Factors that Affect Seasonality in Kentucky Feeder Calf Prices and How Calving Dates Affect Cow-Calf Enterprise Profitability

Dan Hardin and Sayed Saghaian

Department of Agricultural Economics
University of Kentucky

Abstract: This study uses an empirical analysis and a budget analysis to study seasonality in calf prices and cow-calf operator incomes. Calf prices were found to be highest in the summer and lowest in the fall while profits for cow-calf operators were found to be highest for spring calving cow herds.

Introduction

Previous literature has studied the various factors that affect feeder cattle prices. Historically corn and live cattle futures prices have been believed to be the largest influencers of calf prices as shown in Burdine, Maynard and Halich (2013). At the time of purchase most weaned calves will be fed a concentrated diet, consisting of predominantly corn products, until the time of its slaughter. However in recent years high corn prices have led producers to switch to alternative feed sources to keep production costs low. This should lead to a lessened negative correlation between corn and feeder cattle prices than found in previous years.

Live cattle futures prices are also believed to have pronounced affects on feeder cattle prices because they are the best estimate feedlot operators have of future prices for the cattle when they are finished and ready for slaughter. Weight affects the feeding potential of the animal and the expected earnings a feedlot operator can extract from the eventual sale and slaughter of the feeder calves. Lower weights typically demand higher prices due to the increased gain potential of the animal and the relative cost of gain as discussed by Dhuyvetter and Shroeder (2000).

Other factors alleged to affect the unit price paid for a lot of feeder cattle are the number of head in the lot, sex of the cattle, the breed of the cattle and the overall condition of those animals. The number of head in a lot positively affects price but at a marginally decreasing rate because larger lot sizes decrease transaction costs. Steers also demand higher prices than heifers or bulls due to the fact that they are castrated and devote less energy to reproductive organs and therefore have higher rates of gain. Different breeds have different gain and meat quality characteristics and currently the markets favor black cattle and cattle with high Angus lineage as shown in Bulut and Lawrence (2007).

Another factor that has often been over looked is seasonality. Many studies compare months of sale but cattle prices show classic seasonality with peak prices typically experienced in spring when supply is lowest. Trough prices often occur in the fall when supply is highest. In recent years the spread between fall and spring cattle prices has increased due to the increased pressure from summer grazers. More producers have realized the profitability of purchasing light calves at the start of the grazing season and growing them on pasture, a relatively cheap feed, until they reach an optimal feedlot placement weight. High corn prices have simultaneously increased the optimal feedlot placement weight and attractiveness of pasture compared to grain based diets. This has created a unique opportunity for cow-calf producers to potentially increase profits by shifting calving seasons and marketing calves in the spring to meet these demands.

Overall condition also reflects health and gain potential of the animal, which in turn affects the price buyers are willing to pay. Many factors influence condition, like frame size, fill, muscling, source verification and presence of horns as shown in Schulz, et al (2010). This study will focus less on these physical attributes and more on the economic conditions surrounding the sale. All sales used in this study involve source verified preconditioned cattle.

What makes this work unique is the special emphasis placed on the seasonal affects on calf prices. The motivation of this paper is to determine how cattle prices shift through the seasons and how producers can best take advantage of these seasonality swings. The budget analysis in part two will take a closer look at the production costs and revenues affecting the data in the empirical approach. This will give a full understanding of how cow-calf producers can increase profits by taking advantage of seasonal variations in cattle prices.

Literature Review

Buccola (1980) is one of the earliest works to find a negative correlation between corn and feeder cattle prices. While the magnitude of the correlation was found to be high it is also noted that a breakeven analysis found a higher correlation than the empirical work. This suggests that producers will shift away from corn in feed rations in times of high corn prices. This was confirmed by Anderson and Trapp (2000) that concluded that even small increases in corn price significantly reduced the correlation between the two. This suggests that the results from our data collected during an era of high grain prices should show a less dramatic correlation. Tejeda and Goodwin (2011) discussed the affects of grain price on cattle markets before and after the ethanol mandate. Their work found that as corn prices increase corn price fluctuations have a smaller affect on cattle prices. However, Schulz, Dhuyvetter, Harborth and Waggoner (2010) found that no significant relationship existed between corn and feeder cattle prices.

