

“DO CATTLE BREEDS AFFECT CARCASS VALUE?”

by

JULIAN MARIE WORLEY

(Under the Direction of Jeffrey H. Dorfman)

ABSTRACT

The impact of breed on carcass characteristics in various breeds of cattle has been well documented. This thesis attaches these differences in breed characteristics to end revenue via different breed and breed combinations, percentage of Angus pedigree, and purebred status, using standard ordinary least squares methods. It also investigates the impact of percentage of Angus pedigree on marbling, quality, and yield grades to further assess where the differences in value occur using a series of ordered logit regressions. It is found, as compared to a pure Angus base, most breeds are worse off in terms of carcass revenue per CWT. This is further shown in the higher probability of the pure Angus animals grading into the preferred categories for both yield and quality grade.

INDEX WORDS: “Cattle” “Economic Value” “Cattle Breeds” “Meat Science” “Marbling”
“Yield Grade” “Quality Grade”

“DO CATTLE BREEDS AFFECT CARCASS VALUE?”

by

JULIAN MARIE WORLEY

B.S. Virginia Polytechnic Institute and State University, 2016

A Thesis Submitted to the Graduate Faculty of The University of Georgia in Partial Fulfillment
of the Requirements for the Degree

MASTER OF SCIENCE

ATHENS, GEORGIA

2018

© 2018

Julian Marie Worley

All Rights Reserved

“DO CATTLE BREEDS AFFECT CARCASS VALUE?”

by

JULIAN MARIE WORLEY

Major Professor:	Jeffrey H. Dorfman
Committee:	Levi Russell
	Greg Colson

Electronic Version Approved:

Suzanne Barbour
Dean of the Graduate School
The University of Georgia
May 2018

TABLE OF CONTENTS

	Page
LIST OF TABLES	v
LIST OF FIGURES	vi
CHAPTER	
1 INTRODUCTION	1
2 BACKGROUND	4
ECONOMICS	4
GENETICS	5
3 LITERATURE REVIEW	10
4 DATA	13
5 METHODS	16
6 RESULTS	19
7 CONCLUSION	29
REFERENCES	32
APPENDICES	
A Figures.....	34

LIST OF TABLES

	Page
Table 1: Breed Abbreviation Key	19
Table 2: Regression Results for Average Carcass Price per CWT: Sire Breed.....	20
Table 3: Regression Results for Average Carcass Price per CWT: Dam Breed	21
Table 4: Regression Results for Average Carcass Price per CWT: Percent Angus	22
Table 5: Regression Results for Average Carcass Price per CWT: Mix-Breed	23
Table 6: Regression Results on Controls	24
Table 7: Marbling Abbreviation Key.....	25
Table 8: Adjusted Ordered Logit Predictions for Marbling.....	25
Table 9: Adjusted Ordered Logit Predictions for Quality Grade	26
Table 10: Adjusted Ordered Logit Predictions for Yield Grade.....	27

LIST OF FIGURES

	Page
Figure 1: Example of the USDA premium and discount weekly changes.....	34
Figure 2: An example of a pricing grid used to calculate prices per hundred-weight.....	35
Figure 3: Graph of effect of percent Angus in pedigree on Marbling Score.....	36
Figure 4: Graph of effect of percent Angus in pedigree on Quality Grade.....	36
Figure 5: Graph of effect of percent Angus in pedigree on Yield Grade.....	37

CHAPTER 1

INTRODUCTION

While studying Animal and Poultry Science for a bachelor's degree, I learned that different breeds of beef cattle are known for having different favorable traits. For example, if a farmer wished to improve the amount of muscle on their animals, they would use a Charolais dam, because Charolais are known for their ability to grow muscle, or if a farmer wanted to increase the marbling in their herd, they would use an Angus bull, a breed known for its superior marbling ability, or if a farmer was based in Texas, or another similarly warm climate, they would breed a Brahman into their herd, to introduce the breed's heat resistant qualities. The Angus breed has been the American beef industry standard for many years, mainly due to the views of many in the industry that Angus cattle have the best combination of meat quality and yield. Many farmers receive a premium for their animals the more the animals look like the accepted Angus cattle and can even receive a deduction if they stray too far from the norm. The Angus breed association has also made extensive use of their branding ability with the Certified Angus Beef (CAB) label and Angus has since become one of the most recognized beef breeds in the country. Most Angus cattle are regarded as mild-mannered, hardy animals that yield significant quantities of well-marbled and very palatable meat.

This is not to say other breeds are not as good as the Angus, some routinely out-perform the Angus, but only in specific areas and to the detriment of others. The breeds mentioned above are examples. This want for an Angus look-a-like, but with other breed's strength in specific traits has created a selective breeding process in the industry. This breeding process has even led

to some breeds gradually shifting their hide color or average frame size to match the Angus look but have the original breed's improvement in specific desired traits.

After decades of this selective breeding process towards the ideal Angus, however, what is the measurable difference between breeds currently with regards to end line revenue, if there is one? Also, if there is a difference, is it large enough to make any real difference in the lives of the farmers who care for these animals? Knowledge of this difference would certainly increase the ability of farmers to correctly steer their herd breeding programs in the direction to capture improvements in the traits they wish. Knowing which breeds produce better meat quality or superior size and yield would be extremely important in this venture. Even a small difference per pound in quality can be compounded by the current grid pricing mechanism into a sizeable economic advantage.

The cattle industry now uses what is called grid pricing to calculate the proper price for animals, and allows premiums or discounts on animals to reflect both quality and yield grade.¹ An example of a pricing grid is given in Appendix A. The grid shows a price for every combination of different yield and quality grades, with a base price in the middle and different combinations of premiums or discounts moving out on either side. To be clear, farmers can earn premiums for both quality increases over the base norm and quantity increases over the base norm which are additive, the grid simply shows all possible combinations to reduce calculations. One should also note, the additive effect of price changes also works in the opposite direction for quality and quantity decreases from the base norm, sometimes even decreasing prices by as much as \$25 per hundred-weight² (CWT). The USDA publishes a weekly grid update to keep markets current, an example of this is also provided in Appendix A. Knowing which breeds are

¹ Yield grade and quality grade will be explained in more detail in later sections of this thesis

² A hundred-weight is the unit of measure used most often to discuss cattle weight, it is equivalent to 100lbs and is abbreviated CWT.

better at producing desired quantity and quality changes, and which could possibly be detrimental, is extremely important to a farmer's ability to guide her herd to capture more revenue.

This use of grid pricing however, may prove impossible to calculate before processing, since the measurements needed to use the grid pricing are simply not available on a live animal. Many live-animal buyers and sellers rely on their knowledge of cattle breeds and their reputations to place a value on a live animal. This can be a major issue if the understood differences between the breeds have changed due to selective breeding to a standardized breed or other natural mutation which changed relative comparisons.

An improvement in breeding ability, with the knowledge of how different breed qualities have changed, will not only help farmers better control their herd's genetic progress but also lead to a more efficient industry, which could possibly help the consumer through lower retail prices. It will also help buyers and sellers who are judging carcass value from live animals to more accurately predict the true value of an animal and therefore create a more efficient transaction.

Another benefit from this inquiry would be the ability to check the value of cattle genetics as compared to the current market price. Many farmers acquire the male side of their genetics in the form of frozen semen straws, which range in volume from a half fluid ounce to a quarter of a fluid ounce, from various stud farms. These straws, which can cost up to \$25 each, can be ordered via catalog or online. Knowing the true value of this service would give more bargaining power to either side of the stud industry, depending on which direction the inaccuracy is shown. This change of price to the 'true' value of the genetics would again, make the beef industry more efficient.

CHAPTER 2

BACKGROUND

ECONOMICS

While most of this thesis concerns the economic value of various breeds of cattle, much of the economic knowledge needed to understand the concepts presented in this thesis is straightforward.

The most complicated aspect would be the ability to understand the flow of a production chain and follow to which level of the production chain the monetary benefits are greatest and to whom they are the least. This can be a potentially subjective measurement as to who is the most deserving of the increase in monetary benefits in the production chain, especially in the scope of cattle production for example; the farmer who raised the animal adds value, as does the stud farm who provided the genetics, the feedlot who had a superior feed, and the processing facility whose methods were more efficient and lead to more end product.

