Profitability in Marketing Bred Heifers in Alabama

by

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Abstract

In 2018, the inventory of cattle in the United States was of 94,298,000, from which almost the 7% (6,260,000) came from the Southeast (Alabama, Kentucky, Mississippi, and Tennessee) (USDA-NASS). Most cattle producers in Alabama have cow-calf operations that produce calves to be sold as stockers or directly to feedlots in the Midwest. Alabama ranks 8th in the U.S. for the total number of farms with beef cattle, so profitability in cattle marketing is important for the sustainability of Alabama's diverse agricultural industry While previous literature has focused on the value of feeder cattle physical characteristics in marketing decisions, there have been fewer studies on the characteristics that influence replacement/bred heifer prices. Breeding decisions are inputs in cow-calf production and important to the profitability of cow-calf operations. Therefore, there is a need to study the characteristics of bred heifers/cows that buyers value in order to provide information that can inform producers' marketing and purchase decisions. Some of the characteristics of replacement cows are easily visible such as hide color, whether the cows have horns, and lot size; other characteristics are not as easily visible, such as the seller's reputation, the calving range of the lot, and the specific breeds within the lot.

The goal of this paper is to determine (a) if there are reputation effects involved with bred heifer sales, (b) the characteristics that bring a premium or a discount to the final price of heifers, and (c) how the reputation effects compare with the effects of other characteristics. We analyze data from the Herdbuilder Replacement Female Sale that takes place in Uniontown, Alabama in August each year. The dataset is an unbalanced panel of 55 producers selling 749 pens of 3-5 replacement heifers per pen, spanning years 2008-2017. We use a Hedonic pricing model to analyze the values of various bred heifer characteristics.

Results indicate that Alabama producers need to take into consideration some key characteristics, which may make bred heifers more costly when purchasing replacement cows or may bring more value when marketing them. We provide a first look into reputation effects in replacement cattle markets, quantifying the benefits to producers of developing a good reputation among area cow-calf producers. According the analysis we found the variation in producer reputation effects, ranged from a discount of 11% to a premium of 56%, with an overall average premium of 20%. We also identified characteristics that producers in the south value, which may be different than those in the midwest where most of the previous studies focus due to data availability. For example, the Hereford Brahman mix heifers (also known as F1 Tigerstripe) receive a significant premium of 13%-14% compared to the other cattle in this sale. Producers who focus

on creating a good reputation, choosing quality breed types which suit the southern climate, use Artificial Insemination (AI) to make calving dates more predictable, and put together uniform pens of cattle obtain some of the largest premiums when marketing heifers as replacements.

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Table of Contents

List of Tables

List of Figures

1 Introduction

The south was once considered the poorest beef-producing region of the nation, in 1870 the inventory of cattle was of 31,082,000 from which almost 9% (2,761,000) came from the Southeast (USDA-CAHA). However, today this area has become a very promising cattle production area. In 2018 the inventory of cattle in the United States was of 94,298,000, from which almost the 7% (6,260,000) came from the Southeast (Alabama, Kentucky, Mississippi, and Tennessee) (USDA-NASS). An increases in beef production for this area has been stimulated by the expansion of improved pastures and by the utilization of Brahman blood for bred-in resistance to heat and insects (Turner 1995). Hereford, Angus, Shorthorn, and Charolais cattle have all been crossed with the Brahman.

The USA beef herd consists of more than 80 breeds and crosses, reflecting the diversity of environments in which they are produced. According to the National Pedigreed Livestock Council most recent report on breed registrations, breed associations with the greatest number of members registrations were Angus, Hereford, Simmental, Red Angus, Charolais, Gelbvieh, Brangus, Limousin, Beefmaster, Shorthorn, and Brahman. While this list gives some sense of the diversity of cattle types in the U.S., most cattle fed for slaughter actually are crossbreds, with 60% or more having some degree of Angus influence. Heifers constitute approximately 28% to 30% of beef supply in the USA fed in feedlots (Drouillard, J. 2018).

Commercial cow-calf producers maintain cowherds and raise calves from birth to weaning. Under ideal conditions, each cow is expected to produce one calf annually. Calves are the primary source of revenue for the commercial producer as well as the source of heifers to replace breeding cows that are culled (slaughtered). The yearling-stocker operator is responsible for adding weight to weaned calves prior to their shipment to feedlots for additional weight gain prior to harvest. The calves are usually yearlings (12-20) months of age by the time they enter the feedlot. Feedlots are confinement-feeding operations where cattle are fed primarily finishing (high-energy) rations prior to harvest (APHIS-USDA, 2011).

Seed stock breeders, sometimes referred to as purebred breeders or registered breeders, are specialized cow-calf producers. Seed stock breeders are predominantly responsible for identification and propagation of genetics that contribute to the profitability of the industry. The breeders sell breeding animals to commercial cow-calf producers. An operation's choice of breed is important in developing a production and marketing program that can best serve the commercial producers in any given area.

Price is expected to vary among lots of feeder cattle depending on the level and types of characteristics associated with a particular lot of cattle. Price premiums and discounts ultimately reflect how lots of feeder cattle are expected to perform at the feedlot. In the current economic environment, it is critical that cattle producers make management decisions based on the best information possible. It is important that producers understand the relationship between pricing, genetic management, and marketing decisions as this can increase an operation's sustainability and profitability. Cow-calf producers, breeders and, stocker operations have long been interested in the impact that various physical and market characteristics have on feeder cattle and calf prices.

Several previous studies have reported the existence of a significant relationships between feeder cattle prices and the physical and market characteristics associated with the cattle (Bailey and Peterson, 1991; Faminow and Gum, 1986; Lambert et al., 1989; Mintert et al., 1988; Sartwelle et al., 1996a, b; Schroeder et al., 1988; Ward et al., 2005). The most common factors used to determine characteristics of demand for cattle are frame size, flesh condition, weight, and outside market factors occurring simultaneously during the cattle transaction (Bailey, Brorsen, and Fawson, Faminow and Gum; Lambert et al.; Buccola; Schroeder et al.).

While early studies have focused on the value of feeder cattle physical characteristics, there have been fewer studies on the characteristics that influence replacement/bred heifer prices. Breeding decisions are inputs in cow-calf production. Cattle producers pick the breed that best fits their operation. Heifers sold as a replacements can be marketed after being bred, or may be marketed as open for breeding. The goal of the cow-calf producer purchasing a replacement heifer is to get the highest premiums for calves that the heifer produces when selling to feedlots to be finished and harvested. Research on replacement cow price determinants provides sellers with information about which characteristics buyers find more desirable (Mitchell et al. 2017). Some of the benefits of buying replacement heifers as opposed to raising them might be expand herd or change a breeding program in less time, may be able to buy genetically superior heifers, and sometimes may cost less to buy than raise (Schulz and Gunn, 2014).

Research regarding feeder cattle sales has also focused on the role a seller's reputation may play in cattle marketing (Turner et al., 1993, Schulz et al., 2015). When important information about the product is missing to buyers, seller reputation is a natural market signal of quality (Shapiro, 1983). Therefore, the seller will try to build and maintain a good reputation through the years thus the buyers will have some information about the product. Information asymmetry is especially important in bred heifer sales because the buyer does not have all the information about the heifer they are buying. Thus, it could end up being a bad long-term investment.

The principal objective of this research is to determine the value of bred heifer characteristics in a cow-calf operation. Specific objectives are to determine (a) if there are reputation effects involved with bred heifer sales, (b) what other characteristics could bring a premium or a discount to the final price of heifers, and (c) how the reputation effects compare with other characteristics.

