Identifying Factors that Impact Returns to Retained Ownership of Cattle

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Abstract

Retained ownership is a marketing strategy that can be used by cow-calf operators. Therefore, we analyze the profitability of retained ownership over the past decade. We also determine the impact of animal characteristics (e.g., average daily gain, feed conversion) and producer choice decisions (e.g., placement weight, placement season, days on feed) on retained ownership profitability. Data from 2005 to 2015 on 2,953 head of cattle originating in Tennessee and finished in Iowa using a retained ownership strategy were collected. A mixed model was developed with fixed effects for animal characteristics and producer choice variables and random effects for the feedlot, farm origin and the year cattle were harvested. Results indicate that placement weight, placement season, days on feed, animal health and animal sex impacted retained ownership profitability. Our findings could be useful for cow-calf producers to develop more profitable production and marketing strategies.

Keywords: Cattle performance, profitability, profitability determinants, retained ownership

JEL Classifications: Q12, Q13

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Introduction

The beef cattle industry is Tennessee's largest agricultural enterprise (Lewis et al., 2015). The total cash receipts from the sale of cattle and calves during 2007 was $582 million (James, 2014). This value increased to $735.5 million in 2012, which was 20% of the state's total agricultural income (U.S. Department of Agriculture [USDA], 2012). The beef cattle industry is critical to the state's economy. Like most of the southeastern states, cow-calf production is the major cattle enterprise in Tennessee (Sleigh, 1996). Tennessee annually markets more than 750,000 feeder calves to backgrounding operations and feedlots, primarily in the Midwest and High Plains areas of the country (Neel, 2014). However, net returns to cattle feeders are highly variable over time (Langemeier, Schroeder, and Minert, 1992; Sleigh, 1996; McDonald and Schroeder, 2003). These large variations in profits come from variability in input costs, feeder cattle prices, fed cattle prices, feedlot performance (Langemeier, Schroeder, and Minert, 1992) and carcass characteristics (McDonald and Schroeder, 2003). Retaining cattle after a traditional sale point can be utilized by Tennessee cow-calf producers to benefit from increases in prices for the producer and capture the potential benefits of an established breeding program (Lambert and Sands, 1984; Tassell et al., 1997; White et al., 2007a).

Researchers have summarized advantages and disadvantages of retained ownership from cow-calf producers' perspective. For the advantages, first, it can bring cow-calf producers valuable genetic information with which they can evaluate feedlot performance of their cattle (Gill Barnes, and Peel, n.d.), and adjust the breeding program to improve animal quality (Wagner and Feuz, 1991; Lawrence, 2005). Second, it could be a risk efficient strategy to increase marketing flexibility (Carlberg and Brown 2001; Lawrence, 2005). The disadvantages include:

delayed income, increased risk of poor performance, and demanding financing requirements (Davis, McGrann, and Mintert., n.d.; Wagner and Feuz, 1991; Lawrence, 2005).

Several studies analyzed and identified factors impacting the variability of feedlot cattle feeding profitability (e.g. Langemeier, Schroeder, and Minert, 1992; Lawrence, Wang, Joy, 1999; Mark et al., 2000; Forristall, May, and Lawrence, 2002; Stalker et al., 2006). Most studies analyzed data from Kansas feedlots (Simms, Maddux, and Mintert, 1991; Langemeier, Schroeder, and Minert, 1992; Schroeder et al., 1993; Mark et al., 2000) and other Midwestern feedlots (Lawrence Wang, Joy, 1999; Stalker et al., 2006). Relatively few variables explain a large percentage of the variability in calf feedlot profitability (White et al., 2007a). Fed and feeder cattle price variability contributed most to cattle feeding profits over time, followed by corn price, and animal performance (Langemeier, Schroeder, and Mintert, 1992; Albright et al., 1993; Mark et al., 2000).

Although empirical evidence from previous studies indicate that owning calves after weaning generally improves producers' cattle feeding profits in most years, it does not always bring positive profits every year (Wagner and Feuz, 1991; Fausti et al., 2003; Lawrence,2005; White et al., 2007b; Randall and Watt, 2009). Retaining ownership of cattle is regarded as a risky investment decision (Fausti et al., 2003), which was used by less than 10% of the population, and about 14% of the producers were members of a strategic alliance or cooperative (Gillespie, Basarir, and Schupp, 2004). Therefore, cow-calf producers have traditionally sold calves after weaning (Schroeder and Featherstone, 1990; Fausti et al., 2003; Kelsey, Schroeder, and Langemeier, 2011).

The decision of whether to retain weaned calves is dependent on current market conditions, expected price, health performance, and the cow-calf producers' propensity for risk

(Schroeder et al., 1990; White, 2005). Given the cattle industry is characterized by highly variable returns (Wang et al., 1997), understanding how related factors contribute to profit variability will help cattle feeders and cow-calf producers develop risk management strategies associated with feeding cattle.

Lewis et al. (2015) examined data from 2013-2014 and determined how animal characteristics and a supplemental prepartum feeding program for cows affect retained ownership profitability of 160 steers originating in Tennessee. Results indicate that retained ownership was profitable in that selected year. However, they only looked at one year of retained ownership data. Moreover, few studies have examined the difference in retained ownership profitability between steers and heifers. If information about the profitability of retained ownership for both steers and heifers over time were available, cow-calf producers could use it to develop more profitable production and marketing strategies. The objective of this study is to determine the impact of animal characteristics (e.g., average daily gain, feed conversion) and producer choice decisions (e.g., cattle sex, placement weight, placement season, days on feed) on retained ownership profitability from 2005 to 2015 in Tennessee.

Literature Review

Early research by Swanson and West (1963) noted that feeder cattle price margins and feeding margins cannot completely explain levels of net returns to cattle feeding. Their research demonstrated that price margin and feed costs explained 82% of the variation in cattle feeding returns. Langemeier et al. (1992) analyzed a much more detailed dataset of price and performance variables from a Kansas feedlot between 1980 and 1989, and concluded that feeder cattle, fed cattle, and corn prices explained most of the profit variation overtime. Schroeder et al.

