Utilizing cow-calf producer information to increase profits in retained ownership of beef cattle

Brian R. Williams
Oklahoma State University
brian.r.williams@okstate.edu

Matthew C. Stockton
University of Nebraska-Lincoln
mstockton2@unl.edu

Selected Paper prepared for presentation at the Southern Agricultural Economics Association Annual Meeting Corpus Christi, Texas, February 6-9, 2011

Abstract

Retained ownership has been found to be a profitable endeavor, yet many cow-calf producers choose not to retain their calves. While this paper does not directly explore the reasons producers might have for not retaining ownership, which may include uncertainty, it does explore innovative use of asymmetrical information that might reduce some of the uncertainty. Results are summarized in a regression analysis similar to a Hedonic price model where birth weight, weaning weight, and weaning age are found to be important factors to consider when selecting animals to retain.

Introduction

Historically, retained ownership of beef cattle, calves owned from birth through the finishing stage of production by a single owner, has been found to be a profitable endeavor for cow-calf producers (Lambert, 1989; Reisenauer et al., 2001). Despite these findings, observed evidence indicates many producers choose not to retain ownership. Three reasons that may explain this include tradition, cash flow needs of the business, and risk. Of these three reasons, the one discussed here relates to risk. Producers who choose to retain ownership of their cattle face the risk of volatile markets and production challenges. It is possible that cow-calf producers might be able to mitigate a portion of these risks by selectively screening calves with specific physical characteristics.

If physical characteristics predict physical performance and if performance is a large determinant of profitability, it is logical that animal characteristic information could be utilized to predict profitability. This concept is analogous to a hedonic price model. It should be noted that maximum profitability in any given year could be negative.

Cow-calf producers have a distinct advantage over others in the marketing chain with respect to information specific to their animals. These producers have direct access to information such as birth date, dam size, weaning size and date, age and any other information they choose to collect. Others in the market chain generally obtain only fragments of this information. For eample this might include age and source verification or pre-conditioning such as vaccines or weaning date. Much of the information available to the producers is specific and includes vital predictive measures of future performance. Lawrence et al. (2003) found that cow size is negatively correlated with a calf's efficiency and profitability in the feedlot. Stockton et al. (2009) found that pre-weaning characteristics predict future physical performance. These predictive measures include birth weight, growth rate, genetic potential, age, health history, and disposition.

Several methods designed to exploit the information asymmetry between cow-calf producers and the downstream supply chain is examined here. An effort is made to discover if any of these physical characteristics can consistently predict an individual calf's profitability relative to other animals and explore the surrounding economic environment in which this information might be used to increase profit and/or reduce risk.

The following section describes the origin and nature of the data used in the study followed by a description of the methods which includes the development of the econometric models. The last three sections include the results of the application, a discussion of the results, and a summary and conclusion.

Data Summary

Calf data used in this study is collected from 554 spring born calves raised at the University of Nebraska-Lincoln's Gudmundsen Sandhills Laboratory (GSL) near Whitman, Nebraska, for the years 2002-2007. This research ranch is located in parts of Grant, Hooker, and Cherry County, Nebraska, and is typical for the area. GSL consists of 12,800 acres, including 1,200 acres of sub-irrigated meadows and 11,600 acres of upland range. The beef cow herd at GSL is comprised of the Husker Red composite breed developed by UNL's Jim Gosey. The Husker Red breed is 5/8 Red Angus, and 3/8 Gelbveigh and Simmental.

Cows are typically fed hay and supplement just prior to calving, which occurs primarily in the month of March, until the availability of the range sometime in May. The calves are weaned in late October, steers are then transported to the West Central Research and Extension Center (WCREC) in North Platte, Nebraska, and placed in the feedlot as calf-feds. As calf-feds these animals are graduated through several rations and fed to slaughter weight. Cows are subsequently placed on corn crop residue until just prior to the next calving season. Steers are typically taken to slaughter in June, where all carcass data is recorded. UNL is able to control quality well and as a result markets these slaughter animals on a grid system.

