5-6-2017

Assessment of Factors Influencing Sale Price in Mississippi Feeder Calf Board Sales

Elizabeth Anne Caldwell

Assessment of factors influencing sale price in Mississippi feeder calf board sales

By

Elizabeth Anne Caldwell

A Thesis
Submitted to the Faculty of
Mississippi State University
in Partial Fulfillment of the Requirements
for the Degree of Master of Science
in Agriculture
in the Department of Animal and Dairy Sciences

Mississippi State, Mississippi

May 2017

Assessment of factors influencing sale price in Mississippi feeder calf board sales

By

Elizabeth Anne Caldwell

Approved:

_____

Brandi B. Karisch
(Major Professor)

_____

Jane A. Parish
(Committee Member)

_____

John Michael Riley
(Committee Member)

_____

Jamie Larson
(Graduate Coordinator)

_____

John Blanton, Jr.
(Department Head)

_____

George M. Hopper
Dean
College of Agriculture and Life Sciences

Name: Elizabeth Anne Caldwell

Date of Degree: May 5, 2017

Institution: Mississippi State University

Major Field: Agriculture

Major Professor: Brandi B. Karisch

Title of Study: Assessment of factors influencing sale price in Mississippi feeder calf board sales

Pages in Study: 65

Candidate for Degree of Master of Science

The objective of this study was to examine specific factors that affect the selling price of feeder calves marketed through the Mississippi Feeder Calf Board Sale program, an alternative marketing strategy developed to offer producers an opportunity to increase prices received for their calves. A hedonic model was utilized to measure the effects of individual lot attributes on price. Results of sales conducted from 2008 to 2016 revealed a positive relationship between sale price and steer percentage, Brahman influence, the provision of information on growth implant practices, and number of loads per lot. Conversely, price was negatively associated with number of days from sale to loadout and the consignment of assembled lots or those consigned from multiple sellers. Lot hide color classification demonstrated varying effects on prices received. This data can enable commercial producers to evaluate production practices and make educated management decisions to improve the value of their cattle.

DEDICATION

I dedicate this thesis first and foremost to my family. My graduate school experience would not have been possible without my parents' endless encouragement, reassurance, and selflessness. I cannot thank you enough for the sacrifices you've made in allowing me to further my education. I would also like to thank my grandmother, Claire Caldwell, for inspiring my passion for animal agriculture and teaching me the value of hard work. Lastly, I must thank my fiancé Zac Alldredge, for your love and support throughout the last five years of school.

ACKNOWLEDGEMENTS

The opportunities afforded to me during the past two years have been an immense blessing, and I owe them all to my advisor, Dr. Brandi Karisch. Thank you not only for your guidance and direction, but also for your encouragement along the way. I would also like to thank my committee members, Dr. Jane Parish and Dr. John Michael Riley. I appreciate both your time and instruction provided throughout my graduate career. I must also extend sincere thanks to Dr. Brian Williams and Dr. Josh Maples, without whom my project may never have been completed. Thank you both again for your patience and advice in getting my statistics run. To Dr. Trent Smith, thank you for always being available to listen and lend a friendly word of advice. I have truly enjoyed serving as your teaching assistant the past two years, and I am very fortunate to have had such a kind (and occasionally funny) professor to work with.

Lastly, I would like to acknowledge my fellow graduate students, many of whom have become some of the greatest friends I could ask for. Thank you all so much for making my two years in Starkville ones that I will always remember with fondness. From our movie nights to potluck dinners to endless laughs in the office, I will cherish our memories together for many years to come. I will miss you all!

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Beef cattle production serves as an important component of the United States economy. Producers in all segments strive to increase efficiency of their operations while also improving the quality of product made available by utilizing profitable management systems. The industry presents unique challenges for producers with respect to lowering costs of production while optimizing quality and yield. Specifically, commercial cow-calf producers are tasked with producing feeder calves that will excel in both feeding performance and final product quality while remaining conscious of current market conditions. Both buyers and suppliers must balance input costs with selling price, especially when considering the implementation of preconditioning practices and other value-added management systems. Sellers must also select appropriate means of marketing their cattle with regard to sale venue, promotion tactics, and other concerns while building a reputation for a consistent high quality product.

Though local stockyards are the most prevalent form of marketing venue, alternative marketing strategies have become increasingly popular in recent years, though more so in larger operations than small. From 1997 to 2007, the percentage of cow-calf operations selling cattle through local sale barns decreased from 85% to 83.4% (USDA, 2009). The total percentage of operations marketing calves through forward contracting is also appreciably greater than that observed during the previous decade, increasing from

1.5% in 1997 to 3.5% in 2007 (USDA, 2008). The percentage of operations utilizing forward pricing contracts have been shown to increase with herd size, ranging from 2.3% of small operations with less than 50 head to 15.4% of large operations with greater than 200 head (USDA, 2008).

To accommodate the challenge of selecting an appropriate marketing channel, a variety of programs have been developed to aid producers in creating an efficient system of beef cattle marketing. One such program in Mississippi has allowed producers the opportunity to build a more successful marketing strategy in the feeder cattle sector. Established in Fall 2008, the Mississippi Feeder Calf Board Sale program began as a collaboration of the Mississippi Cattlemen's Association, Mississippi Farm Bureau Federation, Mississippi State University Extension Service, and Mississippi Beef Cattle Improvement Association to offer buyers and sellers a potential marketing alternative. The biannual program consists of the Mississippi Homeplace Producers Sale – held in Hattiesburg, MS each August – and the Cattlemen's Exchange Sale – held in Winona, MS each April. To date, the program has recorded 327 total lots sold consisting of an estimated 27,697 head of cattle, with receipts from the sales reaching approximately $24.97 million. Consigning calves to a board sale allows for the accommodation of feeder calves that may not be ready to ship at the time of sale, and thus more uniform load lots are comprised by day of shipment. Cattle lots can be assembled from single or multiple consignments received from areas across the state, with each lot comprised of cattle similar in size and type. Moreover, those cattle with similar management history are also grouped to ensure consistency of lots. Marketing through a board sale can present numerous advantages in comparison to local auction market settings. Reduced

shrink, handling and comingling prior to shipping stem from the off-site marketing of calves, and may subsequently result in decreased morbidity and mortality. Sellers are encouraged to consign calves produced with emphasis on health management and preconditioning practices to capitalize on market demand for value-added programs. Continuing participation in the board sale program may also enable producers to benefit from developing reputations with the consistent supply of high quality feeder cattle and thus attract future buyers. Furthermore, preliminary data reveal a price advantage of selling cattle through the board sale program, as the sales have brought price premiums above the Mississippi average market price for greater than 80% of cattle when loaded out (Riley and Parish, 2012). These price differentials may result from a multitude of factors that affect selling price of feeder cattle.

Specific phenotypic characteristics have been shown to generate premiums at sale, whereas others result in significant discounts (Barham and Troxel, 2007). Regional discrepancies may also account for variation in prices received for feeder cattle, with Southeastern cattle typically discounted relative to cattle sourced from other regions in the United States located in close proximity to major feedlot areas (Blank et al., 2009; King et al., 2006; Zimmerman, 2010). Common factors that may affect selling price include breed type, hide color, muscling, frame size, fill, body condition, health status, lot gender makeup, and presence or absence of horns (Smith et al., 1998; Troxel and Barham, 2012). Producers can work to understand the impact of these factors on selling price of their cattle and adjust their production strategies accordingly to maximize profit. Likewise, studies suggest that preconditioning and value-added management practices can result in greater selling prices (Zimmerman, et. al., 2012). Recognizing the balance

between input costs and selling price is imperative for producers to successfully market healthy, high-performance calves.

However, understanding the quantitative effects of qualitative factors can be challenging. A hedonic pricing model is developed by applying the coefficients generated from a regression analysis, and can be used to measure the influencing effects of specific attributes on selling price (Monson, 2009). In analyses of feeder cattle markets, lot makeup and cattle characteristics are regressed on lot price to determine their impact on final sale price (Coatney et al., 1996).

CHAPTER II

LITERATURE REVIEW

Introduction

Previous literature exploring the various aspects of feeder cattle marketing have detailed the intricate and constantly-changing relationship between cattle characteristics and sale price received. Multiple factors have been shown to substantially impact profitability, and thus considerations must be made with respect to marketing strategy and lot makeup. Studies have demonstrated that a hedonic pricing model can be used to analyze the nature of these relationships by quantifying the individual effects of qualitative factors on lot price.

This literature review is organized to address three primary objectives. The first section will discuss various aspects of marketing strategies in beef cattle production. The second section will review factors shown to influence sale price with regard to region, management, and cattle attributes. The third section will briefly explain the theory and function of the hedonic price model.

Marketing Strategy

Marketing strategy can have a profound influence on profitability in feeder cattle enterprises. Marketing measures involve the sale, advertisement, and pricing of commodities such as livestock, where important considerations must be made with regard to what specific product to market, marketing location and time, and how best to market

the product (Parish et al., 2009). Each sale strategy presents certain advantages and disadvantages, and producers must make marketing decisions accordingly to optimize prices received. Though local auction markets are widespread and conceivably the most common marketing option for many feeder calf producers (USDA, 2009), they may present numerous disadvantages such as limited advertisement capabilities of sellers along with increased shrink, handling, and comingling of calves prior to shipping (Self and Gay, 1972). Additional drawbacks to conventional auction markets can include limited number of buyers at time of sale, which may result in reduced selling price accompanied by more subjective valuation of cattle (Gillespie et al., 2004).

Selecting an alternative marketing approach can allow producers to secure greater price premiums at sale. Potential marketing alternatives such as video auctions, private treaty sales, internet marketing, and strategic alliances offer sellers a viable alternative for marketing their cattle. The discrepancies between traditional and alternative means of marketing warrant a unique approach to cattle pricing, encouraging both buyers and sellers to understand the relative premiums and discounts associated with cattle quality, current and future market information, and marketing strategies relative to the separate types of auctions (Bailey and Peterson, 1991). Studying transaction costs can reveal a greater understanding of buyer and seller decisions in market selection. Generally, explicit transaction costs such as transportation costs, cattle shrink incurred and commission fees can be easily discerned, whereas other costs may be implicit, such as perceived risk and those cost aspects associated with the quality of information and trust between buyer and seller (Bailey and Hunnicutt, 2002). Although immeasurable, these implicit costs are nonetheless a key consideration in selecting marketing strategy.

Furthermore, transaction costs can be categorized into three primary groups: information, negotiation, and monitoring costs (Hobbs, 1997). Information costs include those costs incurred by sellers in relation to analyzing market conditions and those incurred by buyers in obtaining product and price information. Negotiation costs are defined as the costs associated with physically carrying out the transaction and may include commission fees, contract agreement expenditures, etc. Monitoring costs occur following the sale agreement and involve the cost of ensuring the transaction terms are followed. Utilizing an alternative marketing option can potentially reduce transaction costs and thus significantly influence producer marketing decisions (Hobbs, 1997).

Merchandising strategies play a key role in feeder cattle marketing and pricing at video auctions. With proper consideration, entering into forward contracting agreements can serve as a tool to reduce price risk by guaranteeing a set price for a specified amount and quality of product to be delivered at a pre-determined date (Wood, 2012; Bastian, 2002). Although the contract cannot guarantee specific profit obtained, it can minimize negative response of unexpected market changes. Various marketing options in the beef industry implement forward contract agreements of some form, including board sales and internet auctions to allow sellers and buyers flexibility in devising contract terms (Parish et al., 2009). Cattle marketed through video auctions such as a board sale program are typically more intensely managed in comparison to average calves sold at local auction markets, with health management and value-added protocols among the primary differences (Zimmerman et al., 2012). Board sales operate as an off-site marketing avenue, where buyers are provided visual representation of lots through pictures or video accompanied by detailed lot descriptions including cattle type and management

information. One such example lies in the Mississippi feeder calf board sale program. Early analysis of preliminary data from the program drawn from 2008 to 2011 indicates that board sale prices typically exceeded local auction prices on the date of expected delivery; board sales have also yielded significantly higher prices than current market conditions at the time of sale (Riley and Parish, 2012). Video auction marketing also holds potential to reduce transaction costs through elimination of cattle transport to the sale barn, minimization of shrinkage, and reduction of sales commissions (Gillespie et al., 2004). Furthermore, these auctions accommodate larger lot transactions as opposed to traditional sale barns, allowing for more uniform load lots of cattle. Pencil shrink, a term commonly used in cattle purchasing contracts, accounts for the expected reduction in weight due to shrink, which is typically encountered in feeder cattle during transportation (Falkner, 1998). This value is often defined in advance as a fixed percentage to be subtracted in figuring the final sale price. Specifically, pay weight is calculated as the live weight of cattle upon delivery after deducting the established pencil shrink, i.e., subtracting 2% of the actual weight at load-out to yield the final pay weight with application of a 2% pencil shrink (Bailey and Peterson, 1991). A price slide may be implemented to protect buyers against calf weight variances at time of load-out. The "slide" is a predetermined adjustment in sale price that is based on the difference between the weight estimated prior to consignment and the actual pay weight (Dhuyvetter and Schroeder, 2000). More specifically, an up slide is exercised when the weight of calves upon delivery is greater than expected, essentially locking in a maximum sale price to be paid for the load (Machen and Gill, 1998). The slide goes into effect when the average pay weight exceeds the auction weight originally specified in the contract, protecting

buyers from circumstances of sellers not honoring the contract terms by adding surplus body weight. These insurances permit the capture of several dollars per head that would be lost in other marketing scenarios.

