a 425 pound steer placed on September 1st will weigh 667lbs (shrunk sellable weight) on the first of January. These weights provide one plausible explanation as to why on average it has been profitable to hold 425 pound steers through the planned March sale date, while on average it has been counteractive to profitability to hold 500 and 575 pound September placed steers past January. Ex-post net income results indicate that heavier placed steers are being penalized heavily by feedlot buyers on the backside for being excessively heavy post January. Once steers break that 750-800 weight bracket that generally defines a feeder steer they are typically being discounted to a greater degree which is being shown in Table (4.2).

Table 4.3 Percentage of Years Profits Attainable (September/March)

Percentage of Years Positive Profits Attainable in Varying Sales Months, Ex Post, 1996-2015 (September Purchase ; Planned March Sale)						
	Sale Month					
Steer Weight	October	November	December	January	February	March
425 Pounds	30%	40%	60%	55%	50%	50%
500 Pounds	5%	25%	45%	50%	50%	40%
575 Pounds	10%	15%	50%	50%	45%	30%

Table (4.3) above breaks down the percentage of years that it has been profitable to sell steer calves for the different placement weights of cattle in the model. For example, for 425 pound September placements 60% of the years (12 of the 20 years) between 1996 and 2015 you would have been able to generate a positive profit by selling steers in December. Likewise, for 500 pound placements only 5% of the years (1 of the 20 years) between 1996 and 2015 would you have been able to generate a positive profit by selling September placed steers in October. Overall, table (4.3) indicates that it is rather difficult, but not impossible, to generate positive returns by placing calves in September. Once again the results generally show that you are more likely to generate positive returns by carrying lightweight (425lb) steers through the planned March sale date than you are by carrying heavier weight (500lb and 575lb) steers through the planned March sale date. It can additionally be seen that by carrying steers at least three months generally leads to increased likelihoods of generating positive returns.

Figure 4.3 Optimal Ex-Post Sale Month (September/March)

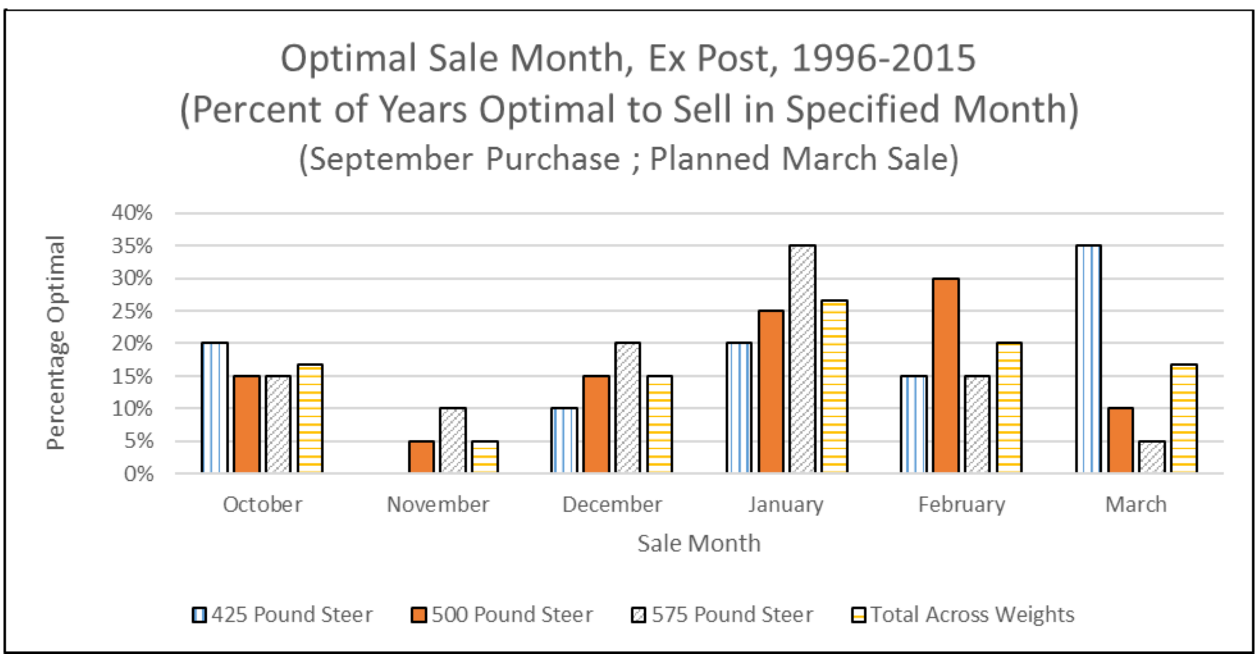


Figure (4.3) above shows the percentage of years that it has been optimal to sell steers in each of the potential sale months. For each year the model calculates the optimal sale date and these results are summarized above. For example, 35% of the years (7 of the 20 years) between 1996 and 2015 it was optimal to sell 575 pound September placed steers in January. Likewise, in 35% of the years between 1996 and 2015 it was optimal to sell 425 pound September placed steers in March. The graph also sums across the three weight classes (60 observations) to give a more general idea as to what the optimal sale strategy for September placed steers has been over the past twenty years. It can be seen that selling steers in January has been the most frequent optimal sale strategy across the weight classes over the time period.

4.2b November/March

This scenario analyzes the placement of steers on November 1st with a planned sale on March 1st. The model looks at placing steers weighing 425 pounds, 500 pounds, and 575 pounds. The placement of steers in November is a common strategy amongst backgrounders. There is typically a sufficient supply of cattle available at this time typically resulting in lower purchase costs per animal.

Figure 4.4 Average Ex-Post Net Income (November/March)

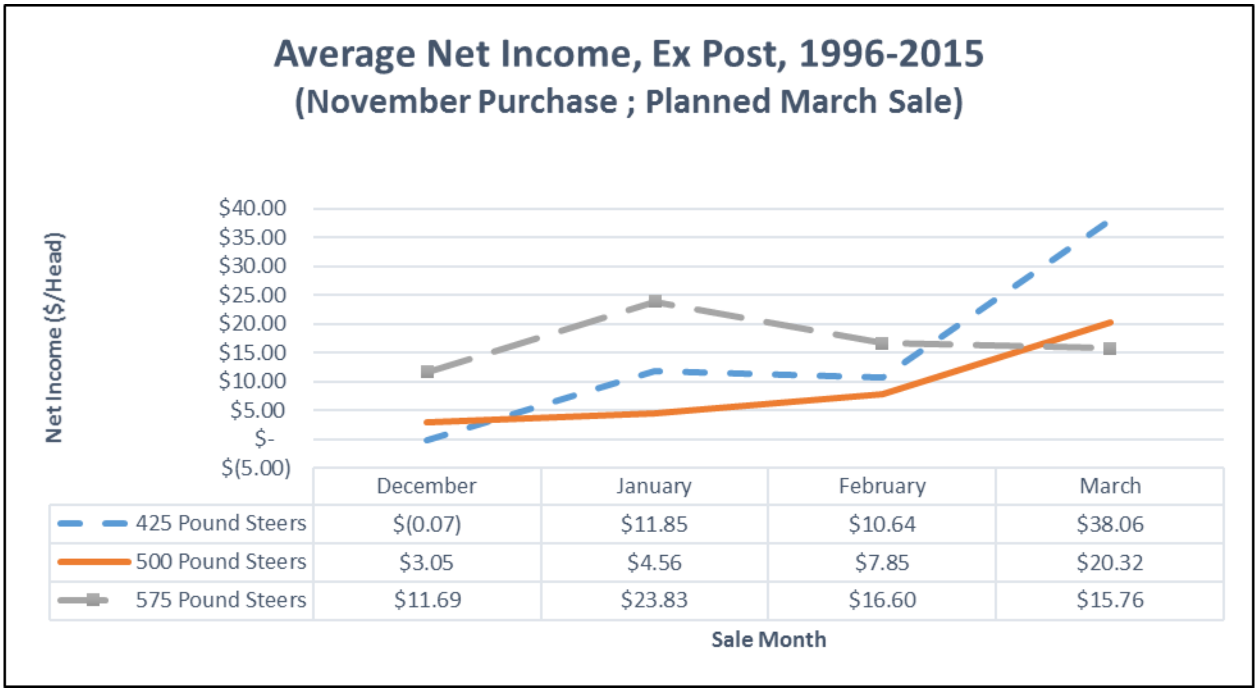


Figure (4.4) above shows the average net income between 1996 and 2016 obtainable from selling November placed steers in varying potential sales months (December, January, February, and March). It is should be noted that the average net returns are generally positive for all three weight classes of cattle. However, they are fairly low. The graph indicates that it has been on average economically beneficial to hold lighter weight steers (425 and 500 pound placements) through the planned March sale date, whereas it has been detrimental to hold heavier weight steers (575 pound placements) past January. February sales have on average resulted in decreased returns or net incomes that are increasing at a slow rate compared with January. If lighter weight steers have been held through the non-encouraging month of February and sold in March, producers have generally benefitted. Historically, 575 pound November placements have been most profitable when sold in the month of January. Overall, the graph indicates that if you are to hold steers through the intended March sale date you are better off to place light weight steers (425 pound placement), but if you are going to sell steers early you are better off placing a heavier weight steer (575 pound placement).

Table 4.4 Net Income Summary Statistics (November/March)

Net Income Summary Statistics for Varying Sales Months, Ex-Post, 1996-2015 (November Purchase ; Planned March Sale)					
Steer Weight	Statistic	December	January	February	March
425 Pounds	Average	-$0.07	$11.85	$10.64	$38.06
	Maximum	$57.81	$90.74	$180.62	$212.12
	Minimum	-$116.51	-$73.42	-$239.38	-$148.84
500 Pounds	Average	$3.05	$4.56	$7.85	$20.32
	Maximum	$53.17	$87.04	$135.89	$194.03
	Minimum	-$76.00	-$78.85	-$228.09	-$186.58
575 Pounds	Average	$11.69	$23.83	$16.60	$15.76
	Maximum	$65.28	$109.04	$150.43	$174.82
	Minimum	-$71.59	-$70.94	-$144.71	-$162.14

Table (4.4) above shows the range of net incomes associated with selling the three placement weights of steers in the four potential sale months. The largest net income obtainable over the time period resulted from selling a 425 pound November placed steer in March of 2014 ($212.12/head). The lowest net income obtainable over the time period resulted from selling a 425 pound November placed steer in February of 2015 (-239.38/head). Figure (4.4) and table (4.4) both indicate that it has historically been more profitable to place light weight steers and hold them through the intended March sale date. Table (4.4) shows that to be exposed to the potential of these higher returns it is necessary to expose oneself to greater levels of net income variability, a higher degree of risk. Across the four potential sales months the average of the range of average net incomes for 425 pound placements was $279.86/head, for 500 pound placements the average of the range was $259.91/head, and for 575 pound placements the average of the range was $237.24/head. It also can be seen that as cattle are held for longer periods of time variability of returns increases. For example, the average of the range of net returns across the weight classes for a January sale of November placed steers was $170.01/head, whereas the average of the range of net returns across the weight classes for a March sale of November placed steers was $359.51/head

Table 4.5 Monthly Sale Weights

Steer Weights (Pounds shrunk 2%) for Varying Sales Months Ex-Post, 1996-2015 (November Purchase ; Planned March Sale)				
	Placement Month			
Placement Weight	December	January	February	March
425	486	556	625	692
500	557	623	689	753
575	627	690	753	814

Table (4.5) above shows the payable sales weights of November placed 425, 500, and 575 pound steers for varying potential sales months. For example, in our model a 425 pound steer placed on November 1st will weigh 625lbs (shrunk sellable weight) on February 1st. These weights provide one plausible explanation as to why on average it has been profitable to hold 425 pound steers through the planned March sale date, while on average it has been counteractive to profitability to hold 575 pound November placed steers past January. Ex-post net income results indicate that 575 pound placed steers are being penalized heavily by feedlot buyers on the backside for being excessively heavy post January. The ability of a producer to hold lighter weight placements through the planned March sale date is at least partially driven by steers not being penalized on the backside by feedlot buyers for being excessively heavy.

Table 4.6 Percentage of Years Profits Attainable (November/March)

Percentage of Years Positive Profits Attainable in Varying Sales Months, Ex Post, 1996-2015 (November Purchase ; March Sale)				
	Sale Month			
Steer Weight	December	January	February	March
425 Pound Steer	55%	55%	70%	80%
500 Pound Steer	55%	50%	60%	65%
575 Pound Steer	75%	75%	65%	65%

Table (4.5) above indicates that obtaining positive profits has been the most likely when selling November placed calves in March for 425 and 500 pound steers, and selling them in either December or January for 575 pound steers. The largest likelihood of obtaining a positive profit from placing steers in November results from placing a 425 pound steer and selling it in March (80% likelihood of obtaining a positive profit; 16 of 20 years). Overall, it is more likely to obtain positive profits by placing calves in November as opposed to September as all placement/sale strategies have resulted in positive net incomes in at least 10 of the 20 years between 1996 and 2015.

Figure 4.5 Optimal Sale Month (November/March)

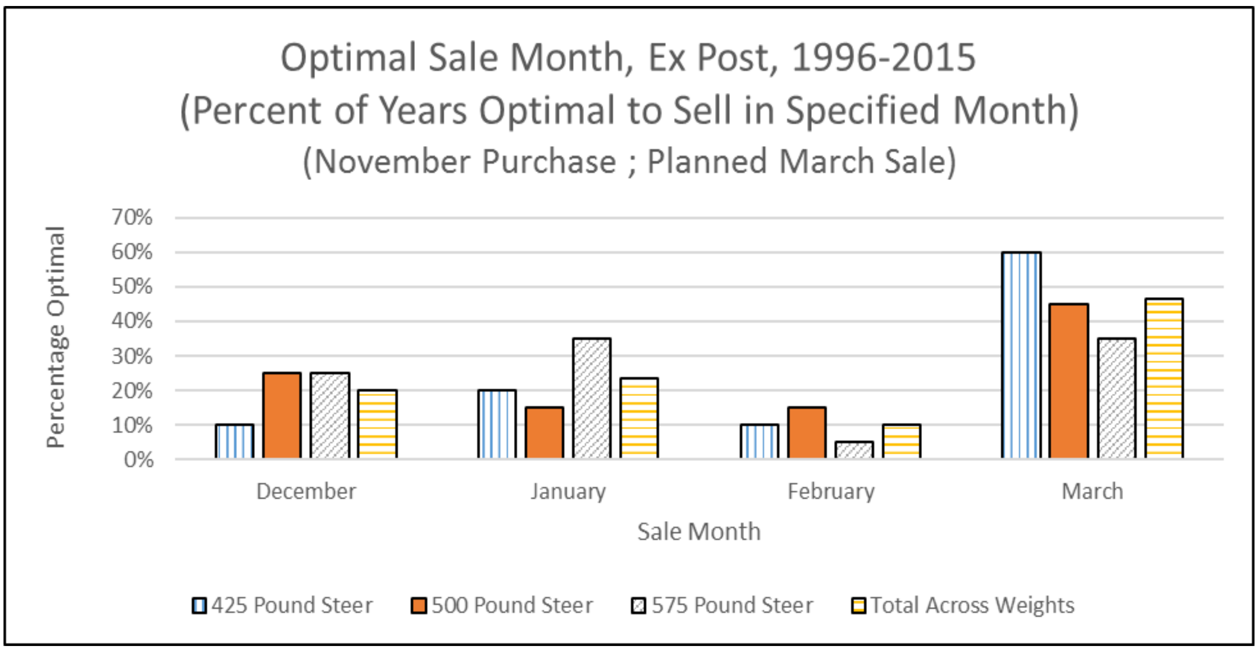


Figure (4.5) above shows the percentage of years that it was optimal to sell steers in each of the potential sale months. For each year the model calculates the optimal sale date and these results are summarized above. For example, 60% of the years (12 of the 20 years) between 1996 and 2015 it was optimal to sell 425 pound November placements in March. Likewise, in 35% of the years between 1996 and 2015 it was optimal to sell 575 pound placements in January. The graph also sums across the three weight classes (60 observations) to give a more general idea as to what the optimal sale strategy for November placed steers has been over the past twenty years. It can be seen that selling steers in March has been the optimal sale strategy across the weight classes over the time period. It should be additionally noted that selling November placed steers in February has on average been a poor marketing strategy. Selling steers in February has been optimal only 10% of the time for 425 pound placements, 15% of the time for 500 pound placements, and 5% of the time for 575 pound placements.

4.2c April/July

This scenario analyzes the placement of steers on April 1st with a planned sale on July 1st. The model looks at placing steers weighing 450 pounds, 600 pounds, and 750 pounds. It is common to see a wider range of placement weights for stocker cattle as there is a wider mixture of calves and yearling than is seen within the two backgrounding scenarios. For this reason, we widened the range of our placement weights. For this scenario and the following scenario (May Placement/July Sale) we switched over to what we are calling the stocking industry. In these scenarios cattle are no longer in a dry-lot scenario and are now grazing on pasture with only mineral supplementation. Management strategies are generally more diverse in stocking scenarios than backgrounding scenarios in terms of steer placement weights.