2 Literature Review

There are several factors determining the price of cattle on U.S that have been studied, mostly concentrated on feeder cattle and just a few on replacement cows. First, we outline some of the previous research on feeder cattle which analyze the effects of the following characteristics on price: weight, horns, muscling and frame size, breed and color, location, sale order, cow age, and lot size. Then, we discuss previous literature that analyzed bred cow characteristics such as: color and cow quality, weight, location and seasonality, cow age, and months bred. Before moving into the analysis, we discuss literature surrounding producer reputation effects.

2.1 Feeder Cattle

Faminow and Gum (1986) used data from individual feeder cattle sale lots (May 1984 and 1985) at the Gila and Mohave County cattle association sales in Arizona. Data from over 400 lots were collected. Lots containing bulls and fewer than five head were discarded from the data. Thus, 368 usable sale lot observations were used for the analysis. A price discount model for feeder cattle was explicitly designed to explore price premiums and discounts based on cattle type (sex), weight, and lot size. Nonlinear price discounting relationship for weight and lot size are directly modeled.

Schroeder et al (1988) used data collected from seven weekly Kansas feeder cattle auction markets.

The date, location, time of sale, price, average weight per head, health, muscling, condition, fill, frame, size, sex, breed, presence of horns, and lot uniformity. The fall data were collected from October 31, 1986 through December 13, 1986, and the spring data were collected from March 19, 1987 through April 15, 1987. The data set included 17,121 lots of cattle consisting of 138,027 head. The analysis was performed on four different categories of cattle separated by sex and weight. A hedonic-pricing model was used suggesting that feeder cattle prices should be a function of the physical characteristics of the cattle in the lot and fundamental market forces.

Lambert et al. (1989) data were collected over ten-week period from late September to early December of 1981 in Kansas. Prices were below levels generally considered profitable and marketing's were lower than expected. Data gathered for each lot-included price, weight, time of sale, sex, breed, horns, frame, muscle, fleshing, health, fill, and lot size. A regression model was estimated incorporating the data with interaction effects for some of the variables.

Coatney et al. (1996) used data from sale catalogs and the SLA (Superior Livestock Satellite Video Auction), sales slip for each lot sold. The data were collected from 28 sale dates in 1992 and consisted consisted of 2,441 sale lots and 790 no-sale lots (28 sale dates in 1992). Cattle age rather than weight was used to separate types of feeder cattle. In order to develop the price expectation for inputs variables, Oklahoma City and Omaha prices for various weight classes were used. This dataset incorporates sale data, delivery data, and seasonal cash price indices for various weight classes for cattle ranging from 400 to 1,200 pounds. A hedonic price model was used to identify characteristics that might be associated with the pricing decisions of feeder cattle buyers.

Parish et al. (2017) collected data from May 5, 2014 to May 4, 2015, at four unique auction markets within Mississippi that sold cattle publicly at weekly sales. Data were collected on 21,128 calf sales lots, representing 21,879 calves sold. A hedonic model is used, and this analysis accounts for market location effects to ensure reliable estimates of the traits of interest.

2.1.1 Effects of Weight

Typically the price per pound falls when weight increases because younger cattle grow faster than do cattle approaching slaughter weight. Coatney et al. (1996) found that weight had a positive and statistically significant, but small, direct impact in prices. Schroeder et al. (1988) found that weight had a nonlinear impact on the feeder cattle price ($/cwt). Price per unit decreases at a decreasing rate with increasing calf weight. In general, the price/cwt declined as weight increased across many studies (Faminow and Gum 1986; Menzie, Gum, and Cable 1972).

2.1.2 Effects of Horns

Cattle retaining horns may be more likely to injure other cattle, particularly during transport, handling or feeding in close quarters, because of this, cattle with horns are typically discounted compared to de-horned cattle. Pens of animals with mixed horns brought about $0.40 more per hundredweight than those with horns (Lambert et al. 1989). Lot of dehorned animals brought about $0.63 more per hundredweight than those with horns (Lambert et al. 1989). Parish et al (2017) found that horned calves were discounted compared with polled or dehorned calves. This result is in agreement with literature; discounts for horns have been documented numerous times in the past (Bulut and Lawrence, 2007; Troxel and Gadberry, 2013; Mallory et al., 2016).

2.1.3 Effects of Sex

The sex of feeder cattle being marketed is very important in determining auction price. Previous research has reported that steers receive a greater price per hundredweight than heifers (Avent et al., 2004; Troxel and Gadberry, 2013; Williams et al., 2014). Lambert et al., 1989, found that steers brought $6.85 more per hundredweight than heifers. This is similar to what found Hawkes et al., 2008, heifers were discounted $9 per hundred weight compared to steers. The price difference may be a result of heifers growing less efficiently than steers; heifers also have smaller carcass weight (Hawkes et al. 2008).

2.1.4 Effects of Muscling and Frame Size

According to previous studies, prices differentiation between heifers and steers was greater for heavy muscled animals than for medium muscled ones (Schroeder et al., 1988; Turner et al., 1991; and Zimmerman et al., 2012). This may be because large frames are a desirable trait for breeding stock, whereas heavy muscling is more desirable for slaughter animals. Medium or light cattle received discounts of 5% to 9% compared with heavily muscled cattle (Schroeder et al. 1988). Lambert found that heavily muscled cattle brought $1.40 more per hundredweight than medium muscled ones. Schroeder et al. (1988) found that discounts for small frames appeared to be greater for heifers than for steers, however, light muscled steers were discounted more heavily than heifers. The different frame size and muscling discounts for steers and heifers reflect the fact that some heifers are being purchased for breeding. At this point, their value would only reflect potential feedlot growth and value at slaughter. According to Parish et al., (2017), the sale price in \$/cwt for large and medium framed calves were comparable. However, small framed calves were discounted. These results are consistent with previous research; small framed calves are significantly discounted relative to their medium and large counterparts (Schroeder et al., 1988; Turner et al., 1991; and Zimmerman et al., 2012).

2.1.5 Effects of Breed and Color

Cattle breed influences the productivity of cattle whether in the feedlot or as breeding stock. Thus, it has an influence on price. Previous research has indicated that producers use hide color rather than breed to distinguish between classes of cattle (Bulut and Lawrence, 2007). The breed category had the largest indirect price impact, particularly for the Holstein and Holstein-English crosses (Coatney et al. 1996). However, Schroeder et al. (1988) found that small premiums were realized for the white-faced crosses relative to Herefords. This result is similar to what Lambert et al. (1989) found: Hereford crosses had a rate of price decrease per hundredweight smaller than pure-breed Hereford. Williams et al. (2012) found all other hide color classifications received discounts relative to black-hided calves. Bulut and Lawrence (2007) report a premium of \$3.34 per hundredweight for black-hide relative to non-black feeder cattle. Similarly, Leupp et al. (2009) estimate a premium of \$3.48 per hundredweight for black calves sold in the fall compared to non-black calves sold in the fall.

2.1.6 Effects of Location

Transportation costs will affect prices because most auctions are located in the urban areas of a state, therefore commercial feedlots with highest prices are the ones in close proximity to the rural areas of a state (Lambert et al. 1989). The difference may reflect the cost of transporting cattle from the more rural areas where the majority of cow-calf operations are located. According to Lambert et al. (1989) the difference in prices from the location with the lowest price and the highest price are over \$4.00 per hundredweight.