(1993) examined closeout data from 7,292 pens of steers placed on feed between January 1980 and May 1991 in two western Kansas feed yards and obtained the similar conclusions. Using data from 1,626 pens of cattle placed on feed between January 1987 and December 1996 in the upper Midwest, Lawrence, Wang, Joy (1999) evaluated the effects of animal sex, animal performance and facility design on profits and found that all variables significantly affect profits. Mark et al. (2000) also found that fed cattle prices and feeder cattle prices have greater impacts on cattle feeding profitability than corn prices, interest rates, and animal performance.

With the adoption of grid pricing, carcass quality characteristics become an important factor affecting cattle feeding profitability (Feuz, 1999). Feeder cattle price and grid based fed cattle price had the greatest effect on profit per head over time (Mark et al., 2000; McDonald and Schroeder, 2003). Profit analysis from the feedlot perspective concluded that feedlot profitability was mostly determined by marbling, carcass weight, and feed efficiency (Forristall, May, and Lawrence, 2002). Producers with high quality fed cattle can use value-based grid pricing to increase their returns from cattle feeding (McDonald and Schroeder, 2003).

Relationships between feed cost of gain, corm price, and cattle feeding performance have also been examined (Langemeier, Schroeder, and Mintert, 1992; Schroeder et al., 1993; Albright et al., 1993). Results revealed that corn price and feed performance explained most of the variation. Anderson and Trapp (2000) found that there existed a linear relationship between changes in cost of gain and changes in corn price.

Several studies focused on the profitability differences between steers and heifers (e.g. Williams et al. 1993; Mark et al., 2000). Effects of corn price, interest rates, and cattle performance on profits between steers and heifers were also compared and examined (Mark et al., 2000). Differences in fed and feeder cattle price, and animal performance can explain most of the

variability in profit differences (Williams et al. 1993). Heifer feeding profits were relatively more influenced by the sale price and performance than steer feeding profits (Lawrence, Wag, and Loy, 1999).

Whether to retain calves after weaning or to sell at weaning is one of many complex questions faced by cattle feeders. Cattle feeders making retaining ownership decisions need to consider the following factors: capital constraints (Lambert, 1989), physical or labor constraints (Lambert, 1989; Fausti et al., 2003), current profit situation, price outlook of the fed cattle, and feasible alternative pricing strategies (Schroeder and Featherstone, 1990).

Agricultural policy analysts and agricultural economists are perennially interested in specifying factors that affect producers' decision about calf retention (Popp, Faminow, and Parsch, 1998). It is suggested that cow-calf producers were generally more risk-averse individuals and tend to sell cattle at weaning (Tassell et al., 1997; Kelsey, Schroeder, and Langemeier, 2011; Pope et al., 2011). Age is also found to be a factor affecting producers' cattle retaining ownership decision. Young farmers are more interested in adopting a retained ownership strategy (Gillespie, Basarir, and Schupp, 2004). Additionally, producers having greater contact with county extension agents and those interested in performance-based management using feedlot and carcass data are more likely to retain ownership of their cattle (Gillespie, Basarir, and Schupp, 2004; Franken et al., 2010).

In a perfectly competitive economy, the objective of the cow-calf operators would be to maximize expected profit (White et al., 2007a). Although an examination of the South Dakota Retained Ownership Demonstration Program indicated that retained ownership improved profitability over several years, a retained ownership program that is profitable in one year may not be profitable on average or in any other year (Wagner and Feuz, 1991). Seasonality is often

overlooked as a factor affecting cattle feeding profits. Mark et al. (2000) studied historical and seasonal trends in cattle performance and economic factors that impact steer feeding profitability. The feed cost of gain was found to be seasonal and follow a different pattern, depending on steer weight. Hardin and Saghaian (2014) conducted a budget analysis using data from a cattle marketing firm located in Lexington, Kentucky and found that seasonality significantly affect calf prices. They found that calf prices are highest in the summer and lowest in the fall while profits for cow-calf operators are highest for spring calving cow herds. However, Henry (2015) analyzed data from spring- and fall-calving cows originating in Tennessee and concluded that the fall-calving season was more profitable than the spring calving season regardless of the feed ration and weaning month.

Most research analyzed retained ownership profitability using data before 2000 (e.g. Wagner and Feuz, 1991; Carlberg and Brown, 2001; Fausti et al., 2003). Continued research using updated data that are representative of current management and production conditions are needed. Such research would provide cattle feeders more solid implications for the future. What's more, most research used average or aggregate data from pen or feedlot closeouts (e.g. Langemeier et al, 1992; Albright et al., 1993; Schroeder et al, 1993; Lawrence, Wang, and Joy, 1999; Mark et al., 2000), few research used individual cattle data to analyze factors affecting cattle feeding profit per head (e.g. McDonald and Schroeder, 2003).

This study extends the work of Lewis et al. (2015) by using individual cattle data over an 11-year time period. The main contribution of this study is the examination of multiple years of retained ownership data in the United States. The study will offer cow-calf producers effective operation strategies in making retained ownership decisions.

Data

Data used in this study were collected by Tri-County Steer Carcass Futurity Cooperative (TCSCF) and include feedlot information and carcass cutout data from November 2004 through February 2015 on 2,297 steers and 689 heifers from the Tennessee Beef Evaluation Program. Thirty-three cattle died during the feeding phase and were excluded from the analysis due to incomplete information, leaving 2,265 steers and 688 heifers for the empirical analysis.

These 2,953 cattle originated from 39 Tennessee producers, who consigned cattle to the program. Cattle were fed in feedlots participating in the TCSCF based in Lewis, Iowa. Eleven feedlots were represented in the study. Cattle were harvested from 2005 to 2015. The feedlot data for individual cattle include cattle sex, placement weight, placement date, days on feed, feed to gain ratio, average daily gain, feed costs, final weight, and harvest date. Data on feeder cattle price on delivery ($/cwt), carcass quality, dressing percentage, and carcass price ($/cwt) were collected. All the cattle were sold using grid-based price. All the prices and costs reported in this study have been indexed for inflation to 2015 dollars by using the Bureau of Labor Statistics Consumer Price index. For cattle placed on feed and harvested in two consecutive years, an average value of the consumer index is assigned to all the costs and prices associated with that cattle.

Table 1 displays the summary statistics of placement weight, days on feed, animal performance statistics, the number of health treatments for steers, heifers, and all of the cattle combined, and dressing percentage. Placement weight was the weight of the cattle (lbs.) when it was placed in the feedlot. Days on feed was calculated as the interval between the delivery date when the cattle entered the feedlot and the harvest date of the cattle. Feed-to-gain ratio was computed as total pounds of feed dry matter divided by pounds of weight gain during the placement period. Average daily gain was computed as the ratio of feedlot gain and days on feed.