Figure 4.6 Average Ex-Post Net Income (April/July)

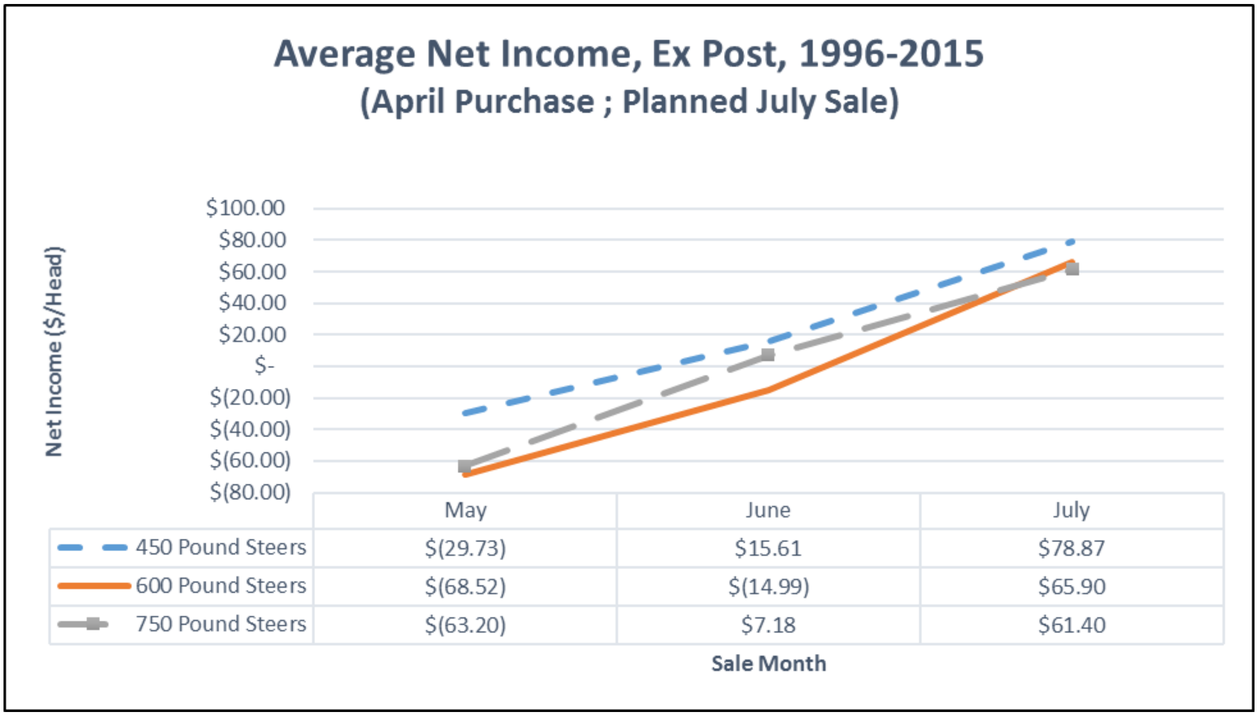


Figure (4.6) above represents the average ex-post net incomes obtainable from selling April placed steers in varying sales months (May, June, and July) between 1996 and 2015. For example, the dashed blue line above represents the average ex-post net income attainable from selling steers that were placed in April weighting 450 pounds. As can be seen in the figure above, July sales have historically resulted in the largest average net incomes for all placement weights. 450 pound placements have had the largest average historical net incomes resulting from July sales with an average net income of $78.87/head. Likewise, July sales have also historically resulted in the largest average net incomes for 600 pound placements ($65.90/head) and 750 pound placements ($61.40/head). Overall, average net incomes obtainable from placing steers in the 450-750 pound weight classes in April appear to be on average relatively large if steers are held through the intended July sale date. However, if steers are not held through the planned July sale date average net incomes have historically been negative or small. This is primarily driven by the fixed costs associated with leasing pasture. The whole cost of grass must be paid for regardless of whether or not steers are held through the intended sale date or pulled early. The results in figure (4.6) tend to indicate that the largest net incomes have been historically attainable from holding cattle through the end of the lease agreement in July, and additionally that it has been historically economically beneficial to place lighter weight steers (450 pounds) as opposed to heavier weight steers (600 and 750 pound steers).

Table 4.7 Net Income Summary Statistics (April/July)

Net Income Summary Statistics for Varying Sales Months, Ex-Post, 1996-2015 (April Purchase ; Planned July Sale)				
Steer Weight	Statistic	May	June	July
450 Pounds	Average	-$29.73	$15.61	$78.87
	Maximum	$27.73	$230.56	$397.33
	Minimum	-$84.97	-$65.93	-$48.27
600 Pounds	Average	-$68.52	-$14.99	$65.90
	Maximum	$7.93	$125.23	$338.08
	Minimum	-$248.73	-$117.73	-$45.49
750 Pounds	Average	-$63.20	$7.18	$61.40
	Maximum	$31.55	$148.02	$345.15
	Minimum	-$121.94	-$126.75	-$60.59

Table (4.7) above shows the range of net incomes associated with selling the three placement weights of steers in the three potential sales months. The largest net income obtainable over the time period resulted from selling a 450 pound placement in July of 2014 ($397.33/head). The lowest net income obtainable over the time period resulted from selling a 600 pound placement in May of 2015 (-248.73/head). Figure (4.6) and table (4.7) both indicate that it has historically been more profitable to hold steers through the planned July sale date and to place lighter weight steers. Table (4.7) shows that to be exposed to the potential of these higher returns it is necessary to expose oneself to greater levels of net income variability. Across the three potential sales months the average of the range of average net incomes for 450 pound placements was $284.93/head and for 750 pound placements the average of the range was $278.00/head. However, the range of average net incomes for 600 pound placements was larger than that of 750 pound placements. It also can be seen that as cattle are held for longer periods of time variability of returns increases. For example, the average of the range of net returns across the weight classes for a May sale was $174.29/head, whereas the average of the range of net returns across the weight classes for a July sale was $411.64/head

Table 4.8 Percentage of Years Profits Attainable (April/July)

Percentage of Years Positive Profits Attainable in Varying Sales Months, Ex Post, 1996-2015 (April Purchase ; July Sale)			
	Sale Month		
Steer Weight	May	June	July
450 Pounds	20%	55%	90%
600 Pounds	5%	35%	80%
750 Pounds	5%	50%	75%

Table (4.8) above indicates that obtaining positive net returns has been the most likely to happen by selling April placements in July for all three placement weights of steers, and by selling steers that were placed at lighter weights. The largest likelihood of obtaining a positive profit from placing steers in April results from placing a 450 pound steer and selling it in July (90% likelihood of obtaining a positive profit; 18 of 20 years). It should be noted that the historical likelihood of obtaining positive profits by selling heavier weight steers earlier than planned in May is very low (5% for both 600 and 750 pound placements; 1 of 20 years). This table again confirms that it has been historically economically beneficial to hold steers up to the planned sale date in July. Fixed costs of pasture leases get spread out by holding steers throughout the entirety of the lease agreement.

Figure 4.7 Optimal Sale Month (April/July)

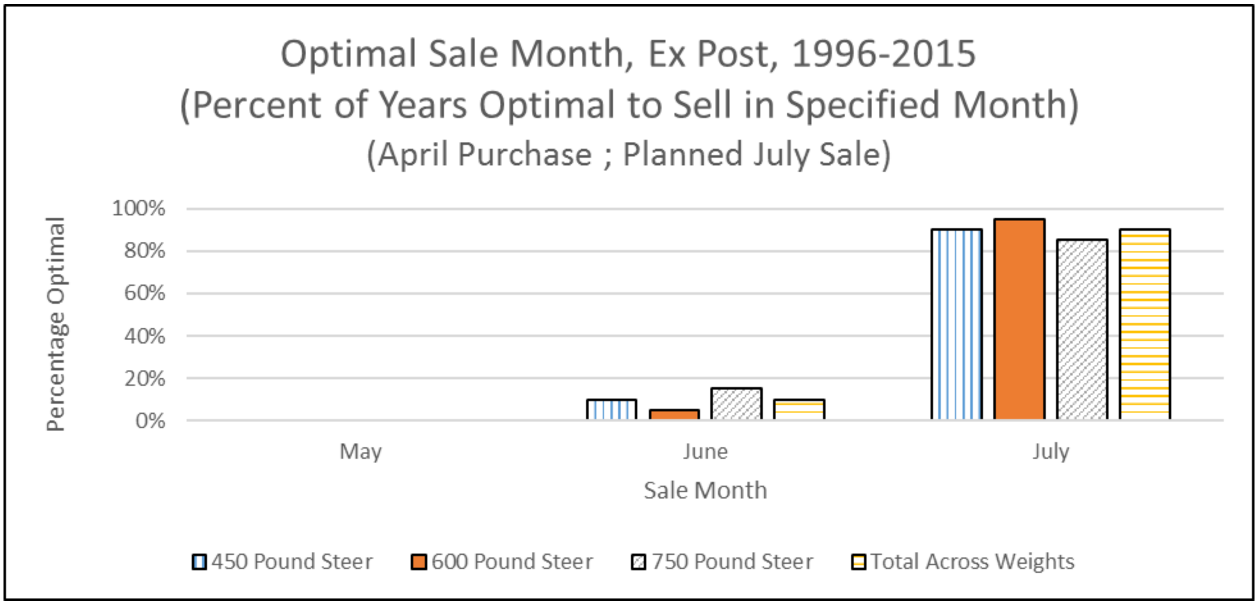


Figure (4.7) clearly demonstrates that it has been historically optimal to hold April placed steers through the planned July sale date. For the 20 years between 1996 and 2015 it was optimal to hold 450 pound placements through July 90% of the time, to hold 600 pound placements through July 95% of the time, and to hold 750 pound placements through July 85% of the time. It was never optimal to sell steers early in May.

4.2c May/July

This scenario analyzes the placement of steers on May 1st with a planned sale on July 1st. The model looks at placing steers weighing 450 pounds, 600 pounds, and 750 pounds. In the Flint Hills it sometimes occurs that there is not enough grass available at the start of the lease agreement to place cattle. This may result in delayed placement of cattle, which is why we chose to analyze this scenario.

Figure 4.8 Average Ex-Post Net Income (May/July)

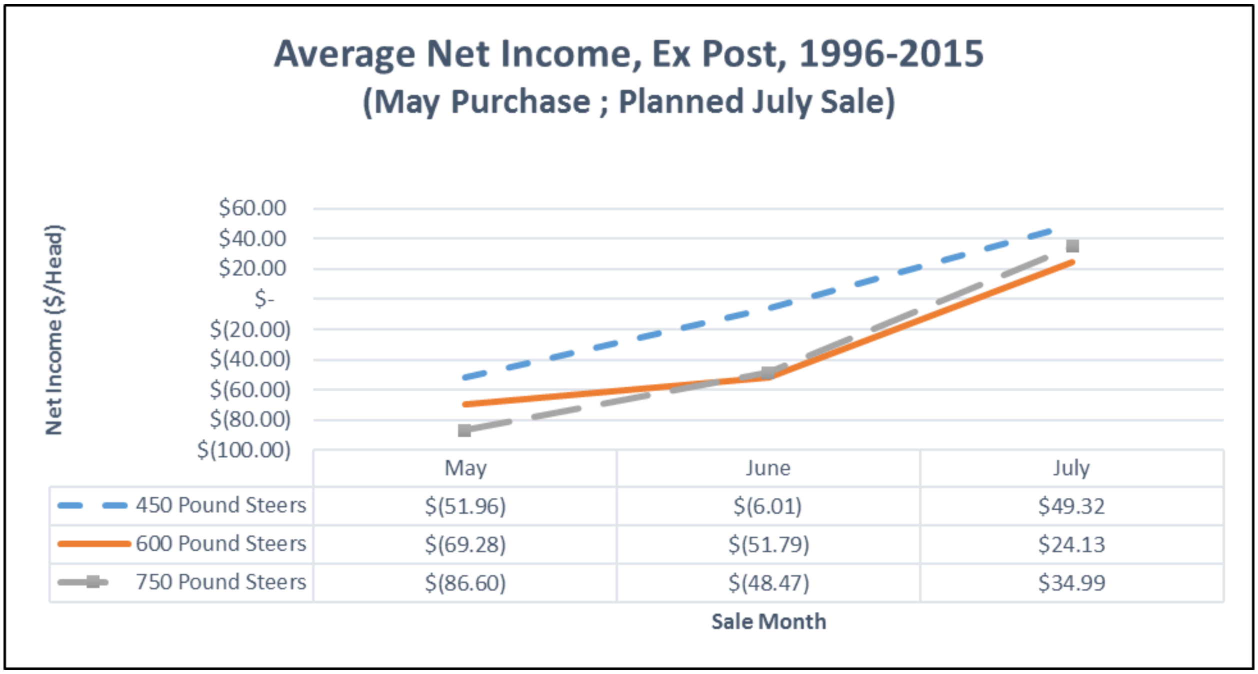


Figure (4.8) above represents the average ex-post net incomes obtainable from selling May placed steers in June and July between 1996 and 2015. For example, the dashed blue line above represents the average ex-post net income attainable from selling steers that were placed in May weighting 450 pounds. The reason that May is included in Figure (4.8) is due to the fact that within the model we are forcing producers to pay for their whole grass lease regardless of whether they delay placement or not. The negative returns representing May in Figure (4.8) above represent the cost of leasing grass and one month's interest expense on half of the cost of a grass lease. As can be seen in the figure above, July sales have historically resulted in the largest average net incomes for 450, 600, and 750 pound May placed steers. Historically, 450 pound placements have had the largest average net incomes resulting from July sales with an average net income of $49.32/head. Likewise, July sales have also historically resulted in the largest average net incomes for 600 pound May placed steers ($24.13/head) and 750 pound May placed steers ($34.99/head). Overall, average net incomes obtainable from placing steers in the 450-750 pound weight classes in May appear to be on average relatively respectable if steers are held through the intended July sale date. However, if steers are not held through the planned July sale date average net incomes have historically been negative. This is again primarily driven by the fixed costs associated with leasing pasture. The entire cost of grass must be paid for even though placement is delayed one month in this scenario. It is not uncommon for cattle to go to grass after a lease agreement has begun as a result of cool weather or limited rainfall limiting the amount of available forage in April. The results in figure (4.8) tend to indicate that the largest net incomes have been historically attainable from holding cattle through the end of the lease agreement in July, and additionally that it has been historically economically beneficial to place lighter weight steers (450 pounds) as opposed to heavier weight steers (600 and 750 pound steers). It should be noted 600 pound placements have historically resulted in lower net returns if sold in July relative to 750 pound placements.

Table 4.9 Net Income Summary Statistics (May/July)

Net Income Summary Statistics for Varying Sales Months, Ex-Post, 1996-2015 (May Purchase ; Planned July Sale)				
Steer Weight	Statistic	May	June	July
450 Pounds	Average	-$51.96	-$6.01	$49.32
	Maximum	-$42.71	$131.93	$380.04
	Minimum	-$63.25	-$67.40	-$57.64
600 Pounds	Average	-$69.28	-$51.79	$24.13
	Maximum	-$56.94	$43.74	$196.63
	Minimum	-$84.34	-$119.63	-$72.50
750 Pounds	Average	-$86.60	-$48.47	$34.99
	Maximum	-$71.18	$26.15	$291.84
	Minimum	-$105.42	-$135.38	-$49.03

Table (4.9) above shows the range of net incomes associated with selling the three placement weights of steers in June and July. The returns for May are representative of the cost of grass and one month's interest expense for grass. The largest net income obtainable over the time period resulted from selling a 450 pound May placement in July of 2014 ($380.04/head). The lowest net income obtainable over the time period resulted from selling a 750 pound May placement in June of 2011 (-135.38/head). Figure (4.8) and table (4.9) both indicate that it has historically been more profitable to hold steers through the planned July sale date and to place lighter weight steers (450 pounds). Table (4.9) shows that to be exposed to the potential of these higher returns it is necessary to expose oneself to greater levels of net income variability. Across the three potential sales months the average of the range of average net incomes for 450 pound placed steers was $318.50/head and for 750 pound placed steers the average of the range was $251.20/head. However, the range of average net incomes for 600 pound placements was larger than that for 750 pound placements. It also can be seen that as cattle are held for longer periods of time variability of returns increases. For example, the average of the range of net returns across the weight classes for a June sale of May placements was $174.74/head, whereas the average of the range of net returns across the weight classes for a July sale of May Placements was $349.23/head

Table 4.10 Percentage of Years Profits Attainable (May/July)

Percentage of Years Positive Profits Attainable in Different Sales Months, Ex Post, 1996-2015 (May Purchase ; July Sale)			
	Sale Month		
Steer Weight	May	June	July
450 Pound Steer	0%	45%	75%
600 Pound Steer	0%	10%	60%
750 Pound Steer	0%	15%	70%

Table (4.10) above indicates that obtaining positive net returns has been the most likely to occur by selling May placed steers in July for all three placement weights of steers, and by selling lighter placements (450 pounds). The largest likelihood of obtaining a positive profit from placing steers in May results from placing a 450 pound steer and selling it in July (75% likelihood of obtaining a positive profit; 15 of 20 years). It should be noted that the historical likelihood of obtaining positive profits by selling heavier weight steers earlier than planned in June is relatively low (10% for 600 pound placements and 15% for 750 pound placements). Table (4.10) again confirms that it has been historically economically beneficial to hold steers up to the planned sale date in July. Fixed costs of pasture leases get spread out by holding steers for a longer period of time.

Figure 4.9 Optimal Sale Month (May/July)

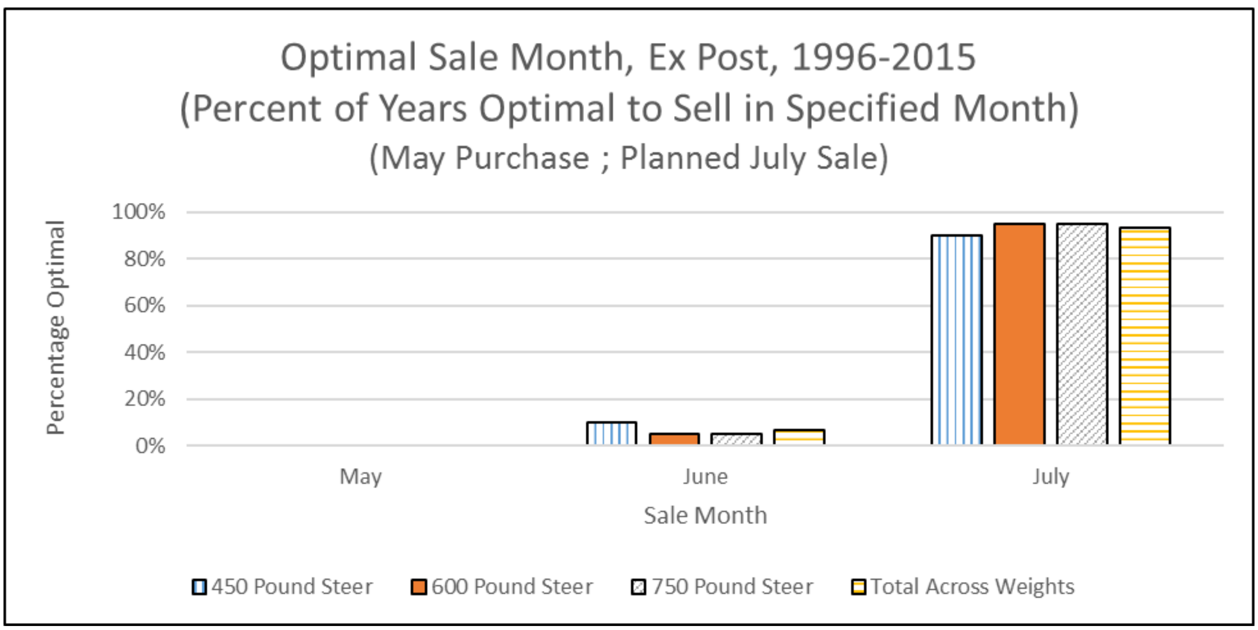


Figure (4.9) above displays the percentage of years between 1996 and 2015 that it was optimal to sell in June and July. It can be clearly seen that it has been historically optimal to hold steers until July to spread out fixed pasture costs.