This thesis will be mostly concerned with the difference between separate cattle breeds, their economic value and where there is an overvaluation or an undervaluation in the supply chain. An example of this would be the ability of a stud farm to raise prices of an overvalued cattle breed semen over their actual economic value and thus take more money from the farmer without really adding as much real value. This disconnect between the price and true value of a good can happen at any section of the supply chain, from the stud genetics to the processing plant. The consumer will most likely not see any effect of the mis-valuation since past the point

of processing most beef products become indistinguishable by breed³. This means a mis-valuation will lead some section of the supply chain to incur a loss. The first question to answer, however, is if there is a mismatch in the actual economic value and perceived economic values of different breeds. Then, depending on the answer, to whom is the excess value going, and is that distribution of excess value ‘fair’?

This paper also uses ordered logit regressions in the investigation of which aspect is driving the price difference. The adjusted predictions from these regressions are presented over the marginal effects due to their ability to vary over the distribution of the variable of interest, the percentage of Angus in an animal’s pedigree. The marginal effects would only give an average of the effect of the percentage of Angus in an animal’s pedigree, which is not as informative.

GENETICS

It is also assumed the reader has a basic knowledge of genetics and how traits are passed from one animal to another, especially along breed lines.

This thesis will discuss the importance of pure-bred animals versus animals who are of mixed breeds. Pure-bred animals are simply animals whose parents are both the same breed. Mix-breed animals, on the other hand, can be broken down into several groups. The first is the F1 generation which would be an offspring of two pure-bred parents of different breeds. The second is generally called the F2 generation and would be the offspring of two animals from an F1 generation. The generations continue on in the same fashion, but this thesis will only discuss F1 and F2 generations for mix breeds.⁴

³ This is assuming the product has not been labeled as breed specific, such as Certified Angus Beef or something similar. The breed must be labeled like this or the breed of the specific product is not determinable.

⁴ This is due to a data restriction and not having more generations worth of pedigrees.

While it is assumed the reader already understands how both categorical, such as coat color, and continuous traits, such as height, milking ability and birth weight, are inherited, the differences in heritability of these traits are not as straightforward. The ability for a trait to be passed along to the next generation and expressed also has to do with the heritability of the trait. If the trait is more highly heritable then there is more of a chance it will be passed on to the offspring. This is important for cattle farmers and breeders who are trying to create an ideal animal type by manipulating traits. There are three broad categories of traits which are based on type and heritability; maternal traits, physical traits, and carcass traits. Maternal traits are traits which help in the rearing of offspring, such as ease of calving, milking ability, and fertility, and are generally considered less heritable. This means it takes more generations of improved animals to see a significant change in the trait for the genetic line as a whole. The second category is production traits, which include traits that affect animal production like frame size, weight, and likelihood of physical defects, and are considered moderately heritable. Carcass traits are traits which are used in carcass production, such as ribeye area, carcass weight, and marbling, and are considered highly heritable. Heritability can be both a help and a hindrance, as progress can be made quickly with carcass traits, but lost just as fast⁵. These inherited traits have also become associated with differences in cattle breeds. For instance, an animal with Charolais in its blood line assumed to have a better yield grade than animals with no Charolais⁶ because the Charolais breed is known for being larger and having lots of muscle. Similarly, an animal with Angus in its pedigree is expected to have better quality grades than animals without Angus in their blood line, because the breed is known for highly marbled meat. Most breeds have some trait they are known for possessing in good quantities, such as the ones mentioned previous, or

⁵ This situation is reversed with lowly heritable maternal traits.

⁶ It should be noted that other breeds are also known for having superior yield grades, Charolais is just one popular example.

still others for milking and mothering ability or their association with calmer disposition traits. This breed-trait association has long been a contributor to the success of selective breeding, allowing for improvement in specific areas without losing as much in others due to complimentary breed crosses. This paper will be concerned with the highly heritable carcass traits which determine the end revenue of the farmers in this study, and ultimately determine the end line value of an animal.

Better knowledge of carcass traits and the impact of marginal improvement in them will allow a more thorough understanding of the implications of the results. Specifically, the marbling, quality grade and yield grade traits used in the grid pricing scheme. One should also note many of these measurements are taken at a specific cut on the carcass, called the 12th rib cut, which is a cut between the 12th and 13th rib of the carcass after it has been split in half along the back bone.

Marbling, a measurement of the amount of intramuscular fat, is important in achieving good tasting products. This is not to be confused with the fat on the edges of steaks and other meat cuts; intramuscular fat looks similar to white flecks in the red muscle parts of uncooked meat cuts. Marbling functions as a major part of the quality grade measure discussed later. It is measured by examining the ribeye area in the rib cut mentioned previous, and judging the amount of intramuscular fat present; the more white fat flecks, the better the marbling, the better the quality grade. In order of most marbling to least, the USDA marbling grades are as follows: abundant, moderately abundant, slightly abundant, moderate, modest, small, slight, traces, practically devoid. Within these grades there are scores of zero to one hundred, with abundant 100 being better than abundant 0. This data set has no animals which were graded 'practically devoid'.

Quality grade is a numerical scale that combines both the maturity of the cattle, since the older an animal is the tougher the meat, and their marbling score. Most animals which are processed for human consumption are of A or B maturity, meaning they are between nine to ninety-two months old. Within this maturity level, animals can be graded for a quality grade of prime, choice, select, and standard, in order of most quality or least, depending on the amount of marbling present. Older cattle, usually older cows older than ninety two months, are graded as commercial, utility, and cutter, in order of most quality to least, and again depending on the amount of marbling present in the ribeye. This paper is more concerned with those animals which will be graded as prime, choice, select, or standard, since there are no animals old enough to grade lower in the data set.

Yield grade measures the amount of marketable product the animal will produce. There are several measurements, explained below, that factor into an animal's yield grade, which is expressed in whole numbers from one to five, with a middle score of three being desired. Grading too far in either extreme can be an issue, either due to size impacting handling ability or simply lack of viable retail cuts.

After an animal is slaughtered the weight of the animal is taken several times, one of which is after the head, internal organs, and hide have been removed, but before the carcass has been cooled in a refrigerator; this is the hot carcass weight (HCW). The effect of an animal's weight on the yield grade is simple—the heavier the animal the more product is produced. Another measurement in the yield grade calculation is the percent of kidney, pelvic, and heart fat (%KPH). An increase in %KPH will increase the yield grade, but is generally stable around 2% of the overall body weight for most animals. The third component of the yield grade is external fat, the amount of external fat in inches, not intramuscular fat, which surround the ribeye at the

12th rib cut. It is measured from the outer edge of the fat to the edge of the rib eye, and an increase in external fat can have negative effects on yield grade as it decreases space for marketable cuts. The last component to the yield grade is the square inches of ribeye present, called ribeye area, measured at the 12th rib cut. This measurements impact is simple to understand – beneficial to increase as it leads to more retail cuts.

These three major traits, marbling, quality grade, and yield grade, are the major contributors to the value placed on a carcass after it has been processed. This valuation however can only be accurately assessed after the animal has been slaughtered and processed, which poses a problem, as mentioned previously.

These issues go back to the concern of different breeds' trait averages moving to some composite average and the industry not being able to recognize or measure the shift, leading to over-weighting the value a particular breed may add to a herd when the real improvement over other breeds is not as large as expected. This misalignment of the expected improvement in a herd and the actual improvement can cause many inefficiencies in the beef industry and should be changed.

CHAPTER 3

LITERATURE REVIEW

The literature basis for this thesis comes from a combination of two different literatures, the economic valuation and the animal science genetics literatures.

The animal science literature starts with Dr. Robert Koch et al. (1963) and their investigation into feed efficiency and how that trait is passed on to future generations. They found 38% of the variations in weight gain of the animals was due to differences in feed efficiency genetics, proving the importance of heritability of traits. This helped launch a push for selective breeding programs mentioned in previous sections and started the investigation into purposeful herd management. Selective breeding programs then led to an interest in breed compatibility or incompatibility. This comparison and cross-breeding of the different breeds lead to several common hybrid types of cattle⁷, such as the Angus-Herford cross, commonly called a Black Baldy, or the Angus-Brahman, called a Brangus.

