The Beneficial Impact of Sorting Heavy Cattle at Re-Implant

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Abstract:
This research examined a simple sorting strategy to reduce the prevalence of heavyweight carcass discounts. Cattle that were identified and sorted off at re-implant had a reduced prevalence of heavyweight carcasses versus unsorted cattle. Re-implant sorting was profitable at pen average in-weights of 800 pounds or less.

Key Words: cattle, fed cattle marketing, cattle sorting, formula marketing

JEL Classifications: Q11, Q16, M31

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The United States Department of Agriculture – Economic Research Service (USDA-ERS) collects, records, and disseminates carcass weight data for fed steers and heifers. A review of this data indicates that dressed weights for live cattle have steadily increased over the past 30 years. Carcass weight is the most important factor in determining carcass value when selling cattle. For example, a heavy carcass may have a greater value than a lighter carcass because of increased pounds sold, even if the lighter carcass is more valuable on a per-pound basis. The most valuable carcass in a pen is the one that weighs 1 pound less than the hot carcass weight (HCW) discount level for an overweight carcass.

A strong prevalence of heavyweight carcasses conflicts with recent customer survey results from beef end-user groups. A review of the most recent 2005 National Beef Quality Audit (NBQA, Smith, et al. 2008) shows that carcass weights that are too heavy are the fifth highest area of concern for the entire industry. Heavy carcasses are an even greater concern to packers, purveyors, restaurants, and supermarket operators, who listed too heavy carcass weights, cut weights, lack of uniformity in cuts, and too large ribeyes in their list of top ten concerns. Heavy carcasses have been in the top-ten list of concerns for the industry in all of the past four NBQAs.

Beef packers realize some production efficiencies with heavier carcasses. When the plant is running at maximum speed, their costs can be spread out over more pounds of beef by processing heavier carcasses. For example, an employee whose job it is to gut carcasses becomes more efficient when working with a 1,000 pound carcass versus a 600 pound carcass. However over weight carcasses also create challenges for the beef production system. Large fluctuations in carcass weights can decrease production efficiency during harvest and fabrication

operations. Heavy carcasses can break or damage overhead rail systems in packing plants. Additionally, wholesale beef cuts that are outside desired size ranges are difficult to market in a boxed-beef system. For these reasons, packers monetarily discount heavyweight carcasses that do not fit their specifications.

Cattle feeders have to do their best with the inputs they are given. This is done by managing days on feed, implant regimes, feeding programs, and negotiating heavyweight carcass discounts with their beef processing partners. With formula pricing, data is reported and collected on an individual animal basis. The pricing formula in most marketing agreements consists of a base price with specified premiums and discounts above and below the base or standard quality specifications. When a feeder sells cattle on a formula, the cattle are normally managed in such a way as to maximize returns by achieving a desired set of carcass characteristics.

One of the greatest concerns for major feeders resulting from marketing cattle on a formula is that this pricing method shifts more of the risk back to the feeder. When cattle are sold on a formula, the feeder assumes the risk of plant performance. The feeder also is responsible for the cattle until they are delivered to the plant and cross the hot scale in the plant. If an animal falls off of the rail or gets condemned, the feeder does not get paid for this animal. Recently, however, more large feedyards in Texas have begun moving away from pricing on averages and toward value-based marketing. According to data from the Texas Cattle Feeders Association (TCFA), 59.4% of all cattle in their trade area were marketed using a pricing formula in 2009 (TCFA, 2010).

Many formulas will discount any carcass over 1,000 lbs. somewhere around $20.00 per hundred pounds of dressed weight. The typical marketing formula is perceived by many cattle feeders to

contain a higher level of discounts relative to the amount of premiums offered. With formula marketing, the seller needs to know more about the cattle being sold. Therefore uniformity in cattle is very important to reduce the formula pricing variability and reduce price risk. To this end, many feedyards that typically market cattle on a pricing formula have adopted various sorting strategies. This may include sorting cattle when placed on feed, sorting at re-implant time, or at the end of the feeding period.