When studying the effects of lot characteristics on sale price, each attribute can essentially be categorized into three groupings: search, experience, and credence attributes (Williams et al., 2012). Search attributes such as hide color and body condition score can be easily identified prior to or at the time of sale, whereas experience attributes are not as readily verified prior to sale, but can be determined by the buyer after purchase. Credence attributes however can be difficult or impossible to determine both before and after purchase, e.g., those qualities generated by on-farm preconditioning practices (Darby and Karni, 1973). Many value-added characteristics result from focused management decisions implemented prior to marketing and may not generate phenotypic differences that are readily visible. Buyers may base animal value more on perception than true animal value, and thus producers who have added "unobservable" value to animals, such as specific vaccinations or preconditioning protocols, may not receive premiums for these animals even though their expected subsequent performance and profitability potential is greater (Gillespie et al., 2004).

Factors Affecting Sale Price

Feeder cattle prices can be determined by the demand for a particular lot of feeder cattle in a given market, with the demand for any lot influenced by the physical attributes of the cattle in that lot (Schroeder et al., 1988). A multitude of lot characteristics such as lot gender makeup and other phenotypic traits of cattle have been shown to affect selling price, with specific traits typically receiving either premiums or discounts relative to

current market demand and regional preferences. These attributes are often subjectively valued; buyers may use them as indicators of animal quality and future performance potential and thus adjust bid prices accordingly (Barham and Troxel, 2007).

Regional Price Differences

Desirable lot characteristics and the accompanying price premiums or discounts may also vary with regional location. The concentration of large scale feedlots and packing plants in the Great plains states (USDA ERS, 2017) ultimately results in the discounting of feeder cattle produced and marketed in other regions of the United States such as the West and Southeast (Blank et al., 2009). The economics of transporting inputs such as feed commodities or live cattle render it most cost effective to ship the most valuable input (on a per-unit of body weight basis) to the location of the least valuable input; thus, calves are shipped to the source of feed grains, the Midwest (Blank et al., 2006). As fed cattle are the primary input for packing and processing plants, these facilities are generally located in close proximity to feedlots in order to minimize transportation and reduce costs associated with the shipment of live cattle. As a result, prices received for feeder cattle can be expected to peak in regions near these concentrated areas, as price ultimately depends on location of the seller relative to that of the buyer. King et al. (2006) found that calves originating in the Rocky Mountain-North Central region sold for the greatest prices, followed by calves from the South Central, West Coast, and Southeastern regions when sold over a 10-year period through a videotape auction service. Zimmerman (2010) reported that discounts for Western calves typically range from $1.29 to $5.57 per cwt, whereas discounts for Southeastern calves may range from $2.17 to $10.61 per cwt. Cattle produced in the Southeast have been

shown to receive the greatest price discounts relative to comparable calves sourced from states closer in proximity to central states (Zimmerman, 2010). These discounts are due to an increase in shipping costs incurred from transporting cattle over greater distance to the feeding and packing facilities. Furthermore, Blank et al. (2009) revealed an apparent increase in mean price discounts over time for calves sold in regions other than the Midwest, with rising transportation costs adding approximately $0.29 to $0.39 per cwt each year to the average discounts sustained by Western cattle. Producers may seek to offset these inevitable discounts by selecting for and selling cattle that are favorable in the current market environment to achieve additional price premiums. However, the dynamic nature of the cattle market is evidenced by fluctuations in pricing differentials, reflecting the necessity of adaptation to ever-changing supply and demand conditions.

Value-Added Management

A primary objective of a typical preconditioning program is the maximization of immunity in calves during the period separating weaning and feedlot placement in order to improve subsequent health and performance while reducing stress (Mathis et al., 2008; King et al., 2006). In the 1990s, extension specialists at Texas A&M University created a standardized set of protocols known as the Value Added Calf (VAC) guidelines for the health management of calves to enable producers to increase prices received at sale (Mathis et al., 2008). These included a variety of unique programs to allow for reduced stress through separation of stressors such as weaning and shipping in addition to the implementation of strict vaccination protocols. The most recognized protocol, the VAC-45 option, involves a minimum 45-day post-weaning period prior to shipping and requires the use of a specific health program along with dehorning, castration of bull

calves, and introduction of feed bunks (Avent et al., 2004). Other preconditioning programs have subsequently been developed by private entities that may entail less stringent requirements with regards to length of post-weaning period and vaccination protocols. However, programs requiring a series of booster vaccinations following initial inoculation, such as the VAC-45 protocol, may bring greater premiums at sale compared to other preconditioning programs due to the expected heightened immunity to bovine respiratory disease and other pathogens in addition to the extended post-weaning period (King et al., 2006).

Calves produced with a comprehensive health and weaning program have been shown to exhibit improvements in performance throughout various stages of production. Cattle feeders may expect to observe improved feeding performance with respect to increased average daily gain and feed conversion rates in addition to decreased cost of gain (Schumacher et al., 2012; Avent et al., 2004). Preconditioned calves also typically experience greater overall health status through reductions in morbidity and mortality following weaning and throughout the feeding phase (Mathis et al., 2008; Step et al., 2008). Ultimately, preconditioned feeder cattle can bring greater net returns for feedlots due to lesser treatment costs, increased average daily weight gain and improved carcass quality, rendering them more profitable during the feeding period (King et al., 2006). Schumacher et al. (2012) estimated that 63% to 100% of feedlot managers are willing to pay some level of price premium for calves participating in a health management and weaning program. However, research pertaining to the exact effects of preconditioning on subsequent performance has remained somewhat inconclusive, as it can be difficult to

separate the impact of preconditioning strategies from those of other management practices or genetic variation among animals (Mathis et al., 2008).

Utilization of a preconditioning program as part of a value-added management system has been shown to earn producers additional premiums at sale. Zimmerman et al. (2012) discovered that for calves sold in Superior Livestock Auction, premiums attained for calves participating in a VAC-45 protocol were typically $2 to $4 per cwt for steers and $1 to $2 per cwt for heifers owing to the vaccination component of the program, with an additional $2 to $5 per cwt for prior weaning. Price premiums achieved for calves marketed through Superior Livestock Auction sales were shown to increase from 2000 to 2004, with average premiums ranging from $3.66 to $7.91 per cwt for utilization of the VAC-45 protocol in 2000 and then increasing to a range of $6.50 to $8.00 per cwt in the years following 2004 (Mathis et al., 2008). Williams et al. (2012) found that calves marketed as having received a vaccination protocol alone received a premium of $1.44 per cwt while weaning alone resulted in premiums of $2.05 per cwt. They also observed that calves certified through the Oklahoma Quality Beef Network preconditioning and health verification program sold with premiums ranging from $2.83 to $5.74 per cwt depending on body weight. Avent et al. (2004) determined a price premium of $3.30 per cwt for use of a strict preconditioning program similar to the VAC-45 protocol when compared to conventional calves sold at auction, and a smaller $1.94 per cwt premium for calves marketed with a more inclusive preconditioning program encompassing a wider variety of vaccination and weaning guidelines. King et al. (2006) analyzed trends in price premiums received through a livestock video auction service over an 11-year period and discovered that total sale prices for calves marketed in a VAC-45 program

were significantly greater in all years than those marketed in alternate preconditioning programs or those not in a certified health program. Specifically, they recorded a minimum price premium of $2.47 per cwt paid for VAC-45 calves in 1995 with increasing premiums paid through 1996, at which time they remained relatively constant until 2001 with values ranging from $3.33 to $4.06 per cwt. Premium values began to steadily increase in 2002, reaching a maximum value of $7.91 per cwt in 2004, though they declined the following year to $6.64 per cwt. Overall, premiums for VAC-45 calves ranged from 3.7% in 1995 to 6.7% in 2003 when expressed as a percentage of the base sale price (King et al., 2006). They noted, however, that comparison to results from other published studies examining price premiums for value-added calves may be problematic due to differences in marketing strategy and variation in types of preconditioning programs.

Moreover, prices received for feeder calves have proven to further increase through participation in a variety of supplemental certification programs in recent years. Additional assurances such as age and source verification (ASV) of calves encourage producer accountability of production and management records. When surveyed to evaluate buyer preference regarding certain management practices, 89% of feedlot producers indicated willingness to pay a premium for ASV calves (Schumacher et al., 2012). Zimmerman et al. (2012) observed similar results, with ASV calves receiving significant premiums at sale ranging from $1.00 to $2.75 per cwt when marketed at Superior Livestock Auction. They reiterated that age and source verification can present feedlots with increased profit potential when marketing feeder cattle as ASV beef eligible for international export. Burdine et al. (2014) afforded the first quantitative estimate of

age and source verification for Southeastern cattle, with price premiums of $1.83 per cwt observed in internet marketing sales. An analysis of a livestock video auction service revealed a significant price premium of $0.52 per cwt for calves participating in the ASV program upon its introduction in 2005 (King et al., 2006). However, international beef exchange policies implemented in 2013 led to the decline of premiums rewarded for ASV calves, as Japan lifted age requirements on international beef imports to allow cattle up to 30 months of age. This permitted the import of beef from the United States that did not require adherence to the Export Verification (EV) program (Giamalva and McConnell, 2013). As such, beef derived from most fed cattle in the United States now qualifies for export to Japan, and thus stringent records verifying age and source for cattle are unnecessary (Dyck and Johnson, 2013).

Furthermore, marketing certified natural (NAT) and non-hormone treated cattle (NHTC) may offer producers additional opportunities to capture premiums as consumer demand for more stringent production standards continues to rise. Zimmerman et al. (2012) reported variable results, with natural-market eligible calves receiving premiums of $0.81 and $1.09 per cwt for steers and heifers in 2006, respectively, although no other years presented significant price differences. Similarly, NHTC-market eligible calves received premiums of $1.81 and $2.78 per cwt for steers and heifers in 2010, respectively, although neither received significant premiums in 2009. King et al. (2006) found that calves qualifying for the NAT program received premiums of $1.05 per cwt during the year of its introduction in 2004. This program encompassed a series of protocols that included, but was not limited to, the requirements that calves not be fed antimicrobials or antimicrobial ionophores, did not receive antimicrobial injections or

synthetic hormone implants, and did not consume feed containing any mammalian-derived protein sources. Similar trends were observed in southeastern feeder cattle markets during 2008 to 2011, with natural calves – those marketed without the use of growth implants, ionophores, or antibiotics – receiving significant price premiums of $2.16 per cwt (Burdine et al., 2014). Preliminary research of Mississippi feeder calf board sale results revealed price premiums for lots that marketed calves raised without use of growth promoting implants when compared to lots that did not specify implant preconditioning practices (Riley and Parish, 2012). However, lots advertising use of implants also received price premiums compared with unspecified lots, illustrating that buyers may prefer having sufficient information to allow for flexibility in designing a specific growth promotant system.

Buyers have also exhibited preference when purchasing lots marketed with the provision of extensive management information. Zimmerman et al. (2012) noted that lots with unknown or inconsistent implant protocols were discounted greater than $2.00 per cwt during certain years when marketed through Superior Livestock Auction. As previously presented, an abundance of research substantiates the economic advantages of marketing feeder calves as part of a preconditioning program. Nonetheless, asymmetric information still manifests in the cattle market as buyers cannot confirm the legitimacy of producers' claims with regard to management practices (Williams et al., 2012). The development of third-party certification programs served to resolve this issue of uncertainty and provide greater credibility beyond sellers' initial claims. A survey of feedlot managers revealed a significant willingness to pay additional premiums exceeding $2.37 per cwt for feeder cattle marketed with USDA-certified records compared to

equivalent claims provided only by the seller (Schumacher et al., 2012). However, they indicated no significant difference in willingness to pay for health program certification through a private third-party agency compared with claims by the seller. Specifically, they reported that 60% of feedlot managers are willing to pay premiums for private third-party certification whereas 84% are willing to pay premiums for USDA certification. This may be due to the independent, unbiased accreditation provided by the USDA, and is thus perceived to be more reliable. Similarly, the Oklahoma Quality Beef Network (OQBN) provides third-party verification of a specific set of preconditioning and health protocols. As a brand-neutral organization, the program is not sponsored by any pharmaceutical company; as a result, suggested premiums to be achieved by implementation of the required management practices may be better received by producers (Williams et al., 2012).

Lot Characteristics

Various phenotypic characteristics have been shown to influence feeder cattle price, with specific traits generating premiums at sale while others often result in significant discounts (Barham and Troxel, 2007). Common factors that may affect selling price include breed type, hide color, muscling, frame size, fill, body condition, health status, lot gender makeup, and presence or absence of horns (Smith et al., 1998; Troxel and Barham, 2012).

Lot gender makeup may influence buyer spending, typically with steer lots receiving greater prices than heifer lots (Schultz and Marsh, 1985). Studies examining feeder cattle prices in eastern Oklahoma observed a steer selling price of $76.96 per cwt with heifers selling for $10.56 per cwt less (Smith et al., 1998). Likewise, Williams et al.