Schroeder, Mintert, Brazle, Grunewald (1988) discussed the variance of feeder cattle prices in Kansas over seasons. It was found that heavier animals received higher discounts in the spring as opposed to the fall. This suggests that smaller animals are more desirable in the spring when forages are more readily available and larger animals face more demand in the fall when grain prices are typically the lowest. The authors also found higher premiums realized in the second and third quarters of the year compared to the first quarter. They attribute this to the increased number of buyers at these later sales.

Seasonality has often been overlooked in previous literature as a factor affecting feeder cattle prices. Seasonality is experienced in cattle prices due to two main reasons, the largest being production. Most calves are born in the same general time span during the spring and while there are differences in gain and production techniques most will hit the market in the fall. So the supply is always highest in the fall and lowest in the spring. The second reason is that consumers demand different cuts of beef at different times of the year, as discussed by Hogan and Ward (2005). This seasonality in beef demand affects prices paid for beef in general and for different grades and cuts. Their study found that higher quality slaughter weight cattle are demanded during the summer "grilling" months and that higher prices accompany this demand.

This study will take a closer look at the affects of seasonality on feeder cattle price. The data set featured in this work includes only certified preconditioned calves. Third party certification is known to influence price, but to varying degrees. Donnell and Ward (2008) found that preconditioned calves receive a $2.49/cwt premium over non-certified preconditioned calves. Bulut and Lawrence (2007) found the same premium to be $6.15/cwt. While this study only contains data from certified preconditioned sales and therefore internal comparison is not possible, it is important to note that the data used will carry some premium over total sales.

Data

The data set used for the empirical analysis was obtained from realized sales at a large cattle marketing firm located in Lexington Kentucky. Values are from the Certified

Preconditioned for Health (CPH) program sales held between four and seven times a year. More than 1,300 observations are included from 2008 through 2011. The CPH program requires that calves be weaned for at least 45 days and are bunk and trough broke, castrated, dehorned and have been administered two rounds of vaccinations. Sale weight, lot size, sex and color/breed type are all included in the data set.

Other variables were added to the data set from various sources for additional analysis. Diesel prices were obtained from the Energy Information Administration (EIA). Prices were collected weekly and were applied to any cattle sale that occurred in that week. Corn and feeder cattle prices were obtained from the Chicago Mercantile Exchange (CME), made available through the Livestock Marketing Information Center (LMIC). The closing price for the nearest futures contract was used on the day of the sale. All variables are shown and explained in Table 1. Tables 2 and 3 show descriptive statistics for continuous and binomial variables, respectively.

This data set is unique in that it includes live fed cattle futures prices. This is done by using estimates from Kansas State University's Focus on Feedlots Survey. This monthly survey tracks gain and finishing data from the cattle finishing industry. It was found that during the time period of this data set average slaughter weights were 1337 pounds and 1216 pounds for steers and heifers respectively. Average daily gain (ADG) was found to be 3.5 pounds per day and 3.15 pounds per day for steers and heifers respectively. Using this information an estimated slaughter date could be determined from the initial weight of the animal at the date of sale. The next live cattle futures contract after the expected slaughter date was used.