Different sorting strategies have been examined and employed with different levels of success in achieving increased profitability. One of the challenges for the cattle feeder is to find cost effective means to sort cattle to more optimum end points. One study at the University of Nebraska (McDonald, et al. 2006) found no increased revenue to sorting. Some of the cattle were sorted on pasture before arriving at the feedyard and some were sorted at the feedyard upon arrival. Upon marketing the cattle, it was found that no sorting strategy increased carcass weight, reduced discounts for overweight carcasses or yield grade 4s, or improved profitability compared to not sorting. However variation in carcass weight was decreased suggesting that sorting improved uniformity of cattle marketed.

In another study conducted at the University of Illinois (Pyatt, et al. 2005), sorting individual cattle by body weight increased profitability over the optimal days on feed endpoint of the group. Ultrasound technology was also used to measure subcutaneous and intramuscular fat deposition, as well as ribeye area. Sorting cattle decreased the variation of hot carcass weight and the number or overweight carcasses without affecting fat thickness. This study found that sorting need not pinpoint each animal's optimum profit to result in economic gain, but that increasing hot carcass weight and decreasing penalties improved profitability. Opportunities exist to use

body weight and ultrasound technology to allocate cattle into feeding and marketing groups that will decrease overfeeding and increase carcass value and profitability.

Ultrasound and weight sorting is used in the commercial cattle feeding industry today mostly at re-implant to sort cattle into different marketing groups. There appear to be potentially large gains to be made from this type of sorting. Computer models generated by one study (Koontz, et al. 2008) suggest returns of $15 - $25 per head in simulations. However ultrasound sorting technology is proprietary and patented, and costs between $5 and $11 per head. The use of ultrasound sorting slows the processing down and challenges the cattle feeder to keep the pens full to capacity. This is one of the key ways that larger cattle feeders can leverage their economies of scale, and is also the main reason why some larger feeders have been hesitant to adopt this type of large-scale sorting strategy.

While the need for more uniform cattle and carcasses is recognized throughout the cattle feeding industry, there are still a wide variety of methods used to achieve it. The industry is still searching for cost effective ways to increase uniformity and efficiency in marketing fed cattle on a grid. One technique which could be adopted by any feedyard at little or no cost is to sort off potential heavy carcass cattle at re-implant time based only on their current individual live weight. These cattle could simply be sold out of their current lot, and into another pen of cattle that is closer to shipping. This technique would prevent the heaviest cattle from feeding long enough to achieve a live weight big enough to yield a carcass over 1,000 lbs. The objective of this research was to evaluate the economic benefit of such a sorting strategy. In addition, this research sought to develop a marketing function for experimental cattle, where a heavy weight

discount value and a projected pen percent heavy weight carcasses value could be used to predict the value of avoiding heavy carcass discounts.

Methods

A Texas panhandle feedyard received 2,824 yearling steers between March 4, 2009 and March 19, 2009. The cattle were #1 English/Exotic and were 81.54% black. The predominant phenotypes represented in the group were of Angus, Charolais, Red Angus, and Gelbvieh origin. The cattle were of medium frame and carried a condition of medium-plus flesh. All but two of the loads of cattle came from wheat pasture in Texas. One load came off of winter pasture in Georgia. Another load had been fed on pasture in Kentucky. Some of the Texas cattle had also been fed silage on pasture. The total pay weight of the group was 2,224,061 pounds, resulting in an average in-weight of 788 pounds per animal. Each load of cattle was unloaded into a dry lot and separated randomly into three equal groups. Each of the three groups of cattle was weighed separately. The cattle were organized into a series of 21 pens, resulting in a randomized complete block designed experiment.

The pen blocks were brought back to the barn for re-implanting at 69 to 76 days on feed. Treatments “A” were the control pens in each block. These cattle were individually weighed in the cattle chute and their weights were recorded using a Digi-Star chute scale and received an implant. All of the treatment “B” and “C” animals were also brought back to the barn and weighed individually. Any animals that weighed over 1,275 pounds were sorted off. These cattle did not receive the implant in an effort to save money since they would ship within the next 51 days. The balance of the treatment “B” and “C” cattle were implanted.