(2012) indicated that heifers received a significant ($P < 0.001$) discount of $11.78 per cwt, and lots of bulls or mixed gender groups were discounted $5.78 per cwt relative to steer-only lots in Oklahoma feeder cattle auctions. Studies conducted to analyze feeder cattle prices in Arkansas reported similar results, as the selling price for steers and heifers were different with heifers consistently selling at lesser prices ($P < 0.001$). In 2005 and 2010, steers sold at $116.16 per cwt and $124.20 per cwt, respectively, whereas heifers sold at $102.71 per cwt and $112.81 per cwt, respectively (Barham and Troxel, 2007; Troxel and Barham, 2012). Zimmerman (2010) indicated an average selling price for steers of $110.33 per cwt in the Superior Livestock Auction video sale, with an approximate $7.50 per cwt discount for heifers. Heifer lots are consistently discounted at sale relative to steer lots as a result of common issues associated with heifers such as reduced body weight gains, lower feed efficiency, and undesirable effects accompanying estrous cycling (Smith et al., 1998; Hawkes et al., 2008). Prices received for bull calves are generally lower in part due to the expected reduction in performance following castration after purchase, such as decreased weight gain in the feedlot (Troxel and Barham, 2012). Bulls castrated upon entering the feedlot also suffer increased morbidity and greater health costs, further declining their economic value (Ratcliff et al., 2014). Avent et al. (2004) observed that bull calves were discounted $4.49 per cwt relative to steers, suggesting a price benefit from castration as part of a preconditioning program.

Consistent and industry-recognizable breed types and hide color patterns may also bring added premiums at sale. Prices are influenced by certain attributes stereotypically assigned to particular breeds, including those affecting growth rate, reproductive traits, and carcass traits (Smith et al., 1998). More specifically, price

differentials may be due to buyer perception of how different breeds or breed types would perform while in a pasture or feedlot setting with respect to weight gain, morbidity, and quality grade (Troxel and Barham, 2012). In Oklahoma livestock markets, dairy and Longhorn steers are heavily discounted relative to Angus steers at an average $27.21 per cwt, and steers marketed with Brahman influence received a slight discount at $1.91 per cwt in 1998, increasing to $3.48 per cwt in 2012 (Williams et al., 2012; Smith et al., 1998). They also found that black-hided lots consistently receive higher selling prices compared with all other hide colors. Conversely, analyses of Arkansas markets reveal significant variation in selling price with respect to both color pattern and breed type. In 2005 market reports, yellow-white faced, yellow, and black-white faced cattle received the greatest selling price per cwt ($120.44 ± 0.26, $120.29 ± 0.15,120.03 ± 0.15, respectively) with spotted or striped feeder cattle receiving a lower selling price ($107.37 ± 0.37) than all other cattle hide colors in the study ($P < 0.001$) (Barham and Troxel, 2007). In 2012, black-white faced calves sold for the greatest price ($111.74 ± 0.29), followed by black ($110.23 ± 0.14), yellow ($110.09 ± 0.29), and yellow-white faced ($109.81 ± 0.61), which were not different from each other ($P > 0.10$) (Troxel and Barham, 2012).

Breed type was also shown to influence price, with specific breeds or breed types receiving premiums while others brought significant discounts. Barham and Troxel (2012) found that Angus calves and crosses of Angus x Brahman, Angus x Hereford, Hereford x Charolais, and Angus x Hereford x ¼ Brahman feeder cattle were not significantly different from each other and sold for prices greater than all other breeds listed at sale. Breeds that sold for the least selling prices included Simmental, Brahman,

and Longhorn. They indicated an approximate $40.00 per cwt difference between the breed types selling for the greatest price and that of Longhorn feeder cattle, which sold for the lowest price. Zimmerman et al. (2012) reiterated that Angus and black or black-white faced calves continue to receive premiums at sale, generating additional $3.00 to $7.00 per cwt compared to Brahman-influenced calves in Superior Livestock Auction video markets.

Whereas the majority of calves marketed in modern livestock auctions are polled, recent studies have found a significant effect of the presence of horns on sale price. Calves with horns often receive discounts in relation to comparable polled or dehorned calves. Smith et al. (1998) found that horned steers sold for $3.03 per cwt less, and horned heifers sold for $1.94 per cwt less. Likewise, Zimmerman et al. (2012) noted that horned calves were typically discounted by approximately $1 per cwt in Superior Livestock Auction markets. In Arkansas, Barham and Troxel (2007) reported that 85.8% of calves sold did not have horns and sold for $118.57 ± 0.05, whereas the remaining horned calves were discounted by $3.70 with a selling price of $114.87 ± 0.14. The volume of polled or dehorned feeder cattle expanded to 89.4% in 2010, with an average selling price of $109.36 ± 0.10 compared to the price of horned calves at $101.33 ± 0.31 (Troxel and Barham, 2012). The prevalence of horned feeder cattle and their subsequent influence on selling price have proven to vary with region. Compared with other regions, nearly twice the percentage of calves produced in the South Central region (22.8%) had or were expected to have horns; the Eastern region (9.8%) had the lowest percentage of operations producing calves with horns (USDA, 2008). Furthermore, of calves that were born with horns, 73.8% of Western calves and 67.3% of Central calves were or would be

dehorned on the operation prior to sale, whereas only 35.8% and 39.5% of horned calves from the South Central and Eastern regions, respectively, were or were expected to be dehorned (USDA, 2008). Dehorning was listed as one of the top five pre-weaning management practices cattle buyers would be willing to pay premiums for at sale (Castro et al., 1998). Prices observed by Avent et al. (2004) further demonstrated that horned and mixed lots of horned and dehorned calves were significantly discounted by $1.22 and $5.89, respectively, with lots of only dehorned calves selling at prices comparable to lots of polled calves. Thus, price incentives may be achieved through the dehorning of calves in a preconditioning program or by marketing lots with polled cattle.

Muscle score determined using the USDA muscle scoring system has been shown to significantly affect price ($P < 0.0001$) with lighter muscled calves selling at significant discounts compared with heavier muscled calves (Troxel and Barham, 2012; Schroeder, 1998). Specifically, for Arkansas cattle classified as having muscle scores of 1, 2, 3, and 4, selling prices in 2005 were $120.45 ± 0.05, $111.31 ± 0.09, $96.28 ± 0.44, and $82.21 ± 1.87, respectively, with price significantly decreasing with each successive reduction in muscle score (Barham and Troxel, 2007). Large discounts were reported for muscle score 4 calves (lightest muscling) in 2000 ($22.65) and 2005 ($38.24) compared with muscle score 1 cattle (Troxel and Barham, 2012). Smith et al. (1998) reported similar results, with light muscled calves receiving price discounts averaging $26.48 per cwt. Williams et al. (2012) in Oklahoma showed that lots consisting of calves with mixed muscle scores of 2 and 3 are discounted $10.11 per cwt while lots of muscle score 3 calves are more heavily discounted at $20.07 per cwt. Kansas feeder cattle auction records from 1986 and 1987 illustrate that discounts incurred for light to medium muscled cattle may range from

approximately 5% to 9% of the average price of heavy muscled cattle (Schroeder et al., 1988).

Frame size has also been shown to affect selling price, with small-frame calves receiving significant discounts compared with medium- and large-frame calves (Barham and Troxel, 2007; Troxel and Barham, 2012). Smith et al. (1998) observed that small frame steers and heifers sold with severe discounts of $18.86 and $20.99 per cwt, respectively, compared with large framed steers and heifers in Oklahoma markets. This preference for larger framed cattle may be due to a perceived superior growth potential, allowing for greater weight gain and profit potential.

Moreover, buyers appear to prefer cattle that are thin to moderate in body condition, allowing for compensatory gains. Overly thin and fleshy or fat cattle are often significantly discounted at sale. Over-conditioned calves that have been on a high plane of nutrition prior to weaning may lose body condition and impede weight gain for a period after weaning, typically due to a decline in nutrition level (Troxel and Barham, 2012). Thus, buyers appear reluctant to pay premiums for calves that will inevitably lose body condition following purchase. However, Barham and Troxel (2007) indicated that feeder calves in very thin body condition received the highest selling price at $119.55±0.11, followed by calves in average body condition at $118.14 ± 0.06. This diverged from typical pricing trends, as buyers generally discount calves in very thin condition due to an unthrifty appearance. They reported in 2012 that calves in thin body condition sold for the highest price at $110.11 ± 0.17 per cwt, which was significantly greater than all other body condition groups, followed by average, fleshy, very thin, and fat feeder calves (Troxel and Barham, 2012).

Pertaining to body fill, buyers have been shown to discount feeder calves with potential for excess shrinkage in favor of cattle that are already shrunk or hold minimal potential for shrinkage. Schroeder et al. (1988) recorded the greatest average price received for calves with average body fill, followed by shrunk calves; steers classified as gaunt or tanked received the lowest average price. Conversely, Barham and Troxel (2007) found that when compared with the average fill selling price of $116.77 ± 0.07, the prices received for gaunt ($119.63 ± 0.11) and shrunk ($120.22 ± 0.10) calves were greater. Calves classified as full or tanked were discounted relative to the average fill price, receiving prices of $110.05 ± 0.30 and $92.80 ± 2.03, respectively. The authors reported similar trend results in the 2012 analysis of Arkansas livestock auctions. Smith et al. (1998) noted that gut fill affected sale price relative to the variation from calves with average fill. More specifically, gaunt and tanked steers received the largest discounts, which were not significantly different, followed by full calves, with shrunk calves selling at the lowest discount compared with the average fill base price.

Although the majority of cattle sold are usually of adequate health, health status can significantly affect calf selling price. Cattle that appear poor in health, have physical impairments or rough muddy hair coats are ultimately discounted relative to healthy calves. Schroeder et al. (1988) explained that stale calves – those calves that are generally unthrifty and stagnate in growth or "lacking bloom" – typically receive discounts of 5% to 8%, and sick calves may receive discounts reaching 20% or greater of the average price of healthy animals. Avent et al. (2004) reported that unhealthy calves – those classified as sick, lame, or otherwise not in adequate health – were collectively discounted $23.68 per cwt relative to healthy calves. In Oklahoma markets, cattle

perceived to be unhealthy or lame received severe discounts averaging $21.58 to $30.48 per cwt when compared with healthy cattle. Calves with poor eyes and stale cattle also received moderate price reductions averaging $6.91 to $13.38 per cwt whereas calves with rough or dirty hair coats were discounted at $2.51 to $2.62 per cwt (Smith et al., 1998). Barham and Troxel (2007) reported the least sale prices for sick and lame feeder calves in Arkansas auctions at $80.22 ± 1.69 and $84.74 ± 1.04, respectively, followed by calves with dead hair ($105.55±1.16), that were stale ($100.01 ± 0.83), or that had bad eyes ($104.39 ± 0.88). Healthy calves sold at $118.21±0.05 whereas calves marketed as preconditioned received the highest selling price at $122.36 ± 0.28.

Although these data collected from livestock markets across the United States have revealed a significant relationship between lot characteristics and selling prices of feeder cattle, further analysis is necessary to evaluate how these factors affect selling price in Mississippi auction markets and alternative marketing strategies.

Hedonic Price Model

Effectively understanding the quantitative effects of the aforementioned qualitative lot characteristics on selling price can be accomplished through utilization of a hedonic pricing model. Certain commodities such as real estate properties, automotive industries, and feeder cattle can be classified as *differentiated goods*, or those products that despite differing in various aspects are perceived by consumers to be one single commodity (Day, 2001). Economic markets for differentiated goods cannot be studied accurately through traditional simple models, and thus a separate model is necessary for proper examination of these market forces. Rosen (1974) proposed a model of product differentiation rooted in the principle that goods are valued according to the specific

functional characteristics of the good, setting the foundation for future hedonic price analysis. They defined hedonic prices as the implicit prices received for specific attributes of a differentiated good. Consequently, developing hedonic price indexes can allow for implicit prices to be estimated from the regression of product price on product characteristics, signifying that implicit prices can be determined from prices received relative to the particular characteristics of that commodity.

Whereas commonly employed in real estate property valuation, hedonic analysis can be equally advantageous in studying the market behavior of other applicable commodities such as feeder cattle. The underlying goal when employing a hedonic pricing model is to develop an accurate predictive model, enabling future research into feeder calf markets and specific trait economics. It can be implemented in determining how a collection of independent variables such as lot attributes influence a single dependent variable such as price. The model is developed by applying the coefficients generated from a regression analysis, a statistical technique used to determine the correlation between different data points (Monson, 2009). For analysis of feeder cattle markets, lot characteristics are regressed on lot price to determine their impact on final sale price (Coatney et al., 1996). In multiple regression analysis, the exact nature of the relationship between predictor and response variables are studied, including both the direction and magnitude of the effect of each predictor variable on the response variable of interest (Kutner et al., 2004). If the various predictor variables included in the model are uncorrelated among themselves or other related external independent variables, conclusions reached about the relationship can be relatively straightforward. However, possible interdependencies among several variables may arise with regard to genetic and

physical traits, and thus collinearity among independent variables can be expected (Coatney et al., 1996). For instance, breed or breed type may influence other physical characteristics such as frame size, fleshing ability, hide color, etc. As a result, a trait may not only affect selling price directly, but indirectly through subsequent traits as well, with the price of one attribute depending partially on the quantity or presence of another (Day, 2001; Coatney et al., 1996). If these interdependencies are accounted for by the system of equations, the coefficient estimate of a particular characteristic that is correlated with another characteristic can be isolated, allowing for more accurate parameter estimation (Belsley, 1991). Coatney et al. (1996) emphasized that utilizing a system of equations as opposed to a simple single-equation approach is beneficial in measuring price effects of cattle characteristics most inclusively to minimize the confounding impact of collinearity in the model. Outcomes of this model may be useful to producers in recognizing the various sources of price discounts and premiums encountered at sale.