This combination of different breeds and trait continued to 1988, when A. F. Groen created a model to assess and possibly predict the impact of selective and planned breeding on dairy herds. While this is not entirely the same segment of the industry, Green's paper notes the possibility of shifting the model to fit a beef operation. The model is sound in its construction, including calculations to account for input costs and energy efficiency of the animals as well as economic values of the end products. However, there is a note stating the model assumes there is "no variation in genetic merit between animals in the herd", which may be applicable to more homogenous, pure-bred dairy herds, but is not applicable to commercial beef herds which are

⁷ These crosses are generally F1 crosses as mentioned above

much more diverse in breed type. There is also no stated adjustment for breed type later in the model, which again may be due to the dairy herd's homogenous breed make up, thus no adjustment was needed, which leaves room for possible improvements in the model.

While there had been several experiments and evaluations of different cattle breeds' production abilities before and during this time, including Peacock et al. (1979), who created a breeding program looking at production differences in different combinations of three popular cattle breeds, Koch et al. (1984) evaluating diverse breeds, as well as an experiment from Bailey et al. (1982) which examines several characteristics of bulls of different breeds. It seems the concern for breed differences in production ability was not addressed in the Groen model, and certainly any monetary value was not attached to the differences in value until the Groen model.

The implication of significant differences in carcass characteristics is further strengthened by D. M. Marshall's (1994) comparison of carcass traits of several different breeds and breed composites. His results confirm a probability of improved production characteristics for crossbred animals due to faster maturation and the fact that different breeds of beef cattle have markedly different strengths and specialties⁸, Gregory et al. (1994, 1995) also confirm the difference in breed types with regards to carcass and production traits is statistically significant. It is interesting to note the two Gregory et al. papers also include some insight into the impact of hybrid vigor on an animal's productive ability over that of its purebred parents. Gregory et al. (1994) states some composite combinations of beef breeds yield better results than other combinations of the same breeds.⁹ This is backed up in Gregory et al. (1995) where the tables show hybrids do better overall regardless of the composition when compared to purebred animals. It may be noted that many of the major commercial crosses always tend to have one Angus parent, since the breed is considered the industry standard as mentioned above.

⁸] Although the concept of hybrid vigor, or the hybrid of two established breeds doing better and their purebred parents, is widely accepted, there is some concern about out-breeding depression where the positive traits of a breed are not passed along to the offspring, which will be discussed later in the thesis.

⁹ Although it should be noted that none of the breed composites showed worse performance than their purebred counterparts

The relevant economic literature concerning the value of different cattle breeds is comprised mostly of choice experiments and revealed preference experiments for different breeds at the farm level, such as Jabbar and Diedhiou's (2003) choice experiment in West Africa and Ruto, Garrod and Scarpa's (2007) choice experiment in Kenya. While these experiments do find differences in farmers' preferences, they do not take into consideration the breakdown of where those preferences come from or even if the farmers' assumption about the values of the breed are correct once the animal has been processed.

This thesis proposes a marriage of the two literatures. It will use the animal science literature to examine the impact of breed on production, but evaluating these differences using revenue to the farmer, instead of measuring the difference in production traits.

CHAPTER 4

DATA

The data used in this thesis were acquired from the Georgia Beef Challenge. The Georgia Beef Challenge is a retained ownership program run by the Georgia Beef Team in conjunction with Tri-County Steer Carcass Futurity Cooperative (TCSCF), Lewis, Iowa. Calves enrolled in the program follow a similar protocol to all other enrolled calves while at the farm and are all shipped to the same feedlot in Iowa, run by the TCSCF, and then sent to the same processing facility to limit unobservable variability in production and processing between animals.

The data from the Georgia Beef program are unique because it allows for comparison of animals from different farms all the way to end production, which normally would require farm level production data or the kind and amount of feed, housing, vaccines, and medical procedures the animals received, as well as data on the differences in auction houses, feedlots, and processing facilities. This data set however, comes from a program which requests farmers to adhere to specific production protocol while the calves are on the farm and then the animals are sent to the same feedlot and on to the same processing facility. This eliminated much of the unmeasurable variability in production and allows for the examination of the effect of breeds and genetics, the only major uncontrolled variable, other than individual and measurable variance of traits such as sex, which would have a significant effect on the production and carcass traits of the calves.

The data set has a large number of variables, some of which are used more than others. Body weights are collected when animals leave the farm, when they arrive at the feedlot in Iowa as well as their final weights. Other carcass trait data is also collected at processing on each animal including REA, %KPH, percent fat cover, as well as the marbling and yield grade.

Production traits such as overall average daily gain (ADG¹⁰), and physical traits such as sex and days of age (DOA) were also collected. The data were cleaned and compiled, data points which were missing observations for critical variables were excluded.

Once I had a full matrix of data, variables were created for the total days on feed, believing the number of days an animal has been on high energy feed at a feed lot would significantly change the final weight of an animal, and for the week the animal was processed, so as to capture weekly changes in base price which are not tied to breed. Indicator variables were also created for the different combinations of sire and dam for every combination of the seventeen sire breeds and thirty-four dam breeds, as well as indicator variables for sire and dam breed separately. Using STATA software, variables were also created for an animal's level of Angus genes. The data set was split into five categories, starting at 100% Angus and decreasing by quarters until 0% Angus. This was designed to allow comparison of the impact of the level of Angus genetics on revenues. A dummy variable was also created to compare the difference in impact of animals which are purebred, regardless of which breed, to those animals which are an F1 cross or an F2 cross. This was done to allow the assessment of the claim of possible improvements due to hybrid vigor.

Several other variables were created, mostly to account for shifts in the overall cattle market, which was particularly volatile during the period of data collection. These will be explained in more detail later.

There are several other traits of the data which should be mentioned here. The sample as a whole is not balanced by breed, there is a significant skew towards the Angus and Angus composite breeds which cannot be helped. Selection into the program, by farmers as well as which specific animals they choose to enroll in the program, may also cause some external

¹⁰ Average daily gain is the total weight of the animal over their total days of age

validity problems with the data. Unfortunately, the pattern and direction of this potential bias may go several ways. Farmers who enroll in the program could be the best of the best in Georgia and wish to prove it, they could also be farmers who are not as good and wish to improve, or it could even be a representative sample. There is, unfortunately, no way to prove which is true, without taking a random sample from all cattle farmers in Georgia and then forcing the random sample to participate. There may also be some selection bias present in the types of cattle enrolled into the program as well. Farmers who elected to participate may send one of their best animals and one of their worst to assess the spread of their herd. Farmers could also send just their best or just their worst which would skew the data. As with the farmer selection bias, this would have to be fixed with a random selection of the cattle from the farms which were randomly selected from the farmer sample. This randomization would alter the focus of the program away from current goals.

CHAPTER 5

METHODS

The data will be compared in a variety of ways, which can be split into two categories. The first will include all comparisons pertaining to continuous distributions in order to compare the breed type to the carcass price per hundred-weight. The second will be those comparisons which will use an ordered logit model. All these comparisons will examine the marginal effect a breed of cattle has on some end product aspect of beef, but which distribution is used is dictated by the continuous or categorical nature of the dependent variable. These dependent variables will be examined in the context of the percentage Angus lineage and hybrid aspects as well as just a comparison of breed make up.

For examining the connection between cattle breed and the total revenue per hundred-weight a continuous distribution will be used. These models will be estimated using standard OLS via the following regression:

$$\begin{aligned} \text{Carcass price per CWT} = & \alpha_0 + \alpha_1(\text{age}) + \alpha_2(\text{sex}) + \alpha_3(\text{final live weight}) \\ & + \alpha_4(\text{final weight}^2) + \alpha_5(\text{days on feed}) + \alpha_6(\text{days on feed}^2) \\ & + \alpha_7(\text{days on feed} * \text{final live weight}) + \alpha_8(\text{year}) + \alpha_9(\text{year}^2) \\ & + \sum_{i=1}^n \alpha(\gamma_i) + \sum_1^{10} \alpha(\text{month dummies}) \end{aligned}$$

The independent variables include the variables of interests, represented by the set of γ_i since they are a collection of varying dummy variables, such as sire breed, dam breed, percentage Angus, or purebred, as well as several others as follows. Final weight and final

weight squared are included to capture the non-linear effects of increasing weight which has a beneficial effect on revenues at first and then a detrimental one after some turning point. The interaction of final weight and days on feed is also included to account for the significant drop in cattle inventory in the United States during the data collection period, animals were kept in the feed lots for longer than the optimal time frame, thus resulting in larger animals at end line.¹¹ Days on feed and days on feed squared were also included to capture the effects of this downturn in cattle inventory as well as it was assumed there is some optimal days on feed, but after some turning point additional days on feed are detrimental, similar to final weight. Gender of the animals is included to adjust for the different physiological differences between the genders which are not attributed to breed. Days of age are similarly included to adjust for the differences in development and size which are due to age and not breed or the other variables of interest. Annual and monthly time variables are used to account for the upward shift in cattle prices around 2014 and then the following plummet in 2015, as well as the cyclical increase in cattle prices for the grilling season. Other possible independent variables, such as average daily gain, were not included since they either are greatly affected by the breed of an animal or the components to calculate them are already included in the above mentioned variables and are excluded to prevent bias.