Dressing percentage was computed as the ratio of hot carcass weight and final live weight of the cattle. The health treatments were the number of individual health treatments for the cattle during the placement period.

The average placement weight for steers was generally heavier than heifers. Steers typically exhibited better feed conversion than heifers. Pairwise comparisons were made using t-tests to determine if statistically significant differences exist between steers and heifers for all the summary statistics. Placement weight, feed to gain ratio, and average daily gain were found to be significantly different at the 1% level between steers and heifers.

[Place Table 1 Approximately Here]

Table 2 displays the summary statistics of placement weight, days on feed, animal performance statistics, the number of health treatments for steers, heifers, and all of the cattle combined, and dressing percentage by placement season. Spring, summer, fall, and winter were defined as March-May, June-August, September-November, and December-February, respectively (Lawrence, Wag, and Loy, 1999). Summer was the basis of comparison.

Cattle placed in fall were kept in the feedlot for the longest period of time and shortest when placed in spring. Both steers and heifers placed in spring and summer were heavier than those placed in fall and winter. Steers placed on feed during the spring exhibited the best feed-to-gain ratio and relatively high average daily gain. Heifers placed on feed in spring had the best feed conversions and the highest average daily gain when placed in winter. Steers and heifers placed in spring were the heaviest at the time of delivery. Average price was the highest for fed steers placed in winter and the lowest in spring. While average price was the lowest for fed heifers placed in fall and the highest placed in winter. On average, individual cattle placed in

winter received the most number of health treatments because of induced health problem caused by cold conditions (Langemeier, Schroeder, and Mintert, 1992).

Pairwise comparisons tests were made using t-tests to determine if statistically significant differences exist between steers and heifers for all the summary statistics. Placement weight, feed to gain ratio, and average daily gain were statistically different between steers and heifers in four placement seasons. Dressing percentage was statistically different between steers and heifers placed in summer, fall, and winter. While number of health treatments were only statistically different between steers and heifers both placed in spring.

[Place Table 2 Approximately Here]

Table 3 displays summary statistics of feed cost, corn prices, total feedlot cost, and specific feedlot costs for steers, heifers, and all the cattle combined. Feed cost was computed as total feed dry matter (lbs.) times the cost of ration dry matter ($/lbs.). Corn prices recorded were the monthly price received by U.S. corn producers from USDA's Agricultural Marketing Service (AMS) from marketing year 2004 to 2015. Total feedlot cost was the sum of all the individual cattle costs incurred in the feedlot and trucking costs. Health treatments were the individual treatment costs (source from TCSCF Steer and Heifer Test Evaluation Formulas). Yardage is calculated as the number of days on feed times the feedlot's yardage charge (source from TCSCF Steer and Heifer Test Evaluation Formulas).

Average health treatment payments were higher for steers than heifers. Average feed costs were higher for steers than heifers. Total cost for steers was higher than heifers. Pairwise comparison t-tests indicated that feed cost, yardage fee, trucking, and total feedlot cost for steers were significantly different from heifers. Corn price was also found to be significantly different between steers and heifers at the 1% level, which was caused by the differentials of placement

time between steers and heifers. Pairwise comparisons tests indicated that feed cost, yardage fee, trucking costs, and total feedlot costs were statistically different between steers and heifers at the 1% level.

[Place Table 3 Approximately Here]

Table 4 displays summary statistics of corn price, feedlot cost, feeder cattle price, and fed cattle price for steers, heifers, and all the cattle combined by placement season.

Average feed cost, corn price, feedlot cost, feed cost of gain, and fed cattle price were highest for all the cattle placed in winter. Average feeder cattle prices were the lowest for steers and heifers placed in spring. Average feeder cattle price for steers were higher than heifers in four placement seasons. Pairwise comparison tests indicated that feedlot cost and feeder cattle price are statistically different for steers from heifers in four placement seasons. Corn price was found to be statistically different for steers from heifers both placed in spring, fall, and winter. While fed cattle price was statistically different for steers than heifers both placed in summer, fall, and winter.

[Place Table 4 Approximately Here]

Retained Ownership Economic Framework

Assuming cow-calf producers are profit maximizers they will choose to retain cattle until slaughter if it is more profitable than selling calves at weaning. Based on marketing information recorded and production experience, a producer can select sex of cattle, days on feed, weight of cattle at the time of delivery (placement weight), and the season in which cattle would be sent into the feedlot (placement season) in order to obtain the highest net returns. Thus, the objective function for a profit maximizing producer can be expressed as:

$$(1)\quad \max_{S_i, PS_i, DoF_i, PW_i} NR_i = [P_i(y_i)y_i(DoF_i, W_i) - PC_i(S_i, PS_i)] \times Retain_i + OC_i \times [1 - Retain_i]$$

Where NR_i is the profit of observed cattle i ($\$/head$); S_i is an indicator variable that is equal to one if the cattle retained is steer and zero otherwise; PS_i is an indicator variable representing placement season and equals one if cattle enter the feedlot in a specific season and zero otherwise; DoF_i is the number of days the cattle are kept in the feedlot; W_i is the weight of cattle at the time of entering the feedlot; P_i is the grid price received at harvesting ($/pound) and is a function of carcass weight (y_i) of the cattle; PC_i is the production cost for finishing the cattle ($/head); $Retain_i$ is an indicator variable that is equal to one when the producer retains ownership of the cattle and zero otherwise; OC_i is the opportunity cost, which equals the Iowa delivery weight of the feeder cattle multiplied by the market value of the feeder cattle ($/cwt) at the time of delivery to Iowa. The market value of the feeder cattle were determined by the USDA Market News Staff based on the USDA frame and muscle scores of the feeder cattle and feeder price in Tennessee.