Conclusion

In brief, feeder cattle marketing is a complex enterprise with respect to marketing strategies and price differentials pertaining to various cattle characteristics. Numerous research studies have afforded a greater understanding of the many components of feeder cattle markets, revealing the distinctive relationship among lot attributes and current market conditions.

CHAPTER III

ASSESSMENT OF FACTORS INFLUENCING SALE PRICE IN MISSISSIPPI FEEDER CALF BOARD SALES

Objectives

The objective of this study was to examine specific factors that affect the selling price of feeder calves marketed through a Mississippi feeder calf board sale.

Materials and Methods

This study did not necessitate Animal Care and Use Committee approval as all data were collected and analyzed through an existing electronic database. Observations were derived from board sale lot information and final price recorded at sale.

Description of Board Sale Data

Data were collected over an 8-year period beginning with the first Mississippi Homeplace Producers sale on August 4, 2008 and ending with the sale on August 1, 2016. Final sale price in dollars per 45.36 kg (cwt) as documented at the time of sale and descriptive lot information for each lot sold were recorded and utilized in this analysis. Records encompass 327 total lots consisting of an estimated 27,697 head of cattle, with receipts from the sales reaching approximately $24.97 million.

The board sale program consists of two individual sales held annually. The Mississippi Homeplace Producers sale is held on the first Monday each August and

hosted by Southeast Mississippi Livestock in Hattiesburg, MS (latitude and longitude of 31.327120, -89.290337). The first Cattlemen's Exchange sale took place on April 7, 2009 and is held on the first Tuesday each April in Winona, MS (latitude and longitude of 33.490168, -89.729235), and hosted by the Winona Stockyard. These sales commenced as a collaboration of the Mississippi Cattlemen's Association, Mississippi Farm Bureau Federation, Mississippi Beef Cattle Improvement Association, and Mississippi State University Extension Service to provide Mississippi beef cattle producers a potential marketing alternative for their operations. Feeder cattle sold in the board sale were marketed as uniform load lots comprised of single or multiple consignments of similar calves with regard to management, type, and source of cattle.

A fundamental objective of the sales was to encourage participating producers to invest in more intensive management practices such as stringent vaccination protocols and preconditioning programs, thus allowing consignors to achieve premiums at sale and establish reputations with buyers for consistently supplying superior cattle. Upon consigning calves to the sale, sellers were required to submit information regarding location of cattle, number within gender, average lot body weight, hide color and breed type composition, source (farm-fresh vs. assembled), nutritional program, and value-added management practices such as castration and dehorning methods and dates, vaccination protocol, parasite control measures, growth promotant administration, age and source verification, and the supply of all natural calves, i.e. antibiotic- and hormone-free. Other information provided included expected delivery date, expected lot body weight on delivery date, load out location, and shrink conditions.

All information provided to buyers was available online prior to the time of sale and subsequently presented in printed form at the time of sale. The auctions were operated as board sales, which are characterized by the off-site marketing of cattle with each lot represented by pictures or video accompanied by the lot descriptions provided to prospective buyers. Lots were then delivered at a predetermined later date following the sale. During initial years of the sale, expected shrink was specified by individual groups of sellers for each lot that sold and varied from 0% to 3%. As the program progressed, participation in the sales increased and shrink was essentially standardized across all lots. A set 2% pencil shrink was applied in calculating the final pay weight of each lot, i.e., by subtracting 2% of the actual weight at load-out to yield the final pay weight. Incorporating standardized pencil shrink as part of the forward contract offered buyers a solution for minimizing cattle weight risk. Furthermore, a price slide was implemented to account for deviations in cattle weight at load out from that originally listed at the time of sale. Specifically, an up slide was employed to protect buyers against increased prices incurred with lots that shipped at a greater weight than originally specified at sale, essentially locking in a maximum sale price to be paid for the lot. The specific price slide varied with each individual sale to follow current market conditions.

Variables

Explanatory variables incorporated in this analysis were selected due to their expected influence on sale price as suggested in previous literature and market demand trends. Some variables were excluded from the model due to low frequency in the dataset. The independent variables studied include weighted average lot body weight, number of days between day of sale and day of load-out, steer percentage per lot, hide

color composition percentages, *Bos indicus* influence, origin of cattle (farm-fresh vs. assembled), the specified administering or withholding of growth implants, and implementation of a day-specific preconditioning program. Weighted average lot body weight was calculated as a weighted average relative to the specified number and weights of steers and heifers comprising each lot. Hide color categories were broken down such that lots containing greater than 95% black, smoke, red, and white cattle were referred to as solid colored lots. Lots composed of 51% to 94% black, smoke, red, and white cattle were denoted as BLACKMIX, SMOKEMIX, REDMIX, and WHITEMIX, respectively. These lot color classifications were similar to those previously specified in methods by Williams et al. (2012), with adjustments made in regard to mixed hide color lots composed of a single majority hide color. All remaining lots comprised of multiple hide colors without a specific majority were combined and therein referred to as MIX lots. Though all lots consigned to the board sale were encouraged to have participated in some form of value-added management, those sold listing a specified 45-day, 60-day, 70-day, or 90-day preconditioning program were included together as a variable for a day-specific preconditioning program. Other factors documented in the original sale data set were excluded from the analysis due to insufficient observations.

Lot selling price and basis were set as the response variables for the study in two separate hedonic models. Futures basis (BASIS) for each lot sold was calculated by subtracting the futures contract price from the actual sale price. The futures prices incorporated were drawn from a Chicago Mercantile Exchange weekly feeder cattle futures contract price archive for each lot to determine futures price at time of delivery as presented the week of sale. In selecting the model's response variable, basis was utilized

in addition to actual lot sale price with the intention of accounting for acute market price fluctuations over the nine-year course of the sales. This addressed concerns of autocorrelation in the dataset, which may be common in historical and time-series econometric data.

Statistical Analysis

To examine descriptive statistics of benchmark values of the board sale program, lot demographics of each sale were analyzed using the Means procedure in SAS (SAS Inst. Inc., Version 9.4). A hedonic price model was employed to determine the specific effects of each explanatory variable on price. The objective of utilizing the hedonic model is to investigate the quantitative effects on price of each lot attribute analyzed in the study. Of the aforementioned variables, only lot body weight was analyzed as a continuous variable. Steer percentage, number of loads per lot, and number of days between sale and shipment were input as discrete variables, whereas the remaining variables were analyzed as binary variables. These binary variables, often referred to as dummy variables, are utilized in hedonic modeling to denote qualitative information that is to be incorporated in the price analysis. The variables are represented by a numerical value of one when a particular trait or lot attribute is present, else the variable will assume a value of zero. The price models constructed are presented in Equations 3.1 and 3.2 as:

$$\text{Price}_{it} = f\left(\sum_{j=1}^{9} \text{Year}_{it}, \text{Wtdavgcwt}_{it}, \text{Daystoload}_{it}, \text{Noloads}_{it}, \text{Percentsteer}_{it}, \sum_{j=1}^{3} \text{NumberSellers}_{it}, \sum_{j=1}^{6} \text{HideColor}_{it}, \text{Ear}_{it}, \sum_{j=1}^{3} \text{Origin}_{it}, \sum_{j=1}^{3} \text{Implant}_{it}, \text{Precon}_{it}\right) \quad \text{(Eq. 3.1)}$$

$$\text{Basis}_{it} = f\left(\sum_{j=1}^{9} \text{Year}_{it}, \text{Wtdavgcwt}_{it}, \text{Daystoload}_{it}, \text{Noloads}_{it}, \text{Percentsteer}_{it}, \sum_{j=1}^{3} \text{NumberSellers}_{it}, \sum_{j=1}^{6} \text{HideColor}_{it}, \text{Ear}_{it}, \sum_{j=1}^{3} \text{Origin}_{it}, \sum_{j=1}^{3} \text{Implant}_{it}, \text{Precon}_{it}\right) \quad \text{(Eq. 3.2)}$$

The sale price of lot *i* on sale date *t* is dependent on individual lot characteristics where:

- Wtdavgcwt = weighted average lot body weight in cwt
- Daystoload = number of days between sale and lot shipment
- Noloads = number of loads constituting each lot
- Percentsteer = percentage of steers per lot
- NumberSellers:
    - Twosellers = two consignors per lot
    - Groupsellers = greater than two consignors per lot
- HideColor:
    - Mix = lots containing 50% or less of all hide colors
    - Redmix = lots containing 51% to 94% red cattle
    - Whitemix = lots containing 51% to 94% white cattle
    - Red = lots containing at least 95% red cattle
    - Black = lots containing at least 95% black cattle
- Ear = lots marketing some percentage of *Bos indicus* influence
- Origin:
    - Assem = assembled lots
    - Farmassem = lots comprised of both farm-fresh and assembled cattle
- Implant:

    - Noimplant = lots marketed as receiving no growth implants
    - Implant = lots marketed as receiving growth implants
- Precon = day-specific preconditioning program

To assess the effects of the independent variables on each dependent variable, the models were analyzed using the MIXED procedure in SAS (SAS Inst. Inc., Version 9.4). The coefficient estimates generated in the statistical model for each binary variable signify the dollars per cwt shift in price that results from the presence of each lot attribute at sale. Estimates for continuous and discrete variables represent the price premium or discount received contingent with one unit change in the independent variable. The MIXED procedure in SAS (SAS Inst. Inc., Version 9.4) was also used to compute least squares means for each year, and differences in least squares means among years were obtained using the PDIFF option for means separation to predict population margins of year for each model.

The sale variable, labeled as a number ranging from 1 to 15 for each of the 15 board sales, was entered into the model as a random effect to better account for discrepancies in the dataset due to day of sale.

The White test was conducted to observe for the presence of heteroskedasticity in each model. This test plotted the squared residuals of each variable against the dependent variable of interest to observe for unequal variance of the error terms across all levels of the independent variables. Any variables that exhibited heteroskedasticity were then entered as a repeated statement to adjust the model accordingly.

The CORR procedure of SAS was employed to obtain Pearson correlation coefficients used in determining the presence of multicollinearity. Variance inflation

factors (VIF) obtained from the REG procedure of SAS were also examined to quantify the extent of multicollinearity, with values greater than five implying a multicollinear relationship among variables.

Autocorrelation is often encountered when analyzing time-series data, in which errors may be dependent and autocorrelated with errors of preceding data points. The Durbin-Watson test was performed to test for presence of autocorrelation in all variables. Utilizing basis as a dependent variable was expected to account for effects of time on sale price. Moreover, each year was included in the model as a binary variable to further adjust for these effects in the model.

Statistical significance was declared at $P \leq 0.05$ for all models, with trends set at $0.05 > P \leq 0.10$.

Expected Outcomes

Prior to statistical analysis, expected relationships between sale price and lot attributes for all models were hypothesized and recorded as listed below:

- Sale year was expected to significantly affect price in the sale price model, as there were no corrections for time-point fluctuations in the cattle market. Anticipated effects of sale year on each basis model were unknown, as this variable could account for arbitrary and extraneous factors that may influence prices received.
- Weighted average body weight was expected to have a negative quadratic relationship with actual sale price and futures basis. As body weight increases, sale price per cwt typically decreases until leveling off at the price floor.
- The days to load coefficient was expected to be negatively associated with price.

- The number of loads coefficient was expected to have a positive relationship with price, with an increasing number of loads per lot corresponding to greater sale prices received.
- Percent steer was expected to have a positive relationship with price, as indicated in previous literature and typical market reports. Steer-only lots have been shown to receive the greatest prices compared to mixed-gender lots, with heifer-only lots selling at significant discounts (Williams et al., 2012; Troxel and Barham, 2012).
- Number of sellers consigning cattle to each lot was expected to have a negative relationship with price.
- Hide color was expected to have varying effects on price. Solid or primarily black-hided cattle have been shown receive the greatest prices at sale (Williams et al., 2012) although other literature revealed no consistent differences between different hide color groups.
- Lots that were assembled or comprised of both assembled and farm-fresh cattle were expected to have a negative relationship with sale price. Cattle shipped directly from the farm of origin may be considered lower-risk, or perceived as less likely to experience common stress-related disease symptoms.
- Both IMPLANT and NOIMPLANT coefficients were expected to have a positive relationship with price. Preliminary data from the board sales revealed that lots providing some information about implant administration received premiums over lots that did not specify (Riley and Parish, 2012), suggesting that buyers prefer having more lot information.

- The coefficient for lots marketed with a day-specified preconditioning program was expected to have a positive relationship with price. Although all consignors were encouraged to participate in some degree of value-added management, this expected relationship is akin to the expected price effects of lot implant status, with buyers paying premiums for those lots providing more explicit information.

Results and Discussion

Sale Demographics

Board sale lot demographics were first analyzed to establish benchmark values for lot price and other applicable price information. Results are displayed in Table 3.1. Lot sale price fluctuated widely, varying from $83.75 to $239.00 per cwt with a mean of $131.09 per cwt. The 2009 Cattlemen's Exchange Sale held the lowest mean lot price across all years at $91.00 per cwt, after which average sale prices steadily increased over the course of the sales before exhibiting a sharp increase at the 2014 Homeplace Producers sale, which secured a mean lot price of $223.63 per cwt. Prices then maintained record highs until declining after Fall of 2015. In efforts to account for this price variability, basis was utilized as a dependent variable.