Dependent variables that are categorical in nature will be examined using an ordered logit. These dependent variables include yield grade, marbling, and quality grade. The same independent variables will be used for these regressions for the same reasoning as previously mentioned. The adjusted predictions of these regressions will be reported rather than the actual regression estimates to avoid any misinterpretations of the coefficient estimates. The adjusted

¹¹ This drop in feeder cattle limited feed lot operators to few choices of having empty feed lots or keeping the cattle they had on hand longer than the optimal and feeding them out to a higher weight and trying to capture some lost revenue there.

predictions, which are not the marginal effects estimates normally reported for ordered logit regressions. These adjusted predictions calculated the probability an animal will grade into each of the dependent variable categories and then how these probabilities change when the variable of interest, percent Angus in an animal's pedigree, is changed. To be clear, all continuous variables included in the model are held at their means and categorical independent variables are held to a specific value, usually the most common, while the percent Angus variable is changed. The resulting differences in probability are reported as adjusted predictions. The categorical variables in the regression include sex, which is held at male, and then the year and month variables which are held at June of 2014, which was the month with the highest average prices in the data set.

Using the probabilities calculated from the ordered logit regressions, the expected value for the percentage of Angus in an animal's pedigree will also be calculated using the current USDA premiums and discounts for quality grade and yield grade. This is to give a concrete dollar amount to the probabilities.

CHAPTER 6

RESULTS

Table 1: Breed Abbreviation Key

Abbreviation	Breed
AN	Angus
AR	Red Angus
BN	Brangus
CH	Charlois
HE	Hereford
LM	Limosin
SM	Simmintal
XX	Commercial
BO	Braford
BR	Brahmin
GV	Gelbvieh
SG	Sainta Gertudis
RB	Red Brangus

The results of the continuous revenue per hundred-weight regressions prove to be interesting on several fronts.

The first and primary finding being they prove the market is running efficiently for the most part with a few exceptions, which will be discussed one at a time below.

When the variable of interest in the OLS regressions is the breed of the animal's sire, the overall trend for the different sires is negative, or earning less in total carcass price, for

almost all breeds compared to the Angus (ANAN) sire used as the base (see Table 2). This would mean the market, at least in reference to sire breeds, generally functions as previously thought, with Angus as the forerunner. Of the sires which have positive coefficients, which includes the Angus-Simmental (ANSM) cross, Angus-Commercial (ANXX) cross, pure-bred Herford (HEHE), pure-bred Braford (BOBO), pure-bred Brahman, and pure-bred Red Brangus (RBRB), only the Braford, which appears nine times in this data set, and the Red Brangus, which appears four times in this data set, are statistically significant at a significance level of 0.01. Hereford sires, appearing 175 times in the data set, are significant with a p-value of 0.02, and Brahman, appearing once in the data set, are significant with a p-value of 0.073. It is interesting to note the presence of Brahman genetics in three of the four breed types mentioned above, which may be due to the breed's heat and pest tolerance. This claim, however, would have to be investigated

further with a larger geographical area than the present data to be validated. It should also be noted, the breed with the largest breed decrease among all breed types, is the Red Angus-Angus (ANAR) cross, appearing four times in the data set.

Table 2: Regression Results for Average Carcass Price per CWT: Sire Breed

	Parameter Values	Standard Error	p-Value
Sire ANHE	-.545	6.096	.929
Sire ANSM	.916	9.598	.924
Sire ANXX	1.656	3.081	.591
Sire ARAR	-3.922**	1.685	.02
Sire ARSM	-2.103	9.595	.827
Sire BNB	-7.753	9.614	.42
Sire CHCH	-1.66	1.965	.398
Sire HEHE	2.553**	1.123	.023
Sire LMLM	-1.656	7.821	.832
Sire SMAN	-7.866***	1.014	<.001
Sire SMAR	-5.265*	2.793	.06
Sire SMSM	-2.032*	1.064	.056
Sire ANAR	-17.995***	6.858	.009
Sire BOBO	14.483***	4.485	.001
Sire BRBR	24.302*	13.55	.073
Sire RBRB	18.23***	6.79	.007

Notes: When presented together, the Sires breed will always be first
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Although it is currently

unclear why it is so negative when compared to a pure-bred Angus, it could possibly be due to the types of dams which were mated to these sires. The rest of the results for the sire variables are in Table 2.

When the variable of interest in the OLS regressions is the breed of the animals' dam, the overall pattern for the different dams is negative, or earning less in total carcass price, compared to the Angus (ANAN) dam used as the base. This would mean the market, at least in reference to dam breeds generally functions as previously thought, and reinforces the findings from the sire regression, with Angus as the forerunner. There are a few positive exceptions to the trend, including pure-bred Brangus (BNBN), the Angus-Limosin (ANLM) cross, and the Limosin-Commercial (LMXX) cross. Of those three, only the pure-bred Brangus, which appears three times in the data set, has a positive value difference that is statistically significant at a significance level of 0.01, matching the pattern of Brahmin genetics being present in animals

which outperform Angus in the sire regression. Another interesting result emerged in the form of the breed makeups of those dams which had negative coefficients, meaning they earned less. Out of eight breeds which were negatively statistically significant at a significance level of 0.01, seven of them are some type of Angus cross. The results for the dam variables are in Table 3.

As for the regressions which combined sire and dam breeds, the results show the same

Table 3: Regression Results for Average Carcass Price per CWT: Dam Breed

	Parameter Values	Standard Error	p-Value
Dam ANHE	-10.249***	3.015	.001
Dam ANSM	-5.803***	2.137	.007
Dam ANXX	-7.115***	.683	<.001
Dam ARAR	-12.521***	2.305	<.001
Dam ARSM	-10.716***	2.203	<.001
Dam BNB	21.059***	7.723	.006
Dam CHCH	-8.743	6.682	.191
Dam HEHE	-.491	1.247	.694
Dam LMLM	-7.88	5.438	.147
Dam SMAN	-10.403***	1.374	<.001
Dam SMAR	-17.339	13.273	.192
Dam SMSM	-13.699***	1.685	<.001
Dam ANBN	-14.258***	3.032	<.001
Dam ANCH	-9.017	7.671	.24
Dam ANGV	-4.972	4.475	.267
Dam ANLM	6.57	9.402	.485
Dam ARHE	-24.656	13.278	.063
Dam ARXX	-.378	2.282	.868
Dam BNSM	-11.652	7.737	.132
Dam BNXX	-3.967*	2.292	.084
Dam BRXX	-6.28	6.008	.296
Dam CHXX	-1.875	2.844	.51
Dam GVG	-6.645*	3.5	.058
Dam GVHE	-2.461	13.286	.853
Dam GVXX	-15.724	13.282	.237
Dam HEXX	-1.722	4.475	.7
Dam LMAR	-11.58	13.304	.384
Dam LMGV	-9.624	9.412	.307
Dam LMXX	.728	13.3	.956
Dam SGXX	-2.374	7.686	.757
Dam SMBN	-12.213**	5.961	.041
Dam SMXX	-3.886*	2.094	.064
Dam XXXX	-2.947	1.791	.1

Notes: When presented together, the Sires breed will always be first

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

patterns as previous regression

results. Of over a hundred

breed combinations present in

the sample only 21 result in

positive coefficients implying

gains over the Angus base

breed. Of those 21 breeds, only

four, the Charolais (CHCH)-

Brangus (BNBN) cross, the

Hereford (HEHE)-Angus-

Gelbvih (ANGV) cross, both

appearing twice in the data set,

the Simmental (SMSM) –

Angus-Commercial (ANXX)

cross, which appears 45 times

in the data set, and the Red Brangus(RBRB) – Red Angus-Commercial (ARXX), appearing three

times in the data set, are statistically significant at a significance level of 0.01. All of the

coefficients on these variables, however, are large and would have a marked impact on revenues.