Net Returns Model

In order to identify factors affecting retained ownership profits, we model net returns of cattle and specify the following linear random effect model:

$$(2)\ NR_i = \beta_0 + \beta_1 S_i + \sum_{j=1}^{3} \beta_j PS_{ji} + \beta_5 DoF_i + \beta_6 W_i + \beta_7 FG_i + \beta_8 ADG_i + \beta_9 D_i + \beta_{10} T_i + \beta_{11} C_i + \mu_{year(i)} + \mu_{feedlot(i)} + \mu_{producer(i)} + \varepsilon_i$$

Here NR_i is the net return of cattle i through retained ownership. S_i is the indicator variable of cattle sex, which is equal to one if the retained cattle is steer, and 0 otherwise. The effects of placement season are examined by including indicator variables of three placement seasons ($PS_{ji}, j = 1,2,3$) with summer as the default. Variables associated with cattle characteristics and performance were also included into the model. DoF_i is days on feed, which represents number

of days the animal was fed in the feedlot. It was calculated as the interval between harvest date and Iowa delivery date. W_i is placement weight, weight of feeder cattle at the time being delivered into the feedlot. FG_i is the feed to gain ratio, which was calculated as total pounds of feed on a dry matter basis divided by pounds of feedlot gain. ADG_i is the overall average daily gain, which was calculated as total weight gain in the feedlot divided by total days on feed. D_i is dressing percentage, which was calculated as hot carcass weight divided by final live weight. T_i is the number of independent health treatments received by an individual animal during the feeding period. C_i is average monthly U.S. corn price during the time the cattle were fed, which was obtained from USDA Statistics Service (2004-2015).

$\mu_{year(i)}$ are the random effects of harvest year, $\mu_{feedlot(i)}$ are the random effects of feedlot, $\mu_{producer(i)}$ are the random effects of producer. The error term ε_i is independent and individually distributed with mean 0 and variance σ_ε^2. The subscript i denotes the individual cattle observed, e.g. $year(i)$ identifier is taken to mean the year that cattle i is harvested. It is clear that different feedlots across regions affect cattle retained ownership profits due to various production facility conditions (Lawrence, Wag, and Loy, 1999). $\mu_{producer(i)}$ was included because socio-economic characteristics of cow-calf producers affect calf performance result from varied production practices and feed rations. These random effects may be significant but difficult to measure, thus random terms were used to avoid omitted variable bias. The Likelihood ratio test and the Hausman test indicated harvest year should be included as a random variable.

Based on existing literature, the expected signs of the coefficients for some variables can be interpreted as follows: good cattle performance (i.e. lower feed-to-gain ratio and higher average daily gain) have positive effects on cattle retained ownership profits (Schroeder, et al, 1993; Jones, et al., 1996; Mark et al., 2000); higher dressing percentage yields more profits

(Fausti et al., 2003).An increase in corn price would decrease retained ownership profits since corn prices directly affect feeding cost, which contributes more than 50% of the variation to the cattle feeding profitability (Miller, et al., 2001). Independent health treatments in the feedlot would incur extra costs and negatively affect cattle retained ownership profits. It has been shown that untreated calves and calves only treated once were more profitable than calves treated multiple times, and calves that recovered after a single treatment had improved average daily gain compared to calves treated multiple times (Hardin and Saghaian, 2014). It is generally believed that steers perform better in the feedlot, thus yield more profits than heifers.

It is difficult to predict which placement season is the most profitable and which one is the least profitable. We are also uncertain how days on feed affects profits in our dataset since more feed costs are incurred as cattle are kept more days on feed in the feedlot. Dressing percentage is posited to be positive related with profits (Fausti et al., 2003; Lewis et al., 2015)

Empirical Results

Net Returns

Retained ownership profits per head were calculated following equation (1). Summary statistics of average annual net returns from retaining ownership of cattle are presented in table 5. Returns to retained ownership were positive in 9 of the 11 years analyzed, with an average return of $47.80 per head (Figure 1). Average retained ownership profits across all years for heifers were higher than steers. Specifically, average net returns to steers were positive in 8 of 11 years, with an average return of $43.62 per head; average net returns to heifers were positive in 9 of 10 years, with an average return of $61.56 per head (Figure 2).

Retained ownership was most profitable for cattle placed in winter with an average profit of $82.40/head. Cattle placed in summer were the least profitable with an average profit of -$9.81 per head (Figure 3). Profits varied seasonally and exhibited different patterns for steers and heifers (Figure 4). Profits for heifers placed in the spring were the highest, and profits for steers placed in the summer were the lowest. Steers placed in spring and summer months were generally less profitable than steers placed in fall and winter. Also, profit variability was higher for steers placed on feed during the summer, fall, and winter. Heifers placed in the spring and winter were more profitable than heifers placed in summer and fall.

[Place Table 5 Approximately Here]

[Insert Figures 1 through 4 Here]

Model Results

Estimated coefficients of the mixed model are presented in table 6. Both the fixed effects and random effects were statistically significant at the 1% level, and estimated coefficients exhibited expected signs except placement weight. Cattle performance significantly affected retained ownership profits. Higher average daily gain and lower feed-to-gain ratio would increase cattle feeding profits. Number of individual health treatments received by the cattle was negatively related to profits as expected. Increasing corn price significantly reduced retained ownership profits. Retaining heifers was more profitable than retaining steers.

Previous research by Mark, Jones, and Minert (1997) indicated that steers placed on feed in late spring to early summer were generally more profitable than steers placed on feed in late winter and early spring at the same weight. However, our findings indicated that cattle placed on feed in summer were least profitable, while cattle placed on feed in winter were the most profitable (Table 5). Placement weight positively affected profits to cattle retained ownership.

Days on feed had a positive effect on profits. The random effects for harvest year, feedlot and producer were all significant at the 1% level.

Conclusions, Implications and Future Research

Two common questions of "what kind of beef animal is most profitable" and "can profits be increased by cattle retention post weaning" are constantly raised by cow-calf producers (Stokes, Farris, and Cartwright, 1981). Our findings provided insight into these questions. Understanding how cattle performance and producer choice variables impact profitability are important for cow-calf producers in making strategic marketing decisions. Retained ownership data for steers and heifers harvested from 2005 to 2015 were analyzed. A mixed model was developed with fixed effects for the factors mentioned previously and related random effects (e.g., feedlot, producer, and harvest year). Empirical results indicated that placement weight, placement season, days on feed, animal health and animal sex impacted retained ownership profitability.