The mean futures market basis over the course of the study was -$5.81 per cwt, indicating a negative average price basis, with minimum and maximum values of -$26.68 and $28.42 per cwt, respectively. This negative basis is typical in Southeastern cattle markets, reflecting regional price discounts relative to national averages. Ultimately, the observed pattern of the futures basis variable in the study reflect regional price tendencies, insinuating that although board sale price results – and most Mississippi market prices as a whole – are discernibly lower than national averages, the board sale

program itself offers producers a superior feeder cattle marketing alternative in contrast to traditional sale barns in Mississippi.

Descriptive statistics of lot characteristics were also examined to establish a quantified description of the data population. Frequencies of hide color characteristics reveal that 92.7% of all lots sold advertised some percentage of black hided cattle, followed by 46.8% of lots with smoke color, 44.4% with red, and 17.7% with white color. Specifically, 85% of lots sold were comprised of greater than 50% black cattle, whereas only 6.1% were majority white, 4.0% were majority red, and 2.8% of lots were majority smoke color.

For analysis in the hedonic pricing model, hide color categories were re-grouped similar to methods used in a previous study by Williams et al. (2012), with demographic results presented in Figure 3.3. BLACKMIX lots comprised 55.4% of all lots sold, and thus was set as the base for comparison. REDMIX lots and SMOKEMIX lots represented only 0.9% and 0.3% of all lots, respectively, and WHITEMIX lots represented 4.3% of lots. Solid BLACK lots comprised 22.9% of lots, followed by RED lots at 2.4% of lots sold, whereas both SMOKE and WHITE lots had only one observation each to represent 0.3% of lots. The remaining 13.1% of lots were comprised of random mixtures of various hide color cattle with no clear majority. With regard to cattle type, lots marketed with some degree of Brahman influence represented 15.3% of lots sold. Lot body weight varied greatly within each sale, with a mean weighted average lot body weight per head across all years of 315.5 kg. Results show that 0.3% of lots had a weighted average body weight per head of less than 226.8 kg, 6.1% weighed 226.8 to 271.2 kg, 46.1% weighed

272.2 to 317.1 kg, 31.5% weighed 317.5 to 362.4 kg, 15.0% weighed 362.9 to 407.8 kg, and 0.3% weighed greater than 408.2 kg (Figure 3.4).

Mixed gender lots comprised 45.3% of all lots sold, followed by steer-only lots at 34.5% and heifer-only lots at 20.2%. Moreover, the mean percent steer composition of all lots was 59.8%, indicating that the majority of lots were predominately steer-oriented.

Sellers that indicated use of growth promoting implants sold 15.0% of total lots, while 21.4% of lots marketed cattle produced without growth implants. With regard to lot origin, farm-fresh calves represented the base at 81.0% of lots sold, in contrast to assembled lots and mixed consignments of both farm-fresh and assembled calves, which represented 13.8% and 5.2% of lots, respectively.

Number of days following the sale until lot shipment varied widely among lots and ranged from 2 to 122 days, with a mean of 41 days. Each lot most commonly shipped as 1 load of cattle, though number of loads varied across lots from 1 to 4 with a mean of 1.2 loads. Although all consignors were encouraged to participate in some degree of value-added management, lots specifying implementation of a day-specific preconditioning program, i.e., 45-day, 60-day, 90-day, or 120-day program, corresponded to 23.9% of lots sold.

Participation results suggest a decline in number of lots per sale since 2008, accompanied by a slight increase in number of head (Figures 3.1 and 3.2). Furthermore, price trends of the board sale program have illustrated a steady increase in relative sale price throughout its history.

Price comparisons were made evaluating the efficacy of the board sale as a marketing alternative. Of the lots with historical Mississippi day-of-sale and day-of-

loadout market information available, 94.2% sold at a greater price in comparison to the average state-wide market price at the time of sale. The average difference in price between board sale lot prices and the average Mississippi market prices ranged from -$9.75 to $27.50 per cwt with a mean of $8.66 per cwt, revealing an average price advantage of lots sold through the board sale in juxtaposition with Mississippi average market prices at the time of sale. This positive mean indicates that on average, lots sold for $8.66 per cwt more than if the same lot had sold at a local auction market on the day of sale. Similarly, 90.1% of lots received greater prices than Mississippi average market prices on the day of shipment, with an average price difference ranging from -$7.38 to $75.93 per cwt and a mean of $12.16 per cwt. This reveals that the majority of participating lots benefitted financially from consigning cattle to the board sale rather than marketing through a local auction barn either at time of sale or when the cattle were actually shipped. These results suggest that utilization of the board sale program as a marketing tool may be advantageous for producers in maximizing profit generated.

Least Squares Means Results

Sale Price Model

Least squares means for each year and differences of least squares means among years were obtained to estimate marginal means of actual lot sale price relative to year. Results for both models are displayed in Table 3.2. All years were significantly different with respect to lot price except for 2008 and 2010, 2012 and 2016, and 2013 and 2016. The first year of the board sales, 2008, had a mean price of $108.30 per cwt and was greater only than that of 2009 ($P < 0.0001$), but less than those of years 2011, 2012, 2013, 2014, 2015, and 2016 ($P < 0.0001$). With a mean price of $95.83, lots sold the

following year received prices significantly lower than all other years of years of the sale ($P < 0.0001$). The third year, 2010, had a mean price of $108.06, with lots selling for less than all subsequent years of sale ($P < 0.0001$). The mean sale price increased the following year to $131.06, and remained significantly less than those of 2012 ($P = 0.0113$), 2013, 2014, 2015, and 2016 ($P < 0.0001$). Sales in 2012 resulted in a mean price of $136.39. These lots sold for less than those of 2013 ($P = 0.0023$), 2014, and 2015 ($P < 0.0001$) and tended to sell for $5.64 less compared with 2016 ($P = 0.0514$). With a mean price of $144.36, lots in the sixth year of the sales sold for prices lower than those in 2014 and 2015 ($P < 0.0001$), but were not significantly different than those of 2016. On average, when compared with lots sold in 2015, lots sold in 2014 received lower sale prices ($P < 0.0001$), but sold at a greater price in relation to lots sold in 2016 ($P < 0.0001$) with a mean price of $191.06 per cwt. The greatest mean selling price among all years was achieved in 2015 at $210.97 per cwt ($P < 0.0001$). The final year of the program had a mean price of $142.03.

The period encompassing the history of the board sales was a turbulent time in the beef cattle industry, in part due to increased feed prices in years prior to 2008 and their subsequent impact on cattle prices. The economic conditions surrounding the beef industry in 2009 are apparent in Table 3.2, revealing record-low sale prices relative to all other years of the sales. Then, drought conditions across much of the United States produced greater price conditions in following years through 2015. Ultimately, a supply response is perceivable in 2016 as calf inventories were replenished.

Futures Basis Model

Futures basis estimates and comparisons are reported as estimates for each year along with comparisons against estimates for subsequent years. With a mean basis of -$6.05, the first year of the sales (2008) was significantly greater than that of 2012 (P = 0.0271), and less than those of 2015 (P = 0.0018) and 2016 (P < 0.0001). With a mean basis of -$3.88, the second year of the program was significantly different from all other years of the sale except 2008 and 2010. On average, 2009 had a mean greater than those of 2011 (P = 0.014), 2012 (P < 0.0001), 2013 (P = 0.0007) and 2014 (P = 0.0496) and less than those of 2015 (P = 0.0221) and 2016 (P = 0.0012). The third year had an average basis greater than those of 2012 (P = 0.0087) and 2013 (P = 0.0438) and less than those of 2015 (P = 0.0002) and 2016 (P < 0.0001), with a mean of -$6.20. The fourth year of the program, 2011, had a mean basis of -$7.01 and was significantly greater than that of 2012 (P = 0.0429) and significantly less when compared with 2015 (P < 0.0001) and 2016 (P < 0.0001). Both 2012 (mean of -$9.81) and 2013 (mean of -$9.41) exhibited comparable differences in mean basis against those of the most recent two years of the program. On average, 2012 had a lower mean than those of 2015 (P < 0.0001) and 2016 (P < 0.0001). Likewise, 2013 also had a lower mean compared with 2015 (P < 0.0001) and 2016 (P < 0.0001). Lastly, 2014 had a mean basis of -$7.22 and was significantly less than that of 2015 (P = 0.0004) and 2016 (P < 0.0001). The final two years, 2015 and 2016, were not significantly different from each other, with means of -$0.05 and $2.07, respectively.

Though basis levels are fairly consistent across most years, those observed in 2009, 2015, and 2016 were different from other years. Interestingly, the results of these

years were more positive, indicating greater cash prices received relative to futures market values. These years are notably representative of more turbulent years in the market, with particularly low prices observed in 2009, and exceptionally high prices typical of 2015.

Differences between Models

Market price fluctuations were overwhelmingly apparent in yearly price estimates when examined in juxtaposition with the futures basis model. These relationships are evident when reviewing trends of historic feeder cattle market data, and can be observed in Figure A.1. Consequently, binary year variables were expected to have a significantly large impact on lot prices, potentially skewing price model results.

With respect to the futures basis model, somewhat of a pattern can be observed when studying price trends throughout the years of sales. This may be attributed to variations in the parameter used in calculating each variable: weekly futures market prices. With lot sale price held fixed, a lesser (more negative) futures basis corresponds with greater futures market prices. It appears that the first year of the sale was met with success, after which prices somewhat declined until greatly improving in more recent years of the sale.

Model Coefficients

Parameter estimates of variables analyzed in each model are provided in Tables 3.3 and 3.4. Several variables were shown to significantly affect lot price, with coefficients reported as premiums or discounts in contrast to associated base parameters. Estimates of both futures basis were interpreted as actual increases or decreases in sale

price. These variables were calculated against fixed values of weekly futures market prices, and thus coefficient effects represent changes in lot price due to respective lot attributes. Many estimates are largely consistent with results of previous literature and thus parallel with expected outcomes.

The White test, used for detecting the presence of heteroskedasticity, revealed a significant influence on certain variables in each model. Year variables for 2009, 2010, 2011, and 2012 were heteroskedastic in the sale price model. In the basis model, weighted average lot weight and binary variables for implanted lots and year eight were heteroskedastic. These variables were then entered into the Repeated statement to correct for bias caused by inconstant variance, essentially adjusting the covariance structure of the model to result in more accurate standard errors. As verified through evaluation of Pearson correlation coefficients and variance inflation factors (VIF), multicollinearity was not detected among any variables.

Sale Price Model

Sale Year Effects on Price

Of the nine binary sale year variables included in the model, coefficients for all years apart from 2010 significantly affected price relative to the first year of the program. Lots sold in 2009 received \$12.42 per cwt less than those of 2008 ($P < 0.0001$) whereas lots in 2011 sold for \$17.76 per cwt greater than those of 2008 ($P < 0.0001$). Furthermore, compared with those of 2008, lots sold for price premiums of \$21.49 in 2012 ($P < 0.0001$), \$28.38 in 2013 ($P < 0.0001$), \$73.31 in 2014 ($P < 0.0001$), \$89.85 in 2015 ($P < 0.0001$), and \$19.74 in 2016 ($P = 0.0290$). These considerable price

differentials confirm a substantial impact of sale year on lot price, as no measures were taken to account for market price fluctuations in this model.

Cattle Characteristics Effects on Price

The sale price model revealed that with respect to cattle characteristics, four variables held a significant impact on price: lot body weight, hide color group, lot gender makeup, and growth implant technology.

Lot body weight was shown to affect sale price as anticipated. A decrease in price of $15.08 accompanied each additional 100 pounds of average lot body weight ($P < 0.0001$). This inverse price-weight relationship is typical in feeder cattle market settings, as price per cwt decreases with weight at a decreasing rate until essentially leveling off contingent with fed cattle market price conditions. Body weight can both directly and indirectly play a key role in feeder cattle prices received, as price differentials can fluctuate with weight, and the effects on specific price-weight relationships can vary with changing market conditions (Dhuyvetter and Schroeder, 2000).

Percentage of steers comprising each lot significantly affected lot price ($P < 0.0001$), corresponding to a $0.07 per cwt premium for each 1% increase in steer makeup. This effect of gender on sale price is consistent with feeder cattle market reports and previous research indicating a price advantage of marketing steers over heifers. Zimmerman (2010) reported that on average, heifers sold for $7.50 per cwt less than steers when sold in Superior Livestock Auction. Troxel and Barham (2012) reported similar findings, with heifers receiving significant price discounts relative to steers. This can be attributed to the greater expected growth potential of steers compared to heifers,

paired with the adverse effects of estrous cycling on feeding performance that may be observed in heifers (Smith et al., 1998; Schultz and Marsh, 1985).

With respect to lot hide color, lots that were classified as mixed with majority (51% to 94%) black cattle represented the greatest number of lots sold, and were thus set as the base for comparison. Of the various hide color groups, only lots that were classified as solid black were significantly different from the base, receiving a $1.14 per cwt premium ($P = 0.0429$). This price benefit is expected, as indicated by Williams et al. (2012) who reported that black cattle sold for the greatest price above all other hide colors represented. Similar results were reported by Troxel and Barham (2012) in that black-white faced cattle received the greatest sale price, followed by black, yellow, and yellow-white faced, which were significantly greater than all other hide colors. No other hide color groups represented sold for significantly different sale prices from the base.