Table 1: Explanation of Variables

Variable	Description
CPH Sale Price	the price the cattle sold in dollars per hundred pounds
Corn futures	the closing price of the nearby corn futures contract on the day of the sale
Lot size	number of cattle in the sale lot, squared variable included as well to reflect diminishing marginal returns to each additional head
Weight	the average weight of the lot of cattle, total weight divided by lot size
Live futures	the closing price of the next closest live cattle futures contract to the estimated slaughter date of the animal as explained above
Diesel price	the weekly published diesel price corresponding to the date of the sale
Time	continuous time variable, days after the first sale date
Steer	binomial variable, 1 if steer, 0 if otherwise
Heifer	binomial variable, 1 if heifer, 0 if otherwise
Winter	binomial variable, 1 if sale in December, January or February, 0 if otherwise
Spring	binomial variable, 1 if sale in March or April (no sales in May), 0 if otherwise
Summer	binomial variable, 1 if sale in June (no sales in July or August), 0 if otherwise
Fall	binomial variable, 1 if sale in November (no sales in September or October), 0 if otherwise
Black	binomial variable, 1 if cattle were sorted as blacks, 0 if otherwise
Blackx	binomial variable, 1 if cattle were sorted as black cross, 0 if otherwise
Charx	binomial variable, 1 if cattle were sorted as Charolais cross, 0 if otherwise
Smoke	binomial variable, 1 if cattle were sorted as smokes, 0 if otherwise
Mix	binomial variable, 1 if cattle were sorted as mixed, 0 if otherwise
Small	binomial variable, 1 if cattle were sorted as small framed, 0 if otherwise

Table 2: Descriptive Statistics for Continuous Variables

Variable	Mean	Std Dev	Minimum	Maximum
Time	12.94504	7.2908601	1	26
Diesel Price	2.967441	0.6065437	2.03	4.574
Corn Price	4.535078	1.2916191	3.1824999	7.5374999
Weight	615.9281	145.841826	314	1063.97
Live Futures	94.82171	11.032363	81.0500031	123.75
CPH Sale Price	95.32466	17.3913647	41	169
Lot Size	19.46718	36.1097987	1	286

Table 3: Descriptive Statistics for Binomial Variables

Variable	% of Observations
Steer	52.5
Heifer	47.5
Fall	10.2
Winter	52
Spring	24.8
Summer	13.1
Black	25.7
Blackx	16.3
Charx	24.8
Mix	5.2
Small	7.2
Smoke	20.9

Procedure

A hedonic model using Ordinary Least Squares (OLS) was used for the statistical analysis. In order to accomplish this Statistical Analysis Software (SAS) was utilized. Hedonic models have been used extensively in similar approaches and OLS was deemed a sufficient estimator to meet the objectives of this work. A similar technique was by Burdine, Maynard and Halich (2013) but with different objectives and variables. The model is specified below followed by a description of all variables.

CPH price = B0 + B1 *lot size* + B2 *lot size2* + B3 *weight* + B4 *live futures* + B5 *corn futures* + B6 *diesel price* + B7 *heifer* + V8 season + V9 cattle sort + B10 *time*,

After regressing the original model a Durbin-Watson test was applied and yielded an unacceptable t-statistic, suggesting the presence of autocorrelation. A Bruesch-Pagin test detected heteroskedasticity. The robust estimator was used in SAS to adjust the variance-covariance matrix and fix this problem without introducing bias. A variance of inflation test (VIF) was used to test for multicollinearity. All variables were below the acceptable threshold of 10 except for corn and live cattle futures prices. However these VIF statistics were still close to 10 and this problem was considered a threat. The deletion of these two key variables would drastically harm the model so the multicollinearity problem was left unaddressed. F testing of the seasonality variables was also utilized to determine if each season was statistically different from every other season.

Results

The model described above explained 77% of the variation in CPH cattle sale prices. In addition to the strength of the model the interpreted results were largely supported by previous literature and intuitive reasoning. It was found that for every dollar increase in corn price there was an average $4.88 decrease in feeder cattle prices holding everything else constant. This relationship is much less dramatic than those found in earlier studies but is fairly consistent with more contemporary literature like Tejeda and Goodwin (2011). The results support the hypothesis that higher corn prices will decrease the effect of corn price fluctuations of cattle prices. However this study does find that there is still a significant relationship between corn and cattle prices, despite evidence from the recent survey Shultz, Dhuyvetter, Harborth and Waggoner (2009) that this relationship no longer exists.