Following the re-implanting process, all of the treatment A cattle and the treatment B and C cattle that weighed 1,275 pounds or less were sent back to their appropriate home pens. These cattle went directly back onto finish ration and stayed in their respective pens until shipment to the plant. The heavy cattle from each treatment B pen (these heavy cattle will now be referred to as treatment D) were placed into a small pen by themselves with only other heavy cattle from their same home pen. A total of seven small pens were used to feed the treatment D heavyweight cattle. The heavy cattle from the treatment C pens (now referred to as treatment E) were sent to a small pen and commingled with other heavy cattle from different treatment C pens. A total of two small pens (one North and one South) were used to feed the treatment E heavyweight cattle.

This experiment attempts to mitigate some of the risk of incurring heavyweight carcass discounts when marketing fed cattle on a pricing formula. Previous research (Smith et. al., 2008) has shown that 3.7% of carcasses in coolers weighed 951 to 1,000 pounds, and that 1.1% of carcasses weighed greater than 1,000 pounds. According to the Texas Cattle Feeders Association 2009 annual report, there were 22,404,000 fed cattle marketed in 2008 from feedyards with 1,000 head capacity or larger. The indication is that 828,948 head would have yielded a carcass weighing 951 to 1,000 pounds. Another 246,444 of these cattle would have yielded carcasses over 1,000 pounds.

The 21 pens were blocked according to source, arrival day and time, and pen locations within the feedyard (Table 1). The three samples were the non-sorted (control) group, the sorted group, and the sorted and commingled group. The heavyweight cattle which were sorted off became treatments D and E, thus resulting in 35 total groups of cattle. There was exactly one

observation from each block in each sample, thus making this a complete block design. The cattle were randomized by sorting each incoming load of feeder cattle three ways and assigning these cattle to the three different sample groups. The effect of the arrival time and day and location within the feedyard (extraneous variable) is accounted for by representing each block in each sample. So any differences found between the sample groups can be ascribed to the factor-effect (sorting).

Table 1: Randomized Complete Block Design of Re-implanting/Sorting Experiment

Block 1	Block 2	Block 3	Block 4	Block 5	Block 6	Block 7
C (Pen 212)	B (Pen 377)	C (Pen 523)	A (Pen 529)	A (Pen 515)	A (Pen 585)	B (Pen 363)
B (Pen 211)	C (Pen 378)	B (Pen 522)	B (Pen 528)	C (Pen 516)	C (Pen 586)	A (Pen 364)
A (Pen 210)	A (Pen 379)	A (Pen 521)	C (Pen 527)	B (Pen 517)	B (Pen 587)	C (Pen 365)
D (Pen271D)	D (Pen271A)	D (Pen SR4)	D (Pen SR2)	D (Pen B6)	D (Pen HPC)	D (Pen HPB)
E (Pen 401)	E (Pen 401)	E (Pen 401)	E (Pen 401)	E (Pen 60D)	E (Pen 60D)	E (Pen 60D)

The five groups are referred to as control (A), sorted at re-implant with heavy cattle sent to unique pens (B), sorted at re-implant with heavy cattle commingled (C), sorted heavyweights kept separate (D), and sorted heavyweights commingled (E). The means were evaluated first for live performance measures including average daily gain (ADG), dry matter conversion (DMC), and cost of gain (COG). Then each of the means were compared in relation to plant performance measures including heavyweight discount dollars and percent heavyweight carcasses. The SAS computer program was used to generate the ANOVA tables and test statistics for these comparisons.

Sorting-off the heavy cattle at re-implanting requires the implanter to know the weight of the animal before the implant is delivered into the animal's ear. If this practice were to be implemented on a large scale, the cattle would also have to be re-tagged with a new lot number, sorted off, weighed, and sold out of their home pen and into a pen of cattle that were farther along in the feeding period. The process of determining the individual weight of the animals and making the decision to implant or not implant the animal, re-tagging the animal and sorting the animal off, slows the process down. Additionally, there is a cost for a feedyard employee to come to the scale and weigh the heavy cattle, and for the pen rider to move these cattle to another pen. The total cost of this procedure is estimated at $1.50 per each animal that was removed.