4.2e Summary of Ex-Post Net Income Comparisons Across Scenarios

Within the backgrounder segment of the beef industry it appears that weight of steers at time of sale plays a large factor in generating positive net returns. The model generally shows that once steers get above the generally recognized 750-800 pound feeder steer weight feedlot buyers begin heavily discounting them. In general, for September placements it has historically been economical to sell steers in January as opposed to holding them through the planned sale date in March. It also appears to be beneficial to place light weight steers. For November placements it has historically been economical to carry steers through the planned March sale date. However, if you are placing heavier weight steers it has been most beneficial to sell those steers after two months of ownership in January. Overall, most signals indicate that it is on average more profitable for producers to place steers in November as opposed to placing them in September. It can be seen in figures (4.2) and (4.4) that the net returns from selling November placed steers in March are significantly larger for than those from selling September placed steers in March. This is also the case when looking at four month returns from a return on investment standpoint. The net returns from selling November placed steers in March are once again significantly larger than selling September placed steers in January, the optimal sale month for September placements. Plausible explanations as to why it is more profitable to place steers in November as opposed to September include; steers can historically be purchased less expensively in November, steers placed in November generally outperform September placed steers in regards to average daily gain and death loss, and lastly steers placed in September that are held through the planned March sale date are discounted heavily because they are too heavy to be desirable to feedlots. On the other hand, some reasons may potentially exist as to why producers would want to place steers in September as opposed to November. Some of these reasons include; ability to expose oneself to more risk if you are a risk loving producer, access to more selling opportunities, potential for not enough steers to be available in November, and from a finance perspective you are able to spread your fixed costs over a greater period of time.

Within the stocker segment of the beef industry it appears the fixed cost of pasture leases play a large factor in generating positive net returns. The model generally shows that steers should be carried the entirety of the length of the lease (April through July) to spread out costs due to the fact that the entire cost of the lease must be paid for regardless of how long steers are on grass. In both scenarios (April and May placement) it appears that placing lightweight steers (450 pounds) has been the most profitable. In the vast majority of circumstances it is more economically beneficial to place steers in April as opposed to delaying placement to May (see net incomes for July in Figures (4.6) and (4.8) above). Years were it was optimal to delay placement have generally been low profitability years where net incomes were negative. The few instances where it was optimal to delay placement it was optimal to place heavier weight steers.

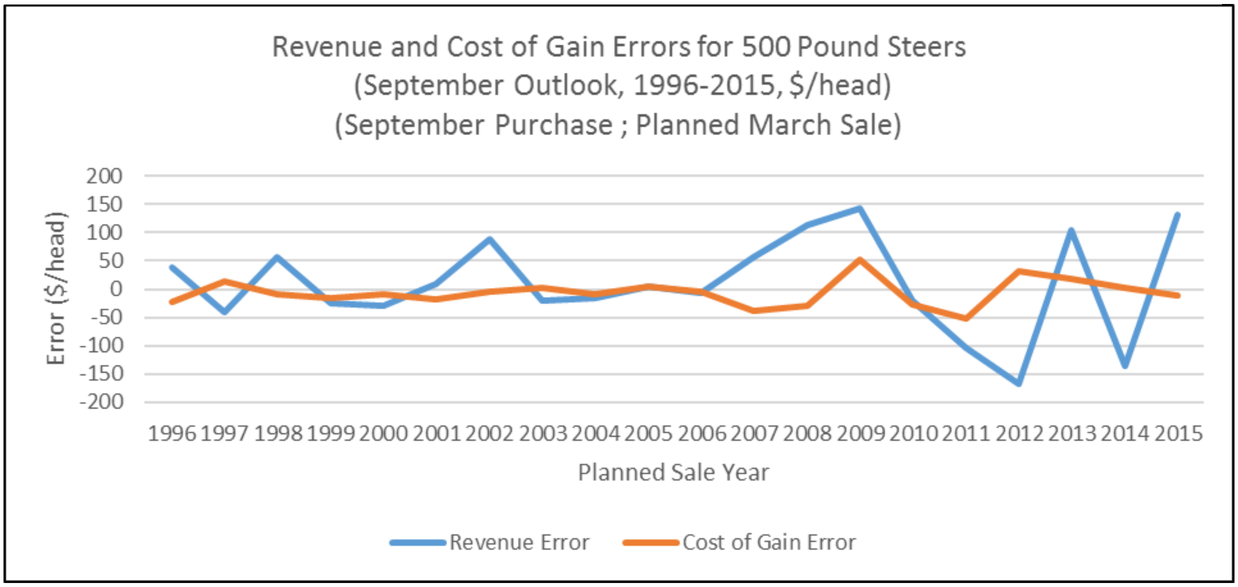
In comparing backgrounding and stocking segments of the beef industry it has historically been more profitable to operate within the stocking segment than the backgrounding segment. However, while larger net incomes have been obtainable within the stocker segment the range of returns have been significantly larger. Thus, depending on your level of risk tolerance you may prefer to operate in the backgrounder or stocker segment of the beef industry. From a financial perspective it may prove advantageous to participate in both sectors as you are able to spread your fixed costs over a greater number of cattle.

The stocking industry is not only historically more profitable from a $/head basis but also from a return on investment perspective (ROI). When September placements are held through the planned March sale date the average six-month ROI is -1.32% or -2.66% on an annualized basis across all years and placement weights. When November placements are held through the planned March sale date the average four-month ROI is 3.2% or 9.91% on an annualized basis across all years and placement weights. When April placements are held through the planned July sale date the average three-month ROI is 8.29% or 37.54% on an annualized basis across all years and placement weights. When May placements are held thought the planned July sale date the average three-month ROI is 4.43% or 18.91% on an annualized basis across all years and placement weights. These numbers show that stocking returns are on average much more appealing than backgrounding returns.

4.3 Prediction Accuracy

Within this section the highlights of the prediction accuracy results within each of the four scenarios will be discussed in subsequent order. The ex-post analysis that was done in the first stage of the model is by definition backwards looking. Therefore, this section that is forward looking is important as it aligns more closely with the producer's actual decision making process. Understanding of historical prediction errors is important information for producers to know as they manage funds and prepare budgets. For example, knowing that when you place a 575 pound steer in September your expected net income has historically been $20.32/head too high is beneficial to have in the back of your mind. For the two backgrounding scenarios net income error, revenue error, and cost of gain error will be discussed. Net income error is a function of revenue error and cost of gain error in our model (making assumption that animal performance is known with certainty). Within the backgrounding scenarios a majority of net income error is typically composed of revenue error as can be seen in Figure (4.10) below. It should also be noted that revenue and cost of gain errors, and thus net income errors, have increased greatly since approximately 2006. This aligns with the increased levels of volatility that were shown and discussed in figure (4.1) at the beginning of this section.

Figure 4.10 Revenue and Cost of Gain Error Comparison



For the two stocking scenarios net income error will only be discussed. This is due to the manner in which we set up our model. In the stocker scenarios we know what our pasture rent expenses are because they are incurred fully on April 1st and we are assuming mineral expenses are known with certainty on the date of placement. Thus, net income error will consist solely of revenue error. Following the display of the results for each individual scenario broad comparisons will be made across the four scenarios.

4.3a September/March

<u>Net Income Error:</u>

Figure 4.11 Average Net Income Error (September/March)

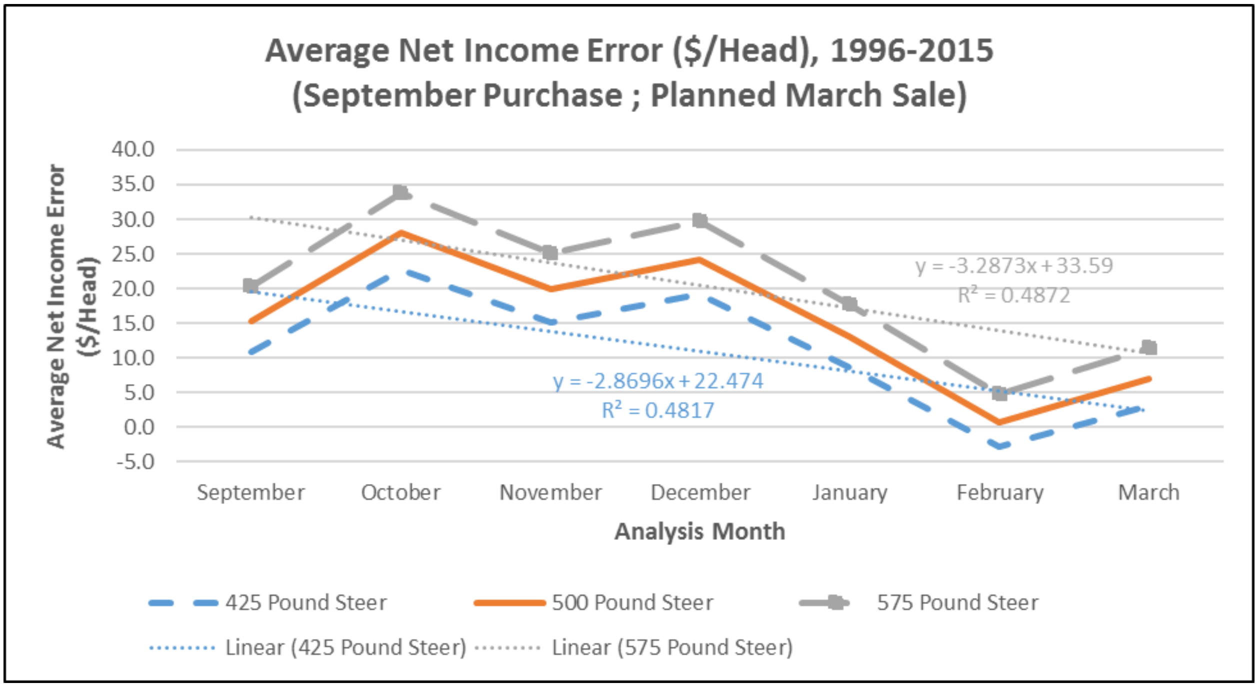


Figure (4.11) above represents the average ex-post net income errors by analysis month from selling September placed steers in the planned sale month of March between 1996 and 2015. Net income error is defined as expected net income minus predicted net income (from model stage 1). The model updates its expectations of net income for a March sale each month animals are owned. These expected net incomes are compared with predicted net incomes from the ex-post net income section above. For example, the dashed blue line above represents the average ex-post net income error for 425 pound September placed steers in each potential analysis month (September, October, November, December, January, February, and March). It can be seen that net income errors tend to go nearer zero the closer the analysis month date is to the March sale. As the planned sale date approaches more information is known, and the forecasting time horizon shrinks, and thus the expected net income should get closer to the actual net income. Net income errors are generally larger for heavier weight steers on a per animal basis. The trend line associated with 425 pound September placements indicates that net income error decreases by $2.87/head each month on average. The trend line associated with 575 pound September placements indicates that net income error decreases by $3.29/head each month on average. The most important point to mention is that net income errors are typically positive which is detrimental to producers. If a producer expects to generate larger net incomes than he does in reality it is detrimental to him.

Table 4.11Net Income Error Summary Statistics (September/March)

Net Income Errors by Analysis Month, 1996-2015 (September Purchase ; Planned March Sale)								
		Analysis Month						
Steer Weight	Statistic	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
425 Pounds	Average	$10.77	$22.71	$15.18	$19.22	$8.70	-$2.75	$3.13
	Maximum	$129.52	$233.47	$209.65	$240.92	$130.39	$81.26	$31.15
	Minimum	-$201.07	-$93.96	-$116.46	-$82.01	-$75.99	-$67.17	-$28.87
500 Pounds	Average	$15.30	$28.02	$19.92	$24.23	$12.99	$0.76	$7.04
	Maximum	$143.55	$274.17	$248.63	$282.09	$154.95	$73.96	$57.67
	Minimum	-$199.23	-$94.27	-$118.46	-$69.48	-$85.67	-$68.85	-$20.17
575 Pounds	Average	$20.32	$33.83	$25.16	$29.75	$17.78	$4.78	$11.47
	Maximum	$158.95	$298.03	$270.79	$306.43	$171.02	$97.21	$75.64
	Minimum	-$197.13	-$96.40	-$122.24	-$75.51	-$85.05	-$79.80	-$34.12

Table (4.11) above lists the average, maximum, and minimum net income error for each placement weight/analysis month combination between 1996 and 2015. For example, average net income error for 425 placements in the November analysis month were $15.18/head, the maximum net income error was $209.65/head, and the minimum net income error was -$116.46/head. The most accurate net income prediction was for a 500 pound placement in the October analysis month of 2005 ($0.10/head). The least accurate net income prediction was for a 575 pound placement in December of 2015 ($306.43/head). The average range of net income errors averaged across analysis months was lowest for 425 pound placements ($245.98/head) and highest for 575 pound placements ($295.48/head). The average range of net income errors averaged across months decreased as the analysis month approached the planned March sale date. For example, average net income errors averaged across placement weights in October were $363.43/head, while the average net income error averaged across placement weights in March was $82.54/head. Overall, the results show that the least accurate net income predictions have historically occurred in October while the most accurate net income predictions have occurred in February. This makes sense as we would expect net income errors to diminish as producers gain access to more information closer to the planned sale date.

Table 4.12 Percentage of Years with Positive Net Income Errors (September/March)

Percentage of Years with Positive (Detrimental) Net Income Errors, 1996-2015 (September Purchase ; Planned March Sale)							
	Analysis Month						
Animal Type	September	October	November	December	January	February	March
425 Pound Steer	55%	65%	65%	60%	55%	45%	55%
500 Pound Steer	55%	55%	65%	55%	50%	50%	60%
575 Pound Steer	55%	70%	60%	55%	50%	55%	55%

Table (4.12) above lists the percentage of years that positive (detrimental) net income errors for each placement weight/analysis month combination have occurred. For example, for 425 pound placements positive (detrimental) net income errors occurred 60% of the years (12 of 20) between 1996 and 2015 in the December analysis month. It should be noted that in all but one of the analysis combinations detrimental net income errors have occurred in at least 50% of the years between 1996 and 2015.

Figure 4.12 Most Accurate Net Income Predictions (September/March)

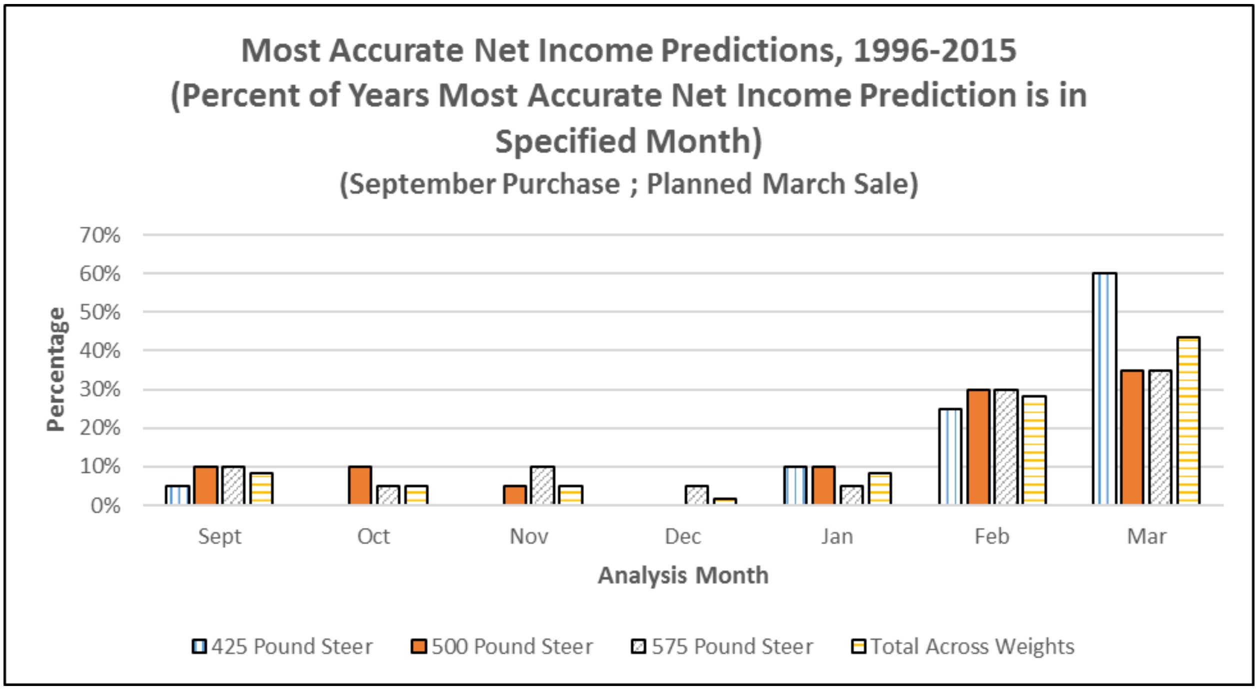


Figure (4.12) above shows the percentage of years where the most accurate net income prediction occurred within each analysis month. For example, for 425 pound placements the most accurate net income prediction occurred 60% of the time in the March analysis month. The graph shows that a vast majority of the most accurate net income predictions occur in either February or March. This again makes sense as producers should more accurately predict net incomes as they gain access to additional information.