The seasonal variables were all found to be significant with fall experiencing the lowest prices on average as expected. However summer was found to experience the highest prices, with an average premium of $4.39/cwt over fall prices. On average, spring and winter prices were found to experience premiums of $3.14/cwt and $2.32/cwt over fall prices, respectively. Through T-testing all periods were found to be significantly different from one another. Not surprisingly the largest gap in prices was between the summer and fall, however the most significant difference was between summer and winter prices.

Live cattle futures were found to have a significant impact on feeder cattle prices and on average a one dollar increase in live cattle futures prices resulted in a $1.41/cwt increase in CPH feeder cattle prices. Similar yet slightly smaller premiums were found by Schroeder, Mintert, Brazle, Grunewald (1988). Lot size was found to have a significant yet very small monetary affect and diesel prices were found to have no significant affect on price received. Weight was found to significantly affect feeder calf prices and each 100 pound increase in animal weight resulted in an average $3.35/cwt discount. However, as supported by past literature, this relationship varies widely across weight ranges.

The time variable proved to be significant and showed that for every day after the original sale date price per hundred pounds increased 33 cents. There was also found to be a significant difference in price between steers and heifers with heifers receiving a $10.38/cwt discount. This is consistent with recent literature on animals of similar size as found in Shultz, Dhuyvetter, Harborth and Waggoner (2009).Black Angus cattle received the highest prices on average as expected due to current market conditions. Small and mixed breed cattle received the highest discounts on average. All regression results are shown in Table 4 below.

Table 4: Regression Results

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	16	305103	19069	271.49	<.0001
Error	1293	90817	70.23746		
Corrected Total	1309	395920			

Root MSE	8.38078	**R-Square**	0.7706
Dependent Mean	95.32466	**Adj R-Sq**	0.7678
Coeff Var	8.79183		

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Variance Inflation
Intercept	Intercept	**1**	9.60959	4.93334	1.95	0.0516	0
Lot size	head	**1**	0.10649	0.02009	5.30	<.0001	9.80609
Lot size 2	head*head	**1**	-0.00049330	0.00010261	-4.81	<.0001	7.64095

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Variance Inflation
Weight	weight	**1**	-0.03353	0.00170	-19.73	<.0001	1.14446
Live cattle futures	mglivefut	**1**	1.40630	0.07935	17.72	<.0001	14.28256
Corn futures	cornprice	**1**	-4.84320	0.64747	-7.48	<.0001	13.03424
Diesel price	diesel	**1**	-0.60276	0.84315	-0.71	0.4748	4.87427
Heifer	heif	**1**	-10.37618	0.46882	-22.13	<.0001	1.02225
blackx	blackx	**1**	-10.18932	0.92241	-11.05	<.0001	2.16072
charx	charx	**1**	-9.07214	0.81022	-11.20	<.0001	2.28395
mix	mix	**1**	-17.59699	1.27352	-13.82	<.0001	1.48868
small	small	**1**	-20.34331	1.15405	-17.63	<.0001	1.65452
smoke	smoke	**1**	-0.93837	0.79892	-1.17	0.2404	1.96386
Winter	Winter	**1**	2.32337	0.80051	2.90	0.0038	2.98328
Spring	Spring	**1**	3.13826	0.87006	3.61	0.0003	2.62836
Summer	Summer	**1**	4.39264	0.99984	4.39	<.0001	2.11614
time	time	**1**	0.33788	0.04366	7.74	<.0001	1.88822