The types of breeds which were significant and positive are also interesting as they are all composites of at least three¹² breeds, which seems to increase the support for crossbreeding, but perhaps goes against the concept of the F1 generations being the most productive due to hybrid vigor. All breeds which outperform the Angus base also have at least some Angus in their pedigree as well.

With all the separate breed comparisons, it should be noted the data set is not balanced evenly among all breed and breed combinations. Of the 2,645 observations, the significantly positive results are, for the most part, less than ten observations each. This small amount of observations for the significant results may point to the positive significant results being positive and significant simply in terms of random chance. However, The results with the combined breed groups are presented below and help support the results found in the separate breed regressions.

The regression in which the variables of interest are the percentages of Angus in an animal’s pedigree produces some interesting results. The regression still supports the Angus dominance of the industry as all coefficients on the variables of interest are negative, it is rather more interesting to compare the magnitude of the negativity for each category. These results imply the next best thing to having a 100% Angus animal would be to have an animal which is 25% Angus, or 0% Angus as the confidence intervals for these two overlap. The next best after

Table 4: Regression Results for Average Carcass Price per CWT: Percent Angus

	Parameter Values	Standard Error	p-Value
0 % Angus	-4.24***	1.058	<.001
25% Angus	-3.969***	1.093	<.001
50% Angus	-7.113***	.835	<.001
75% Angus	-9.21***	.691	<.001

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

those two categories would be to have a 50% Angus animal and, lastly, the 75% Angus animals

are the most penalized. This is the opposite of the expected outcome, and again seems to lend

¹² Brangus animals, while their own breed, are a composite breed of a Brahman and an Angus.

more merit to having F2 generation animals so as to achieve the 25% Angus versus the highly touted F1. These results are presented in Table 4.

The regression which compared purebreds with mix-breeds regardless of which specific kind of purebred shows that purebreds are valued over mix-bred animals. This regression is not particularly interesting but helps confirm the pure-bred Angus dominance over other mixed breeds, even though the effect is surely diluted with the pure-bred category combining all pure-bred animals regardless of breed. These results are available in Table 5

Table 5: Regression Results for Average Carcass Price per CWT:

	Parameter Values	Standard Error	P-Value
Mix-breed	-7.163***	.589	<.001

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

As for other variables used as controls in these regressions, there were some interesting results

but not without explanations. Since the same controls were used for all five of the previous regressions and coefficients for the controls are similar in sign, magnitude, and significance, they will be discussed together and are available in Table 6 The parameter on the gender variable shows heifers have more value than steers, by about \$3.50-\$4.00 per CTW over their male counterparts. This seems completely against the norm for the entire cattle industry; however, because the model also includes the final weight, the sex control picks up more of the quality

Table 6: Regression Results on Controls

	Sire Breed	Dam Breed	Combined Breed	Percent Angus	Purebred
Gender	-4.037 *** (.709)	-4.122*** (.697)	-4.461*** (.687)	-3.571*** (.689)	-3.652*** (.692)
Days of Age	-.003 (.004)	.008* (.004)	.008* (.004)	.006 (.004)	.004 (.004)
Final Weight	-.116 *** (.04)	-.106*** (.039)	-.091** (.038)	-.093** (.039)	-.103*** (.04)
Final Weight ²	0** (0)	0** (0)	0** (0)	0** (0)	0** (0)
Days on Feed	.829*** (.243)	.945*** (.241)	.993*** (.237)	1.106*** (.239)	1.036*** (.239)
Days on Feed ²	-.004*** (.001)	-.004*** (.001)	-.004*** (.001)	-.004*** (.001)	-.004*** (.001)
Interaction	0** (0)	0** (0)	0** (0)	0 (0)	0 (0)
Year	8.942*** (1.36)	8.655*** (1.349)	6.009*** (1.376)	7.779*** (1.321)	7.874*** (1.325)
Year ²	-.539*** (.172)	-.561*** (.17)	-.227 (.174)	-.467*** (.166)	-.472*** (.167)
January	-19.145*** (1.709)	-18.578*** (1.67)	-21.022*** (1.789)	-19.22*** (1.616)	-20.149*** (1.614)
February	-9.931*** (1.53)	-9.315*** (1.475)	-12.694*** (1.609)	-10.312*** (1.435)	-10.893*** (1.441)
March	-10.229*** (1.451)	-9.346*** (1.36)	-12.253*** (1.485)	-10.14*** (1.357)	-10.545*** (1.367)
April	-13.829*** (1.467)	-14.174*** (1.382)	-17.703*** (1.51)	-15.466*** (1.382)	-15.353*** (1.389)
May	-15.136*** (1.616)	-14.752*** (1.524)	-18.649*** (1.638)	-15.806*** (1.519)	-16.016*** (1.527)
June	-18.581*** (1.834)	-17.091*** (1.734)	-19.858*** (1.834)	-16.405*** (1.721)	-17.255*** (1.721)
August	-15.261*** (3.483)	-12.86*** (3.468)	-11.889*** (3.677)	-18.168*** (3.339)	-18.168*** (3.356)
November	5.361 (10.317)	.168 (10.127)	-6.696 (9.829)	-2.892 (10.156)	-2.039 (10.227)
December	-6.587** (3.294)	-5.535* (3.19)	-8.626*** (3.228)	-6.489** (3.185)	-6.47** (3.206)
N	2,645	2,645	2,645	2,645	2,645
R ²	0.302	0.331	0.379	0.325	0.316
F-stat	34.78	26.62	13.06	58.98	65.30

Notes: standard errors in parentheses.

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

difference between the two sexes. If one is comparing two animals of different sexes, ceteris parabis, the female of the two will generally grade better which will then lead to the female earning a higher price, and a negative parameter. The time variables, the year and year squared, show the correct pattern of the extreme spike in cattle prices around 2014, and the subsequent plummet in

2015, with the positive parameter on the year variable and the negative parameter on year squared. The monthly variables, which is the month of the year the animal was processed, also show the typical cyclical changes in beef prices throughout the year, with the summer months having higher prices than winter months. The month of July was used as the base month, as it had the highest mean prices, the month of September is not included as there are no data points with processing dates in that month. The resulting changes in feed lot behavior, mentioned above, are shown in the days on feed and days on feed squared parameters, which show the expected changes of an upward limit on the benefits to keeping an animal on the feed lot, and

then subsequent days in the feed lot resulting in a loss. The optimal days on feed that would maximize carcass value range from 104 days for the sire regression to 138 days for the percent of Angus in pedigree regression. This calculation may seem higher compared to the general practice, but this result is not for maximum profit, since it does not consider cost of keeping an animal on the feedlot for another day, but just simply the optimal days on feed to maximize the carcass value. The results for the control variables are found in Table 6.

The categorical dependent variables, marbling, quality grade, and yield grade, were

Table 7: Marbling Abbreviation Key

Abbreviation	Marbling
1	Moderately Abundant 50+
2	Moderately Abundant 49- to Slightly Abundant 50+
3	Slightly Abundant 49- to Moderate 50+
4	Moderate 49- to Modest 50+
5	Modest 49- to Small 40+
6	Small 49- to Slight 50+
7	Slight 49- to Traces 50+

examined using ordered logit models. For simplicity, the only breed variables presented here are the percent of Angus in an animal's

pedigree. Since the parameters on ordered logit regressions are tricky to interpret, I calculated the adjusted predictions which can be interpreted as normal OLS regression results. I will be discussing adjusted predictions in this paper.