Revenue Error:

Figure 4.13 Average Revenue Error (September/March)

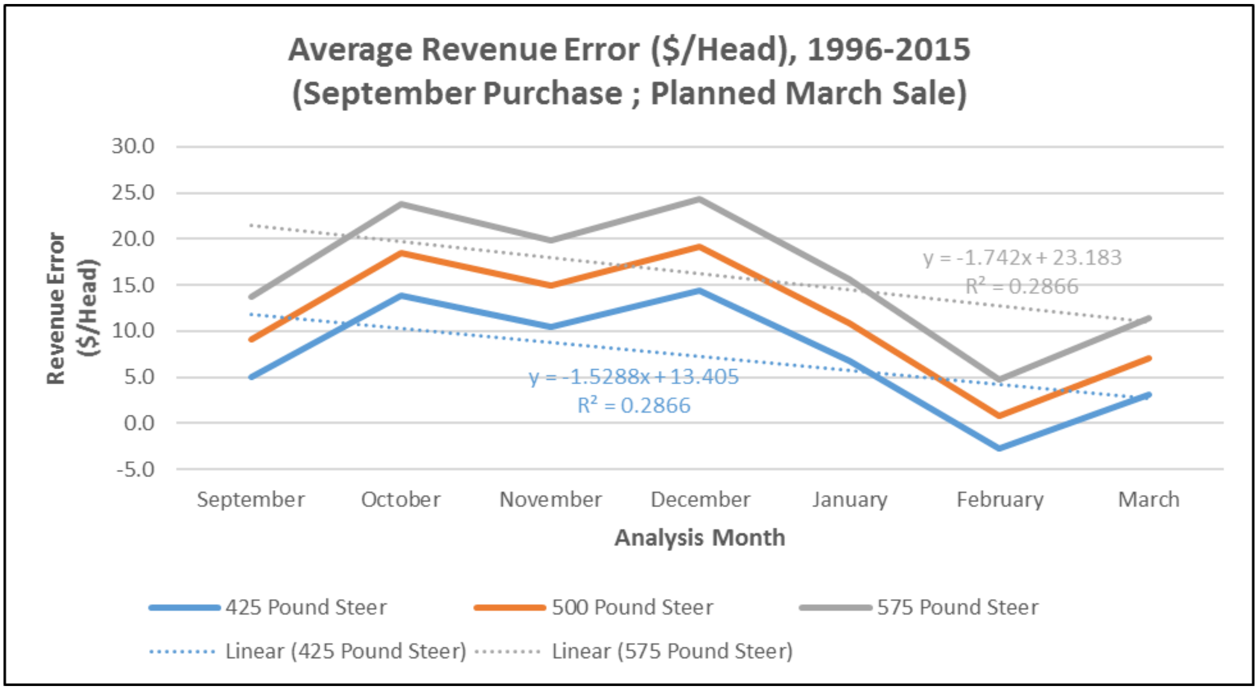


Table 4.13 Revenue Error by Month (September/March)

Revenue Errors by Analysis Month ($/Head), 1996-2015 (September Purchase ; Planned March Sale)								
		Analysis Month						
Steer Weight	Statistic	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
425 Pounds	Average	$5.06	$13.88	$10.50	$14.45	$6.76	-$2.75	$3.13
	Maximum	$137.82	$219.51	$207.84	$241.23	$125.47	$81.26	$31.15
	Minimum	-$171.23	-$127.67	-$126.04	-$85.26	-$79.66	-$67.17	-$28.87
500 Pounds	Average	$9.11	$18.55	$14.93	$19.15	$10.93	$0.76	$7.04
	Maximum	$142.59	$259.16	$246.69	$282.40	$156.84	$73.96	$57.67
	Minimum	-166.99	-130.35	-128.60	-72.94	-89.56	-68.85	-20.17
575 Pounds	Average	$13.67	$23.73	$19.87	$24.37	$15.61	$4.78	$11.47
	Maximum	$146.67	$282.00	$268.72	$306.76	$173.01	$97.21	$75.64
	Minimum	-162.55	-134.79	-132.93	-76.72	-89.15	-79.80	-34.12

Table 4.14 Percentage of Years with Positive Revenue Errors (September/March)

Percentage of Years with Positive (Detrimental) Revenue Errors by Analysis Month, 1996-2015 (September Purchase ; Planned March Sale)							
	Analysis Month						
Animal Type	September	October	November	December	January	February	March
425 Pound Steer	45%	60%	65%	60%	55%	45%	55%
500 Pound Steer	50%	55%	65%	55%	50%	50%	60%
575 Pound Steer	50%	55%	60%	55%	50%	55%	55%

Figure (4.13) and Table (4.13) above generally indicate that revenue errors tend to decrease as the analysis month gets closer to the planned March sale date. However, there are slight increases in revenue errors for the October and December analysis months. The trend line associated with 425 pound September placements indicates that revenue error decreases by $1.53/head each month on average. The trend line associated with 575 pound September placements indicates that revenue error decreases by $1.74/head each month on average. Once again, revenue errors are on average larger for heavier placement weights on a per animal basis. The most accurate revenue prediction was for a 500 pound placement in March of 2008 (-$0.18/head). The least accurate revenue prediction was for a 575 pound placement in December of 2015 ($306.76/head). In general, revenue errors are positive which is detrimental to a producer. If a producer expects to make more revenue than he does in reality it is detrimental to him. Table (4.13) indicates that the range of revenue errors generally gets smaller as the analysis month becomes closer to the planned March sale date. Table (4.14) above shows that for a majority of placement weight/analysis month combinations between 1996 and 2015 positive (detrimental) revenue errors have historically occurred.

Figure 4.14 Most Accurate Revenue Predictions (September/March)

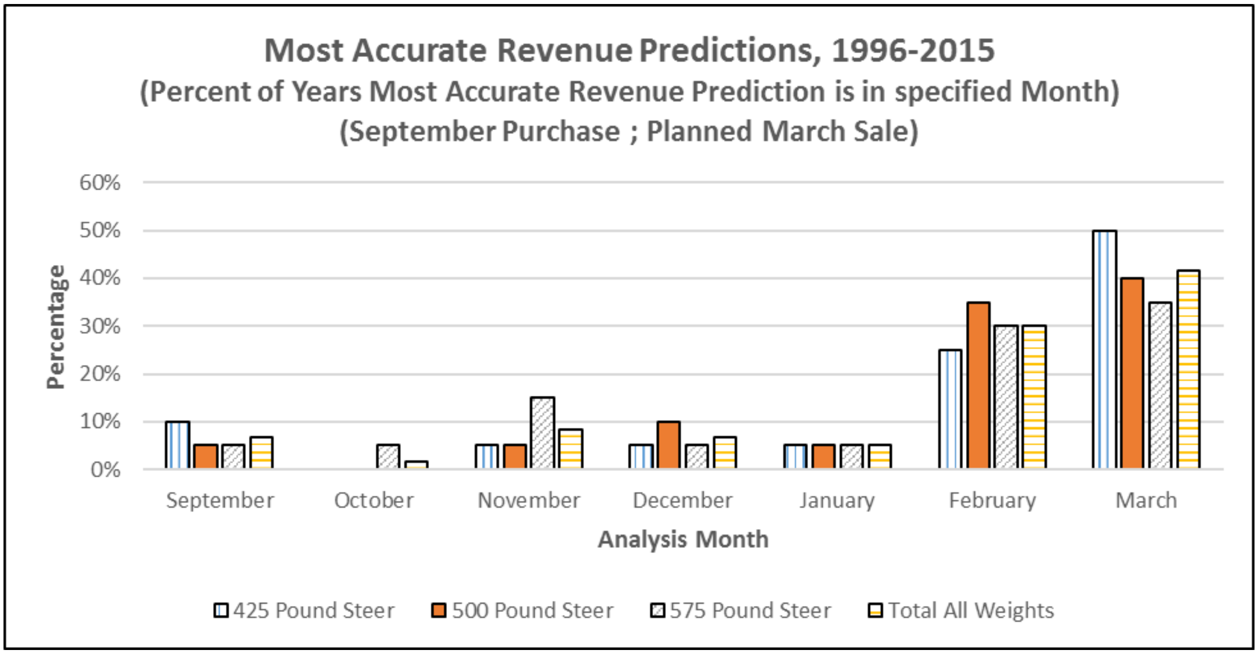


Figure (4.14) above shows that the most accurate revenue predictions have historically occurred in February and March. October revenue predictions have generally been inaccurate relative to other analysis months. This again aligns with the added benefit of knowing more information the closer one gets to the planned sale date.

Cost of Gain Error:

Figure 4.15 Average Cost of Gain Error (September/March)

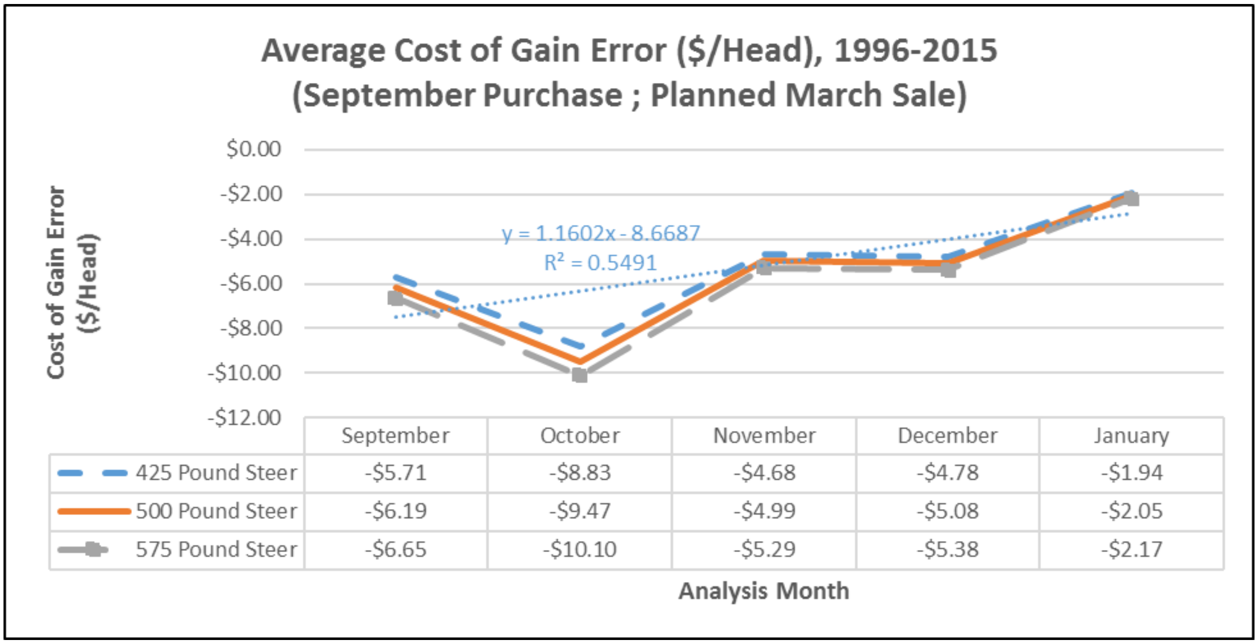


Table 4.15 Cost of Gain Error Summary Statistics

Cost of Gain Errors by Analysis Month ($/Head), 1996-2015 (September Purchase ; Planned March Sale)						
		Analysis Month				
Steer Weight	Statistic	September	October	November	December	January
425 Pounds	Average	-$5.71	-$8.83	-$4.68	-$4.78	-$1.94
	Maximum	$48.56	$25.45	$4.21	$0.50	$2.42
	Minimum	-$49.27	-$33.72	-$17.17	-$15.93	-$6.39
500 Pounds	Average	-$6.19	-$9.47	-$4.99	-$5.08	-$2.05
	Maximum	$52.11	$27.29	$4.51	$0.54	$2.56
	Minimum	-52.93	-36.08	-18.28	-16.92	-6.76
575 Pounds	Average	-$6.65	-$10.10	-$5.29	-$5.38	-$2.17
	Maximum	$55.59	$29.10	$4.81	$0.58	$2.70
	Minimum	-56.51	-38.40	-19.37	-17.89	-7.14

Figure (4.15) and Table (4.15) above indicate that as the analysis month draws closer to the March sale date cost of gain errors generally get closer to zero. Again, it can be seen that the month of October has historically resulted in the most inaccurate cost of gain predictions and that

January has led to the most accurate cost of gain predictions. Cost of gain error is defined as expected cost of gain minus predicted cost of gain. February would have zero cost of gain error because the last feed purchases occur on February 1st so from that point on we know our total cost of gain with certainty. It can also be seen that the range of cost of gain errors generally declines as the analysis month draws closer to the planned March sale date. The trend line for 425 pound placements indicates that cost of gain errors increase (go closer to zero) by $1.16/head each month as the planned March sale date draws closer. The reason for cost of gain errors being larger for larger placements is due to larger placements consuming increased volumes of feed. With larger intake volumes, any inaccurate price predictions have a larger impact on cost of gain for a given animal. The most accurate cost of gain prediction was for a 425 pound placement in the November analysis month of 2012 ($0.05/head). The least accurate cost of gain prediction was for a 575 pound placement in the September analysis month of 2011 (-$56.51/head). In general, cost of gain errors are negative which is detrimental to producers. If a producer expects their cost of gain to be lower than they are in reality this hurts the producer.

4.3b November/March

<u>Net Income Error:</u>

Figure 4.16 Average Net Income Error (November/March)

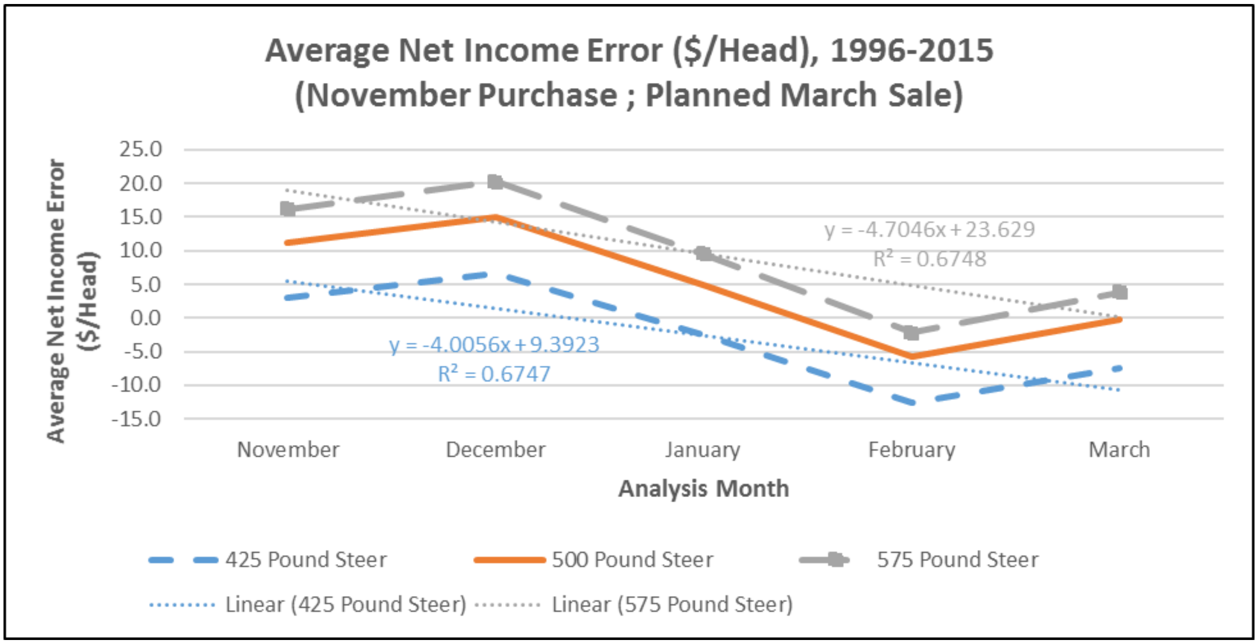


Table 4.16 Net Income Error Summary Statistics (November/March)

Net Income Errors by Analysis Month, 1996-2015 (November Purchase ; Planned March Sale)						
		Analysis Month				
Animal Type	Statistic	November	December	January	February	March
425 Pound Steer	Average	$3.00	$6.53	-$2.61	-$12.57	-$7.48
	Maximum	$94.19	$121.27	$98.00	$55.35	$28.13
	Minimum	-$97.89	-$97.09	-$79.94	-$113.38	-$60.36
500 Pound Steer	Average	$11.11	$14.92	$4.98	-$5.83	-$0.29
	Maximum	$181.55	$211.02	$129.20	$82.83	$25.15
	Minimum	-$110.50	-$95.48	-$76.82	-$81.52	-$45.41
575 Pound Steer	Average	$16.14	$20.26	$9.51	-$2.16	$3.83
	Maximum	$213.42	$245.30	$124.10	$73.80	$31.41
	Minimum	-$114.19	-$74.09	-$79.84	-$58.98	-$19.92

It can be seen in Figure (4.16) and Table (4.16) above that as the analysis month draws closer to the planned March sale date net income errors tend to converge towards zero. November, December, and January analysis months tend to display positive net income errors which are detrimental to producers. February tends to have negative net income errors which are beneficial to producers (expected net incomes lower than realized net incomes). Table (4.16) indicates that the range of net income errors narrows as the analysis month grows closer to the planned March sale date. The trend line associated with 425 pound November placements in figure (4.16) indicates that net income error decreases by $4.01/head each month on average. The trend line associated with 575 pound November placements indicates that net income error decreases by $4.70/head each month on average. The most accurate net income prediction was for a 500 pound placement in the March analysis month of 1999 (-$0.16/head). The least accurate net income prediction was for a 575 pound placement in the December analysis month of 2015 ($245.30/head). The most accurate analysis month in terms of net income error has historically been March, while the least accurate analysis month has been December. This again makes sense as producers should make more accurate predictions as they gain access to more information.

Table 4.17 Percentage of Years with Positive Net Income Errors (November/March)

Percentage of Years with Positive (Detrimental) Net Income Errors, 1996-2015 (November Purchase ; Planned March Sale)					
	Analysis Month				
Animal Type	November	December	January	February	March
425 Pound Steer	60%	55%	55%	45%	50%
500 Pound Steer	65%	55%	55%	45%	45%
575 Pound Steer	65%	60%	55%	50%	55%

Figure 4.17 Most Accurate Net Income Predictions (November/March)

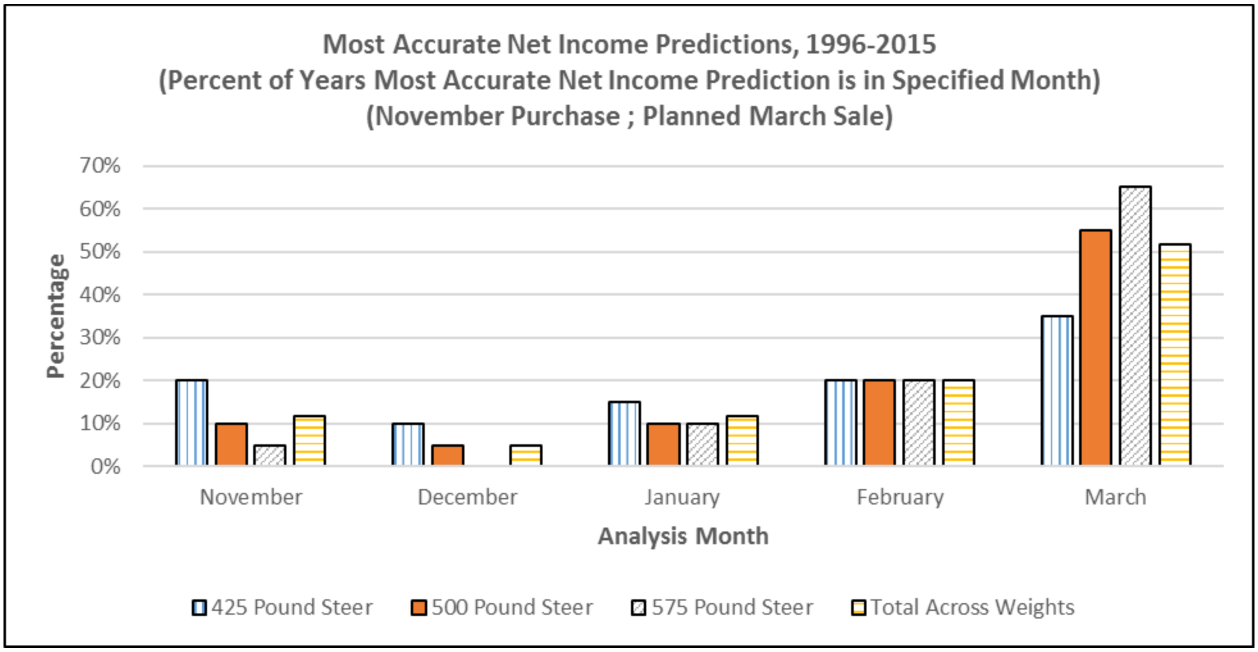


Table (4.17) above indicates that as the as the analysis month draws closer to the planned March sale date the historical likelihood of detrimental net incomes occurring grows smaller. However, the overall likelihood of detrimental net incomes occurring has been historically rather large. Figure (4.17) above indicates that the most accurate net income predictions between 1996 and 2015 have historically occurred in February and March while the least accurate net income predictions have occurred in December. This again aligns with logic.