Budget Analysis

To better understand how the seasonality in feeder cattle prices explained in the empirical analysis can be used by producers to increase profits, a cow-calf budget was created to determine the profits associated with different calving dates. Costs and revenues associated with six calving dates in four years, 2008 through 2011, were replicated to calculate approximate profits. Three fall calving dates, August 15th, September 15th and October 15th, and three spring calving dates, March 15th, April 15th and May 15th, were chosen. These scenarios are referred to as Fall 1, Fall 2 and Fall 3 respectively and Spring 1, Spring 2 and Spring 3, respectively. Weaning and sale dates each occur seven months after the calving date. Each calving date is representative of the herd average, however the budget was created on a per cow basis. All costs are associated with the cost to maintain one brood cow for that year in that specific calving date scenario. Revenues are also calculated on a per cow basis by taking the calculated per-calf revenue and multiplying it by a typical herd weaning rate, which varies by calving season.

The budget was built by modifying the 2008 University of Kentucky Beef Enterprise Budget and the data from that budget was used for 2008, the base year of this study. Price data included pasture maintenance, hay, grain, salt and mineral, vet and medical, and breeding and marketing costs. Costs excluded for the budget analysis in this study were replacement heifer costs, machinery costs and interest. This was done for the purpose of simplicity and does not affect the results of this examination as these costs would have been equal for all calving dates within a year. Therefore the resulting profits are actually returns to the most basic variable costs.

Costs faced by Kentucky producers were outlined in the Beef Enterprise Budget for 2008 but not for the subsequent years. Many of these prices, like local grass hay prices, were not collected on a regular basis so national price trends were applied to these 2008 base costs to create realistic costs for the following years. For example, by using alfalfa hay prices collected by the USDA for 2008 through 2011 a price percentage change was found for each year after 2008. This percentage change was applied to the 2008 base grass hay price from the UK data. This way hay prices consistent with grass hay prices in Kentucky for the four study years could be applied to the budget while the affects of hay price trends on profits could still be observed. The same process was repeated with grain prices using annual prices changes also derived from USDA data. For the remaining costs the CPI supplied by the U.S. Department of Labor, Bureau of Labor Statistics, was applied to the 2008 base cost.

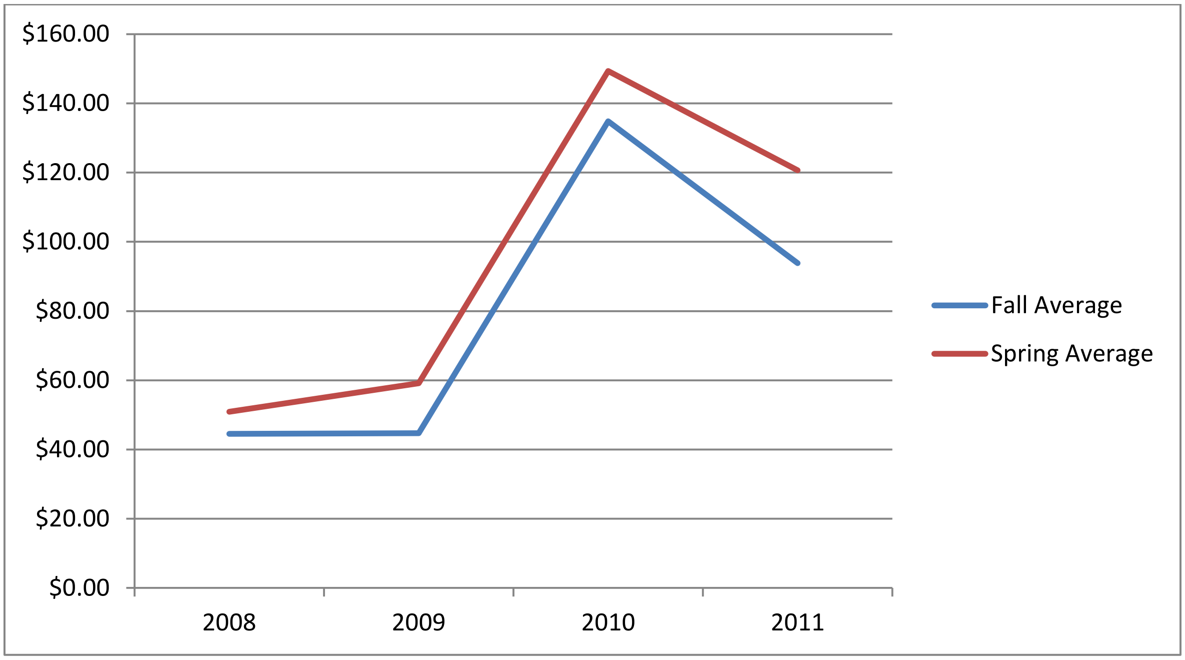
Cow nutrient requirements were found in the Kentucky Beef Book along with the nutrient composition of various cattle feeds. Hay was considered a required feed between