Lots marketing cattle produced without the use of growth implants received a $3.15 per cwt premium over those lots that did not specify growth implant practices ($P < 0.0001$). However, sale price of lots that specified administration of growth promoting implants did differ from lots that did not indicate implant practices. These results suggest that buyers prefer having the flexibility in designing their own growth promotant system in managing calves. Conversely, this premium may reflect a penchant for cattle destined for niche markets, such as those demanding the supply of natural and non-hormone treated (NHTC) cattle. Zimmerman et al. (2012) reported that natural-market eligible calves received premiums of $0.81 and $1.09 per cwt for steers and heifers in 2006, respectively, although no other years presented significant price differences, with NHTC-market eligible calves receiving premiums of $1.81 and $2.78 per cwt for steers and

heifers in 2010, respectively, although neither received significant premiums in 2009. Similar trends were observed in southeastern feeder cattle markets during 2008 to 2011, with natural calves – those marketed without the use of growth implants, ionophores, or antibiotics – receiving significant price premiums of $2.16 per cwt (Burdine et al., 2014).

Lot Sale Characteristics Effects on Price

Lot origin was the only sale characteristic variable that significantly affected selling price. As expected, assembled lots received a price discount of $1.78 per cwt compared to lots marketing cattle from the farm of origin ($P = 0.0131$), though sale price of lots comprised of both farm-fresh and assembled lots was not significantly different from farm-fresh lots. Assembled market calves are often designated as "high risk," characterized by increased morbidity, mortality as a result of respiratory disease, and health costs when compared to farm-fresh calves from a single origin (Smith, 2009; Step et al., 2008). As such, these cattle may be discounted at sale to account for this expected reduction in performance.

Futures Basis Model

Sale Year Effects on Price

Of the nine binary sale year variables, only years two (2009) and nine (2016) corresponded to a significant difference in basis compared with 2008, the first year of the board sale program. The second year witnessed a $5.21 per cwt greater sale price than 2008 ($P < 0.0001$), whereas the final year of the program resulted in a $14.80 per cwt price increase ($P = 0.0438$). All other years did not pertain to a significant difference from that of the first year. This suggests that in relation to the initial launch of the board

sales, the program may have largely become more successful the following year after attracting a larger producer base and providing tangible results of program success.

Cattle Characteristics Effects on Price

Previous studies have demonstrated that lot makeup in regards to cattle type and management has a substantial impact on selling price. Hide color group, lot gender makeup, Brahman influence, growth implant administration, and participation in a day-specific preconditioning program are variables represented as cattle attributes included in the model that significantly affected lot price.

Percentage of steers comprising each lot significantly affected lot price ($P < 0.0001$), corresponding to a \$0.08 per cwt premium for each 1% increase in steer makeup. This effect of gender on sale price is consistent with the aforementioned results from the sale price model together with feeder cattle market reports and previous research indicating a price advantage of marketing steers over heifers.

Of the various hide color groups, only lots that were a random mixture with no specific color majority and mixed lots with majority white cattle were significantly different from the base. Majority white lots were discounted \$1.93 per cwt compared with majority black lots ($P = 0.0485$), whereas completely mixed color lots received a discount of \$1.19 per cwt ($P = 0.0438$). The remaining lot hide color groups – solid black, solid red, and majority red – were not significantly different from majority black lots. These results suggest that lots composed primarily of black or red cattle are perceived as more valuable to prospective buyers. Studies conducted by Troxel and Barham (2012) found dissimilar results, with red cattle selling for significantly lower sale prices than black cattle, though they were not different from white cattle. Their findings

are similar to results by Williams et al. (2012), who reported that solid black lots sold for the greatest price followed by majority black and solid white/grey lots; solid red and majority red lots were further discounted compared with these lots.

With regard to cattle type, lots specifying the inclusion of cattle with a small degree of *Bos indicus* influence tended to receive a premium of $0.95 per cwt ($P$ = 0.0731). This potential price advantage is contrary to findings reported in several previous studies. Of calves sold in Superior Livestock Auction, Brahman-influenced calves sold at the lowest price compared with all other breed types (Zimmerman, 2012). Smith et al. (1998) reported that steer calves with greater than ¼ Brahman influence received a significant discount compared with both Angus and continental type steers in eastern Oklahoma, though steers with less than ¼ Brahman influences did not differ in price compared with Angus steers. The hot and humid climate of many Southeastern states render some level of incorporation of *Bos indicus* type cattle into crossbreeding systems beneficial, providing additional heat tolerance and hardiness. Troxel and Barham (2012) reported that Angus calves and crosses of Angus x Brahman, Angus x Hereford, Hereford x Charolais, and Angus x Hereford x ¼ Brahman feeder cattle sold for the greatest prices and were not different from each other. This may suggest added value for calves relative to geographical location, specifically those in areas where heat stress may be an issue.

Lots specifically indicating growth promoting implant use, either the administration or withholding of, sold for greater prices than those lots that did not specify. A $1.59 per cwt premium was achieved for lots marketing cattle produced without growth implants (P = 0.0096), whereas lots advertising the use of implants

received a premium of $2.00 per cwt ($P = 0.0062$). This implies that potential buyers may exhibit a preference for lots providing extensive management information, allowing for flexibility in designing a specific growth promotant system. Zimmerman et al. (2012) reported similar outcomes, reporting that lots with unknown or inconsistent implant protocols were discounted more than $2.00 per cwt during certain years compared with lots that specified implant practices, though other years presented no significant difference.

To this effect, lots listing participation in a day-specific preconditioning program tended to receive a premium of $1.00 per cwt ($P = 0.0748$). Although all consignors were encouraged to participate in some degree of value-added management, this price advantage tendency is akin to the price benefits of specifying lot implant status, with buyers offering premiums for those lots providing more specific information. Avent et al. (2004) alluded to this premise, revealing a significant premium of $3.30 per cwt for use of a strict preconditioning program similar to the VAC-45 protocol when compared to conventional calves sold at auction, with a lesser $1.94 per cwt premium for calves from a general, more inclusive preconditioning program encompassing a wider variety of vaccination and weaning guidelines. Likewise, King et al. (2006) reported that sale prices of calves marketed in a VAC-45 program were significantly greater compared those marketed in alternate preconditioning programs or those not in a certified health program.

Lot Sale Characteristics Effects on Price

Number of days from sale until shipment, number of loads per lot, and group consignment lots were three factors pertaining to lot structure characteristics that significantly affected basis.

Some lots contained cattle that were sold at the desired body weight and ready to ship at the time of sale, whereas others would not reach final body weight until a specified period of time following the sale. Each additional day following the day of sale until lot loadout corresponded to a \$0.04 per cwt discount in price ($P < 0.0001$). This suggests that buyers preferred lots that shipped at or close to the time of sale, discounting those that did not ship until subsequent months. A perceived increase in risk may be associated with purchasing cattle that will not be available for shipment for longer periods of time, particularly due to the possibility of unforeseen circumstances that may negatively impact the cattle sold.

Number of loads included per lot sold significantly affected sale price, with a premium of \$0.71 per cwt for each additional load per lot ($P = 0.0280$). A greater number of loads purchased within lots provides the buyer larger numbers of uniform calves, allowing for more effective sorting at the time of shipment.

Relative to lots consigned by a single producer, lots compiled from multiple consignors (three or more) were discounted \$1.42 per cwt ($P = 0.0084$), though lots from two consignors were not significantly different from single-consignor lots. This price discount indicates that buyers exhibit a preference for lots sold from one or two consignors rather than groups, possibly due to the day-of-shipment commingling among calves from multiple consignors, rather than those that are kept segregated from calves of other locations through shipment.

Prices of assembled lots and those comprised of both farm-fresh and assembled cattle were not significantly different than lots shipping directly from the farm of origin. These results were somewhat unanticipated, as farm-fresh cattle are typically considered

"lower risk" and thus less likely to experience adverse health and performance issues often associated with commingled calves assembled from unknown sources. However, assembled lots and mixed lots of assembled and farm-fresh calves represented a small proportion of lots sold in comparison to 81% of lots marketing farm-fresh calves. Nonetheless, by encouraging consignors to contribute cattle produced with an emphasis on health management practices, the board sale essentially relegated this negative perception of assembled cattle. Though purchased from unknown sources, calves are essentially allowed to undergo an initial receiving period to improve health through implementation of vaccination and parasite control measures prior to shipping through the board sale. In doing so, potential buyers may perceive assembled lots as less of a risk.

Conclusions

Results from this study confirmed a relationship between sale price and lot characteristics with respect to both cattle traits and management factors for cattle sold in in a Mississippi feeder calf board sale. A number of factors were determined to result in either premiums or discounts when expressed as values of futures basis or actual sale price upon adjusting for year effects.

Of the factors showing a significant influence on price across models, lots comprised primarily of steers can typically be expected to receive price premiums compared with heifer-only lots. Akin to previous literature, solid or primarily black lots or those with red cattle received greater prices, especially in comparison to lots including greater numbers of white cattle, or lots with a random assortment of hide colors (Troxel and Barham, 2012). Lots of cattle with some degree of Brahman influence were also shown to receive price premiums. Though previous literature has revealed price discounts

for eared cattle (Zimmerman, 2012), this price differential could likely be attributed to regional climate traits, as *Bos indicus* cattle are expected to contribute heat tolerance and hardiness in traditionally hot, humid climates such as Southeastern states.

With respect to cattle management, those lots marketed as either receiving or being withheld from growth implants have been shown to receive premiums at sale compared with those lots that did not specify, indicating buyer preference for lots providing more extensive management information. Though not significant in all models, lots comprised of assembled cattle may nonetheless receive price discounts compared with farm-fresh calves. Furthermore, lots drawn from multiple consignors may be discounted relative to lots from a single consignor. These results reiterate the negative perception of commingling among calves, whether occurring prior to sale or at the time of shipment. By consigning cattle that are ready to ship at the time of sale, producers may avoid potential discounts accompanying prolonged periods between sale and loadout. Lots selling as multiple loads may also receive greater prices, suggesting that buyers prefer lots providing greater numbers of more uniform calves.

Year effects as demonstrated in the actual sale price model primarily reflect patterns in cattle market fluctuations. In models with these market fluctuations accounted for, yearly price discrepancies may reveal arbitrary effects on prices received such as sale participation or buyer turnout. Effects observed in analysis of the basis model potentially suggest trends in program success, with earlier years of the sale exhibiting prices greater than subsequent years; sales held in most recent years were shown to receive the greatest prices of all years.

Implications

Many of the major variables that influence the selling price of feeder cattle can be addressed through genetic selection and routine management decisions. As a result, commercial producers can evaluate their production practices and make educated management decisions to improve the value of their cattle and thus overall returns. Future research may also focus on further determining the optimal levels of these different factors as they may vary with region and current market conditions.

Table 3.1 Descriptive statistics for sale demographics

Characteristic	Variable	N	% of Lots	Mean	Maximum	Minimum
Lot Sale Price	price	327	100.0%	131.09	239.00	83.75
Futures Basis	basis	327	100.0%	-5.81	28.42	-26.68
Day of Sale Price Diff.	msdosbasis	294	89.9%	8.66	27.50	-9.75
Loadout Price Diff.	msloadoutbasis	294	89.9%	12.16	75.93	-7.38
Lot gender makeup	mixedlot	148	45.3%	1.00	1.00	1.00
	heirferlot	66	20.2%	1.00	1.00	1.00
Days to loadout	daystoload	327	100.0%	41.07	122.00	2.00
Number of loads per lot	noloads	327	100.0%	1.21	4.00	1.00
Percent steer	percentsteer	327	100.0%	59.77	100.00	0.00
Number of consignors	oneseller	171	52.3%	1.00	1.00	1.00
	twoseller	59	18.0%	1.00	1.00	1.00
	groupsellers	97	29.7%	1.00	1.00	1.00
Hide color group	onetofiftyblk	25	7.6%	1.00	1.00	1.00
	majorityblk	278	85.0%	1.00	1.00	1.00
	onetofiftysmk	144	44.0%	1.00	1.00	1.00
	majoritysmk	9	2.8%	1.00	1.00	1.00
	onetofiftywht	38	11.6%	1.00	1.00	1.00
	majoritywht	20	6.1%	1.00	1.00	1.00
	onetofiftyred	132	40.4%	1.00	1.00	1.00
	majorityred	13	4.0%	1.00	1.00	1.00
	mix	43	13.1%	1.00	1.00	1.00
	smokemix	1	0.3%	1.00	1.00	1.00
	whitemix	14	4.3%	1.00	1.00	1.00
	blackmix	181	55.4%	1.00	1.00	1.00
	redmix	3	0.9%	1.00	1.00	1.00
	red	8	2.4%	1.00	1.00	1.00
	black	75	22.9%	1.00	1.00	1.00
	white	1	0.3%	1.00	1.00	1.00
	smoke	1	0.3%	1.00	1.00	1.00
Brahman influence	ear	50	15.3%	1.00	1.00	1.00
Lot origin	assem	45	13.8%	1.00	1.00	1.00
	farmassem	17	5.2%	1.00	1.00	1.00
	farmfresh	265	81.0%	1.00	1.00	1.00
Growth implant status	noimplant	70	21.4%	1.00	1.00	1.00
	implant	49	15.0%	1.00	1.00	1.00
Day-specific preconditioning	precon	78	23.9%	1.00	1.00	1.00