Revenue Error:

Figure 4.18 Average Revenue Error (November/March)

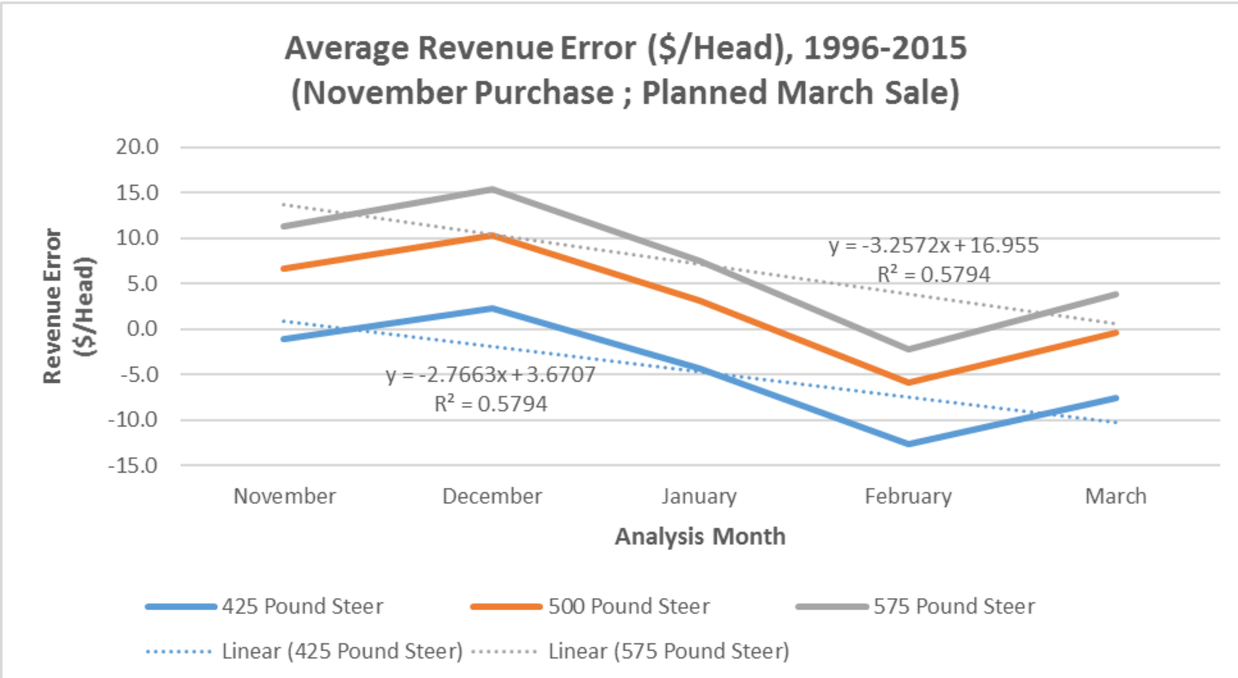


Table 4.18 Revenue Error Summary Statistics (November/March)

Revenue Errors by Analysis Month ($/Head), 1996-2015 (November Purchase ; Planned March Sale)						
		Analysis Month				
Animal Type	Statistic	November	December	January	February	March
425 Pound Steer	Average	-$1.09	$2.33	-$4.33	-$12.57	-$7.48
	Maximum	$92.64	$121.56	$93.63	$55.35	$28.13
	Minimum	-$102.36	-$99.96	-$82.41	-$113.38	-$60.36
500 Pound Steer	Average	$6.66	$10.38	$3.13	-$5.83	-$0.29
	Maximum	$179.84	$211.32	$124.51	$82.83	$25.15
	Minimum	-119.64	-98.58	-79.85	-81.52	-45.41
575 Pound Steer	Average	$11.35	$15.37	$7.53	-$2.16	$3.83
	Maximum	$211.56	$245.61	$125.92	$73.80	$31.41
	Minimum	-123.96	-77.42	-83.58	-58.98	-19.92

Table 4.19 Percentage of Years with Positive Revenue Errors (November/March)

Percentage of Years with Positive (Detrimental) Revenue Errors by Analysis Month, 1996-2015 (September Purchase ; Planned March Sale)					
	Analysis Month				
Animal Type	November	December	January	February	March
425 Pound Steer	55%	55%	55%	45%	50%
500 Pound Steer	65%	55%	55%	45%	45%
575 Pound Steer	65%	60%	50%	50%	55%

Figure (4.18) and Table (4.18) above generally indicate that revenue errors tend to decrease as the analysis month draws closer to the planned March sale date. However, there are slight increases in revenue errors for the December analysis month and revenue errors generally become negative for the February analysis month. The trend line associated with 425 pound November placements indicates that revenue error decreases by $2.77/head each month on average. The trend line associated with 575 pound November placements indicates that revenue error decreases by $3.26/head each month on average. Once again, revenue errors are on average larger for heavier placement weights on a per animal basis. The most accurate revenue prediction was for a 500 pound placement in February analysis month of 1996 ($0.20/head). The least accurate revenue prediction was for a 575 pound placement in December analysis month of 2015 ($245.61/head). In general, revenue errors are positive which is detrimental to producers. Table (4.18) indicates that the range of revenue errors generally grows smaller as the analysis month approaches the planned March sale date. Table (4.19) above shows that for a majority of placement weight/analysis month combinations between 1996 and 2015 positive (detrimental) revenue errors have occurred least 50% of the time.

Cost of Gain Error:

Figure 4.19 Average Cost of Gain Error (November/March)

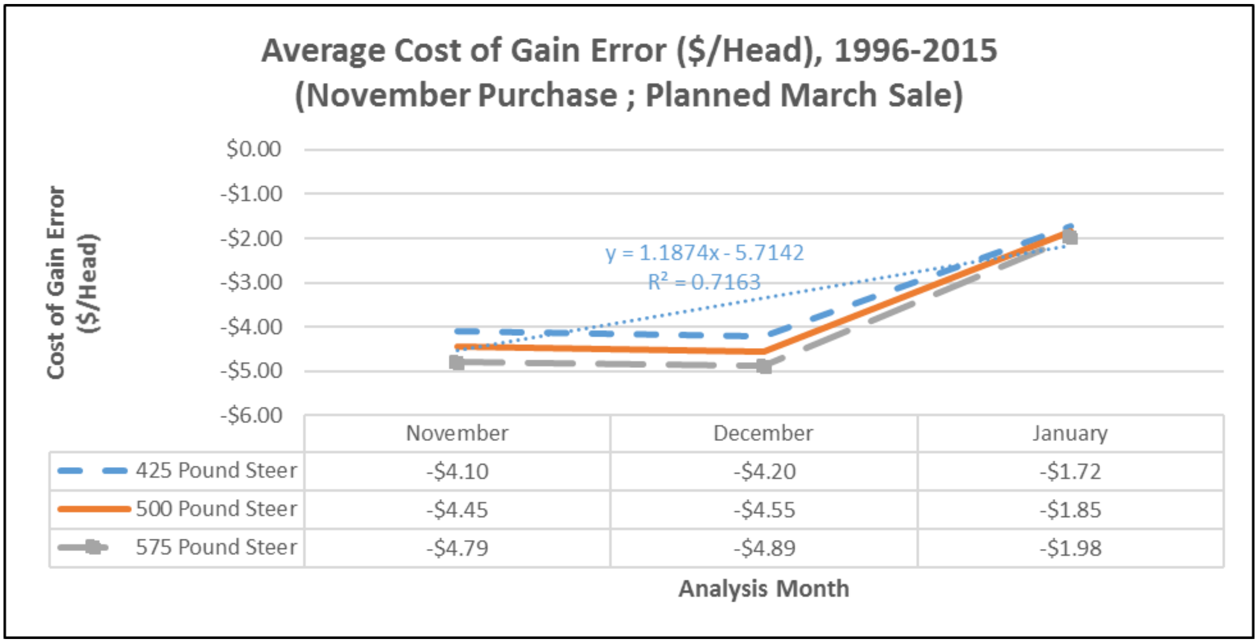


Table 4.20 Cost of Gain Error Summary Statistics (November/March)

Cost of Gain Errors by Analysis Month ($/Head), 1996-2015 (November Purchase ; Planned March Sale)				
		Analysis Month		
Animal Type	Statistic	November	December	January
425 Pound Steer	Average	-$4.10	-$4.20	-$1.72
	Maximum	$3.62	$0.42	$2.14
	Minimum	-$15.06	-$14.04	-$5.66
500 Pound Steer	Average	-$4.45	-$4.55	-$1.85
	Maximum	$3.98	$0.47	$2.30
	Minimum	-16.33	-15.16	-6.09
575 Pound Steer	Average	-$4.79	-$4.89	-$1.98
	Maximum	$4.33	$0.52	$2.47
	Minimum	-17.58	-16.28	-6.52

Figure (4.19) and Table (4.20) above indicate that as the analysis month draws closer to the planned March sale date cost of gain errors get closer to zero. However, there appears to be little improvement (actually worsens) in cost of gain prediction errors in December relative to

November. It can also be seen in table (4.20) that the range of cost of gain errors generally decreases as the analysis month draws closer to the planned March sale date. The trend line for 425 pound placements in figure (4.19) indicates that cost of gain errors increase (go closer to zero) by $1.19/head on average each month as the planned March sale date draws near. The reason for cost of gain errors being larger for larger placements is again due to larger placements consuming larger feed volumes than smaller placements. The most accurate cost of gain prediction was for a 500 pound placement in the November analysis month of 2012 ($0.02/head). The least accurate cost of gain prediction was for a 575 pound placement in the November analysis month of 2008 (-$17.58/head). In general, cost of gain errors are negative which is detrimental to producers.

4.3c April/July

Figure 4.20 Average Net Income Error (April/July)

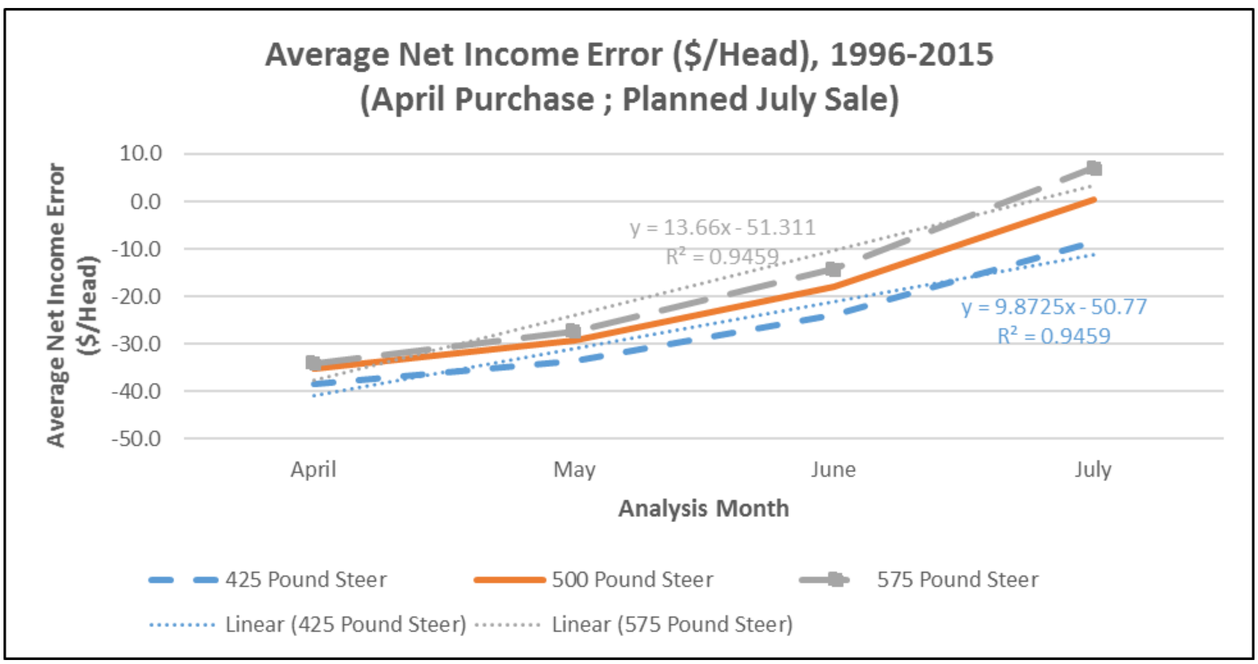


Table 4.21 Net Income Error Summary Statistics (April/May)

Net Income Errors by Analysis Month, 1996-2015 (April Purchase ; Planned July Sale)					
		Analysis Month			
Animal Type	Statistic	April	May	June	July
450 Pound Steer	Average	-$38.32	-$33.48	-$23.97	-$8.58
	Maximum	$67.23	$94.65	$104.42	$40.32
	Minimum	-$366.60	-$310.66	-$238.58	-$127.48
600 Pound Steer	Average	-$35.11	-$29.34	-$18.00	$0.34
	Maximum	$64.45	$79.88	$91.54	$49.36
	Minimum	-$274.45	-$207.78	-$121.87	-$82.31
750 Pound Steer	Average	-$34.09	-$27.39	-$14.23	$7.06
	Maximum	$99.13	$103.74	$101.05	$79.72
	Minimum	-$305.48	-$228.07	-$128.35	-$58.38

It can be seen in Figure (4.20) and Table (4.21) above that as the analysis month gets closer to the planned July sale date net income errors tend to converge towards zero. Net income errors have historically on average been negative which is beneficial to producers. It is better to realize larger net incomes than you expected to receive as opposed to realizing smaller net incomes than you expected to receive. Table (4.21) indicates that the range of net income errors narrows as the analysis month grows closer to the planned July sale date. The trend line associated with 450 pound April placements in figure (4.20) indicates that net income error increases (moves towards zero) by $9.87/head each month on average. The trend line associated with 750 pound April placements indicates that net income error increases (moves towards zero) by $13.66/head each month on average. The most accurate net income prediction was for a 450 pound placement in the June analysis month of 1999 (-$0.05/head). The least accurate net income prediction was for a 450 pound placement in the April analysis month of 2014 (-$366.60/head). The most accurate analysis month in terms of net income error has historically been July, while the least accurate analysis month has been April. Overall, the results indicate that we are slightly better at predicting net incomes for lighter placement weight steers on a per animal basis. Figure 4.20 and Table 4.21 both are representative solely of revenue error as the model assumes zero cost of gain errors for stocker scenarios.

Table 4.22 Percentage of Years with Positive Net Income Errors (April/July)

Percentage of Years with Positive (Detrimental) Net Income Errors, 1996-2015 (April Purchase ; Planned July Sale)				
	Analysis Month			
Animal Type	April	May	June	July
450 Pound Steer	35%	30%	25%	40%
600 Pound Steer	30%	30%	35%	60%
750 Pound Steer	35%	30%	25%	60%

Figure 4.21 Most Accurate Net Income Predictions (April/July)

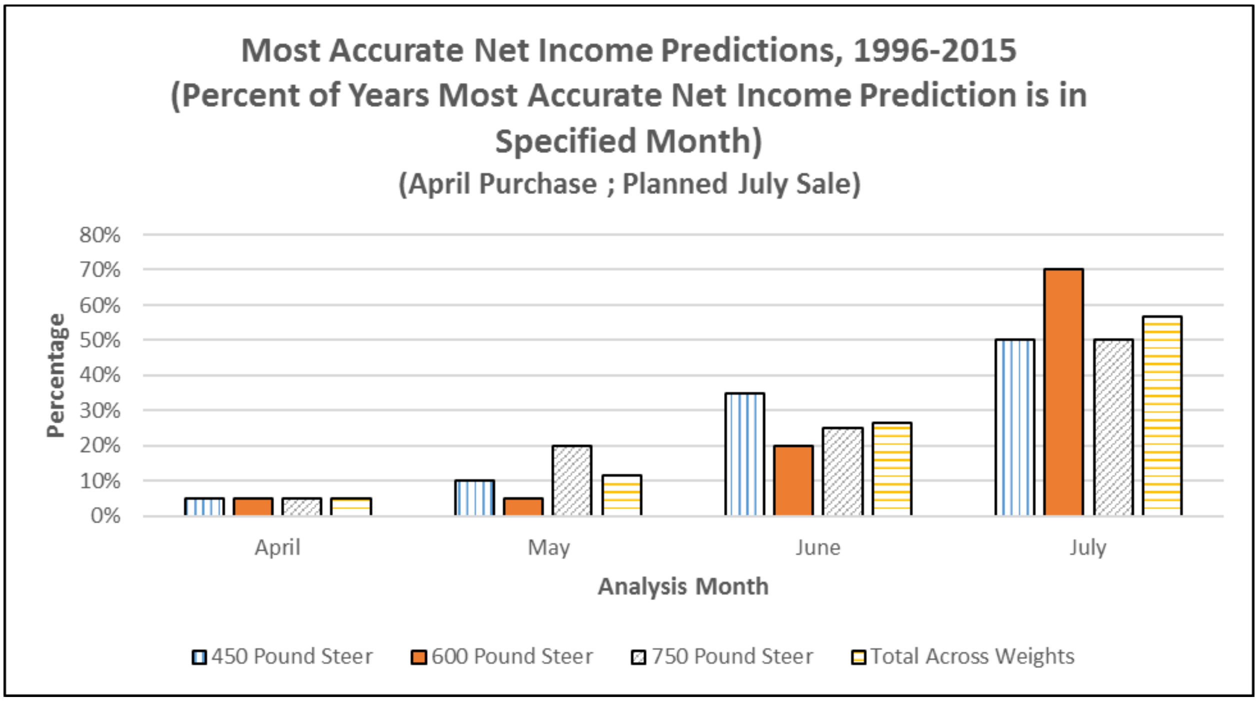


Table (4.22) above indicates that on average it has been relatively uncommon for net income errors to be detrimental to producers. Figure (4.21) indicates that the most accurate net income predictions between 1996 and 2015 have historically occurred in June and July while the least accurate net income predictions have occurred in April. For example, in 90% of the years between 1996 and 2015 the most accurate net income predictions for 600 pound placements occurred in either June or July whereas in only one year did the most accurate income prediction for 600 pound placements occur in April. As with the backgrounding scenarios acquisition of new information as the planned sale date draws near allows for more accurate predictions.