Beginning with the regression with marbling as the dependent variable, the results show a clear picture. Both the 100% Angus animals and the 25% Angus animals follow

Table 8: Adjusted Ordered Logit Predictions for Marbling Logits

	1	2	3	4	5	6	7
100% Angus	.001* (.001)	.013*** (.003)	.044*** (.006)	.15*** (.013)	.388*** (.013)	.368*** (.022)	.036*** (.005)
75% Angus	0* (0)	.01*** (.002)	.033*** (.005)	.12*** (.012)	.361*** (.015)	.428*** (.023)	.047*** (.006)
50% Angus	0* (0)	.007*** (.002)	.024*** (.004)	.09*** (.011)	.316*** (.02)	.496*** (.026)	.066*** (.009)
25% Angus	.001* (.001)	.013*** (.003)	.041*** (.007)	.142*** (.018)	.383*** (.017)	.383*** (.034)	.038*** (.007)
0% Angus	0* (0)	.009*** (.002)	.029*** (.005)	.107*** (.015)	.344*** (.022)	.456*** (.033)	.054*** (.009)
N	2,645						

Notes: delta method standard errors in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

closely together overall marbling levels, being within two tenths of a point of each other at the maximum distance. They both show decreases in probability of grading in the lower quality

marbling levels, which would be the 6, or 7 categories, with the 100% Angus animals decreasing a little bit sooner, and a peak probability being in category 5; 25% Angus maintains its peak in both the 5 and 6 categories. The other three Angus percentages show peak probabilities at category 6. All five Angus percentages show a gradual increase in probability until their peak probabilities and then a decrease there after. The 50%, 75% and 0% Angus groups do, however, show a higher probability in the lower marbling, categories 6 and 7, than those of the 25% and 100% Angus animals. The results from this regression can be found in Table 8. Figure 3 also helps visualize these results in a line graph.

The results for the ordered logit explaining quality grade repeats this pattern. The 100% and 25% Angus

Table 9: Adjusted Ordered Logit Predictions for Quality Grade Logits

	Prime	Prime-	Choice+	Choice	Choice-	Select+	Select-	Standard
100% Angus	.002** (.001)	.021*** (.004)	.075*** (.009)	.183*** (.014)	.545*** (.011)	.128*** (.012)	.04*** (.005)	.005*** (.001)
75% Angus	.002** (.001)	.017*** (.003)	.062*** (.007)	.159*** (.013)	.554*** (.01)	.151*** (.013)	.049*** (.006)	.006*** (.002)
50% Angus	.001** (.001)	.013*** (.002)	.046*** (.007)	.126*** (.014)	.55*** (.011)	.189*** (.018)	.066*** (.009)	.008*** (.002)
25% Angus	.002** (.001)	.019*** (.004)	.067*** (.011)	.169*** (.019)	.552*** (.011)	.142*** (.019)	.045*** (.008)	.005 (.002)
0% Angus	.001** (.001)	.013*** (.003)	.047*** (.008)	.129*** (.017)	.551*** (.011)	.186*** (.021)	.065*** (.011)	.008*** (.002)
N	2,645							
<i>Notes:</i> delta method standard errors in parentheses.								
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$								

groups still follow each other much more closely than the other three categories, again within two tenths of a percentage point. All five categories have at least a 54% chance of grading Choice minus, with differences being mostly in the spread of the probabilities on either side of this peak. The 100% and 25% Angus groups have very narrow distributions on either side of the choice minus peak, with more probability of being on the upper end of the quality grade than on the lower end. The 75% Angus group has a more symmetric spread on either side of the choice minus peak, with a very slight skew towards grading on the upper end of quality grade. The 50% and 0% Angus groups, however, both have wider distributions on either side of the choice minus peak, with a higher probability of grading on the lower end of quality grade versus grading above

the peak. The results from this regression can be found in Table 9. Figure 4, a line graph of these results also helps visually show the result patterns discussed above.

Lastly, the regression with yield grade as the dependent variable shows a different pattern than the other two categorical variable regressions.

Table 10: Adjusted Ordered Logit Predictions for Yield Grade Logits

	1	2	3	4	5
100% Angus	.023*** (.003)	.295*** (.022)	.576*** (.016)	.102*** (.011)	.004*** (.001)
75% Angus	.028*** (.004)	.339*** (.024)	.545*** (.019)	.084*** (.01)	.003*** (.001)
50% Angus	.034*** (.006)	.38*** (.029)	.513*** (.025)	.07*** (.01)	.003*** (.001)
25% Angus	.036*** (.007)	.394*** (.035)	.501*** (.031)	.066*** (.011)	.003** (.001)
0% Angus	.032*** (.006)	.369*** (.035)	.522*** (.029)	.073*** (.012)	.003** (.001)
N	2,645				

Notes: delta method standard errors in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

All five Angus

percentage groups have peak probabilities at a yield grade 3, which is the most desired, the 100% Angus group, however, has a much higher chance of grading a 3 as compared to the other four. The 100% Angus groups also has a much more symmetrical and tight spread on either side of the grade 3 peak, as compared to the other groups, meaning if an animal does not grade 3 for yield, it has a much higher probability of grading just on either side of that then the other groups. The 25% Angus group, which has been keeping up with the 100% Angus animals in previous regressions, are shown to grade the worst in yield, still with a peak at grade 3, but of the other four groups, it has the lowest probability of grading 3. The 25% Angus group is also the most lopsided spread, having a much greater probability of grading in the lower extremes than the other groups. The 50% and 0% Angus groups closely match each other again, with peaks at grade 3. Both are also skewed towards grading lower, similar to the 25% Angus group; nevertheless, they are more symmetrical than the 25% Angus group, meaning they more likely to

grade on either side of the grade 3 peak. The 75% group, actually looks similar to the 100% Angus group, but is slightly less likely to grade 3, although the peak probability is still a grade 3, and slightly more likely to grade on the lower yield grades as compared to the 100% Angus group. The 75% Angus group is also the next most symmetric spread after the 100% Angus group. The results for this regression can be found in Table 10. Figure 5 will also help visualize the results of this regression in a line graph.

CHAPTER 7

CONCLUSION

There are several important insights gained in this thesis, each with its own set of implications for the beef industry. The first and main insight is the existence of a difference between certain breeds in their carcass values, and that it can make about a \$10/cwt, or \$100/head, difference to the revenue of the farmer in the retained ownership program.

The second insight would be the validation of the Angus breed as the forerunner in performance for industry, due to their combination of both quality and quantity over other breeds. This strengthens the position of groups like the Angus Breed Association to campaign for even more benefits for their members. It also could lead more farmers to breed their herds to be more like the Angus to capture potential increases in revenue up to or over \$240/head in extreme cases.¹³

This proof of breed differences also decreases concern for the idea of gradual breed drift in other breeds to be more like the Angus, unless the breed drift is incredibly slow. The main concern of breed drift is the loss of genetic animal diversity and the ability of the species to withstand potential catastrophic illnesses. Farmers have gone through about 30 generations of cattle from the time the Koch paper was published. The genetic gain on the Angus breed would lead to the differences being smaller than they are currently shown to be if genetic drift were fast enough to be a concern. If the drift is, in fact, slow enough that the differences in breeds persist as shown, it somewhat calls into question the validity of the selective breeding programs, at least

¹³ This number was taken from the regressions results (which are given in a per CWT measure) and multiplying them by the number of CWT an animal weighs.

the ones which select within breeds. If a breed cannot be directed in a new direction within a short enough time span to make a difference, what is the use of the selective breeding program? Determining which of these two cases is true, however, would require a longer-term study of same breed animals.

Another finding, which was rather unexpected, was the Brahman breed's frequent appearance in the breed composites as outperforming the Angus. While the Brahman's main claim is to increase hardiness in hot, pest-prone climates, which would have been washed out of the results via the controls, they are not well known for having good quality or extraordinary yield. It is unclear at present what particular factor is helping animals with some degree of Brahman genetics perform better than the Angus, but the pattern leads me to believe there is some trait these animals have in common.

Another unexpected finding occurred in the ordered logit models and the high probability of the 25% Angus group to produce at the same quality as an animal which was 100% Angus. This finding, especially in conjunction with the much lower probability of the 50% Angus group to achieve the same quality, turns conventional genetic concepts on its head. Animals of an F1 cross pair, which would include a large amount of the 50% Angus group, should be able to outperform animals of an F2 generation, which would include a large number of the 25% Angus animals. This is assumed to derive from the hybrid vigor being higher in the first cross of two breeds than in subsequent crosses. This idea does not hold, however, in these results.