A previous study (McDonald and Schroeder, 2003) does a good job of defining the determinants of profitability under a formula pricing system. Profit per head for a pen of fed cattle is defined in the following equation:

(1) $$Profit = P_{fed\ cattle} \times Q_{fed\ cattle} - P_{feeder\ cattle} \times Q_{feeder\ cattle} - cost\ of\ gain - other\ costs$$

where $P_{fed\ cattle}$ is the price of fed cattle, $Q_{fed\ cattle}$ is the quantity of fed cattle, $P_{feeder\ cattle}$ is the feeder cattle price, $Q_{feeder\ cattle}$ is feeder cattle quantity, *cost of gain* is the feeding cost of getting cattle from feeder to finished weight, and *other costs* are non-feed costs of finishing cattle. The $P_{fed\ cattle}$ component of *profit* in the current study is defined by the "National Weekly Direct Slaughter Cattle – Premiums and Discounts" report which is published by the USDA Market News Service.

Of primary interest to this study was the weight over 1,000 lbs., discount which was $19.58 per dressed hundredweight. The current study deals directly with only a portion of the overall profit equation for fed cattle. If the study can show that *cost of gain* is unaffected by the sorting

process, then this part of the profit equation is eliminated from consideration. In addition, $P_{feeder\ cattle}$ and $Q_{feeder\ cattle}$ are not significant to the study because they are neither a dependent variable nor an independent variable.

Equation 2 is a modified version of the overall profit equation for fed cattle which relates directly to the current study. The research is concerned only with the increased revenue associated with the sorting function as it relates to any additional costs incurred by the process. This study only dealt with the impact of the treatments on the heavyweight discounts for cattle yielding a carcass over 1,000 pounds assuming that all other carcass parameters were unaffected.

(2) $$Sorted\ Profit = SP_{fed\ cattle} \times SQ_{fed\ cattle} - sorting\ costs$$

Results and Discussion

The independent variables associated with this study include sorting at re-implant and commingling. The dependent variables examined include average daily gain (ADG), dry matter conversion (DMC), cost of gain (COG), heavy weight discount dollars per live hundredweight (HvyDscnt), and percent heavy weight carcasses greater than 1,000 pounds (Hvy%). The blocking factor was the arrival time and day of each set of cattle and was used to reduce experimental error. A summary table of the experimentwise mean standard errors and p values for each dependent variable is listed in table 3.

Of particular interest is the relationship between the treatment A group (control), and the combination of the sorted heavyweight groups (D + E). The sorted D and E groups exhibit a robust p value relative to the A control group of cattle for heavyweight discounts (0.0131) and

percent heavyweight carcasses (0.0070). The means for treatment A were different from the sorted heavy cattle (D+E) with regard to heavyweight discount dollars per live hundredweight and percent heavyweight carcasses at the $p < 0.05$ level. The null hypothesis was rejected and it was determined that sorting at re-implant caused a decrease in heavyweight discounts and percent heavyweight carcasses. Commingling exerted no significant effect.

Table 3: Treatment Means and p values According to Treatment

	A	B	C	D	E	SE_M	Pr > F	A vs. D+E	Pr > F
ADG	3.693	3.594	3.647	4.181	4.083	0.259	0.3320	2.12	0.1588
DMC	6.154	6.571	6.350	6.586	6.984	0.503	0.7889	1.17	0.2897
COG	.7359	.7726	.7510	.8145	.8581	.0603	0.5762	1.99	0.1708
HvyDscnt	.3691	.2199	.1596	.1557	.0000	.0935	0.0943	7.17	0.0131
Hvy%	2.926	1.739	1.263	1.099	0.000	.6922	0.0612	8.69	0.0070

Correlation

The weight of the steers when placed on feed, or "in-weight", showed some predictive power in determining the heavyweight discounts and the percent heavyweight carcasses for a control pen of cattle (treatment A). Pearson's correlation coefficients, "r", were calculated for heavyweight discounts and percent heavyweight carcasses as a function of in-weight (Equation 3).

(3) $r_{yx} = \text{cov}(y,x) / \text{sqrt}(\text{var}_y \times \text{var}_x)$

Table 4 lists the relevant inputs for the formula. The correlation coefficient for heavyweight discounts as a function of in-weight is 0.856. This indicates that as animal in-weights increase, discount dollars come closer to zero. The correlation coefficient for percent heavyweight

carcasses as a function of in-weight was -0.864. This indicates a strong negative correlation. As animal in-weight increased, the percent heavyweight carcasses decreased.