4.3d May/July

Figure 4.22 Average Net Income Error (May/July)

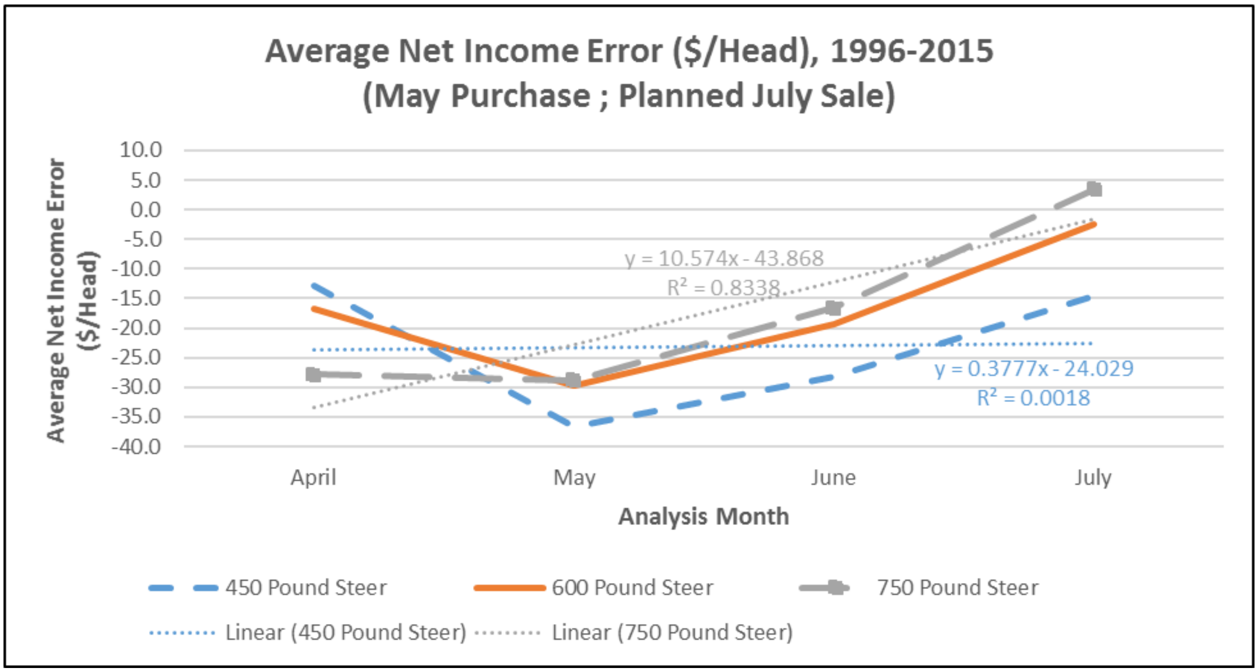


Table 4.23 Net Income Summary Statistics (May/July)

Net Income Errors by Analysis Month, 1996-2015 (May Purchase ; Planned July Sale)					
		Analysis Month			
Animal Type	Statistic	April	May	June	July
450 Pound Steer	Average	-$12.94	-$36.69	-$28.21	-$14.50
	Maximum	$246.81	$38.97	$40.27	$44.20
	Minimum	-$263.02	-$329.75	-$265.51	-$166.49
600 Pound Steer	Average	-$16.79	-$29.67	-$19.28	-$2.48
	Maximum	$102.66	$87.78	$98.45	$35.30
	Minimum	-$166.27	-$193.87	-$115.14	-$112.24
750 Pound Steer	Average	-$27.77	-$28.82	-$16.52	$3.38
	Maximum	$50.89	$104.45	$117.09	$40.40
	Minimum	-$261.31	-$208.55	-$115.33	-$49.95

It can be seen in Figure (4.22) and Table (4.23) above that as the analysis month gets closer to the planned July sale date net income errors tend to converge in the direction of zero. The results for April are included due to the fact that producers start paying for grass in April even if they delay placement until May. Additionally, in April they have expectations as to what it will cost to purchase steers in May along with expectations as to the revenue they will receive from selling steers in July. Net income errors have historically on average been negative which is beneficial to producers. It should be noted that net income errors in the analysis month of May generally increase relative to net income errors in April. Table (4.23) indicates that the range of net income errors on average narrows as the analysis month grows closer to the planned July sale date. The trend line associated with 450 pound May placements in figure (4.22) indicates that net income error increases (moves towards zero) by $.038/head each month on average. The trend line associated with 750 pound May placements indicates that net income error increases (moves towards zero) by $10.57/head each month on average. The most accurate net income prediction was for a 450 pound placement in the July analysis month of 1998 (-$0.10/head). The least accurate net income prediction was for a 450 pound placement in the May analysis month of

2014 (-$329.75/head). The most accurate analysis month in terms of net income error has historically been July, while the least accurate analysis month has been May which again is due to greater access to information in July than in May.

Figure 4.23 Most Accurate Net Income Predictions (May/July)

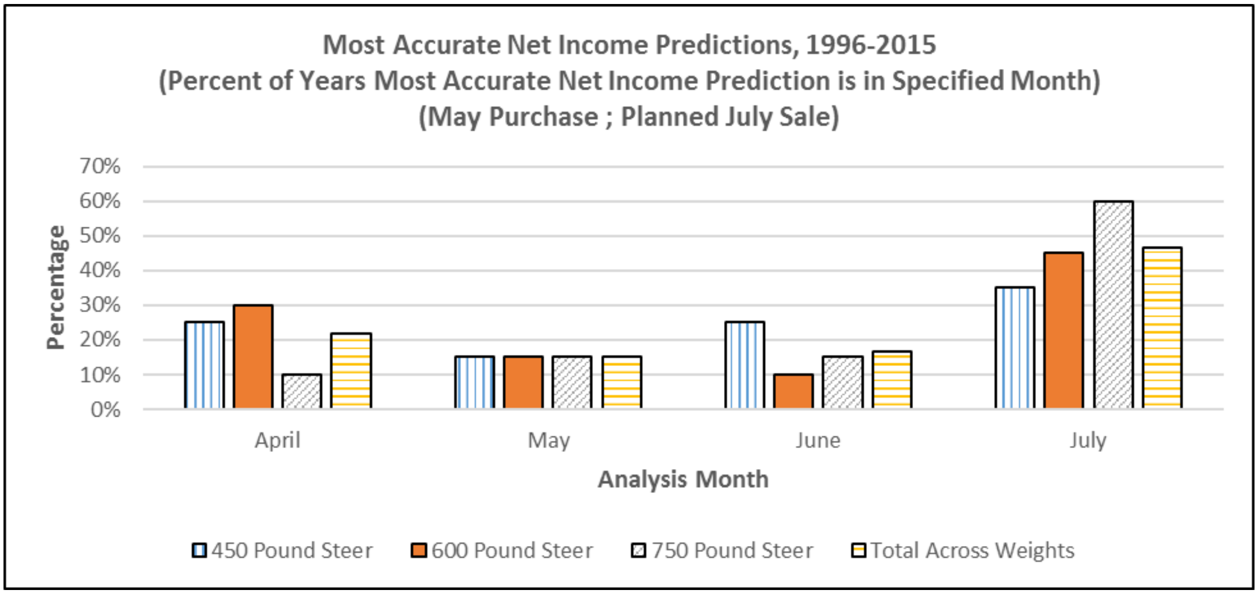


Figure (4.23) above shows the percentage of years between 1996 and 2015 that each analysis month has had the most accurate net income prediction. Overall, July analysis has resulted in the most accurate net income predictions. However, the distribution of accurate net income predictions is wider than that from the April placement/planned July sale scenario.

4.3e Summary of Net Income Comparisons Across Scenarios

Within the backgrounder segment of the beef industry it appears that as the analysis month grows closer to the planned sale month net income errors tend to diminish and move closer to zero. This makes sense because as more information is available across time our expectations should become more accurate. For both backgrounding scenarios net income errors tended to be positive which is detrimental to producers. On average net income errors are larger for September placements as opposed to November placements and also net income errors were typically larger for steers that weighed more at placement. Net income errors for November placed steers also converge towards zero at a faster rate per month than September placements.

Within the stocker segment of the beef industry it also appears that as the analysis month grows closer to the planned sale month net income errors tend to diminish and move closer to zero. For both stocking scenarios net income errors tended to be negative which is beneficial to producers. Net income errors were relatively similar for April and May placements. On average, net income predictions for heavier weight steers were slightly more accurate than net income predictions for lighter weight steers.

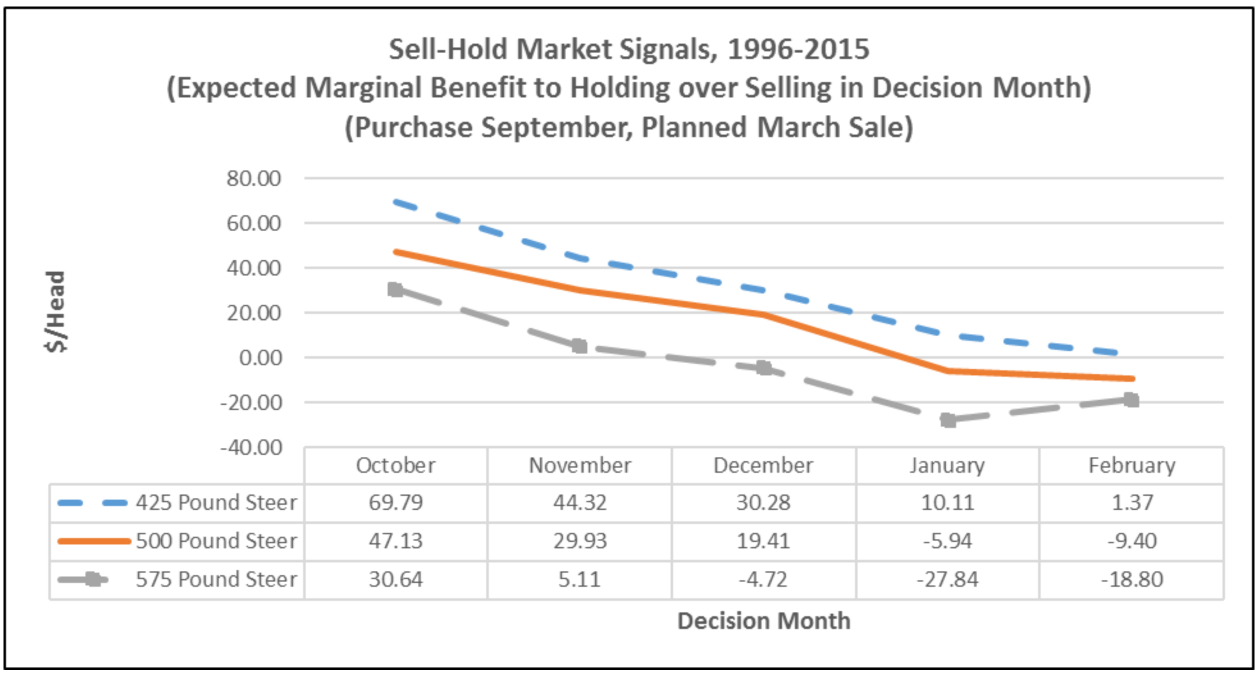
In comparing backgrounding and stocking segments of the beef industry net income errors have historically been positive (detrimental) for backgrounding scenarios, whereas net income errors have historically been negative (beneficial) for stocking scenarios. This is likely primarily driven by historical seasonal price movements.

4.4 Market Signals/Incentives

Within this section the highlights of the market signals/incentives for the four scenarios will be discussed in subsequent order. This analysis represents real time production decisions that producers faced between 1996 and 2015 in regards to selling steers early or retaining them through their planned sale date. Results within this section will not necessarily be the same as results within the ex-post net income section. Following the display of the results for each scenario broad comparisons will be made across the four scenarios.

4.4a September/March

Figure 4.24 Sell-Hold Market Signals (September/March)



	October	November	December	January	February
425 Pound Steer	69.79	44.32	30.28	10.11	1.37
500 Pound Steer	47.13	29.93	19.41	-5.94	-9.40
575 Pound Steer	30.64	5.11	-4.72	-27.84	-18.80

Table 4.24 Market Incentives to Retain Cattle (September/March)

Market Incentives to Retain Cattle by Decision Month, 1996-2015 (September Purchase ; Planned March Sale)						
		Decision Month				
Animal Type	Statistic	October	November	December	January	February
425 Pound Steer	Average	$69.79	$44.32	$30.28	$10.11	$1.37
	Maximum	$179.69	$126.78	$81.88	$68.89	$33.07
	Minimum	-$1.32	-$51.71	-$29.56	-$81.04	-$51.35
500 Pound Steer	Average	$47.13	$29.93	$19.41	-$5.94	-$9.40
	Maximum	$158.71	$93.40	$97.97	$37.05	$24.98
	Minimum	-$20.27	-$60.25	-$40.55	-$69.51	-$40.98
575 Pound Steer	Average	$30.64	$5.11	-$4.72	-$27.84	-$18.80
	Maximum	$273.05	$61.12	$96.45	$49.78	$21.55
	Minimum	-$48.32	-$59.37	-$78.39	-$101.87	-$65.58

Table 4.25 Percentage of Years Market Signals Cattle Retention (September/March)

Percentage of Years Market Gives Incentive to Retain Calves by Decision Month, 1996-2015 (September Purchase ; Planned March Sale)					
	Decision Month				
Animal Type	October	November	December	January	February
425 Pound Steer	95%	95%	85%	70%	50%
500 Pound Steer	80%	70%	70%	45%	40%
575 Pound Steer	60%	55%	35%	20%	30%

Figure (4.24) and Table (4.24) describe the average historical market incentive (expected return from holding steers versus attainable return from selling steers at the time the decision is made) to retain September placed steers in each potential early sale month (October, November, December, January, and February). For example, for 500 pound placements the market will historically offer you $19.41 to hold steers through the planned March sale date instead of selling them in December. Table (4.24) gives the range of market incentives for each placement weight/early sale month combination. For each combination between 1996 and 2015 the market has given both sell and hold signals in at least one year for all placement weight/early sale month combinations. On average the market has signaled the retention of 450 pound placements through the planned March sale date, the sale of 500 pound placement in January, and the sale of 575 pound placements in December. Overall, the market suggest carrying lighter weight steers for a longer period of time than heavy weight steers. Table (4.25) shows the percentage of years between 1996 and 2015 that the market gave producers incentive to retain steers through the planned March sale date. This table does not account for instances were cattle were sold early. It can be seen that generally as the decision month gets closer to the planned sale date the incentive to hold steers has historically decreased. This table again suggests that the market more often signals to hold lightweight placements longer than heavyweight placements. For example, 70% of the time the market has historically suggested retaining 425 pound placements in January, whereas only 20% of the time did the market suggest retaining 575 pound placements in January.