I do not believe it is a fluke of the ordered logit regressions. The continuous regressions in which the independent variable of interest was the combination of both the sire and the dam show a similar pattern. The breed combinations which did better than the pure Angus base were those animals who had three different breeds in their pedigree. These animals are probably the

same ones who are included in the 25% Angus group since all breeds have at least some Angus in their background. This finding could really change the way breeding programs operate in the future. If the animals who earn the most are composites of three breeds, many more cow/calf operations should begin to invest in cross-bred cows instead of pure-bred, so they can produce three breed composite calves. Stud farms as well could start offering cross-bred studs for the same reason, though I think this is the less likely of the two options.

The confirmation of a breed difference in end line prices for cattle helps to confirm long held beliefs in the beef industry and provides support for strategic breeding programs to match complementary breeds. It also provides support for the dominance of the Angus breed in the industry, due to the probability of an Angus animal grading better in both yield and quantity over other animals. It should be noted, however, other animals who are 25% Angus graded similarly in quality, but not yield. The closest group to Angus in the yield grade were animals with 0% Angus, although they were not particularly close.

REFERENCES

- Bailey, C. M., David, P. J., Dow, J. S., Ringkob, T. P., & Speth, C. F. (1982). Growth and Compositional Characteristics of Young Bulls in Diverse Beef Breeds and Crosses. *Journal of Animal Science*, 55(4), 787-796. doi:10.2527/jas1982.554787x
- Gregory, K. E., Cundiff, L. V., Koch, R. M., Dikeman, M. E., & Koohmaraie, M. (1994). Breed effects, retained heterosis, and estimates of genetic and phenotypic parameters for carcass and meat traits of beef cattle. *Journal of Animal Science*, 72(5), 1174-1183. doi:10.2527/1994.7251174x
- Gregory, K. E., Cundiff, L. V., & Koch, R. M. (1995). Genetic and phenotypic (co)variances for production traits of female populations of purebred and composite beef cattle. *Journal of Animal Science*, 73(8), 2235-2242. doi:10.2527/1995.7382235x
- Groen, A. (1988). Derivation of economic values in cattle breeding: A model at farm level. *Agricultural Systems*, 27(3), 195-213. doi:10.1016/0308-521x(88)90057-1
- Jabbar, M., & Diedhiou, M. (2002). Does Breed Matter to Cattle Farmers and Buyers? Evidence from West Africa. *SSRN Electronic Journal*. doi:10.2139/ssrn.297082
- Ruto, E., Garrod, G., & Scarpa, R. (2007). Valuing animal genetic resources: a choice modeling application to indigenous cattle in Kenya. *Agricultural Economics*, 38(1), 89-98. doi:10.1111/j.1574-0862.2007.00284.x
- Koch, R. M., Swiger, L. A., Chambers, D., & Gregory, K. E. (1963). Efficiency of Feed Use in Beef Cattle. *Journal of Animal Science*, 22(2), 486-494. doi:10.2527/jas1963.222486x
- Koch, R. M., Dikeman, M. E., Grodzki, H., Crouse, J. D., & Cundiff, L. V. (1983). Individual and Maternal Genetic Effects for Beef Carcass Traits of Breeds Representing Diverse Biological Types (Cycle I). *Journal of Animal Science*, 57(5), 1124-1132. doi:10.2527/jas1983.5751124x
- Marshall, D. M. (1994). Breed differences and genetic parameters for body composition traits in beef cattle. *Journal of Animal Science*, 72(10), 2745-2755. doi:10.2527/1994.72102745x

Peacock, F. M., Koger, M., Palmer, A. Z., Carpenter, J. W., & Olson, T. A. (1982). Additive Breed and Heterosis Effects for Individual and Maternal Influences on Feedlot Gain and Carcass Traits of Angus, Brahman, Charolais and Crossbred Steers. *Journal of Animal Science*, 55(4), 797-803. doi:10.2527/jas1982.554797x

APPENDIX A

LM_CT169				
St. Joseph, MO Mon Feb 05, 2018 USDA Market News Service				
5-AREA WEEKLY WTD AVERAGE DIRECT SLAUGHTER CATTLE - PREMIUMS AND DISCOUNTS				
For the Week of: 2/5/2018				
Value Adjustments				
	Range	Wtd Avg	Change	
Quality:				
Prime	10.00 - 22.00	17.29	0.00	
Choice	0.00 - 0.00	0.00	0.00	
Select	(10.00)- (5.00)	(6.20)	0.03	
Standard	(40.00)- (12.00)	(19.13)	0.04	
CAB	3.00 - 5.00	4.03	0.28	
All Natural	22.00 - 28.00	23.92	0.00	
NHTC	16.00 - 22.00	19.31	0.00	
Dairy - Type	(14.00)- 0.00	(4.12)	0.00	
Bullock/Stag	(55.00)- (25.00)	(40.93)	0.00	
Hardbone	(55.00)- (20.00)	(33.66)	0.03	
Dark Cutter	(55.00)- (25.00)	(36.77)	0.03	
Over 30 Months of Age	(40.00)- (10.00)	(16.36)	0.03	
*Cutability Yield Grade, Fat/Inches				
1.0-2.0 < .10"	4.00 - 8.00	5.71	0.00	
2.0-2.5 < .20"	2.00 - 5.00	3.03	0.00	
2.5-3.0 < .40"	0.00 - 5.00	2.93	0.00	
3.0-3.5 < .60"	0.00 - 0.00	0.00	0.00	
3.5-4.0 < .80"	0.00 - 0.00	0.00	0.00	
4.0-5.0 < 1.2"	(12.00)- (8.00)	(9.77)	0.00	
5.0/up > 1.2"	(20.00)- (10.00)	(14.80)	0.00	
Weight:				
400-500 lbs	(40.00)- (15.00)	(25.78)	0.00	
500-550 lbs	(40.00)- (12.00)	(23.12)	0.00	
550-600 lbs	(15.00)- 0.00	(2.80)	0.00	
600-900 lbs	0.00 - 0.00	0.00	0.00	
900-1000 lbs	(15.00)- 0.00	(0.19)	0.00	
1000-1050 lbs	(15.00)- 0.00	(2.36)	0.00	
over 1050 lbs	(35.00)- (10.00)	(22.70)	0.00	
<i>Figure 1: Example of the USDA premium and discount weekly changes</i>				
https://www.ams.usda.gov/mnreports/lm_ct155.txt				

Quality grades	Yield grade				
	1	2	3	4	5
	(\$/cwt carcass)				
Prime	8.00	7.00	6.00	-9.00	-14.00
CAB	3.00	2.00	1.00	N.A.	N.A.
Choice	2.00	1.00	Base	-15.00	-20.00
Select	-7.00	-8.00	-9.00	-24.00	-29.00
Standard	-16.00	-17.00	-18.00	-33.00	-38.00
CARCASS WEIGHTS		OTHER			
550-900 lb		Base (105.00)	Dark Cutter, etc.		-25.00
			Bullock/Stags		-25.00
Less than 550 lb		-19.00			
More than 900 lb		-19.00			

Figure 2: An example of a pricing grid used to calculate prices per hundred-weight
<http://agrilife.org/agecoext/files/2013/10/rm1-11.pdf>