Table 4: Pearson's Correlation Coefficient Formula Inputs

	In-Weight	Δ^2 v.Mean	HvyDscnt	Δ^2 v.Mean	PrcntHvy	Δ^2 v.Mean	ΔInWt x ΔHvyDscnt	ΔInWt x ΔPrcntHvy
	776	144	-.363	3.77E-05	2.99	0.0041	-0.0737	-0.771
	828	1600	-.097	0.07406	0.78	4.6040	10.8857	-85.829
	792	16	-.260	0.01191	2.08	0.7152	0.4366	-3.383
	790	4	-.282	0.00759	2.26	0.4432	0.1743	-1.331
	797	81	-.125	0.05961	1.00	3.7084	2.1973	-17.331
	767	441	-.670	0.09052	5.26	5.4489	6.3180	-49.020
	766	484	-.787	0.17461	6.11	10.1397	9.1929	-70.054
Mean	788		-0.369		2.93			
Σ		2770		0.41833		25.0636		
cov							29.131	-227.72
r							0.856	-0.864

Predictive Economic Model

Using in-weight as a predictor variable and percent heavyweight carcasses as the dependent variable, a curvilinear, quadratic relationship can be formulated, given the relatively high r value of -0.864. The quadratic regression equation is represented as follows (Equation 4).

(4) $Y = a + b_1X_i + b_2X_i$

The parameter estimates for heavyweight percent are given in Table 5. The resulting equation becomes the following:

(5) % *Heavy Carcass* = 1347.5155 – 3.3010(*In Weight*) + 0.0020(In Weight^2)

Table 5: Parameter Estimates for Quadratic Regression of Percent Heavyweight Carcasses as a Function of In Weight

Parameter	Estimate	Standard Error	t Value	Pr > |t|
Intercept	1347.5155	315.6067	4.27	0.0130
In Weight	-3.3010	0.7936	-4.16	0.0141
In Weight x In Weight	0.0020	0.0005	4.06	0.0154

Typical pen sizes for a large commercial feedyard are anywhere from 120 head to 250 head per pen. With an in-weight of 825 pounds the formula predicts there will be less than one heavyweight carcass for most pen sizes. As the pen average in-weight decreases and head count increases, a pen becomes more likely to produce a heavyweight carcass.

Because there is a negative correlation, as more cattle are included in the sorting process, it is more likely that at least one animal will be heavy at smaller probabilities. At a discount level of $19.58 per dressed hundredweight, and a carcass weight of 1,000 pounds, each heavy animal eliminated increases revenue by $195.80. The cost of re-implant sorting was estimated earlier at $1.50 per head. Therefore the net return to this process varies some at different heavyweight probabilities and different pen sizes. The payoff matrix is listed in Table 6 for the re-implant sorting process. The matrix represents net return on a per pen basis for different in-weights and different pen sizes. The actual breakeven in-weight to re-implant sorting at a discount level of $19.58 per dressed hundredweight ends up at 800 pounds. As in-weight decreases, the projected return to re-implant sorting increases across all pen head counts.

Table 6: Payoff Matrix for Re-implant Sorting at Selected In-Weights and Pen Sizes ($19.58/cwt. heavy discount level)

In Weight	120 Head	150 Head	180 Head	210 Head	240 Head
700	$6,440	$8,050	$9,660	$11,270	$12,880
725	$3,992	$4,990	$5,988	$6,985	$7,983
750	$2,136	$2,670	$3,204	$3,738	$4,271
775	$870	$1,087	$1,305	$1,522	$1,739
800	$191	$239	$287	$335	$382
825	$0	$0	$0	$0	$0

Carcass Performance

Plant performance was also of interest to this study to examine the relationship between the re-implant sorting and commingling on carcass characteristics. Although this relationship did not involve any of the dependent variables measured, pen dressing percentage, percentage of animals in a pen grading choice or better, and percent yield grade 4 or 5 animals within a treatment pen are presented in Table 7. The treatment D and treatment E pen head counts were very small in comparison to their home pen counterparts and thus the standard deviations of their plant performances were also higher. However the data included in the table is of interest to the researcher concerned that shipping some of the heavyweight sorted cattle at 120 days on feed might cause a detriment to yield and grade in the plant.