2.1.7 Effects of Sale Order

Previous literature has found conflicting effects of sale order on the price per hundredweight for feeder cattle. Kuehn (1979) found sale order to be a significant, but no a strong, influence on price, with sale price higher in the last third of the sale. Schroeder et al. (1988) found that cattle sold in the second and third quarters of the sale received from $1 to $2 per hundredweight premiums versus cattle sold in the first quarter. On the other hand, Lambert et al. (1989) found that the best prices are obtained in the first and second quarters of the auction, and then fall steadily after that.

2.1.8 Effects of Age

Typically age has a significant decrease impact on the price received for feeder cows. Coatney et al. (1996) found that older animals get a discount, because the cost of gain in the feedlot tends to be higher.

2.1.9 Effect of Lot Size

Cattle are normally transported in large semi-trucks; truckload-sized lots of cattle may be worth a premium to the buyer because of reduced transportation cost per head. Once lot size has reached the maximum capacity for transport, transportation costs increase significantly. Faminow and Gum (1986), Davis et al. (1976) and Kuehn (1979) found that prices per cwt increases with lot size, until the point at which maximum truckload size has been reached. The maximum premium for lightweight cattle was for lots of 45 to 50 head, with premiums of $6.50 per hundredweight for steers and $6.15 per hundredweight for heifers, compare to single-head lots (Schroeder et al. 1988). The highest premium for heavier cattle was for lots of 55 to 65 head, with premiums of $4.25 per hundredweight for steers and $5.24 per hundredweight for heifers, relative to single-head lots (Schroeder et al. 1988). However, the price increases at a decreasing rate as the number of head increases (Lambert et al. 1989). The results found by Parish et al., (2017) suggest that there is a progressive price incentive to market calves in large lots. Hedonic analysis of feeder cattle prices has consistently shown a nonlinear effect for lot size in which prices increased at a declining rate. (Bailey and Peterson, 1991; Coatney et al., 1996; Zimmermen et al., 2012; Williams et al., 2014).

2.2 Bred Cows

Mitchell et al. (2017) used data from U.S. Department of Agriculture (USDA)-AMS bred cow reports. The final data set includes 776 weeks composed of 14,811 bred cow lots from January 5, 2000, to May 21, 2015. The price of a bred cow lot ranges from $330/head to $3,400/head. Weight ranges from 700 lb to 1,700 lb. Fifteen auction markets were selected based on location and size as a representative sample of the 77 licensed Kansas livestock markets. A Hedonic pricing model as used to analyze the effects of age, weight, months bred, hide color, sale location, corn and feeder futures prices, and quality on price.

2.2.1 Effects of Color and Cow Quality

In Mitchell et al. (2017), cow quality was determined by visual inspection and has breeding, calving, and health implications. Producers purchasing bred cows tend to pay significant premiums for high and high-average quality cows. High and high-average quality bred cows garnered premiums of 14.81% and 8.67%, respectively. Heavy discounts are assigned to cows perceived as low quality; the respective discount for low-quality cows was 13.78%. Lower quality may be a function of factors that cannot be changed but may also reflect management of the cow (Mitchell et al. 2017).

The only hide color reported for bred cows in AMS is black. As expected, according to previous literature (Bulut and Lawrence, 2007, Leupp et al. 2009) black cows brought a premium of 6.86% relative to non-black cows (Mitchel et al., 2017).

2.2.2 Effects of Weight

In order to maximize pregnancy rate the body weight at breeding time should be 65% of mature body weight (Mark, 2014). In other words, if the average cow weighs 1,400 lb. a heifer would optimally weigh 910 lb. at breeding time. Mitchell et al. (2017) found that cows weighing between 1,601 and 1,700 lb. receive the greatest premium of 14.58% compare to cows weighing between 901 to 1,000 lb. Although the cows are marketed as bred, some could be purchased for slaughter, because the extra weight would be valuable. Research on feeder cattle has identified smaller cows as receiving higher premiums, but Mitchell et al. (2017) found that buyers place the greatest value on heavier cows for bred purposes.

2.2.3 Effects of Location and Seasonality

Mitchell et al. (2017) found, bred cows sold in location closer to Oklahoma City receive a premium of 6.67% compare to 2.03% that further locations receive. The difference may reflect the cost of transporting cattle to the more rural areas where the majority of cow-calf operations are located. Buyers place the greatest value on cows sold in February and March. Prices are lowest in summer and fall months because producers are more likely to cull their herds in this period.

2.2.4 Effects of Age

First-calf heifers have a longer useful life than older bred cows, which results in a premium price. Mitchell et al., (2017) find that age has a significant impact on the price received for bred cows, bred heifers of 1 year old bring the greatest premiums; 3.44% higher compared to 3-year-old heifers. Eight and nine-year old bring a discount of 10.93% and 15.79%, respectively, compared to 3-year-old heifers.

2.2.5 Effect of Months Bred

Buyers pay the highest premiums for 8-month bred cows. There is less risk of losing a calf and lower production costs prior to the calf's birth, and revenue is received more quickly when producers purchase late-gestating cows. Early and mid-gestating cows bring discounts compare to late-gestating cows (Mitchell et al. 2017).

2.3 Producer Reputation

Producer reputation may have a positive or negative impact on prices, the effect on prices will depend on the kind of reputation that the producer has. Seller reputation has been documented for pure-bred bulls, but due to data availability.

Turner et al. (1993) used data from Georgia teleauctions during 1977 to 1988. The bid prices for teleauctions feeder cattle are based on written information about cattle, lot, delivery characteristics, and some markets conditions. Information was better and more complete in one of the tele-auctions than the other two. The two teleauctions that had less information of cattle characteristics and health treatments. The objective was to determine the possible impact of seller's reputation on price.

Schulz et al. (2015) data collected from December 2008 to February 2014, data included individual lots of feeder calves sold through one preconditioned sale and eleven regular auction sales occurring the week of and the week following the preconditioned sale. Data collected include price, lot size, gender, frame size, and muscles scores. The objective of this study was to determine whether a seller reputation exists for calves sold at a preconditioned sale.

Producer reputation have a positive or negative impact on prices, the effect on prices will depend on the kind of reputation that the producer has. Seller reputation has been documented for pure breed bulls, but there a few considered for feeder cattle due to data availability. Schulz et al. 2015 found that 21% of the lots in the sale received prices that were statistically different (18% higher and 3% lower) indicating that for some producers the seller reputation does exist. Turner et al. (1993) found that seller reputations are more likely to exist in markets that transfer less information to buyers. This result is consistent with Shapiro's comment "The idea of reputation makes sense only in an imperfect information world" (Shapiro, 1983).

3 Data

Sales data for this research are from the Herdbuilder Replacement Female Sale, a bred heifer auction held annually in Uniontown, Alabama. The dataset spans sale years 2008 through 2017 and is an unbalanced panel of 749 lots sold by a total of 55 producers. Lots typically consist of three to five bred heifers.

The bred heifer lots are auctioned based on a price per head for all the heifers in the lot, so the lots are grouped by the sale organizers and producers for uniformity. Each heifer within a lot included information regarding price, pen, producer, breed, color, sale order, calving range, and reproductive techniques. The data for this study had to be aggregated to the lot level. The following paragraphs discuss our aggregation methods. Variable definitions and summary statistics for the data are provided in Tables 1 and 2.