Figure 4.25 Market Incentives for Early Sale: $0 Threshold (September/March)

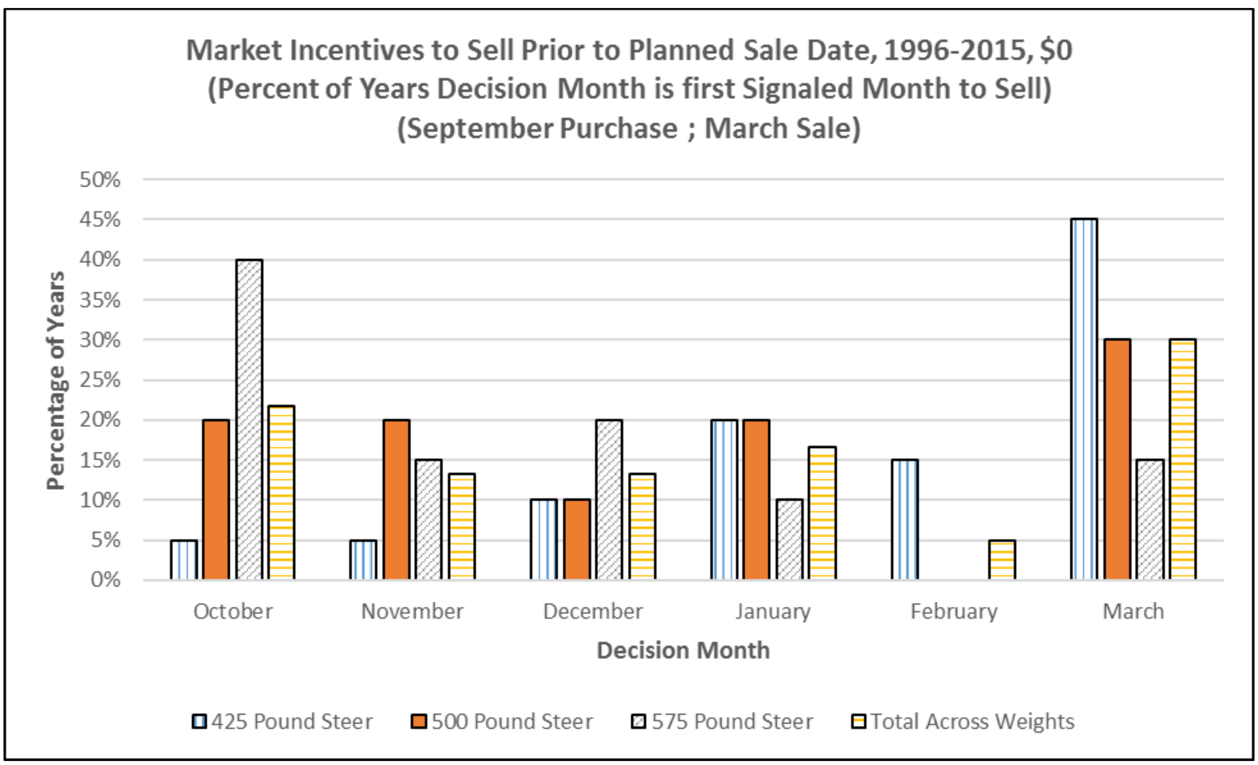
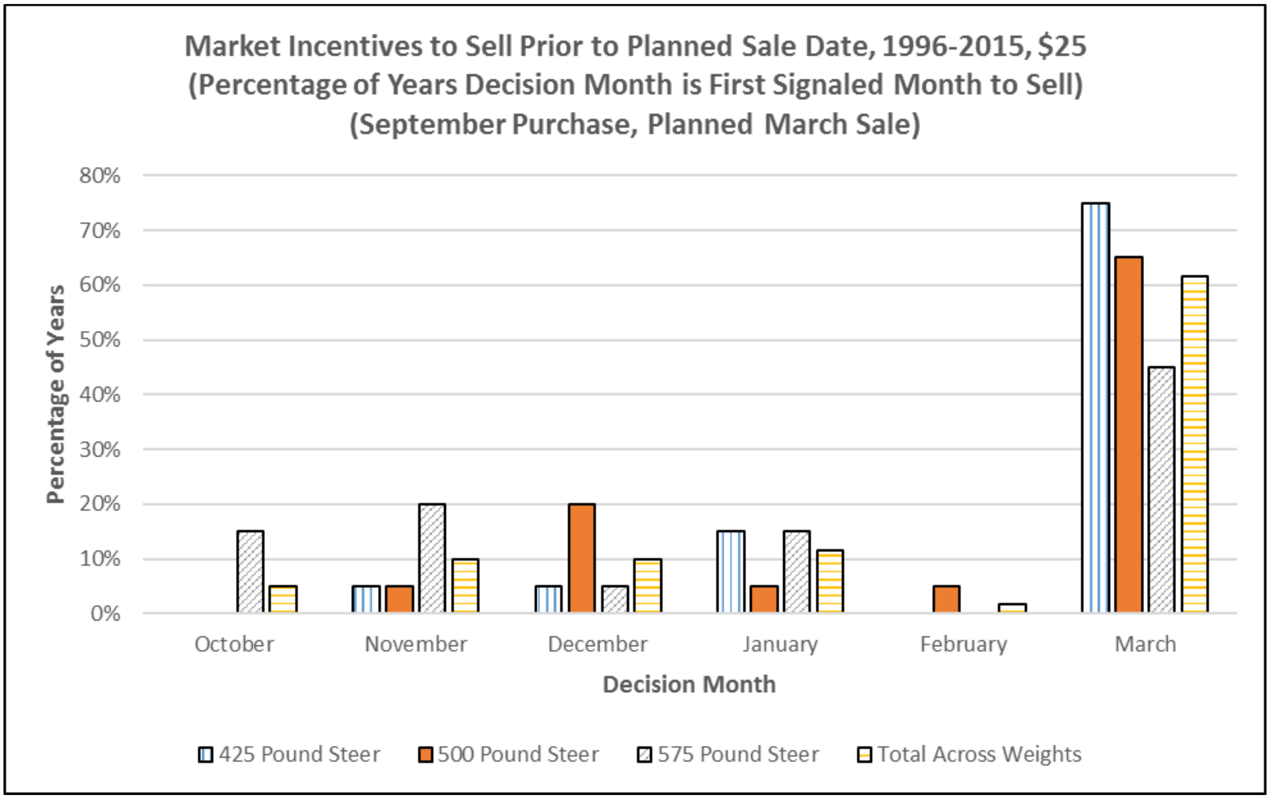


Figure 4.26 Market Incentives for Early Sale: $25 Threshold (September/March)



Figures (4.25) and (4.26) show the percentage of years that each potential sale month was the first signaled sell month between 1996 and 2015. In figure (4.25) the retain/sell threshold is set at zero dollars of net income, so if the expected net income from holding steers through the planned March sale month is at all smaller than the income attainable from selling steers in the decision month then the market suggest selling steers. It can be seen that 45% of the time for 425 pound placements March is the first suggested sale month, whereas only 15% of the time March is the first suggested sale month for 575 pound placements. Overall, the first suggested sale month has typically occurred earlier for heavyweight placements as opposed to lightweight placements. In figure (4.26) the retain/sell threshold is set at $25 of net income, so if the expected net income from holding steers through the planned March sale month is at least $25 smaller than the income attainable from selling steers in the decision month then the market suggest selling steers. Producers place some value in sticking to a set plan so their retain/sell threshold will typically be set above $0 of net income. It can clearly be seen that when the retain/sell threshold is increased the first suggested sell month is typically pushed back to a later month. For example, for 425 pound placements when the threshold is set at $0 March is the first suggest sell month 45% of the time, but when the threshold is set at $25 March is the first suggested sell month 75% of the time.

4.3b November/March Market Signals

Figure 4.27 Sell-Hold Market Signals (November/March)

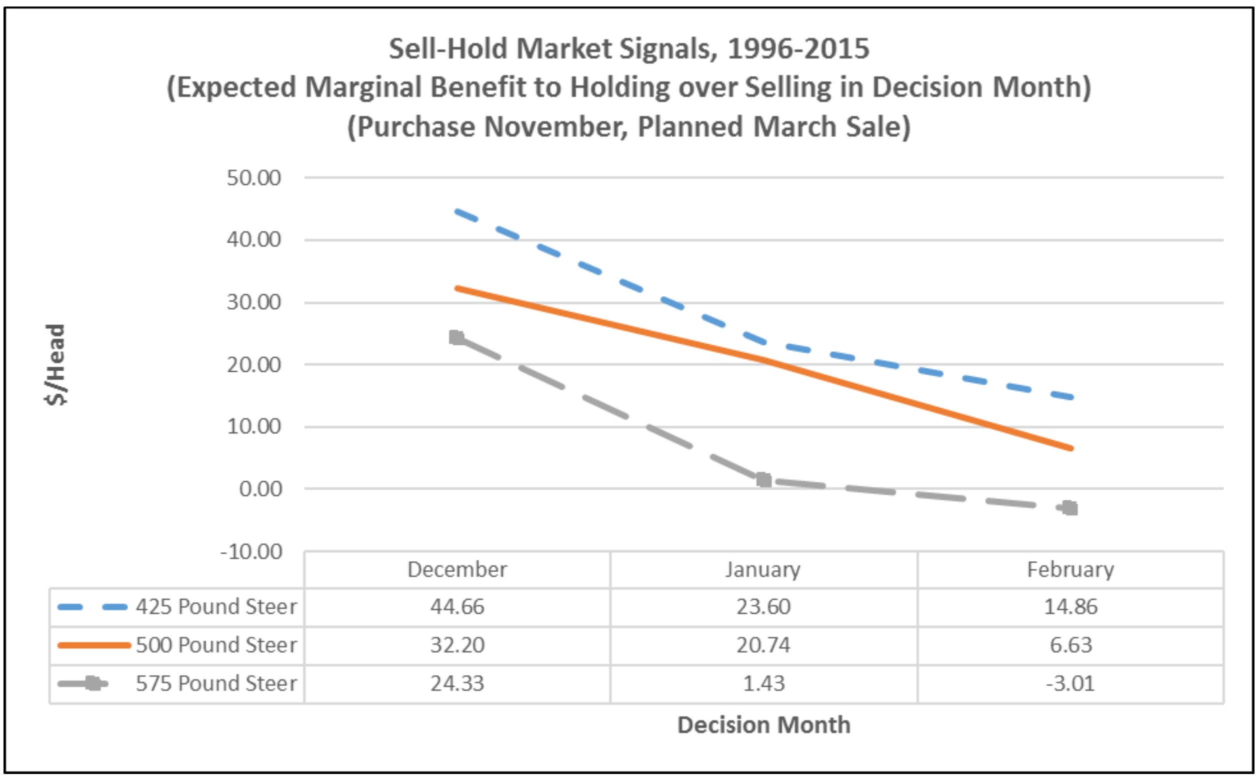


Table 4.26 Market Incentives to Retain Cattle (November/March)

Market Incentives to Retain Cattle by Decision Month, 1996-2015 (November Purchase ; Planned March Sale)				
		Decision Month		
Animal Type	Statistic	December	January	February
425 Pound Steer	Average	$44.66	$23.60	$14.86
	Maximum	$103.27	$67.59	$66.24
	Minimum	-$18.13	-$117.28	-$22.84
500 Pound Steer	Average	$32.20	$20.74	$6.63
	Maximum	$96.01	$58.15	$37.57
	Minimum	-$28.91	-$68.79	-$24.24
575 Pound Steer	Average	$24.33	$1.43	-$3.01
	Maximum	$62.89	$58.83	$24.92
	Minimum	-$25.16	-$87.82	-$48.45

Table 4.27 Percentage of Years Market Signals Cattle Retention (November/March)

Percentage of Years Market Gives Incentive to Retain Calves by Decision Month, 1996-2015 (November Purchase ; Planned March Sale)			
	Decision Month		
Animal Type	December	January	February
425 Pound Steer	95%	90%	70%
500 Pound Steer	90%	85%	60%
575 Pound Steer	70%	60%	50%

Figure (4.27) and Table (4.26) describe the average historical market incentive (expected return from holding steers vs attainable return from selling steers at the time the decision is made) to retain November placed steers in each potential early sale month (December, January, and February). For example, for 500 pound placements the market will historically give you $32.20 to hold steers through the planned March sale date instead of selling them in December. Table (4.26) gives the range of market incentives for each placement weight/early sale month combination. It should be noted that for each combination between 1996 and 2015 the market has given both sell and hold signals in at least one year. On average the market has signaled to hold 450 and 500 pound placements through the planned March sale date and carry 575 pound placements until February. Overall, the market suggest carrying lighter weight steers (425 and 500 pound placements) for a longer period of time than heavy weight steers. Table (4.27) shows the percentage of years between 1996 and 2015 that the market gave producers incentive to retain steers through the planned March sale date. This table does not account for instances were cattle were sold early. It can be seen that generally as the decision month gets closer to the planned March sale date the incentive to hold steers has historically decreased. This table again suggests that the market more often signals to hold lightweight placements longer than heavyweight placements. For example, 90% of the time the market has historically suggested retaining 425 pound placements in January, whereas only 60% of the time did the market suggest retaining 575 pound placements in January.

Figure 4.28 Market Incentives to Sell Cattle Early: $0 Threshold (November/March)

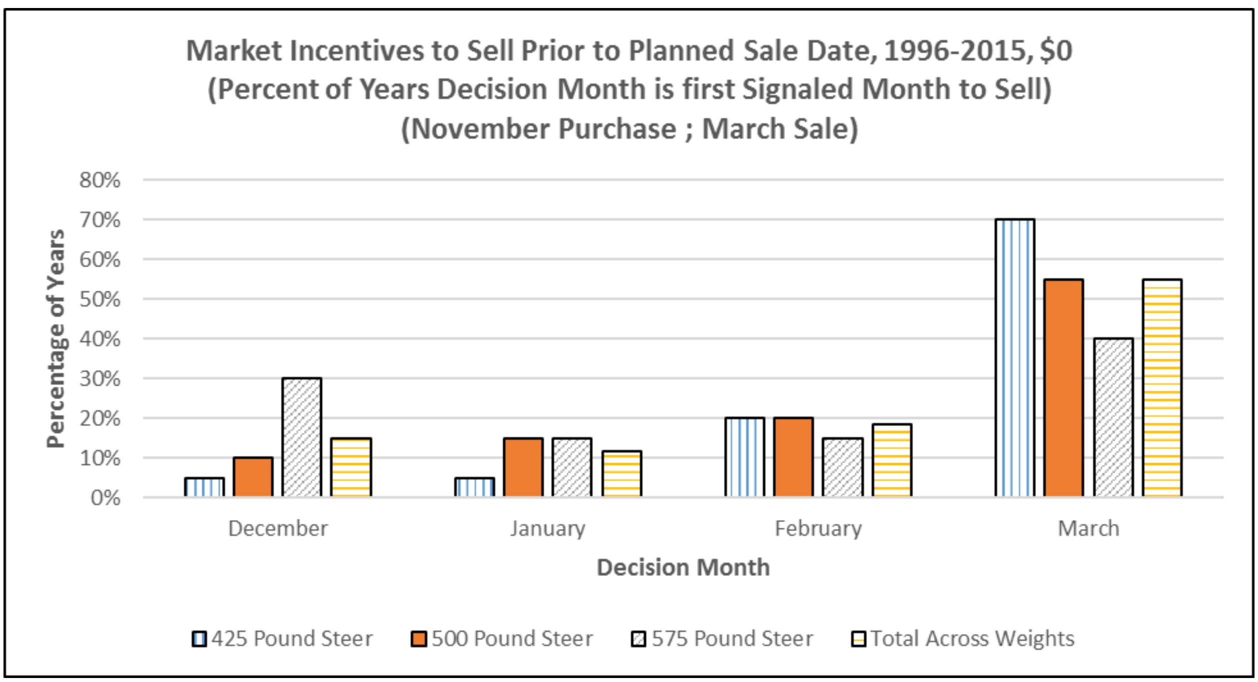
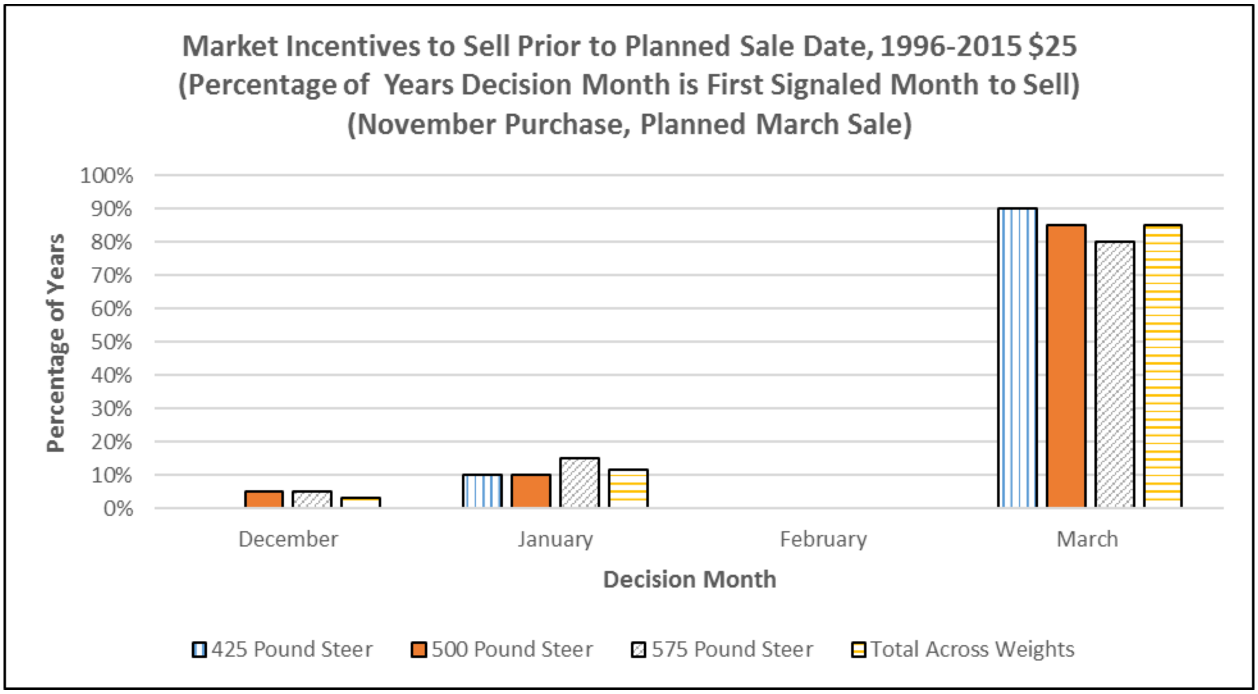


Figure 4.29 Market Incentive to Sell Cattle Early: $20 Threshold (November/March)



Figures (4.28) and (4.29) show the percentage of years that each potential sale month has been the first signaled sell month between 1996 and 2015. In figure (4.28) the retain/hold threshold is again set at zero dollars of net income. It can be seen that 70% of the time for 425 pound placements March is the first signaled sale month, whereas only 40% of the time March is the first suggested sale month for 575 pound placements. Overall, the first suggested sale month has typically occurred earlier for heavyweight placements as opposed to lightweight placements. In figure (4.29) the retain/hold threshold is again set at $25 of net income. It can clearly be seen that when the retail/sell threshold is increased the first suggested sell month is typically pushed back to a later month. For November placements with a $25 threshold March has been the first suggested selling date a vast majority of the time for all three placement weights.