Table 7: Plant Performance Measures by Treatment Group

Treatment	Head Count	Mean Dressing Percent	Yield Standard Deviation	Mean % Grading Choice +	Choice + Standard Deviation	Mean % YG 4 or 5	YG 4 or 5 Standard Deviation
A	932	64.07	1.179	50.64	20.549	10.73	12.109
B	861	64.27	0.965	47.39	13.726	11.85	12.598
C	895	64.46	0.735	46.15	10.760	12.74	12.658
D	65	62.98	1.057	58.46	27.499	13.85	35.681
E	41	62.58	1.069	68.29	36.138	7.32	11.073

Conclusions and Implications

Formula marketing of fed cattle is becoming more accepted among major cattle feeding companies. It is a means of producing a product which has more value throughout the entire beef production system and does a better job of meeting the customer requirements. However there is much more risk associated with this form of marketing for the producer. Feedyards are constantly searching for ways to maximize profitability in all aspects of production including cattle marketing. Sorting cattle has been a part of the cattle feeding process through the years as a means of increasing value by minimizing feed cost. Recently, sorting has proven to be a viable means for mitigating some of the price risk associated with formula marketing. The cattle feeding industry is still searching for cost effective ways to increase uniformity and efficiency in marketing fed cattle.

It has been shown that carcass weights have been steadily increasing over the past 30 years. Marketing cattle on a formula is as much about avoiding price discounts as it is about realizing

premiums. Most marketing formulas incur a penalty for carcasses over 1,000 pounds, usually around $19 to $25 per dressed hundredweight. However because carcass weight is the primary determinant of profitability in cattle marketing, the cattle feeder has an incentive to feed cattle to the heaviest possible weight before the discount is incurred. Therefore, some "out" cattle might be accepted with the overall goal of maximizing profitability. The biggest cattle in a pen could be sorted off during the routine feedyard task of re-implanting. These heavy cattle would not need a re-implant, but could be cut off and sold out of their home pen and into a set of cattle that was closer to shipping, thus reducing the risk of heavy carcass discounts. Sorting re-implants has been shown to slow down the processing crew. However the total cost has been estimated at $1.50 per head for all the cattle run through the re-implant barn.

Sorting off heavier cattle at re-implant was shown to reduce the occurrence of heavy discounts at slaughter. In fact, only one of the 106 cattle that were sorted off during this trial ended up as a heavy carcass at harvest. This sorting process did not completely eliminate any heavy cattle generated from their home pen counterparts however. It is possible that if this trial were repeated, the sort cut-off weight could be reduced from 1,275 pounds to 1,250 pounds and more of the potential heavy discounted animals could be removed from the home pen. The time of day that the cattle were re-implanted allowed for a wide degree of variation in sorting accuracy, because some of the cattle were actually re-implanted before the first feeding of the day, and were naturally lighter. It may be that the sort weight could be lowered to catch a few more of the heavies.

The correlation between in-weight and heavy percent was an interesting finding, since it was backwards from what was expected. The cattle chosen for this experiment weighed in the range

of 775 pounds to 825 pounds going on feed. The assumption was that these were the highest risk cattle for heavy discounts. The study showed the opposite to be true. That with lighter in-weights, days on feed are increased, and the cattle have more time to grow apart. It would be interesting to repeat this trial using cattle with in-weight 100 pounds lighter, say 675 pounds to 725 pounds. With more days on feed, the data indicates there may be a great propensity for heavyweight carcasses.

The mean separation was not robust given the relatively small amount of cattle included in the study, and the fact that they were fed in large pens in a commercial feedyard environment. Feeding more cattle and repeating the re-implant sorting process will give greater confidence to the values found in this experiment. However this trial does show that it made the feedyard money to sort these heavy cattle off. Eliminating even one heavy carcass in a pen of cattle paid for the additional cost of the sorting process.

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