$Price$ is the average price per head for the lot of bred heifers. We used a price deflator in order to convert prices from all years to 2017 dollars. For each heifer, the producers provided an expected calving range for the time period that they expected that a heifer would calve based on their breeding practices. The length of calving range and months of the year will vary by producer based on whether they're on a spring or fall calving schedule, and whether they use Artificial Insemination (AI) or conventional breeding. Typically, using AI methods results in a smaller expected window of calving due to the producer having more control over the breeding process. We aggregated the corresponding variables as follows: $CRange$ represents the average expected range in days that the bred heifers within a lot could calve. $MBegin$ measures the first possible month calving is expected after the sale for the lot of bred heifers. $MBegin$ values range from 1 to 12, with 1 representing September calving (one month after the sale) and 12 representing calving in the following August. There were no pens that included mixes of AI and conventionally bred heifers, therefore $AI/Conv$ is 1 if the lot was AI and 0 if the lot was conventionally bred.

$PColor$ indicates whether the lot was uniform in hide color or contained heifers of different colors. $PColor$ is 1 if all heifers in the lot are the same color or 0 if they are mixed. $Black$ represents the percentage of heifers within the lot that were black-hided. $SaleO$ measures the order in which the lots were sold during the sale. $LotSize$ measures the number of bred heifers sold in each lot.

Lots are grouped together based on uniformity, however there could be slight differences in the breeds that are marketed together. Table 3 shows specific breeds that represent at least 1% of the total number of heifers in the dataset. The variable $PBreed$ measures the breed variability within a lot. $PBreed$ is 1 when the lot is the same breed and 0 when the lot is mixed. $Regist$ represents a dummy variable that can take values of 1 if the pen (specific breed) is registered with their purebred breed association and 0 otherwise.

Table 2 shows the minimum, maximum, average and the standard deviation of the variables in the model. The average price is $1843 per heifer with a max of $3792 and a min of $1117, three heifers per lot on average with a max of 20 heifers and a min of one, 85 days of calving range on average, with an average expected begin month of two months after the sale (October). 80% of the lots were bred conventionally. 71% of heifers marketed were black-hided, and 76% of lots were of the same color. 60% of lots were the same breed, and 1.7% of lots were registered with the official breed organization.

Table 1: Description of Variables Used in Analysis

Variable	Definition	Expected Sign
Price	The average price per head of lot ($/head)	
CRange	Average length (in days) of expected calving time period	(-)
MBegin	First possible month calving expected in relation to sale	(-)
	(1=September of sale year, ...8=April of sale year+1)	
Black	Percentage of black cattle in lot	(+)
PColor	Hide coloring in lot	(+)
	0=Mixed hide colors, 1=Same hide color	
AI/Conv	Reproductive practice used	(-)
	0=Artificial Insemination, 1= Conventional	
Regist	Registered breed cattle	(+)
	0=Not registered, 1=Registered	
SaleO	Sale order number for lot	(-)
LotSize	Number of heifers in lot	(+)
Breedvar	Variability in breed within lot	(+)
	1=All heifers same breed, 0=Heifers differ in breed	

Table 2: Summary Statistics of Herdbuilder Replacement Female Sale Dataset, 2008-2017

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
Price	749	1,842.740	429.410	1,116.957	1,539.096	2,050.000	3,792.004
LotSize	749	3.335	1.328	1	3	4	20
CRange	749	85.041	17.340	24	77	92	153
MBegin	749	2.263	1.431	1	1	3	8
PColor	749	0.760	0.428	0	1	1	1
Black	749	0.714	0.403	0	0.5	1	1
AI.Conv	749	0.792	0.406	0	1	1	1
SaleO	749	38.359	22.505	1	19	56	96
Regist	749	0.017	0.131	0	0	0	1
Breedvar	749	0.595	0.491	0	0	1	1

4 Empirical Model

Prices reflect supply and demand conditions in a given market at a point in time. For any auction, supply is fixed in the short run and a set of bred cow characteristics determine the prices. From Ladd and Martin (1976), the demand for an input is influenced by the characteristics of the input itself, which allows price to be a function of physical characteristics. Much of the previous literature showing the value of feeder cattle characteristics used the Hedonic method (Bailey, Brorsen, and Thomsen, 1995; Dhuyvetter et al., 1996; Mintert et al., 1990; Parcell, Schroeder, and Hiner, 1995; Schroeder et al., 1988; Williams et al., 2012; Zimmerman et al., 2012). Similarly, the price of a lot of bred cows can be specified as a function of physical characteristics, formulated as follows:

$$Price_{ikt} = \beta_0 + \sum_j \beta_j X_{ikjt} + \epsilon_{ikt} \tag{1}$$

Where i refers to a lot of bred heifers sold in year t from some producer k with specific characteristics j, β_j is the marginal value of j^{th} characteristic, Equation (1) states that the price per head equals the sum of the marginal implicit values of each lot's characteristics times the yield of each characteristic (Ladd and Martin, 1976).

The idea of reputation makes sense only in an imperfect information world (Shapiro, 1983). When relevant information about the product is missing prior the purchase, consumers will use historical records of quality of the producers products to determine present or future quality (Turner et. al, 1993). In other words, when a producer makes the decision of producing high quality items; the

Table 3: Common Breeds in Herdbuilder Replacement Female Dataset, 2008-2017

(Sire Breed)	(Dam Breed)	(#Heifers)
SimAngus	SimAngus	483
Brangus	Brangus	176
Angus	Angus	164
Angus	Brangus	141
Angus	SimAngus	126
Brangus	Angus-Others	121
Herford	Brahman	93
Simmental	Angus	80
Simmental	Simmental	77
Brangus	Brangus-Other	76
SimAngus	Angus	72
Simmental	SimAngus	71
Angus	Brangus-Simmental	55
Angus	Simmental	53
Brangus	Brangus-Simmental	52
SimAngus	Simmental	45
Angus	Brahman	45
Angus	Braford	42
Simmental	Brangus-Simmental	39
Brangus	SimAngus	38
Angus	Other	35
SimAngus	Brangus-Simmental	34
Brahman	Angus	33
Angus	Angus-Other	26
Angus	Brangus-Other	25
Brahman	Angus-other	25
Other	Other	237
Total		2498

Note: Breeds representing 2% or more of total heifers sold.
Note: Ang: Angus, Her: Herford, Bra: Brahman, Sim: Simmental

Table 4: Summary of Effects of Characteristics Affecting Cattle Prices Found by Existing Literature

Papers	SO	LS	AI/CV	R	B	MB	PC
Lambert et al (1989)	-$0.68	$0.08					
Schroeder et al (1988)	$2.00	$6.15					
Parish et al (2017)	$0.02			$0.02			$0.165
Parcell et al (2006)	55-70%	$26.54	$18.69			$23.69	
Hawkes et al (2008)		$1.29					
Mitchell et al (2017)					6.86%	3.66%	
Bulut and Lawrence (2007)		$12.43			$3.34		$3.06
Leupp et al (2009)					$3.48		
Turner et al (1993)	-$0.06						
Pinto et al (2020)	-$1.24***	$24.97*	-$65.34*	$174.46**	-$28.69	-$60.48***	$38.92***

Note: *p<0.1; **p<0.05; ***p<0.01

Note: Lot Size look at $/head; while the other variables look at $/cwt.

SO: Sale Order, LS: Lot Size, AI/CV: Artificial Insemination vs Conventional, R: Register, B: Black, MB: Month Begin, PC: Pen Color

benefits of doing so would increase in the future through the effect of building up a reputation. In this context, reputation formation is a type of snowballing activity: the quality of items produced in the past serves as a signal of the quality of those produced during the current period. Producer reputation may have a positive or negative impact on prices. These will depend on the kind of reputation that proceeds the producer.