Overall, retained ownership profits to heifers were higher than steers on average. Cattle placed on feed in winter were most profitable, while cattle placed on feed in summer were least profitable. Days on feed had a positive effect on retained ownership profits. Desirable cattle feedlot performance (i.e. lower feed-to-gain ratio and higher average daily gain) increased retained ownership profits. Dressing percentage and placement weight positively affected retained ownership profits, while the number of individual health treatments and corn price negatively impacted retained ownership profits. Overall, returns to retained ownership were positive in 9 of the 11 years analyzed, indicating that retained ownership could be a beneficial marketing strategy.

Useful implications can be drawn from the empirical evidence presented above. The results that placement season and days on feed impacted profits provide cow-calf producers a

unique opportunity to determine the optimal days and season for the cattle to be placed on feed. An improvement in cattle performance would increase the likelihood of positive net returns to retained ownership. Cattle performance data records would act as useful references in making a wise retained ownership decision. Whether to place steers or heifers can be a hard decision faced by many cow-calf producers (Williams et al., 1993). Cattle feeders should jointly consider cattle performance factors and price outlook of feeder and fed prices for both steers and heifers when making procurement decisions.

This study extends earlier research (e.g. Lewis et al., 2015) by including other placement decisions that may impact cattle feeding profitability and by using multiple years of retained ownership data. Future research could include sensitivity analysis of our results by examining the relationship between feeder and fed prices.

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Table 1. Summary Statistics for Steers and Heifers Finished and Harvested in Iowa and Originating in Tennessee for 2005-2015

	All			Steer			Heifer		
Variable	Mean	Minimum	Maximum	Mean	Minimum	Maximum	Mean	Minimum	Maximum
Days on Feed	147.91 (25.26)	101	206	147.78 (25.70)	101	206	148.33 (23.76)	101	206
Placement Weight (lbs.)	716.27 (108.89)	410	1110	728.12*** (105.75)	425	1110	677.25*** (110.03)	410	1070
Feed-to-Gain Ratio	6.63 (0.77)	4.20	13.08	6.54*** (0.70)	4.20	10.76	6.91*** (0.90)	4.56	13.08
Average Daily Gain	3.42 (0.62)	1.05	5.66	3.53*** (0.60)	1.05	5.66	3.06*** (0.54)	1.20	5.13
Dressing %	61.53% (0.02)	53.61%	69.68%	61.45% (0.02)	53.61%	69.68%	61.77% (0.02)	56.23%	67.16%
#Number of Health Treatments	0.31 (0.69)	0	5	0.31 (0.71)	0	5	0.30 (0.66)	0	4
Number of Observations	2,953			2,265			688		

Note: Standard deviations are in parenthesis.

*,**, *** denotes pairwise differences between steers and heifers at the 10%, 5%and 1% levels.

Table 2. Summary Statistics of Cattle Performance by Cattle Sex and Placement Season for 2005-2015

Placement Season	Cattle Group	Variables						Number of Observations
		Days on Feed	Placement Weight	Feed-to-Gain Ratio	Average Daily Gain	Dressing %	Number of Health Treatments	
Spring	All	131.33 (16.51)	787.62 (109.49)	6.38 (0.73)	3.52 (0.65)	61.44% (0.02)	0.30 (0.68)	266
	Steer	131.77 (17.52)	800.02*** (112.63)	6.29*** (0.70)	3.67*** (0.62)	61.44% (0.02)	0.23*** (0.56)	185
	Heifer	130.32 (14.00)	759.32*** (96.78)	6.57*** (0.74)	3.18*** (0.57)	61.45% (0.01)	0.48*** (0.87)	81
Summer	All	144.77 (26.71)	746.82 (122.86)	6.54 (0.77)	3.53 (0.70)	61.52% (0.02)	0.27 (0.66)	877
	Steer	143.79* (27.28)	763.76*** (119.98)	6.40*** (0.72)	3.68*** (0.67)	61.43%*** (0.02)	0.28 (0.68)	668
	Heifer	147.92* (24.60)	692.67*** (116.37)	6.97*** (0.78)	3.05*** (0.56)	61.81%*** (0.02)	0.22 (0.58)	209
Fall	All	155.98 (26.52)	694.78 (94.13)	6.78 (0.85)	3.25 (0.58)	61.57% (0.02)	0.24 (0.56)	749
	Steer	155.86 (25.91)	701.10*** (87.48)	6.66*** (0.71)	3.38*** (0.55)	61.47%*** (0.02)	0.26* (0.59)	574
	Heifer	156.40 (28.50)	674.05*** (111.02)	7.19*** (1.13)	2.80*** (0.45)	61.91%*** (0.02)	0.18* (0.43)	175
Winter	All	148.96 (22.32)	688.29 (90.22)	6.66 (0.69)	3.43 (0.53)	61.52% (0.02)	0.38 (0.80)	1,61
	Steer	148.97 (23.48)	702.34*** (86.20)	6.63 (0.66)	3.49*** (0.53)	61.46%* (0.02)	0.37 (0.81)	838
	Heifer	148.91 (17.38)	635.49*** (85.46)	6.76 (0.79)	3.22*** (0.50)	61.75%* (0.02)	0.40 (0.75)	223

Note: Standard deviations are in parenthesis.

[a] Placement season: Spring = March-May, Summer = June-August, Fall = September-November, Winter = December-February.

*,**, *** denotes pairwise differences between steers and heifers at the 10%, 5%and 1% levels.

Table 3. Summary Statistics of Feedlot Feed Cost ($/head) by Cattle Sex for 2005-2015

	All			Steer			Heifer		
Variable	Mean	Minimum	Maximum	Mean	Minimum	Maximum	Mean	Minimum	Maximum
Feed Cost	328.29	126.06	786.56	339.01***	135.54	786.56	293.01***	126.06	711.96
	(102.25)			(105.77)			(80.19)		
Health Treatments	9.24	0	162.81	9.59	0	162.81	8.10	0	128.08
	(22.08)			(22.87)			(19.19)		
Vaccines	16.66	4.43	38.40	16.91	4.43	38.39	15.84	4.43	37.15
	(7.42)			(7.69)			(6.37)		
Yardage	54.74	36.46	74.73	55.08***	36.46	74.73	53.61***	36.46	74.73
	(8.80)			(8.81)			(8.67)		
Trucking [a] & Checkoff	62.74	29.29	107.89	63.69***	29.29	106.62	59.58***	37.02	107.89
	(12.26)			(11.51)			(13.98)		
Miscellaneous[b]	23.13	7.78	18.24	23.11	7.78	18.24	23.19	18.55	29.92
	(2.86)			(2.97)			(2.46)		
Total Feedlot Cost	494.79	268.15	1008.83	507.38***	283.80	1018.1	453.34***	277.59	906.11
	(114.65)			(119.10)			(86.52)		
Corn Price[c] $/bu.	4.52	2.38	7.32	4.55	2.38	7.32	4.40	2.38	7.32
	(1.27)			(1.32)			(1.04)		
Number of Observations	2,953			2,265			688		

Note: Standard deviations are in parenthesis.