Daily corn prices, fed prices, and grid discounts and premiums used in this work are those reported by USDA-AMS for the years 2002 to 2007. Monthly slaughter cow and bull prices, weekly feeder prices, monthly forage prices, feeder futures, fed futures and weekly Nebraska dressed steer prices are obtained from the Livestock Marketing Information Center (LMIC). Mineral and feed additive prices are those paid by the feedlot at WCREC in 2003. Very little variation in these prices is observed over this period. Average corn crop residue grazing rates were obtained from the Dawson County, Nebraska extension office, while pasture rental rates are those published in the *Nebraska Farm Real Estate Marked Developments* report for the appropriate year, available through the University of Nebraska-Lincoln's Department of Agricultural Economics. Bred cow prices are lifted directly from the Cattle Fax database. Reported base grid prices are averages over all cattle grades and are adjusted to fit the cattle in this study. The base grid price is expressed in Equation 1 as:

1.) Grid Base = Dressed Price + (1- Percent Grading Choice) * Choice-Select Spread,

where the adjustment is one minus the percent grading choice multiplied by the choice-select spread.

Methods

The focus of this work is to determine if information available to producers of beef calves (i.e., physical characteristics observed at and before weaning) provide viable criterion to predict relative profitability of individual calves in the feedlot. Information about the calves' genetics, birth weight, dam weight and body condition score, weaning age, health, growth, and futures market information are all available to the cow-calf operator. Conversely, buyers of calves at weaning have limited, if any, documented information about the calves, especially if they buy through an auction market or sale barn. Buyers can make inferences based on the reputation of the seller or other observed facts such as frame size and vigor, but those inferences are only educated guesses and are subject to a degree of error.

Stockton et al. (2009) established relationships between birth weight, weaning weight, mature size, and growth as well as dam age and size in their work on heifer development. Since physical factors predict physical performance it is logical to expect that these factors might also be used to predict profitability. It is hypothesized that cow-calf producers can use the physical information they collect on their calves to select calves that are more likely to be profitable as a retained calf. By only selecting calves that are likely to have higher profits it is expected that overall profits would increase while risk would decrease.

The total cost (TC, Equation 2) of producing a fed calf is defined as the sum of the weaned calf production cost (TWC) and the feedlot costs (yardage costs (TYRD), feed costs (TFC), interest/opportunity costs (INTF), transportation costs (TRAN), death loss (DTHFL), veterinary and medical costs (VMED), and implant costs (IMPL)). TC is calculated using the same formula for calves whether they are sold on a grid or as live slaughter cattle in the open market. It should be noted that calves are fed by the pen, so efficiency cannot be directly measured. As a proxy for individual animal dry matter intake, a mathematical relationship proposed by Tedeschi et al. (2006) is used.

$$2.)\ TC = TWC + TYRD + TFC + INTF + TRAN + DTHFL + VMED + IMPL$$

Costs are further broken down where TWC, Equation 3, is the sum of the total ownership costs (TOC), and total operating costs (TOPC) which include labor, management, feed and other variable costs divided by the survival rate of calves from pregnancy through weaning (SURV).

$$3.)\ TWC = (TOC + TOPC)/\text{SURV}$$

TOC are the opportunity costs and risks associated with ownership of the cattle and include depreciation costs, death loss, and interest/opportunity cost.

Total revenue generated by each calf is assigned using two separate schemes, calculated as grid revenue and as live market revenue. These schemes both derive an end value for each animal. In the Grid pricing system (Equation 4) specific carcass traits receive premiums or discounts. In the live market weight scheme (Equation 5), the traditional measure of animal value, whole pens of animals are assigned a single price per pound regardless of quality differences among animals.

4.) $GREV$ = Hot Carcass Weight*(Base Grid Price + Yield Grade Premium + Quality Grade Premium – Size Discount)

5.) $MREV$ = Mkt Price/CWT * Animal Weight/100

Grid profit (Π_g), Equation 6, is expressed as the difference between the grid revenue (GREV) and TC. Profits from selling animals with live pricing (Π_m), Equation 7, are expressed as the difference between the live market revenue (MREV) and TC.