However, a seller must initially invest in his reputation through the production of quality products if he chooses to enter to the high quality segment of the market. Until producer reputation is established, he cannot establish those prices associated with high quality items. This means that during this investment period the seller must sell his product at less than cost (Shapiro, 1983) .

Following Turner et al. (1993) and Shapiro (1983), we adjust equation (1) to measure the impact of the reputation (R) of the producer (k) at time (t) is as follow:

$$Price_{ikt} = \beta_0 + \sum_j \beta_j X_{ikjt} + \sum_k m_k R_{kt} + \epsilon_{ikt} \tag{2}$$

Where m_k refers the price impact of the producer's reputation and $R_{kt} = q_{kt-1}$, i.e., the producer's reputation in year t is based on quality supplied in year $t-1$.

Equation (2) is estimated to get the marginal value of bred heifer characteristics. Average price per head per lot is the dependent variable in equation (2). Therefore, the empirical model with respect to the Herdbuilder dataset is as follows:

$$\begin{aligned} Price_{ikt} =& \beta_0 + \beta_1 LotSize_{ikt} + \beta_2 {LotSize_{ikt}}^2 + \beta_3 CRange_{ikt} + \beta_4 MBegin_{ikt} + \beta_5 PColor_{ikt} + \\ & \beta_6 Black_{ikt} + \beta_7 AI/Conv_{ikt} + \beta_8 Regist_{ikt} + \beta_9 SaleO_{ikt} + \beta_{10} Breedvar_{ikt} + \\ & \beta_{11} Breed_{ikt} + m_k * R_{kt} + \epsilon_{ikt}, \\ where \quad \epsilon_{ikt} =& \mu_t + \eta_k + \lambda_{ikt}. \end{aligned} \tag{3}$$

The random error ϵ_{ikt} is separated into the following components: μ_t is error associated with yearly supply and demand factors that influence the market, η_k is error due to characteristics associated with the producer k, and λ_{ikt} is the independent and identically distributed random error. The errors ϵ_{ikt} are assumed to be correlated within each producer but independent across pens and years:

$$cov(\epsilon_{ikt}, \epsilon_{jms}) = \begin{cases} {\sigma_k}^2 for\ Producer\ k{=}m, \\ 0\ otherwise \end{cases} \tag{4}$$

Table 1 displays the expected relationship based on previous literature for each characteristic and the price. Table 4 displays the findings from previous studies. Note that the variables or columns that have (*) the amount in dollars represents a changes in the average price per hundred weight. On the other hand, the variables or columns that have (**) the amount in dollars represents a changes in the average price per head. In most of the previous hedonic models for feeder cattle or bred heifers, there is no information on the seller of the cattle. By showing the variations in models, we give information on what those models lack in specification.

The calving range ($CRange_{ikt}$) and month ($MBegin_{ikt}$) are going to be important in a buyer's decision because the bred heifers purchased need to sync with their currently breeding program. Prices are generally expected to be higher for lots in which the calving range is smaller or more precise. Prices are expected to be higher for lots in which the beginning month of the calving range is closer to the month of sale. The closer bred heifers get to calving, the lower the risk of complications associated with calving and the fewer inputs a producer must put into the heifer prior to calving (Mitchell et al. 2017). The use of AI vs conventional breeding ($AI/Conv_{ikt}$) is related to the calving range in that producers that use AI have more control over genetics and a better idea of the specific calving range and month compared with those that are conventionally bred. Thus, AI lots are assumed to get a premium compared to conventional breeding.

The variables $Breedvar_{ikt}$ and $Pcolor_{ikt}$ are measures of uniformity of the lots. We expect that buyers would value more uniform lots, as they are looking for specific characteristics to fit in to their cattle operation. Thus, uniformity in breed and color are expected to result in premiums compared with lots of mixed breed and/or color (Lamber et al. 1989, Williams et al. 2012).

Many previous studies have found price premiums for black-hided cattle due to the potential marketability of Certified Angus Beef (Zimmerman and Schroeder 2011). We expect prices to be higher for the more black heifers that are in the pen ($Black_{ikt}$).

Specific breeds may be valued more than others based on their estimated performance in the southern climate and their calves' future potential in feedlots (Fowler, 1979). We include indicator variables ($Breed_{ikt}$) for the breeds listed in Table 3 that represent over 2% of the heifers sold to control for price effects associated with a specific breed. The term purebred refers to genetic uniformity of all characteristics; in cow-calf operations is important to have knowledge of breed characteristics. Additionally, buyers may value a lot that is registered with its purebred association. Thus, lots sold with registration may result in higher prices ($Regist_{ikt}$). These associations help producers by adding value to feeder calves through information documentation and to match calves with the most advantageous marketing channels based on their particular attributes (Falko et al. 2001).

From conversations with those who run the auction, we know that sale order is a proxy for bred heifer quality because typically higher quality pens are put in line to be sold earlier in the auction. Sale Order ($SaleO_{ikt}$) is expected to have a negative impact on prices through the decrease in quality during the sale.

Typically in studies of feeder cattle, the size of a lot ($LotSize_{ikt}$) increases price until the truckload limit, at which point price would decrease (Faminow and Gum 1986, Davis et al. 1976, and

Kuehn 1979). Most of the lots in this sale range from three to five heifers, so we expect prices to increase with larger lots. We include a squared term for lot size similar to previous studies (Faminow and Gum 1986, Davis et al. 1976, and Kuehn 1979) to assess if there is an optimal range in lot size.

We include $Year$ as a categorical variable to control for market conditions in each year. Some years in our sample, i.e., 2014 and 2015, included abnormally cattle high prices, so a linear trend does not make sense in this context.

We include dummy variables for producers who sold in more than one year following (Turner et al. 1993). This provides a measure of the average reputation effects of a producer in comparison to producers who have not developed reputation effects, i.e., sold in only one year of the sale. We included only producers selling in more than one year because it takes time and money to develop reputation (Shapiro, 1983). There were 26 producers who sold in two or more years. However, it may be the case that some producers may have already participated in the Herdbuilder sale prior to the beginning of our dataset, therefore having reputations established already, or producers may have their reputation developed in other sales in the area. So we include an additional specification in which dummy variables for all producers are included. This is the method for estimating reputation effects used by Dhuyvetter et al. (1996). We selected the default producer as the producer who had an average price per head closest to the overall average for the sample.

5 Results

Table 5 displays the regression results using cluster robust standard errors by producer to control for the variation described in equation 4. Five different regressions were run to show the explanatory power of the effects of producer reputation and breed. In particular, reputation effects will control for some production practices, particularly breeding decisions (AI vs conventional, calving season, etc.) as well as breed choices. By showing regressions with and without the reputation effects, we explore the impacts reputation effects have on the on the production practice coefficients.

The R^2 and adjusted R^2 show that regression (5) with all producer dummy variables has the most explanatory power of all the regressions and represents the best fit. Table 6 displays F-tests comparing regression (5) with regressions (1)-(4) which are nested versions of (5). The significance of the F-tests show that model 5 fits the data better than the other models. Regression (4) with both reputation effects and breed fixed effects has a fairly high explanatory power. Looking at regressions (2) and (3), reputation effects seem to add more explanatory power to the model than breed fixed effects, though the regression (1) with no reputation or breed fixed effects still has a fairly large R^2 value (0.71).

Coefficients are fairly robust across all models, for every variable signs stay the same across the models, though effects may decrease due to incorporating reputation and/or breed fixed effects. Particularly, for reproductive management variables (calving range, beginning month, AI vs Conventional breeding) see decreasing effects with the addition of producer dummy variables. This makes sense given producers would typically use the same reproductive practices over time and this may aid in their reputation development.