4.4c April/July

Figure 4.30 Sell-Hold Market Signals (April/July)

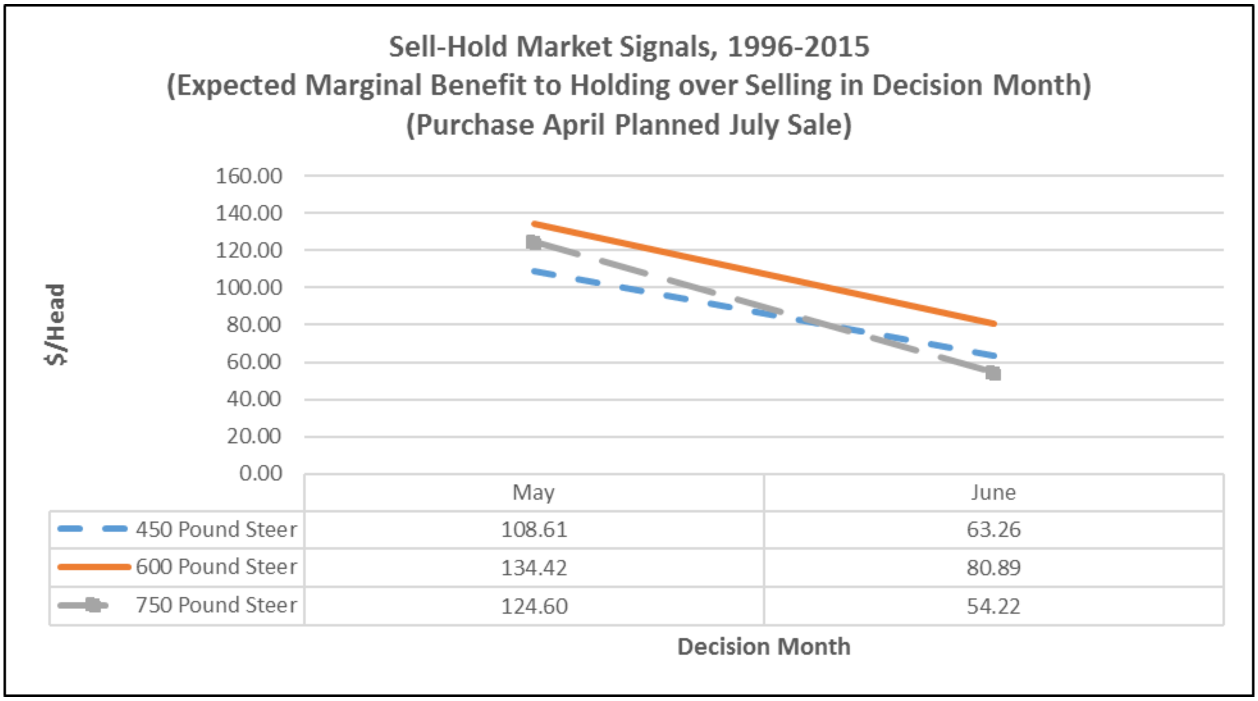


Table 4.28 Market Incentives to Retain Cattle (April/July)

Market Incentives to Retain Cattle by Decision Month, 1996-2015 (September Purchase ; Planned March Sale)			
		Decision Month	
Animal Type	Statistic	May	June
450 Pound Steer	Average	$108.61	$63.26
	Maximum	$433.34	$166.77
	Minimum	$14.31	-$35.21
600 Pound Steer	Average	$134.42	$80.89
	Maximum	$401.83	$212.85
	Minimum	$40.12	-$17.69
750 Pound Steer	Average	$124.60	$54.22
	Maximum	$430.04	$223.82
	Minimum	$5.30	-$101.32

Table 4.29 Percent of Years Market Signals Cattle Retention

Percentage of Years Market Gives Incentive to Retain Calves by Decision Month, 1996-2015 (September Purchase ; Planned March Sale)		
	Decision Month	
Animal Type	May	June
450 Pound Steer	100%	90%
600 Pound Steer	100%	95%
750 Pound Steer	100%	85%

Figure (4.30) and Table (4.28) describe the average historical market incentive to retain April placed steers in each potential early sale month (May and June). For example, for 600 pound placements the market will typically give you $134.42 to hold steers through the planned July sale date instead of selling them in May. Table (4.28) gives the range of market incentives for each placement weight/early sale month combination. It should be noted that for each May combination between 1996 and 2015 the market has not signaled to sell calves (minimum market incentives is positive). On average the market has signaled to hold all placements through the planned July sale date. Table (4.29) shows the percentage of years between 1996 and 2015 that the market gave producers incentive to retain steers through the planned July sale date. This table does not account for instances were cattle were sold early. It can be seen that in all years between 1996 and 2015 the market suggested to hold steers past May. In both potential early sales month the market has historically suggested retaining steers. Like in the ex-post net income section this is likely a result of the fixed cost of grass that is incurred on April 1st.

Figure 4.31 Market Incentives to Sell Early: $0 Threshold (April/July)

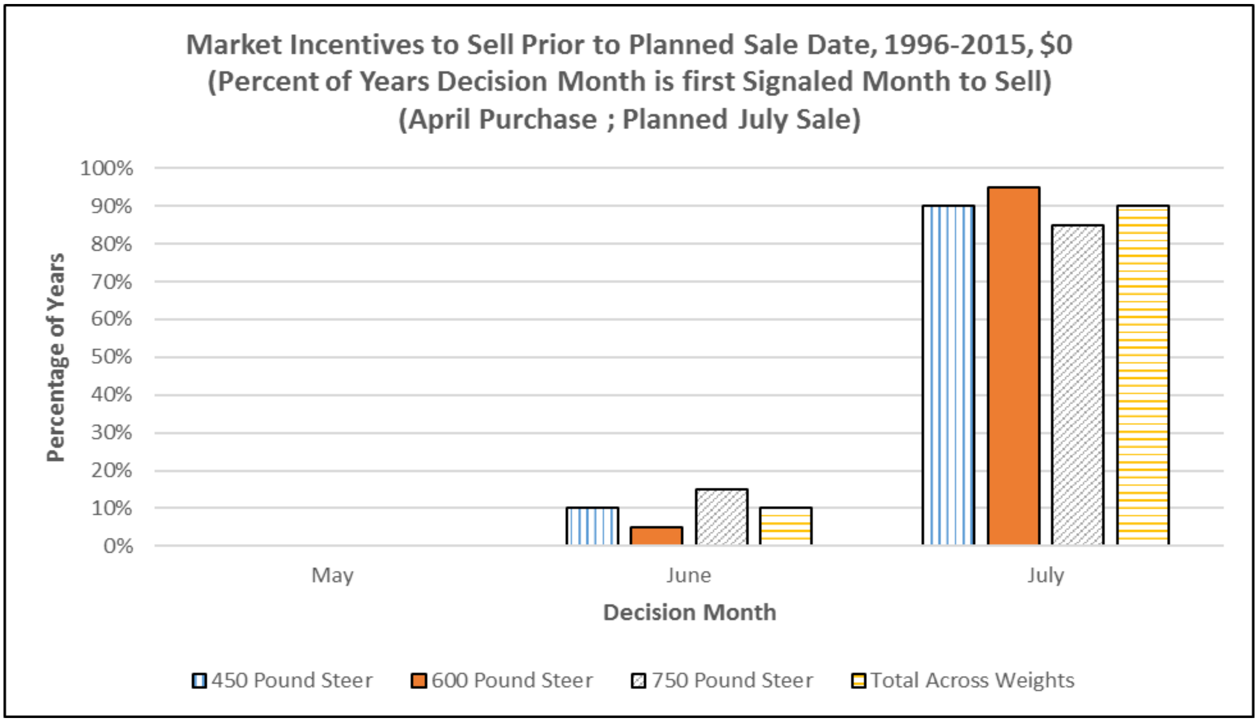
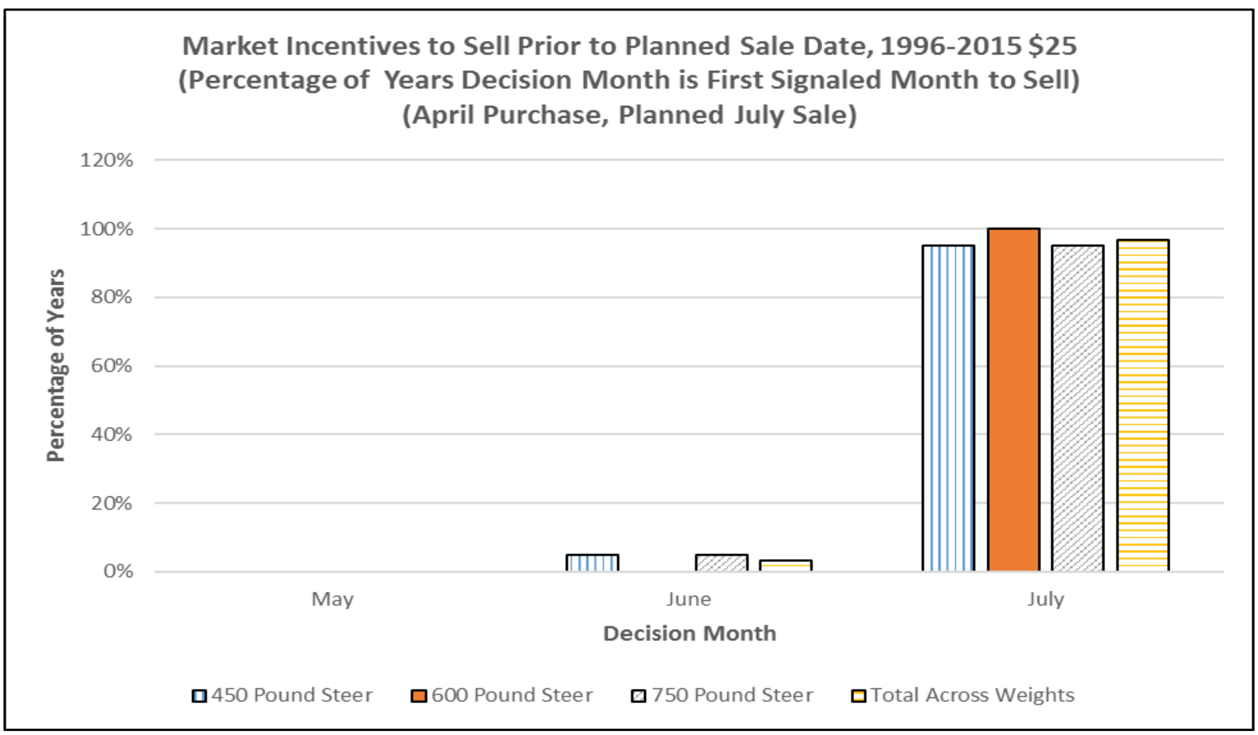


Figure 4.32 Market Incentives to Sell Early: $20 Threshold (April/May)



Figures (4.31) and (4.32) show the percentage of years that each potential sale month has been the first signaled sell month between 1996 and 2015. In figure (4.31) the retain/hold threshold is again set at zero dollars of net income. It can be seen that for all placements July has historically been the first signaled sale month and that May was never signaled as the first sell month. In figure (4.32) the retain/hold threshold is again set at $25 of net income. When the threshold is increased we see slightly more years where the first signaled sale date was July. For April placements with both a $0 and $25 threshold July has been the first suggested selling month a vast majority of the time for all three placement weights.

4.4d (May/July)

The same story that was told in the April/July section above applies to the May placement scenario. Market signals are again driven by the fixed cost of grass. Historically, the market has signaled to hold steers through the planned July sale date instead of selling steers early in June.

4.4e Summary of Market Signals/Incentives across Scenarios

Within the backgrounder segment of the beef industry it appears that like with the ex-post net income analysis the weight of steers at time of sale plays a large factor in market signals/incentives. The model generally shows that once steers get above the 750-800 pound recognized feeder steer weight the market begins to signal that steers should be sold as opposed to retained. In general, for September placements if the retain/sell threshold is set at $0 of net income the market has historically signaled that 425 pound placements be carried through the planned March sale date, 500 pound placements be sold in January, and 575 pound placements be sold in December. Likewise, for November placements if the threshold is again set at $0 of net income the market has historically signaled that both 425 and 500 pound placements be carried through the planned March sale date, while 575 pound placements be sold in February

In the stocker segment of the beef industry it appears that like with the ex-post net income analysis the fixed cost of pasture leases plays a large factor in market signals/incentives. The model generally signals that steers should be carried the entirety of the length of the lease (April through July) to spread out grass costs due to the fact that the cost of the lease must be paid in full regardless of how long steers are on grass. In both stocking scenarios (April and May placement) and for all placement weights the first signaled sale month is generally July.

In comparing backgrounding and stocking segments of the beef industry the market has generally signaled retention of steers up until the planned sale date in the stocker segment, while in the backgrounding segment the first signaled sale month is dependent on placement date and placement weight. Within the stocking scenarios fixed cost dominate market signals/incentives, whereas animal sale weight drives market signals/incentives in the backgrounding scenarios.

One caveat that applies to our analysis of market signals/incentives is that we defined only two specified thresholds for our sell-retain thresholds. We chose these thresholds to demonstrate that minimal changes in threshold levels can have significant effects on a livestock owner's marketing decisions. This section could be enhanced in future research with a more detailed risk analysis of producers and how risk plays into their decision making process. This analysis could be incorporated into the model to have a more fluid set of decision making criterion.

4.5 Summary/Synthesis of Scenarios

Table 4.30 Scenario Comparison

425/450lb Scenario Comparison, 1996-2015				
	Scenarios			
Criterion	Sept-March	Nov-March	April-July	May-July
Average Ex-Post Net Income ($)	23.26	38.06	78.87	49.32
Ex-Post Net Income Range ($)	(-125.96,272.41)	(-148.84,212.12)	(-48.27,397.33)	(-57.64,380.04)
Coefficient of Variation	4.304	2.024	1.161	1.893
Average Net Income Prediction Error ($)	10.77	3	-38.32	-12.94
% of Years the Market Signals Early Sale	55	30	10	10

Table (4.30) compares details across the four scenarios covered in this analysis. The two backgrounding scenarios are looking at 425 pound placements while the two stocking scenarios are looking at 450 pound placements. These are the closest weight classes available for us to compare across scenarios. When comparing across all four scenarios there is not one specific strategy that is optimal in all criterion areas in table (4.30), but there are some that appear to be generally better than others.

For instance, when looking at the two backgrounding scenarios it would appear that November placements are typically superior to September placements. November placements have larger average net incomes, a narrower net income range, a smaller COV, and lower net income prediction errors. However, September has had at least one year with larger net incomes than November placements. When looking at the two stocking scenarios it would appear that April placements are typically superior to delayed placements in May. April placements have larger average net incomes and a smaller COV. However, May has a smaller average net income prediction error and a narrower range of net incomes. When comparing backgrounding scenarios with stocking scenarios it would appear that stocking scenarios are superior to backgrounding scenarios as stocking scenarios have larger average net incomes, smaller COV's, and net income errors that are more beneficial to producers. However, stocking scenarios have a wider range of net incomes.

So overall there is no scenario that is superior in all of the criterion listed in table (4.30), but typically between 1996 and 2015 you were better off placing steers in November over placing them in September in the backgrounding scenarios, better off placing steers in April over May in the stocking scenarios, and if you were limited to doing only backgrounding or stocking you were better off operating as a stocker operator.

Chapter 5 - Conclusions, Implications, and Further Research

Due to the fact that the backgrounder/stocker industries are not heavily researched and much of the existing literature is outdated, this research is beneficial to the industry. This researched focused on historical profitability, prediction error (net income, revenue, and cost of gain), and market signals/incentives within the industry. A complete schedule of historical returns within the industry is not currently available due to a majority of cattle research focusing on the cow-calf and feedlot segments of the industry. This research goes a long way in filling that gap. Understanding when, by how much, and in which direction producers are inaccurately predicting net incomes, revenues, and cost of gain can aid in improving producers marketing efforts. Lastly, analyzing the decisions that backgrounder and stocker operators have faced over the past 20 years aids in understanding the market structure within the industry.

5.1 Conclusions/Implications

Within the model historical profitability, prediction accuracy, and market signals/incentives were analyzed for the backgrounding and stocking industries within the Flint Hills region of Kansas. Four separate production scenarios were analyzed in this research, two for the backgrounding segment of the industry and two for the stocking segment of the industry. The two backgrounding scenarios included September placement with a planned March sale and November placement with a planned March sale. The two stocking scenarios included April placement with a planned July sale and May placement with a planned July sale.

When looking at historical profitability it appears that within the backgrounding segment of the beef industry steer weight at the time of sale is a large driver of profitability. If steers weigh above the 750-800 pound weight that generally defines a feeder steer they are typically being penalized on the back side by feedlots for being too heavy. Within the stocker segment of the industry it appears that grass rents are a large driver of profitability. The fixed costs associated with pasture leases tend to lead to cattle staying on pasture through the planned July sale date in order to spread out fixed costs over a longer period of time. In general, for September placements it has historically been economical to sell steers in January as opposed to March and also to place lighter weight cattle. For November placements it has historically been economical to carry steers though the planned March sale date and again carry lighter cattle. However, heavy weight steer placements have been most economical when sold in January. In general, for both April and May placements it has been most economical to carry steers to the planned July sale date to spread out the fixed costs of grass and to carry lighter cattle.

When looking at prediction error, revenue prediction errors make up a larger piece of net income prediction error than does cost of gain error. Producers are typically overestimating net incomes within the two backgrounding scenarios and underestimating net incomes within the two stocking scenarios. Overestimating net incomes tends to hurt producers as they expect to have larger cash flows than they end up having in reality. Underestimating net incomes tends to help producers as they tend to do a better job of budgeting and minimizing their costs. However, if a producer is being aggressive and wanting to expand their operation underestimating future cash flows may limit their growth potential and planning.

When looking at market signals/incentives it again appears that like with the ex-post net income analysis steer weight at the time of sale plays a large factor in market signals/incentives. In general, for September placements if the retain/sell threshold is set at $0 of net income the market has historically signaled that 425 placements be carried through the planned March sale date, 500 pound placements be sold in January, and 575 pound placements be sold in December. Likewise, for November placements if the threshold is again set at $0 of net income the market has historically signaled that both 425 and 500 pound placements be carried through the planned March sale date, while 575 pound placements be sold in February. It again appears that grass rents play a large factor in market signals/incentives for stocker cattle. The market generally signals to hold both April and May placements through the planned July sale date.

While no scenario was superior to the other three in all twenty of the years analyzed between 1996 and 2015, we did find that certain scenarios were typically superior to other scenarios. In terms of the two backgrounding scenarios we found that on average it is more profitable to place steers in November. In terms of the two stocking scenarios we found that on average it was more profitable to place steers in April than to delay placement until May. When comparing the two segments of the industry we found stocking to be more profitable on average than backgrounding. We also found that in regards to placement weights it was generally more profitable to place lighter weight cattle than it is to place heavier weight cattle.

5.2 Further Research

Potential expansions of this research project include; adding bulls and heifers to our model, expanding the placement weights to include other weight classes of cattle, and adding production risk to the model. Analyzing whether or not lower prices make up for the decreased performance of bulls would be interesting to study. Additionally, the interaction of an expanding or contracting beef herd with the heifer market would also be interesting to study. Adding larger placements to the model will probably be beneficial down the road as cattle genetics continue to improve. Lastly, adding production risk to our model would be very intriguing and would add significant value to our project. In our model we took animal performance as given, when in reality it is quite variable and is a very large factor in producer profitability. For example, the largest return for September placements occurred in 2014 and was the result of placing a 425 pound steer. If this steer were to have had a 20% lower ADG the net income from that steer would have decreased from $272.41/head to $218.63/head, a $53.78 decline in net return/head. Alternatively, the smallest return for September placements occurred in 2008 and was the result of placing a 575 pound steer. If this steer were to have had achieved a 20% higher ADG the net income from that steer would have increased from -$188.46/head to $-131.35/head, an improvement of $57.11/head. For a larger producer that is running 1,000 head of cattle, this change in average daily gain would result in over a $50,000 alteration to their bottom line, either a significant increase or decrease. Needless to say, differences in animal performance can significantly affect a producer’s profitability. Overall our current model is a rather risk free/neutral model so adding different risk elements throughout various portions of the model would enhance its alignment with management perceptions of risk and its ability to benefit producers.

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