[a] Trucking costs consist of the cost of transportation for the cattle from home to Iowa and the cost of transportation for the cattle from the feedlot in Iowa to the packing plant to be slaughtered.

[b] Miscellaneous expenses include data collection fee, interest paid less interest received, tags, peril insurance, labor, scale charge and meals for weaning cattle, GA health inspections and electrolytes if used.

[c] Corn price differences between steers and heifers are caused by differentials of placement time.

*,**, *** denotes pairwise differences between steers and heifers at the 10%, 5%and 1% levels.

Table 4. Summary Statistics of Feedlot Feed Cost ($/head) by Cattle Sex for 2005-2015

Placement Season	Cattle Group	Variables				Number of Observations
		Feedlot Cost $/HD	Corn Price $/bu.	Feeder Cattle Price $/cwt	Fed Cattle Price[b] $/cwt	
Spring	All	438.52	4.37	97.73	163.59	266
		(57.50)	(0.69)	(10.55)	(10.89)	
	Steer	454.05***	4.43**	100.68***	163.22	185
		(56.57)	(0.72)	(9.97)	(11.31)	
	Heifer	403.06***	4.23**	91.01***	164.43	81
		(41.96)	(0.58)	(8.63)	(9.87)	
Summer	All	463.62	4.09	116.30	167.33	877
		(97.58)	(1.14)	(12.34)	(19.72)	
	Steer	476.03***	4.07	119.83***	169.54***	688
		(105.37)	(1.24)	(10.53)	(21.33)	
	Heifer	423.98***	4.15	105.02***	160.26***	209
		(49.52)	(0.73)	(10.83)	(10.60)	
Fall	All	480.18	4.29	114.88	174.37	749
		(123.73)	(1.35)	(18.60)	(22.37)	
	Steer	500.92***	4.40***	118.57***	178.64***	574
		(129.70)	(1.42)	(16.74)	(22.53)	
	Heifer	412.16***	3.94***	102.78***	160.94***	175
		(65.91)	(1.01)	(19.30)	(15.58)	
Winter	All	544.97	5.06	106.82	178.60	1,061
		(113.29)	(1.22)	(31.63)	(28.59)	
	Steer	548.58***	5.06***	108.91***	179.64***	838
		(119.01)	(1.24)	(30.83)	(27.52)	
	Heifer	531.44***	5.07***	98.95***	174.68***	223
		(87.51)	(1.13)	(33.41)	(32.08)	

Note: Standard deviations are in parenthesis.

[a] Placement season: Spring = March-May, Summer = June-August, Fall = September-November, Winter = December-February.

[b] Fed cattle price is represented by the actual carcass price ($/cwt).

*,**, *** denotes pairwise differences between steers and heifers at the 10%, 5% and 1% levels.

Table 5. Summary Statistics for Net Returns by Harvest Year

Year	Observations	All	Steer	Heifer
2005	26	205.71	230.71	171.63
		(85.28)	(72.83)	(92.41)
2006	299	-56.03	-67.53	4.11
		(107.89)	(104.70)	(105.31)
2007	489	9.86	-9.93	65.69
		(137.48)	(145.69)	(90.57)
208	418	27.80	25.62	32.04
		(91.31)	(94.14)	(85.71)
2009	484	32.25	29.04	37.31
		(85.36)	(85.56)	(85.03)
2010	488	159.60	154.19	187.59
		(111.52)	(112.72)	(101.22)
2011	193	196.87	193.30	227.77
		(107.63)	(107.49)	(106.53)
2012	279	0.83	-7.72	51.91
		(89.11)	(88.71)	(73.79)
2013	176	-70.73	-67.12	n.a.[1]
		(161.58)	(158.81)	
2014	48	205.82	205.82	n.a.
		(158.74)	(158.74)	
2015	53	131.49	149.84	68.82
		(124.70)	(108.14)	(159.51)
Average		47.80	43.62	61.56
		(138.74)	(145.02)	(114.71)
Observations	2,953	2,953	2,265	688

Note: Numbers in parentheses are standard errors;
[1] No heifers were harvested in 2013 and 2014

Table 6. Parameter Estimates of Retained Ownership Net Returns for Cattle Originating from Tennessee and Shipped to Iowa Feedlot (n=2953)

Independent Variables	Parameter Estimates	
Fixed Effects		
Steer (yes=1; no=0)	-73.94***	
	(4.28)	
Spring	100.46***	
	(10.73)	
Fall	126.06***	
	(6.59)	
Winter	131.0***	
	(8.16)	
Days on feed	0.54***	
	(0.09)	
Placement weight	0.26***	
	(0.02)	
Feed to gain ratio	-54.91***	
	(3.38)	
Average daily gain	49.39***	
	(3.87)	
Dressing percentage %	24.00***	
	(0.92)	
Number of health treatment	-26.03***	
	(2.57)	
Corn Price, $/bu.	-61.42***	
	(6.07)	
Constant	-1250.27***	
	(78.66)	
Random Effects Variance		ρ
Year effects, σ_y^2	7415.17***	$\frac{\sigma_y^2}{\sigma_y^2+\sigma_f^2+\sigma_p^2+\sigma_\varepsilon^2} = 0.40$
	(2737.64)	
Feedlot effects, σ_f^2	4307.09***	$\frac{\sigma_f^2}{\sigma_y^2+\sigma_f^2+\sigma_p^2+\sigma_\varepsilon^2} = 0.23$
	(1015.03)	
Producer effects, σ_p^2	501.25***	$\frac{\sigma_p^2}{\sigma_y^2+\sigma_f^2+\sigma_p^2+\sigma_\varepsilon^2} = 0.27$
	(53.67)	
Residual, σ_ε^2	6471.26***	$\frac{\sigma_\varepsilon^2}{\sigma_y^2+\sigma_f^2+\sigma_p^2+\sigma_\varepsilon^2} = 0.35$
	(173.32)	