Table 4 displays our coefficient estimates in comparison to estimates from previous literature. In general, most of our estimates agree with the signs of previous literature, the exception is Black. The coefficient values are discussed more thoroughly in the following paragraphs.

Table 5: Regression results from Hedonic Price Model, Standard Errors Clustered at Producer Level

	Dependent Variable: Average Real Price/Heifer				
	(1)	(2)	(3)	(4)	(5)
LotSize	11.56	20.39	11.96	20.71	24.97*
	(20.96)	(16.76)	(19.28)	(17.07)	(14.87)
LotSizeSquare	−1.09	−1.66**	−0.85	−1.40	−1.56**
	(1.13)	(0.83)	(1.01)	(0.89)	(0.77)
CRange	−1.74**	−0.93	−1.43*	−0.78	−1.45*
	(0.82)	(0.91)	(0.78)	(0.80)	(0.80)
MBegin	−75.18***	−60.30***	−74.66***	−58.48***	−60.48***
	(13.50)	(10.54)	(14.61)	(10.64)	(11.12)
PColor	39.29**	39.64***	28.09	33.02***	38.92***
	(18.09)	(13.56)	(18.97)	(12.76)	(12.06)
Black	−67.69**	−86.34***	−11.02	−36.48*	−28.69
	(34.09)	(32.48)	(21.98)	(21.61)	(23.37)
AI.Conv	−145.68***	−33.99	−133.93***	−33.70	−65.34*
	(51.14)	(37.21)	(43.99)	(33.82)	(37.80)
Regist	15.21	90.12	63.95	105.19	174.46**
	(78.91)	(80.97)	(88.49)	(77.21)	(68.84)
SaleO	−2.09***	−1.43***	−1.90***	−1.25***	−1.24***
	(0.44)	(0.43)	(0.39)	(0.42)	(0.40)
Breedvar	−33.27	−13.51	−74.43***	−50.89***	−36.71**
	(21.16)	(18.72)	(28.02)	(19.57)	(17.76)
Constant	2,153.39***	1,791.71***	2,123.01***	1,780.75***	1,520.07***
	(95.52)	(112.81)	(88.75)	(99.18)	(113.03)
Reputation Effects	No	2+Years	No	2+Years	All Producers
Breed Fixed Effects	No	No	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	749	749	749	749	749
R^2	0.71	0.78	0.73	0.80	0.82
Adjusted R^2	0.71	0.77	0.72	0.78	0.79
F Statistic	95.70***	56.94***	57.83***	45.48***	33.78***
	(df = 19; 729)	(df = 45; 703)	(df = 34; 714)	(df = 60; 688)	(df = 88; 660)

Note: *p<0.1; **p<0.05; ***p<0.01

Table 6: Nested F-tests of Regression Models (1)-(5)

	Res.Df	RSS	Df	Sum of Sq	F	Pr(>F)
Model 5	660	25, 061, 909.00				
(1)	729	39, 472, 312.00	-69	-14, 410, 402.00	5.50	0
(2)	703	29, 695, 358.00	26	9, 776, 953.00	9.90	0
(3)	714	36, 743, 148.00	-11	-7, 047, 789.00	16.87	0
(4)	688	27, 772, 074.00	26	8, 971, 074.00	9.09	0

5.1 Effects of Reproductive Management

As expected, conventionally bred heifers were discounted in comparison to AI heifers. Using the average bred heifer price per head for the dataset, in regressions (5), conventionally bred heifers were discounted 3.5% to AI heifers. The length of calving range has the same sign as we predicted, i.e., an increase in one day in the calving range will decrease average price/head by $1.45 in regression (5). The first month when calving could begin has the expected impact on price. For each additional month after the auction that the lot may begin calving, the average price per head decreases by $60.48. This variable is statistically significant in every model. Using the regression (5) coefficient, this means a fall calving lot of heifers (beginning in September) would on average receive a premium of 19.7% compared with a lot that would begin calving in March.

5.2 Effects of Hide Color and Breed

As discussed by Bulut and Lawrence (2007), producers often use hide color to distinguish breeds. The variables $PColor$ and $Breedvar$ were included in the model to control for uniformity of the lots being sold. As expected, pens of the same hide color received premiums of 2.1% of the average price. Surprisingly, the variation in breed had the opposite effect as anticipated, lots containing the same breed contained discounts to ones with multiple. Though this effect is statistically significant in regressions (3), (4), and (5) when breed fixed effects are included. This finding again supports Bulut and Lawrence that producers may be more concerned with color than specific breeds. Additionally, it may suggest that some breeds are interchangeable to buyers when other desired characteristics have been met.

Increasing the proportion of the number of black-hided heifers in a lot decreased the average price per head of the lot. This is somewhat surprising as it is not consistent with findings of previous studies (Bulut and Lawrence 2007, Leupp et al. 2009, Williams et al. 2012). The significance of this coefficient goes away when breed fixed effects are included in the model, which supports the conclusion of Bulut and Lawrence (2007) that hide color and breed are used interchangeably by producers. Additionally, at least part of the explanation behind the effect of the black hides is that producers in the south often prefer to have some mix of Brahman blood in their cattle. The Brahman breed are ideal for the south due to their heat tolerance and tolerance to fescue toxicosis (Troxel, 2013). For example, the second most common breed in the sample is purebred Brangus cattle, and roughly 45% of heifers sold during this time period had some Brahman influence.

Table 7 shows the coefficients associated with the fixed effects for frequent breeds included in the sale. Many are not significantly different than the other breeds marketed at the sale, with the exception of a couple. Those breeds with a Brangus-Simmental mix Dam and Brangus Sire are discounted roughly 6% when compared to other breeds. This is consistent across regressions (3), (4), and (5) so reputation effects of a specific breeder selling this breed are ruled out. The Hereford Brahman mix heifers (also known as F1 Tigerstripe) receive a significant premium of 13%-14% compared to the other cattle in this sale. The effect of this breed decreases slightly when producer dummy variables are included, suggesting that reputation effects are playing into this to some extent, but there is still an effect beyond a specific producer's reputation. The Brangus sired and Angus mixed Dam breed receives a 5.4% discount compared with other cattle when the reputation effects are not included, though this effect disappears when reputation effects are controlled for. This suggest the discount is primarily attributed to certain producer(s) marketing this breed at the auction.

The effect of a lot being registered with the breed organization had a positive effect as predicted, however there was no statistical significance. This is not surprising giving less than 2% of lots were registered.

5.3 Effects of Quality and Producer Reputation

As predicted, given our knowledge of the sale organization, lots sold later in the auction received discounts compared with lots sold earlier. At the average (and median) sale order number of 38, a lot would be discounted approximately 2.5% from the first lot sold after controlling for breed and producer reputation effects. At the 75^{th} percentile, the discount is 3.7%. This suggests the organizers do a fairly good job estimating quality of lots and position them correctly in the sale lineup, and/ or buyers tend to pay less for lots later on in the sale (Kuehn 1979, Schroeder et al. 1988).

Figure 1 shows the estimated producer reputation effects from regression (4) when only producers selling in two or more years of the sale were included as dummy variables. In this Figure, coefficients are interpreted as premiums/discounts in comparison to producers who marketed in only one year. Figure 2 shows the estimated producer reputation effects for all producers estimated by (5). These coefficients are interpreted as compared to the producer who was closest to the overall average for the sample. The figures show significant variation in producer reputation effects, from premiums over \$1000 per head to discounts of over \$200 per head. As a percentage of the average price for the sample, the reputation effects from model (5) ranged from a discount of 11% to a premium of 56%, with an overall average of 20%. Figure 3 from Model 5 shows that producers that have been in the sale two or more years have higher reputation effects on average. In other words, we can see a clear relationship between the number of years in the sale and premiums that producers can bring.