November 15th and April 1st for every year of the study. A cow's nutrient requirements vary depending on where she is in the reproductive cycle and fall calving cows typically require more nutrients over the winter months when hay is fed, resulting in higher annual feed costs. (Burris & Johns , 2007) The hay prices for each budget year were multiplied by the cow hay requirements of each calf date scenario resulting in the annual hay cost. Hay costs are the highest variable costs for a cow calf operation and vary the most with the calving date compared to other costs. This means an operator must pay close attention to hay markets and production costs when setting a calving date.

To construct revenues, a different cattle price data set was used for the budget analysis and was obtained from the Kentucky State Livestock Market Report. From this report monthly averages from 400-500 pound steers and heifers classes were averaged together assuming that calves would be sold at 450 pounds and an equal number of steers and heifers would be marketed together.

While the fall calving dates all had higher costs than the spring calving dates, revenues were also higher due to higher prices when the fall born calves were marketed in the spring. On average the spring calving scenarios were still 20 percent more profitable than the fall scenarios, as shown in Graph One. The most profitable scenario was Spring 2, with calving in April and weaning in October and average annual profits of $98.80 for the four years studied. The least profitable scenario was Fall 1, with calving in August and weaning in March and average profits of $69.81. This can explain why a majority of producers still calve in the spring and market calves in the fall. However production costs vary heavily among operations and the small differences in profits among the various calving dates suggest that for some operators fall calving could be a more profitable venture. Above all hay consumption and costs should be the primary factor in determining calving dates from an economics standpoint. However many other factors, such as animal health, labor and shifting market factors can affect an operator's decision in setting calving dates.

Graph 1: Calving Date Profits



Conclusions on Seasonality

Many of the findings of this study are aligned with previous literature and strengthen hypothesis on current trends in cattle markets. However the seasonal approach contributes to the understanding of feeder cattle price determinants through its unique observation of price variations over seasons, not months as in previous studies. Results from this data set conclude that peak prices are experienced in the summer, not spring as previous literature suggests. This may be due to the uniqueness of the data set or because the data set features only preconditioned cattle. Preconditioned cattle are typically ready for feedlot introduction and are typically not purchased by summer grazers, taking away high spring demand for such cattle. Also cattle typically enter a preconditioning regime in fall or winter and are sold in the winter or spring. This results in a short supply in summer which would theoretically drive up prices.

Another hypothesis is that feedlots are typically consigning large numbers of animals through the fall, winter and even spring months. During summer supply is much lower which should also raise prices. The revelation of these peak prices in summer, not spring, will be crucial to Kentucky producers willing to rework marketing plans to take advantage of higher prices. Knowledge of the steep price drops from summer to fall will also be helpful to producers. By cutting summer grazing or preconditioning regimes short and marketing calves earlier, producers may be able to increase profits. On the other hand cow calf producers can also increase profits by changing calving dates. While our data suggests that calves born in April and marketed in November will be the most profitable, calves born in October and marketed in May may also be nearly as profitable. Above all hay costs and consumptions should be the largest factor in determining calving dates.

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