Table 3.2 Least squares means estimates among years

	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sale Price	108.3^{f}	95.84^{g}	108.06^{f}	131.06^{e}	136.39^{d}	144.36^{c}	191.06^{b}	210.97^{a}	142.03^{cd}
Futures Basis	-6.05^{bcd}	-3.88^{b}	-6.2^{bc}	-7.01^{cd}	-9.81^{e}	-9.41^{de}	-7.22^{cde}	-0.05^{a}	2.07^{a}

^{a,b,c,d,e,f,g}Means within row with different superscripts differ ($P < 0.05$)

Table 3.3 Coefficient estimates for Sale Price model

Variable	Estimate	Standard Error	Pr > |t|
Intercept	174.71	12.88	<.0001
yeartwo	-12.42	2.69	<.0001
yearthree	-3.10	3.32	0.3516
yearfour	17.76	4.15	<.0001
yearfive	21.49	5.28	<.0001
yearsix	28.38	6.71	<.0001
yearseven	73.31	7.70	<.0001
yeareight	89.85	8.79	<.0001
yearnine	19.64	8.95	0.0290
wtdavgcwt	-15.08	3.64	<.0001
wtdavgcwt*wtdavgcwt	0.66	0.26	0.0113
daystoload	-0.01	0.01	0.1036
noloads	0.44	0.38	0.2389
percentsteer	0.07	0.01	<.0001
twoseller	-0.18	0.56	0.7547
groupsellers	-0.76	0.53	0.1518
mix	-0.66	0.51	0.1986
redmix	-0.10	1.73	0.9558
whitemix	-0.78	1.47	0.5949
black	1.14	0.56	0.0429
red	0.43	1.60	0.7904
ear	0.66	0.60	0.2712
assem	-1.78	0.71	0.0131
farmassem	0.13	0.90	0.8891
noimplant	3.15	0.76	<.0001
implant	0.92	1.22	0.4497
precon	-0.24	0.58	0.6763

Table 3.4 Coefficient estimates for Futures Basis model

Effect	Estimate	Standard Error	Pr > |t|
Intercept	34.63	15.1131	0.0226
yeartwo	5.22	1.3349	0.0001
yearthree	2.90	2.2073	0.1904
yearfour	2.81	3.1336	0.3707
yearfive	1.46	4.1676	0.7257
yearsix	4.36	5.2444	0.4061
yearseven	5.72	6.1892	0.3562
yeareight	9.60	7.5510	0.2047
yearnine	14.80	7.3083	0.0438
wtdavgcwt	-7.02	4.1878	0.0946
wtdavgcwt*wtdavgcwt	0.08	0.2907	0.7711
daystoload	-0.04	0.007722	<.0001
noloads	0.71	0.3231	0.0280
percentsteer	0.08	0.005343	<.0001
twoseller	-0.57	0.5596	0.3108
groupsellers	-1.42	0.5355	0.0084
mix	-1.19	0.5865	0.0438
redmix	-0.69	1.8274	0.7057
whitemix	-1.93	0.9725	0.0485
black	0.79	0.4925	0.1102
red	2.06	1.2903	0.1111
ear	0.94	0.5253	0.0731
assem	-0.38	0.6539	0.5603
farmassem	-0.31	0.8047	0.6982
noimplant	1.59	0.6081	0.0096
implant	2.00	0.7258	0.0062
Precon	1.00	0.5589	0.0748

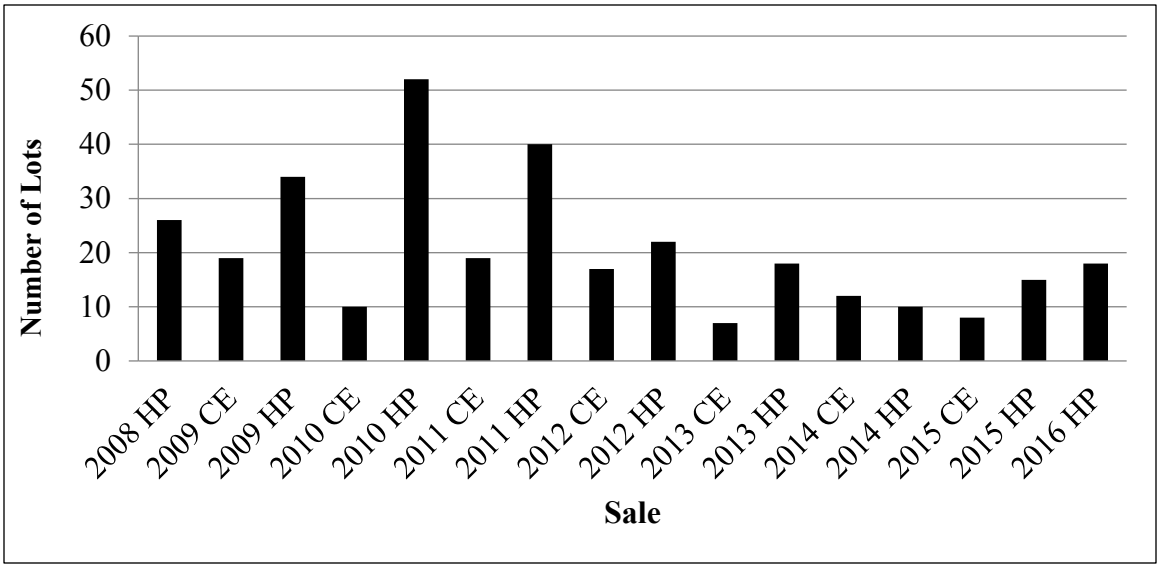

Figure 3.1 Participation results by year

[1]HP = Homeplace Producers Sale
[2]CE = Cattlemen's Exchange Sale

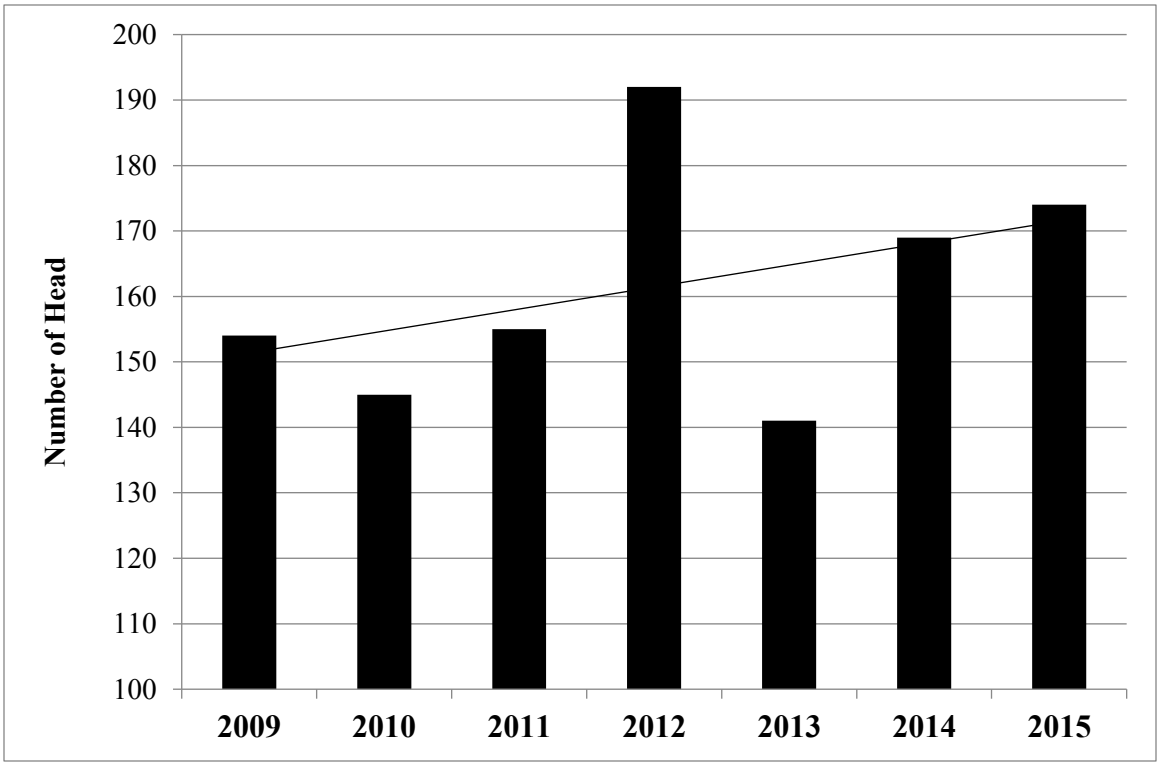

Figure 3.2 Number of head by sale year

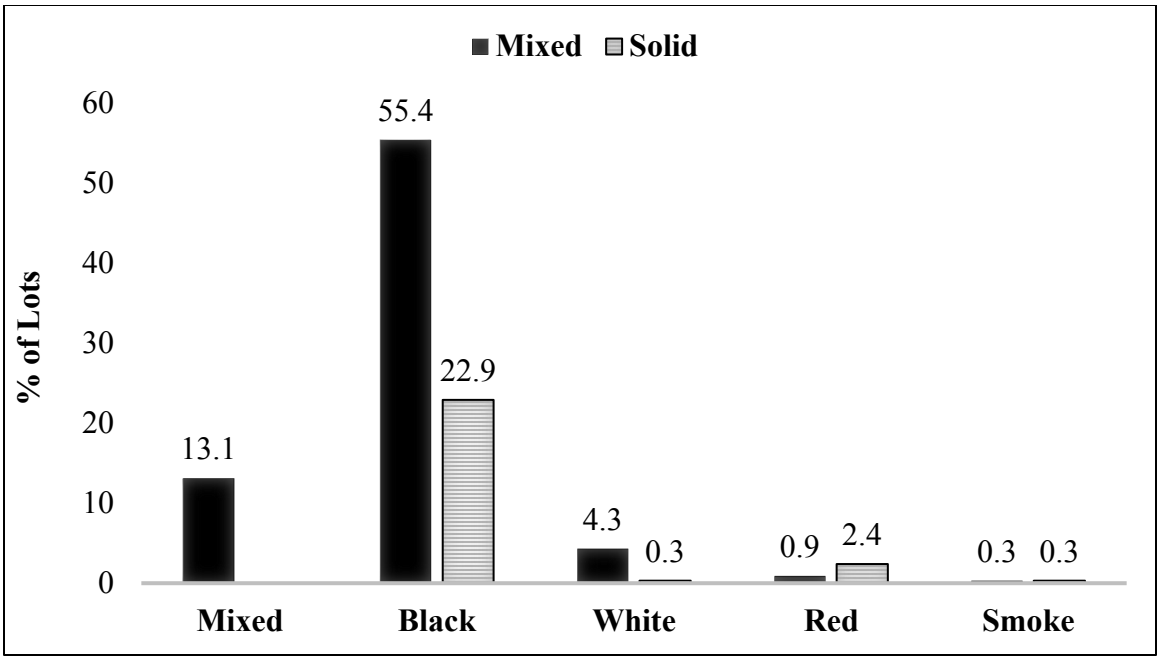

Figure 3.3 Sale demographics of lot hide color makeup

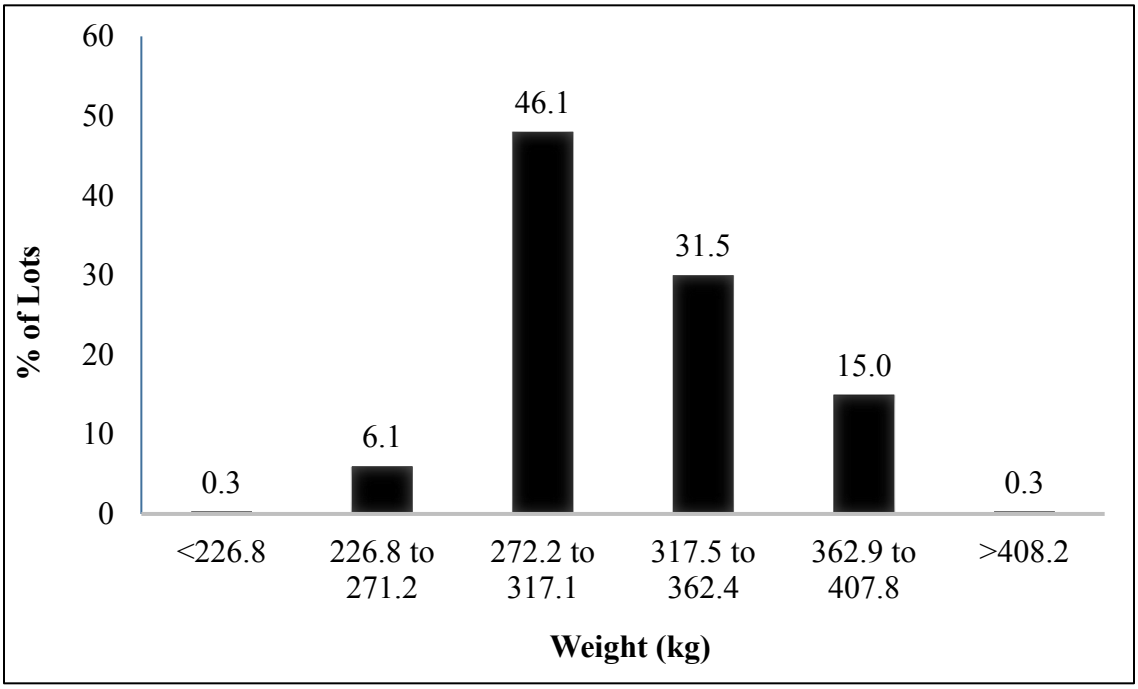

Figure 3.4 Sale demographics of weighted average lot body weight

REFERENCES

Avent, R. K., C. E. Wood, and D. L. Lalman. 2004. Market valuation of preconditioning feeder calves. J. Agr. Appl. Econ. 36,1:173-183.