6.) $\Pi_g = GREV - TC$

7.) $\Pi_m = MREV - TC$

Grid Revenue, Equation 8, is the product of the estimated grid price per pound and the carcass weight (HCW). The grid price per pound is the sum of the base grid price and premiums less the discounts.

8.) $GREV = HCW * (Base\ Price + Premiums - Discounts)$

The profit from selling a calf at weaning (Π_w) is defined as the difference between the revenue at weaning (WREV) and TWC, Equation 9. The resulting profit at weaning is used to determine the difference in profits between selling the animal at weaning and retaining ownership for either the grid or live marketing schemes. The difference in profits under the grid scheme, GDIFF, Equation 10, is defined as the difference between expected profit at slaughter on the grid, Π_g and expected profit at weaning, Π_w. Similarly, the difference in profits under the live marketing scheme, MDIFF, Equation 11 is defined as the difference between expected profit at slaughter priced as a live slaughter animal, Π_m and expected profit at weaning, Π_w.

9.) $\Pi_w = WREV - TWC$

10.) $GDIFF = \Pi_g - \Pi_w$

11.) $\mathrm{MDIFF} = \Pi_m - \Pi_w$

The grid price scheme and live market scheme profits are dependant variables used in conjunction with the independent variables, those characteristics observed up to and including weaning. The resulting regression equations become the econometric model that predicts the profit of the particular scheme based on physically observable characteristics of the subject animals up to and including weaning. The actual format of the equations are expressed as linear functions, as expressed in the general form of Equation 12. The relationship between the dependant variable profit, y, for the jth scheme, is predicted as a function of the independent variables (x), the vector of physical characteristics (birth weight, weaning weight, weaning age, daily gains before weaning, dam weight, and dam body condition score), and control variables to account for cost and annual price variations (z).

12.) $y_j = \hat{\beta}_1 + \hat{\beta}_2 x_{j2} + \ldots + \hat{\beta}_k x_{jk} + \alpha z_{1j} + \cdots + \alpha z_{nj}\, \hat{e}_j$

Multiple variables are expected to have predictive power in determining differences in feedlot profitability among calves. Among those characteristics are the calf's birth weight, weaning weight, average daily gain pre-weaning, weaning age, and dam weight.

The effect of a calf's birth weight is expected to be an indicator of the calf's frame size and stature, with larger birth weights associated with an overall larger size. Larger sized animals would generate additional revenue both at weaning and at slaughter. Conversely, a larger birth weight is likely associated with a larger dam, creating an increase in production and feeding costs. The fact that revenue is increasing simultaneously with costs confounds the total effect of birth weight on profitability.

As with birth weight, weaning weight is expected to have a similar effect on cost and revenue resulting in the same difficulty of determining its effect on profitability potential.

Calf age is expected to also have a mixed effect, with older calves putting finish on faster, reducing costs. Older calves at weaning should tend to be larger with a slightly lower per pound value due to the price slide, but having a higher overall value, making a prediction of the total effect on profitability confounded.

The control variables in the model such as market conditions and input prices are expected to contribute to the predictive power of the model. Corn prices are directly linked to the cost of producing a finished animal whereas current market prices contribute to revenue.

Twelve variables (birth weight, weaning weight, weaning age, gain as a calf, dam weight, corn price, feeder-fed cattle price spread, and annual differences in price, in the form of dummy variables for 2002-2006), allow for a large number of possible models that could be specified. By using a loss function commonly used in determining the most parsimonious regression, the model that uses the least number of statistically significant variables and the greatest predictive power is identified. The loss function used for this task is the Akaike information criterion (AIC) (Akaike, 1974).

Results

Only AIC scores considered in the ranking process are those of models that test to have no multicollinearity and whose coefficient estimates show statistical significance at the 95% confidence level using the student t-statistic. The live slaughter cattle market scheme includes coefficient estimates for birth weight, weaning weight, weaning age, corn prices, and dummy variables for 2004, 2005, and 2006, with a base year of 2007 (Table 1). Birth weight and weaning weight coefficients are found to be positive, indicating an increasing effect on profitability, while weaning age is negative, indicating a decreasing effect on profitability. The corn price coefficient is negative, consistent with reduced profits from increasing corn prices. The years 2004 to 2006 have a negative sign, making these years of reduced profit relative to 2007. The adjusted-R^2 for this model is 0.7226.