Table 7: Coefficient Estimates for Common Breeds in Table 4, Models (3)-(5)

Dependent Variable: Average Real Price/Heifer			
	(3)	(4)	(5)
Angus_S:Angus_D	−57.96	−51.30	−34.33
	(36.03)	(32.16)	(34.66)
Angus_S:Brangus_D	−20.25	−21.75	−21.33
	(32.66)	(32.73)	(36.35)
Angus_S:Brangus_Simm_D	28.57	36.16	6.98
	(35.63)	(38.95)	(42.67)
Brangus_Simm_D:Brangus_S	−95.58***	−84.04**	−114.95***
	(30.88)	(39.28)	(36.72)
Angus_S:Sim_D	−0.67	−65.19	−45.08
	(33.68)	(55.30)	(55.55)
Sim_S:SimAng_D	−3.43	13.15	6.73
	(39.91)	(32.38)	(36.97)
Angus_D:SimAng_S	−50.90	−10.46	−3.87
	(31.62)	(12.13)	(11.86)
Brangus_S:Brangus_Oth_D	−12.24	−80.35	−83.61
	(28.77)	(82.16)	(88.12)
Sim_D:Sim_S	−31.20	1.24	17.34
	(49.54)	(58.49)	(56.06)
Angus_D:Sim_S	3.37	−29.60	−72.13
	(39.38)	(50.70)	(50.45)
Her_S:Bra_D	251.64***	231.80***	256.93***
	(49.55)	(33.38)	(48.54)
Brangus_S:Angus_Oth_D	−98.90**	−72.72	−58.89
	(40.46)	(51.34)	(55.92)
Angus_S:SimAng_D	−29.26	−27.76	−48.75
	(22.94)	(38.78)	(35.44)
Brangus_D:Brangus_S	42.54	21.13	53.56*
	(42.57)	(49.01)	(31.25)
SimAng_D:SimAng_S	8.24	−39.45	−20.31
	(52.67)	(41.93)	(42.69)

Note: *p<0.1; **p<0.05; ***p<0.01
Note: _S: Sire Breed and _D: Dam Breed
Note: Ang: Angus, Her: Herford, Bra: Brahman, Sim: Simmental

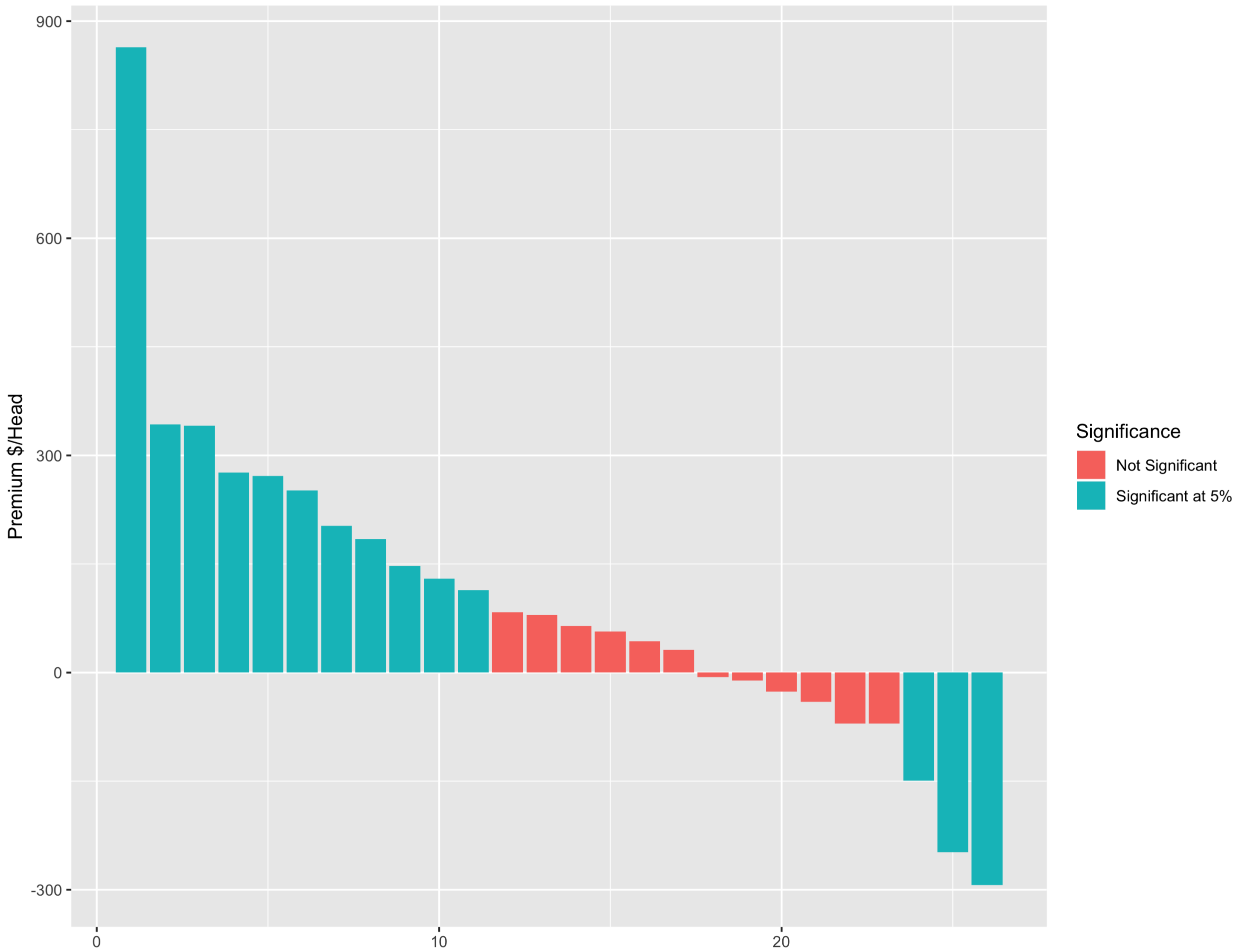

Figure 1: Reputation Effect Coefficients, Model 4

6 Conclusions

Our contribution to the previous literature and cow-calf industry is two-fold: First, we provide a first look into reputation effects in replacement cattle markets, quantifying the benefits to producers of developing a good reputation among area cow-calf producers. Second, we identify characteristics that producers in the south value, some of which are different than those in the midwest where most of the previous studies focus due to data availability.