Note: Numbers in parentheses are standard errors; *** denotes significance at the 1% level.
ρ represents the within-cluster correlation, usually referred to as intra-class correlation. It directly measures the "closeness" of observations within the same cluster (i.e. harvest year, feedlot, and producer). If the intra-class correlation approaches zero then the grouping by harvest year, feedlot, and producer are of no use

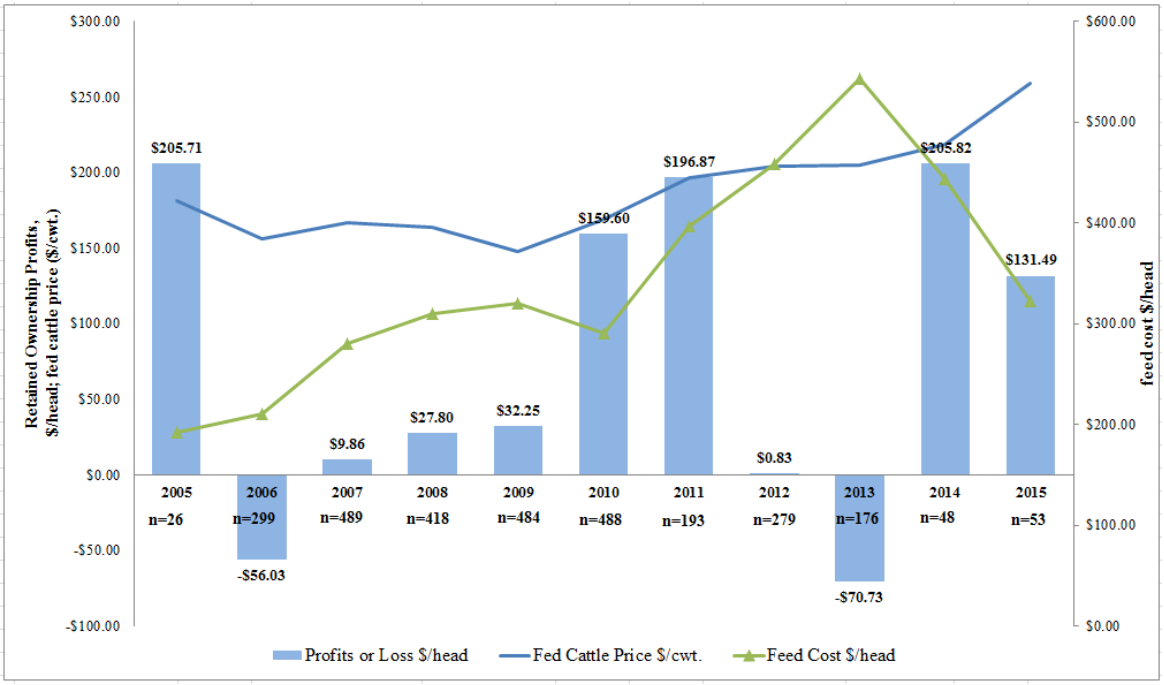

Figure 1. Retained ownership profits by harvest year.

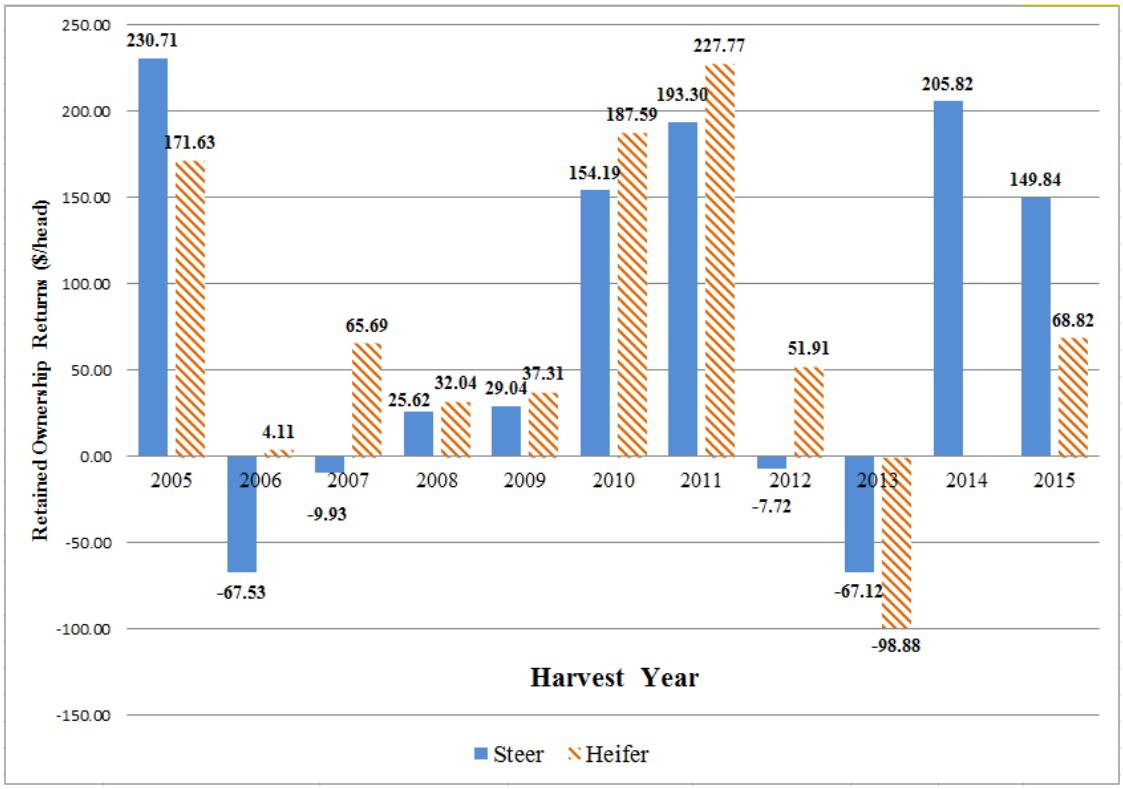

Figure 2. Retained ownership profits for both steers and heifers by harvest year.