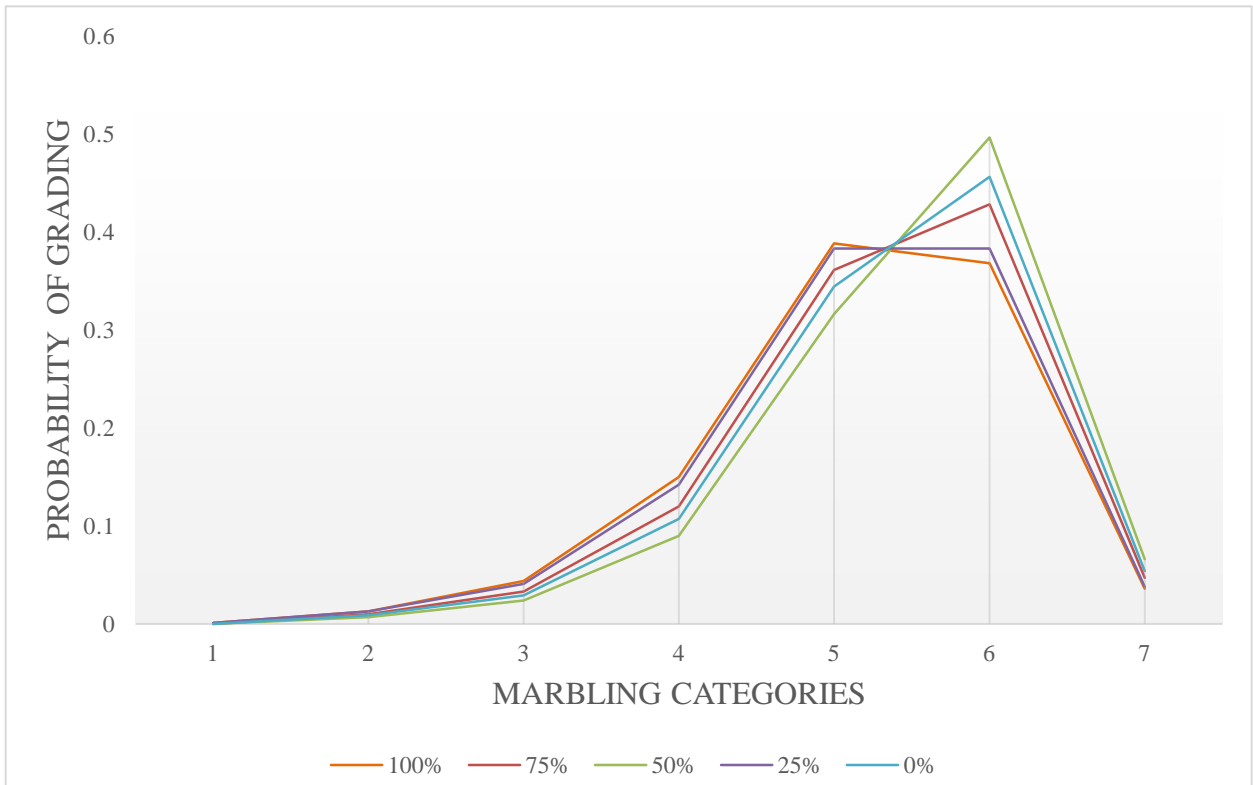


Figure 3: Effect of percent Angus in pedigree on probability of Marbling Score

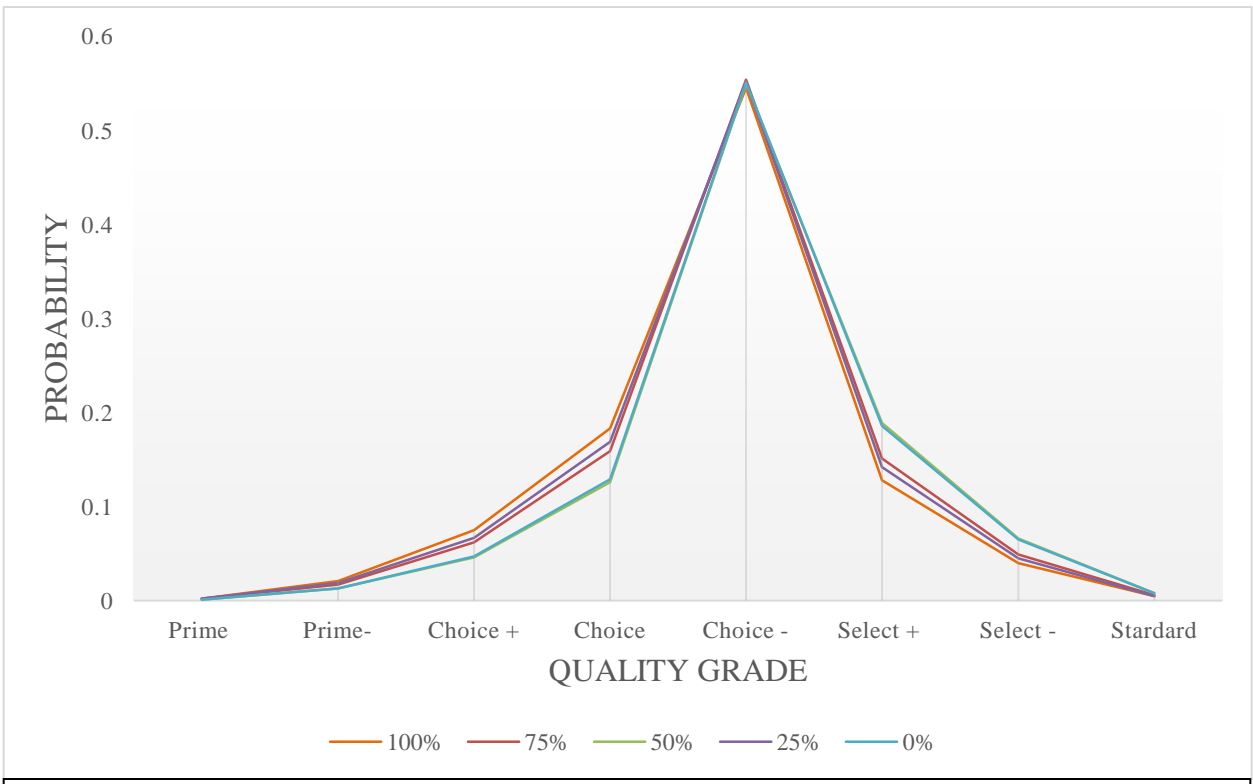


Figure 4: The effect of percent Angus in pedigree on probability of Quality Grade

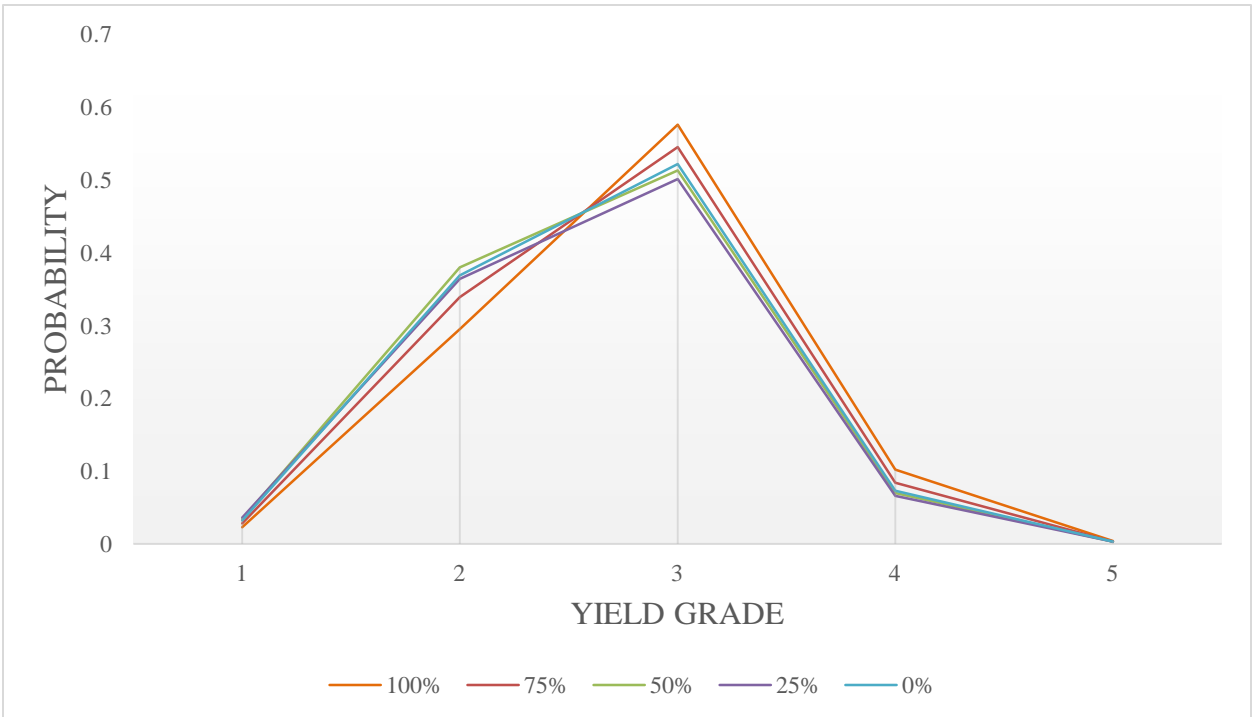


Figure 5: Effect of percent Angus in pedigree on probability of Yield Grade