Bailey, D. and L. Hunnicutt. 2002. The role of transaction costs in marketing selection: market selection in commercial feeder cattle operations. In: Am. Agr. Econ. Ass. Ann. Meet., Long Beach, CA.

Bailey, D. and M. C. Peterson. 1991. A comparison of pricing structures at video and traditional cattle auctions. West. J. Agr. Econ. 16(2):392-403.

Barham, B. L. and T. R. Troxel. 2007. Factors affecting the selling price of feeder cattle sold at Arkansas livestock auctions in 2005. J. Anim. Sci. 85:3434-3441. doi:10.2527/jas.2007-0340.

Bastian, C. 2002. Comparing your marketing opportunities. In: Managing for today's cattle market and beyond. Livestock Marketing Information Center.

Belsley, D. A. 1991. Conditioning diagnostics: collinearity and weak data in regression. Wiley Interscience Publication, New York, NY.

Blank, S. C., H. Boriss, L. Forero, and G. Nader. 2006. Western cattle prices vary across video markets and value-added programs. California Agriculture. 60:160–165.

Blank, S. C., L. Forero, and G. A. Nader. 2009. Video market data for calves and yearlings confirm price discounts for Western cattle. California Agriculture. 63:160-165.

Burdine, K. H., L. J. Maynard, G. S. Halich, and J. Lehmkuler. 2014. Changing market dynamics and value-added premiums in southeastern feeder cattle markets. Prof. Anim. Sci. 30:354-361.

Castro, V. M., G. M. Veserat, and J. W. Oltjen. 1998. Buyer survey to determine desired production practices for a value-added program for beef cattle in California. J. Anim. Sci. 79(Suppl. 1):105. (Abstr.)

Coatney, K. T., D. J. Menkhaus, and J. D. Schmitz. 1996. Feeder cattle price determinants: an hedonic system of equations approach. Review of Agricultural Economics 18:193-211.

Darby, M. R. and E. Karni. 1973. Free competition and the optimal amount of fraud. J. Law and Econ. 16(1):67-88.

Day, B. H. 2001. The theory of hedonic markets: obtaining welfare measures for changes in environmental quality using hedonic market data. CSERGE Economics.Dhuyvetter, K. C. 2004. Preconditioning beef calves: are expected premiums sufficient to justify the practice? In: West. Agr. Econ. Ass. Ann. Meet., Honolulu, Hawaii.

Dhuyvetter, K. C. and T. C. Schroeder. 2000. Price-weight relationships for feeder cattle. Canadian J. Agr. Econ. 48:299-310. Dyck, J. and R. J. Johnson. 2013. Japan announces new rules for imports of U. S. Beef. LDP-M-225SA. In: Livestock, Dairy and Poultry Outlook: Special Article. ERS-USDA.

Falkner, T. R. 1998. Shrink management in cattle. In: Kansas Veterinary Quarterly. Kansas State Research and Extension, Veterinary Medicine. p. 3.

Faminow, M. D. and R. L. Gum. 1986. Feeder cattle price differentials in Arizona auction markets. West. J. Agr. Econ. 11:156-63.

Giamalva, J. and M. McConnell. 2013. Japan allows expanded access for U. S. beef. In: Executive Briefing on Trade. Agriculture and Fisheries Division, Office of Industries-Informa Economics.

Gillespie, J., A. Basarir, and A. Schupp. 2004. Beef producer choice in cattle marketing. J. Agribusiness. 22,2:149-161.

Hawkes, J. M., J. M. Lillywhite, and J. Simonsen. 2008. Breed influence on feeder calf prices. New Mexico State University Cooperative Extension Service. Circular 634.

Hobbs, J. E. 1997. Measuring the importance of transaction costs in cattle marketing. Am. J. Agr. Econ. 79:1083-1095.

King, M. E., M. D. Salman, T. E. Wittum, K. G. Odde, J. T. Seeger, D. M. Grotelueschen, G. M. Rogers, G. A. Quakenbush. 2006. Effect of certified health programs on the sale price of beef calves marketed through a livestock videotape auction service from 1995 through 2005. J. Am. Vet. Med. Assoc. 229(9):1389-400. doi:10.2460/javma.229.9.1389.

Kutner, M. H., C. J. Nachtsheim, and J. Neter. 2004. Applied linear regression models. 4th ed. McGraw-Hill/Irwin, The McGraw-Hill Companies, Inc., New York, NY.

Lalman, D. and G. Mourer. 2001. Effects of preconditioning on health, performance and prices of weaned calves. Oklahoma Cooperative Extension Service. ANSI-3529.

Machen, R. and R. Gill. 1998. Using a slide in beef cattle marketing. Texas A&M AgriLife Extension. L-5063.

Mathis, C. P., C. A. Loest, and B. Carter. 2008. Preconditioning beef calves. New Mexico State University Cooperative Extension Service. Circular 637.

Monson, M. 2009. Valuation using hedonic pricing models. In: Cornell Real Estate Review. 7(10):62-73. Cornell Univ.

Parish, J. A., J. D. Rhinehart, and J. D. Anderson. 2009. Marketing feeder calves. Mississippi State University Extension Service. Pub. 2552.

Peel, D. S. Economics of stocker production. 2006. Vet. Clin. Food Anim. 22:271–296. doi:10.1016/j.cvfa.2006.03.007.

Ratcliff, M. D., E. B. Kegley, J. G. Powell, J. Hawley, K. S. Lusby, M. P. Rowe, S. A. Gunter, L. B. Daniels, and D. S. Hubbell. 2014. Effect of method and timing of castration on newly arrived stocker cattle. Prof. Anim. Sci. 30:457-465.

Riley, J. M. and J. A. Parish. 2012. Analysis of prices received for feeder calves sold through video board sales in Mississippi. Mississippi Agricultural and Forestry Experiment Station. J-12027.

Rosen, S. 1974. Hedonic prices and implicit markets: product differentiation in pure competition. J. Political Economy. Vol. 82:34-55.

Schroeder, T., J. Mintert, F. Brazle, and O. Grunewald. 1988. Factors affecting feeder cattle price differentials. West. J. Agr. Econ. 13(1):71-81.

Schultz, R. W. and J. M. Marsh. 1985. Steer and heifer price differences in the live cattle and carcass markets. West. J. Agr. Econ. 10(1):77-92.

Schumacher, T., T. C. Schroeder, and G. T. Tonsor. 2012. Willingness-to-pay for calf health programs and certification agents. J. Agr. Appl. Econ. 44,2:191-202.

Self, H. L. and N. Gay. 1972. Shrink during shipment of feeder cattle. J. Anim. Sci. 35(No.2):489-494.

Smith, R. A. 2009. North American cattle marketing and bovine respiratory disease (BRD). Animal Health Research Reviews 10(2):105-108. doi:10.1017/S1466252309990101.

Smith, S. C., D. R. Gill, S. C. Jones, and B. A. Gardner. 1998. Effect of selected characteristics on the sale price of feeder cattle in eastern Oklahoma. In: 1998 Animal Science Research Report. Oklahoma State Univ., Stillwater. p. 89-95.

Step, D. L., C. R. Krehbiel, H. A. DePra, J. J. Cranston, R. W. Fulton, J. G. Kirkpatrick, D. R. Gill, M. E. Payton, M. A. Montelongo, and A. W. Confer. 2008. Effects of commingling beef calves from different sources and weaning protocols during a forty-two-day receiving period on performance and bovine respiratory disease. J. Anim. Sci. 86(11):3146-3158. doi:10.2527/jas.2008-0883.

Sullivan, G. M. and D. A. Linton. 1981. Economic evaluation of an alternative marketing system for feeder cattle in Alabama. S. J. Agr. Econ. 13:85-89.

Troxel, T. R. and B. L. Barham. 2012. Phenotypic expression and management factors affecting the selling price of feeder cattle sold at Arkansas livestock auctions. Prof. Anim. Sci. 28:64-72.

Turner, S. C., N. S. Dykes, and J. McKissick. 1991. Feeder cattle price differentials in Georgia teleauctions. S. J. Agr. Econ. 23: 75-84.

USDA. 2008. Beef 2007-08, Part I: Reference of beef cow-calf management practices in the United States, 2007-08. USDA-APHIS-VS, CEAH. N512-1008.

USDA. 2009. Beef 2007-08, Part III: Changes in the U. S. beef cow-calf industry, 1993-2008. USDA-APHIS-VS, CEAH. N518-0509.

USDA ERS. 2017. Background, cattle feedlots. https://www.ers.usda.gov/topics/animal-products/cattle-beef/background.aspx (Accessed 19 January 2017.)

Williams, G. S., K. C. Raper, E. A. DeVuyst, D. Peel, and D. McKinney. 2012. Determinants of price differentials in Oklahoma value-added feeder cattle auctions. J. Agr. Resource Econ. 37:114-127.

Wood, R. W. 2012. Prepaid forward contracts: what's all the fuss? In: The M&A Tax Report. 20(7):5-7. Wood LLP, Attorneys at Law.

Zimmerman, L. C. 2010. Factors influencing the price of value-added calves at superior livestock auction. M. S. Thesis. Kansas State Univ., Manhattan.

Zimmerman, L. C., T. C. Schroeder, K. C. Dhuyvetter, K. C. Olson, G. L. Stokka. J. T. Seeger, and D. M. Grotelueschen. 2012. The effect of value-added management on calf prices at Superior Livestock Auction Video Markets. J. Agr. and Resource Econ. 37(1):128–143.

APPENDIX A

SUPPLEMENTAL FIGURES

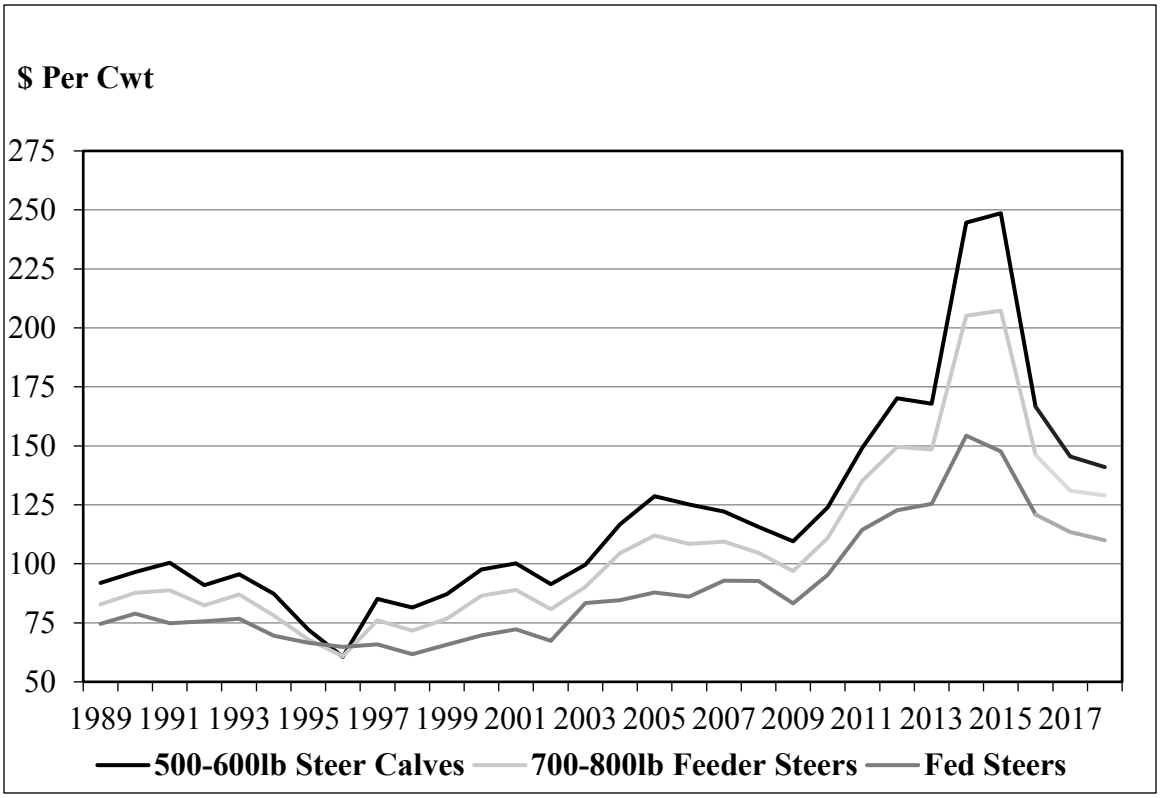

Figure A.1 Historical trends of average annual cattle prices

Data source: USDA-AMS, Compiled and Forecasts by LMIC
Figure source: Livestock Marketing Information Center