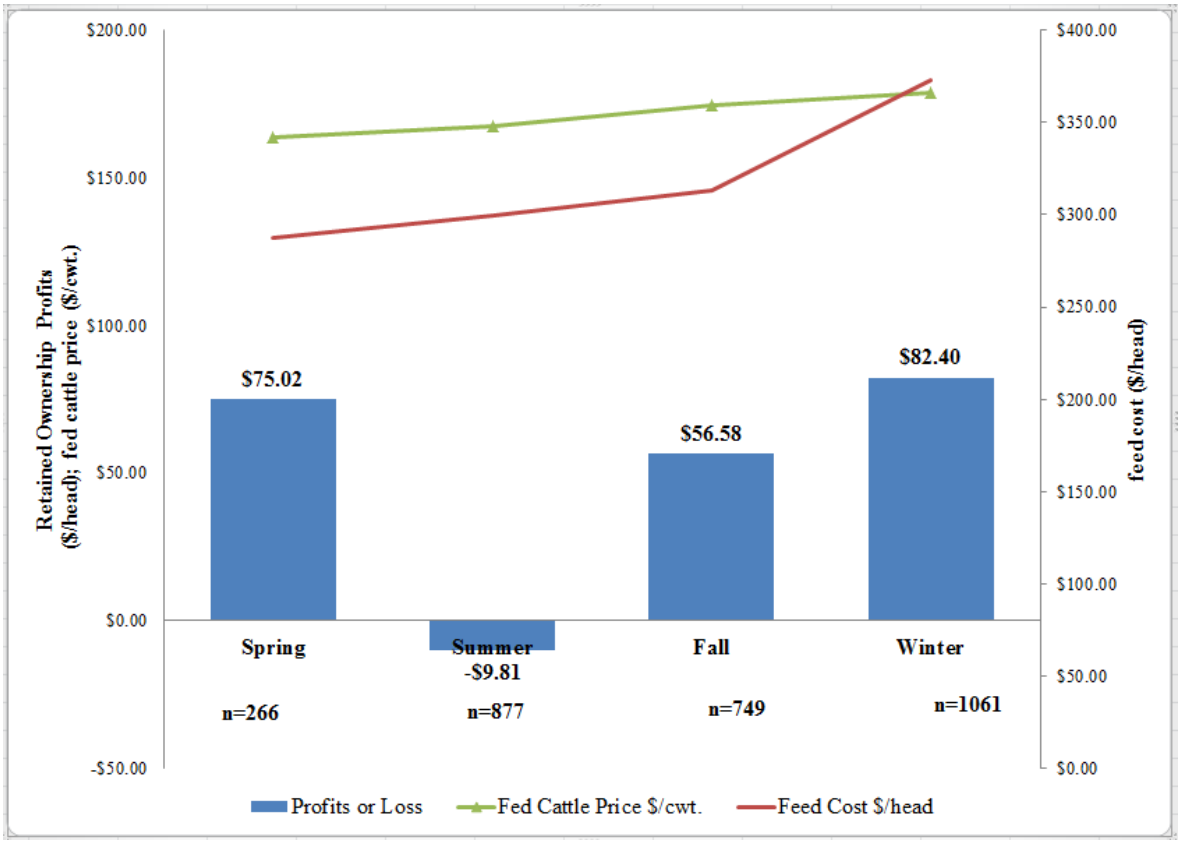

Figure 3. Retained ownership profits by placement season.

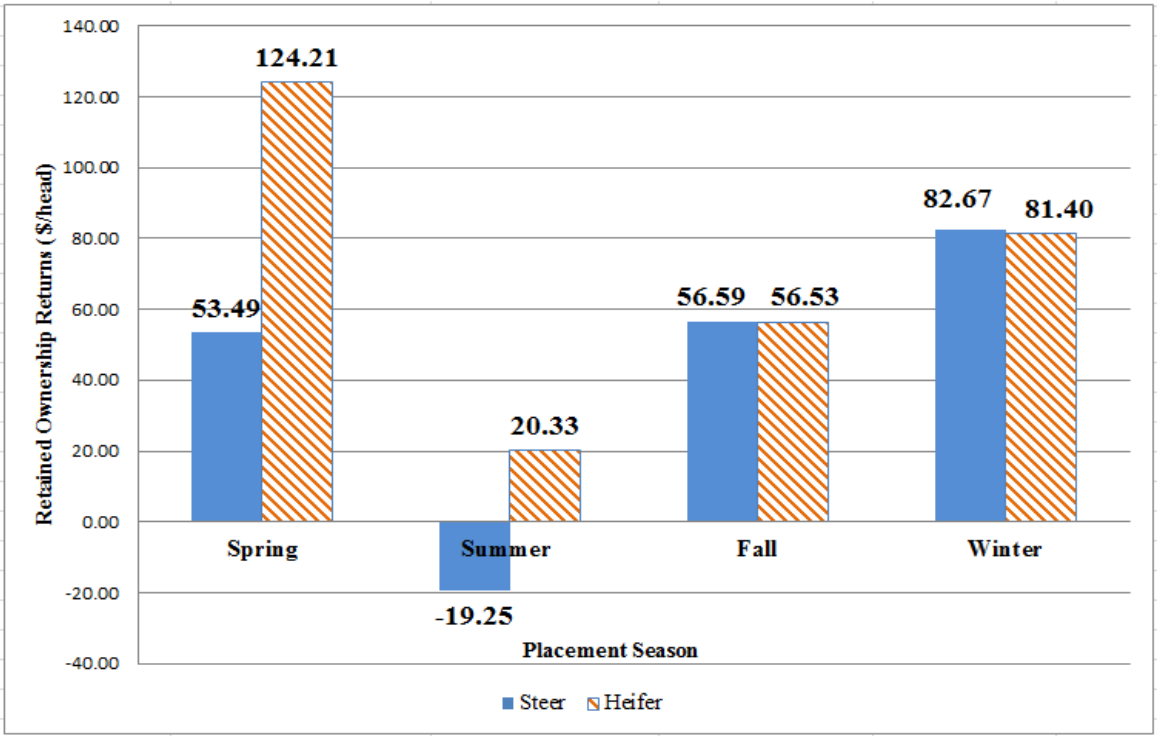

Figure 4. Retained ownership profits for steers and heifers by placement season for cattle harvested from 2005 to 2015.