The grid pricing scheme is found to have only one statistically significant physical characteristic coefficient, birth weight, which is positive (Table 1). The control variables had the same effect in this model as the live slaughter price model. Corn price coefficient estimates are negative, having a decreasing effect on profits as price increases. The years 2004 through 2006 are less profitable than 2007. The adjusted-R^2 for the grid pricing model is smaller than the live slaughter cattle model by nearly 0.20 and calculated as 0.5289.

Discussion

Calves' birth weights affect the profitability in both live market and grid marketing retained ownership scenarios. The birth weights influence cost and revenue factors, with the revenue factors overpowering the cost factors on average over the years in this work. A larger birth weight is often associated with larger cows, and ultimately larger carcass weight, which would increase revenues. This is consistent with the finding that birth weight is a good predictor of size and growth (Stockton et al. 2009).

While birth weight has a positive effect on the profitability of a retained steer, weaning age is negatively associated with profits. One possible explanation for this negative effect is that calves gain close to 2 pounds for each day of age, making them relatively larger at weaning. This results in increased opportunity costs of retaining ownership. Another key bit of information that might help explain this inverse relationship is that weaning age may identify slow growing cattle. A third contributing factor is that older calves are more likely to be overly fat or finished in the feedlot as a result of being fed to the pen's average, thus increasing cost, reducing value, and lowering estimated efficiency.

The positive effect that heavier weaned or faster growing calves might have on profitability may be a result of a larger frame size. Heavier calves may have also experienced faster growth as a calf, which could carry over to the feedlot. The negative impact of higher corn prices is directly related to feed costs. As corn prices increase, feedlot ration costs will generally increase, narrowing margins.

The adjusted-R^2 for the live pricing scheme is significantly higher than that of the grid pricing scheme. This could imply that there is more variation in a grid marketing system than in a live marketing scheme. All animals in a live marketing scheme receive the same per-pound price, while those in the grid scheme are priced based on their carcass characteristics. Under the grid scheme, it is difficult to predict an individual calf's quality or yield grade at the time of weaning with the available variables, likely resulting in the lower R^2 values.

Conclusions

In this article, information asymmetry in the beef cattle supply chain is used as a hypothesis to explore retained ownership options. Methods are developed and compared to investigate the predictive power of calf characteristics observed up to and including weaning by cow-calf producers on profitability. Two marketing regimes are explored: a grid-based market and a live slaughter weight market.

Producers can improve profitability by ranking and selecting calves based on models developed in this research. In general, the live marketing scheme model suggests that a calf with a large birth weight and weaning weight that is weaned at a relatively young age is the best calf to retain. Larger birth weight calves are more likely to have a larger frame and higher genetic growth potential than smaller calves at birth. Meanwhile, older calves are less likely to perform as well as calves of similar birth weight and size that are younger. This may be the result of over finishing compared to their younger counterparts. It is also possible that younger calves are under finished. While using a formula with birth weight, weaning age, weaning weight, and corn price can predict a calf's future profitability with relative success, it is possible that if additional information about the calf's genetic potential and health were included in the analysis, the accuracy and success of the models might improve.

It was reaffirmed that calf characteristics are not the only contributors to profitability. Both input costs and revenue related prices play major roles in overall profitability and retained profits verses weaned calf sales profit.

Additional research is needed to explore many of the questions generated by this investigation. It is expected that future work would include more information about the calf such as breed, the sire's EPD's, health indicators such as medical treatments prior to weaning as well as cost and price relationships of production. While this work simply addressed the issue of predictive power, nothing was mentioned about the degree of retention that should be incorporated, or how that might be predicted based on cost, price and physical attributes of the cattle. This study limits the analysis to steers, but could be extended to heifers, although they are priced differently and have a discount as feeder animals.