The first and main insight is the existence of a reputation effect between sellers, and that it can

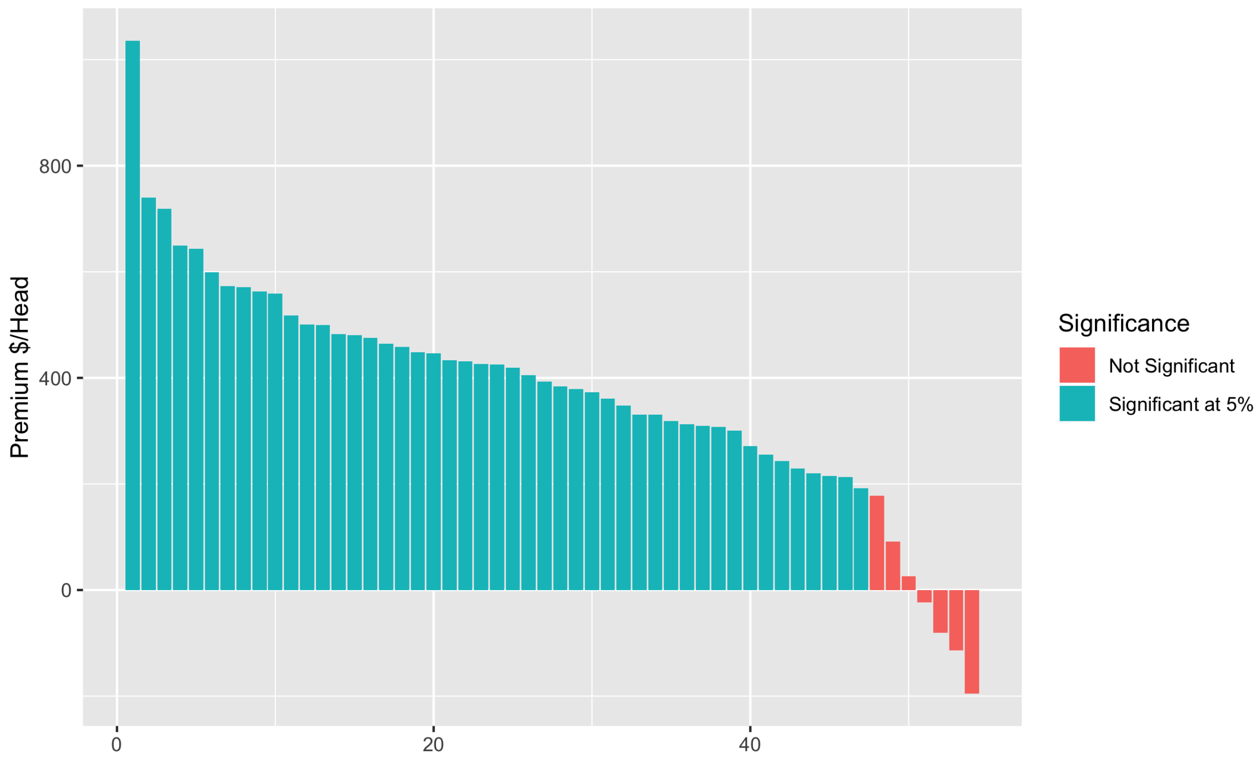

Figure 2: Reputation Effect Coefficients, Model 5

make a premiums over 56% per head to discounts of over 11% per head. The comparison between models with and without breed effects are suggesting the specific breed the producer sells is less important that his/her reputation effect. Regarding the reputation effects, we show econometrically that when researchers do not have information regarding the producers selling bred cattle, controlling for reproductive practices such as calving range, AI, etc. provide some explanatory power though coefficient estimates may be biased. On the other hand, if one has information on the seller, but not all of the specific characteristics on the lot being sold, simply controlling for the seller can encompass reproductive practices that producers in the area may value.

The second insight is that some of our findings conflict with previous literature. The Angus breed is the forerunner in performance for industry, due to their combination of both quality and quantity over other breeds. However, according to our findings the combination of Sire Hereford and Dam Brahman received the largest premiums. This may be a unique characteristic of the specific

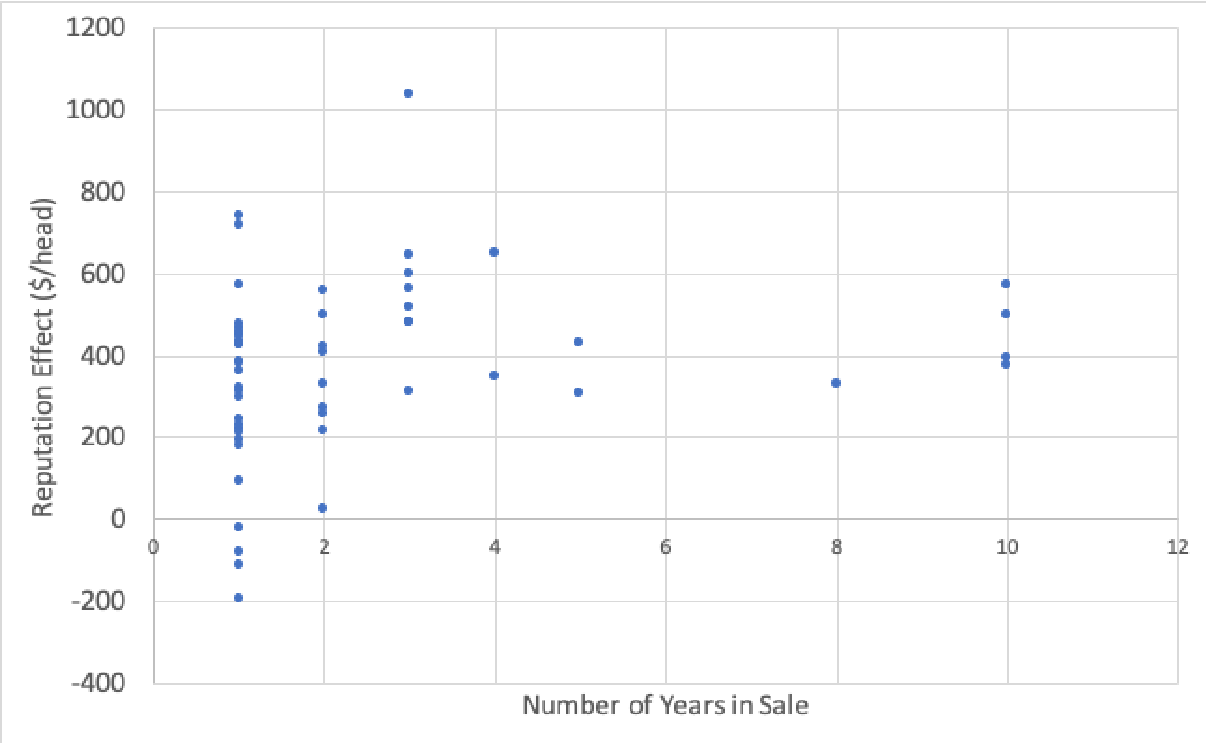

Figure 3: Reputation Effect by Years in Sale, Model 5

sale and region. However, the Brahman influence provides many benefits to producers in the south. Brahman-influenced or crossbred cows with Bos taurus breeding are known for their adaptation to stressful environments, utilization of reproductive heterosis (individuals shows qualities superior to those of both parents), calving ease and maternal care benefits. Also, Brahman cows are ideal for the south due to tolerance to heat and fescue toxicosis, and ultimately enhance longevity in the cow herd. So, even though purebred Brahman and crossbred heifers with Brahman influences may not be black-hided, or the typical breeds feedlots desire, they may still bring a premium. This is because these heifers can be bred to Angus or Simmental bulls to obtain the desired black feeder calf, but retain the benefits of the Brahman breed. This also explains why roughly 45% of heifers sold during this time period had some Brahman influence and shows that there is regional variation in preferences in the bred heifer/cow market.

There has been little research on the premiums and discounts associated with sales of replacement cattle, even though it is such a large investment for cow-calf operations. Primarily research has focused on the value of characteristics for bull and feeder calf sales, and only recently Mitchell et al. (2017) provided a first look into bred cattle sales. In this research, we have built on the Mitchell et al. study by highlighting the importance of reputation effects and regional factors in bred cow sales. This provides essential information for producers regarding the development of marketing strategies for bred cows, as well as those producers looking to buy the best bred cows for the lowest price.

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