It is hoped that future investigation will extend the models, leading to more information about the relationships between the various observable characteristics of the animals and their profitability.

References

Akaike, Hirotugu. 1974. "A New Look at the Statistical Model Identification." *IEEE Transactions on Automatic Control*. 19(6):716-723.

Cattle Fax. "Bred Cow and Pair Price." http://www.cattlefax.com/

Clark, Richard T., Roger K. Wilson, Don C. Adams, Jerry D. Volesky, and Russell E. Sandberg. 2002. *Breeding and Feeding Management Practices Used by Cow-Calf Producers in Western and North Central Nebraska.*

Economic Research Service. "Commodity Costs and Returns: U.S. and Regional Cost and Return Data, Cow-calf." http://www.ers.usda.gov/data/CostsandReturns/testpick.htm.

Edwards, William. 2008. "Pricing Forage in the Field." Iowa State University Extension. http://www.extension.iastate.edu/agdm/crops/pdf/a1-65.pdf.

Federal Reserve Statistical Release. "Average majority prime rate charged by banks on short-term loans to business, quoted on an investment basis." http://www.federalreserve.gov/releases/h15/data/Annual/H15_PRIME_NA.txt

Johnson, Bruce, Ben Blomendahl, and Ryan Lukassen. 2008. "Nebraska Farm Real Estate Market Developments 2007-2008."

Jose, H. Douglas and Paige Bek. 2008. "2008 Nebraska Farm Custom Rates - Part 2." University of Nebraska - Lincoln Extension.

Lambert, D. K. 1989. "Calf Retention and Production Decisions Over Time." *Western Journal of Agricultural Economics.* 14(1):9-19.

Lawrence, John D, Cody Forristall, Gary May, Wendy Miller. 2003. "Implications of Grid Marketing for Retained Ownership." Iowa Beef Center. http://www.iowabeefcenter.org/pdfs/gridret.pdf.

Livestock Marketing Information Center (LMIC). Englewood, CO. http://www.lmic.info

National Research Council. 2000. *Nutrient Requirements of Beef Cattle: Seventh Revised Edition: Update 2000.* Washington, D.C.: National Academy Press.

Reisenauer, V.L., M. W. Tess, D. A. Griffith, and J. A. Paterson. 2001. "Evaluation of Calving Seasons and Marketing Strategies in Northern Great Plains Cow-Calf Enterprises." Presented at the Western Section, American Society of Animal Science annual meeting, 2001.

Stockton, Matthew C, Roger K. Wilson, Rick N. Funston, and L. Aaron Stalker. 2009. "Optimal Heifer Replacement." Working Paper. University of Nebrask Lincoln, West Central Research and Extension Center.

Tedeschi, L. O., D. G. Fox, M. J. Baker, and D. P. Kirschten. 2006. "Identifying Differences in Feed Efficiency Among Group-Fed Cattle." *Journal of Animal Science*. 83(3):767-776.

Treffer, Bruce. 2002-2008. “Dawson County Area Price and Rent Survey.” Various issues.

United States Department of Agriculture. “Agricultural Marketing Service Market News Search.” Various issues and reports. http://search.ams.usda.gov/mnsearch/mnsearch.aspx.

University of Nebraska-Lincoln Department of Agricultural Economics “Nebraska Farm Real Estate Marked Developments.” www.agecon.unl.edu

University of Nebraska-Lincoln West Central Research and Extension Center. 2007. http://westcentral.unl.edu/gsl/about.shtml.

Table 1. Least Squares Regression Results for Live Market and Grid Pricing Schemes

	Live Market Pricing	Grid Pricing
Intercept	269.47128***	115.149***
Birth Weight	1.42815***	1.14696***
Weaning Weight	0.13134**	
Weaning Age	-0.50456***	
Corn Price	-56.74333***	-27.88366***
2004 Dummy Variable	-133.97872***	-80.23587***
2005 Dummy Variable	-259.86424***	-280.89447***
2006 Dummy Variable	-180.96794***	-146.81679***
Adjusted R-Squared Value	0.7226	0.5289

*** Variables are significant at the 1% level

**Variables are significant at the 5% level