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Economically Efficient Cow Size Selection Using the Product/Product Model

Kelly J. Bryant, Thomas G. Montgomery, Whitney A. Whitworth and C. Robert Stark, Jr.

Southeast Research and Extension Center
University of Arkansas Division of Agriculture
University of Arkansas at Monticello
Box 3508
Monticello, AR 71656
870-460-1091
bryantk@uamont.edu
montgomery@uamont.edu
Whitworth@uamont.edu
Stark@uamont.edu

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Abstract

Economically optimal cow size is examined using a two product production framework with a single allocable factor. Auction price data is used to construct a Total Revenue Curve for sales of small and large calves. A Production Possibilities Curve is constructed for a farmer with 100 animal units of resources. Results show that smaller calves are the solution regardless of calving season or market location.

Objectives

This study examines the question of economically optimal cow size using a two product production framework with a single allocable factor as described by Beattie and Taylor. This approach allows us to easily examine market incentives for cow size.

Background

The subject of "cow size" has received some attention from animal scientists in recent years (Walker). Mostly the issue has been addressed from the cost associated with feeding larger cows and the weaning weights of their calves.

Whitworth, Stark and Montgomery examined the relationship between cow size, calf weaning weight, and maintenance cost per cow using five years of production data from a research herd. The sample size ranged from 35 to 71 animals per year. Their analysis revealed that larger cows did not in fact wean larger calves. The authors show that while their smallest group of cows (averaging 1,223 lbs) was the most economically efficient, a group of 1,000 lb. cows was expected to be even more profitable according to university cow/calf budgets.

Walker references two studies from the northern plains. According to Walker, researchers in North Dakota split a herd of cows in half resulting in a group of lighter cows and a group of heavier cows. “With a 299 lb difference in mature cow body weight between the two cow weight groups, there was only a 1 lb difference in calf weaning weight between the two groups” resulting in “a net loss of $53.60/hd/year for all cows that fall into the heavy weight group.”

“However, based on data from the Northwest Minnesota Beef Improvement Program (BIP), most herds showed an increase in calf weaning weights from dams in the heavy weight group.” (Walker) According to Walker, 1148 cow/calf pairs across nine herds were divided into two groups based on cow weight. Differences in cow and calf weights were 194 lbs and 19 lbs, respectively, resulting in a loss of $5.44/cow for each cow in the heavy weight group (Walker).

Researchers in some of these studies advise culling cows based on their individual Cow Production Efficiency (CPE) rating rather than on total cow weight, keeping those cows with the highest CPE statistics. “Cow Production Efficiency is simply the calf weight-to-cow weight ratio.” (Whitworth et al.) CPE is equivalent to average physical product in the economics literature. Maximizing APP means production will occur on the border line of stage 1 and stage 2 of production. While this may be the profit maximizing level of production, it is not guaranteed. Costs and returns must be addressed to see if the technically efficient level of production is also the economically efficient level of production.

Since the question of cow size to employee is really a question of calf size to produce, this study examines the question using a product/product framework. A producer can choose to sell small calves at weaning, or large calves at weaning, or some of both. This study only applies to the question of selling calves at weaning in an economically efficient manner. It does not address back-grounding or retained ownership of weaned calves.

Data and Methods

A Production Possibilities Curve (PPC) was constructed for a farmer in the business of producing calves at weaning. At her disposal are small cows (1,000 lbs. each) or large cows (1,200 lbs. each) or a mixed herd containing some of both. The producer is assumed to have sufficient resources to maintain 100 animal units over the long run. All cows are assumed to wean 50% of their body weight as proposed in the literature (Barham, 2006; Troxel and Wallace), and the herd is assumed to have a 90% weaning rate regardless of cow size. Thus the PPC is anchored by 90 small calves (450 to 500 lbs each) or 75 large calves (550 to 600 lbs each) with numerous combinations in-between.

Auction price data from weekly sales in Oklahoma City, OK, Joplin, MO, and Dalhart, TX was obtained from the Agricultural Marketing Service. The data consisted of weekly prices for the months of October, November, April and May from the year 2000 to 2010. The prices were for medium and large frame number 1 feeder steers and heifers weighing from 450 to 500 lbs and steers and heifers weighing from 550 to 600 lbs.

The simple average of cattle price was calculated for the 450 to 500 lb group and the 550 to 600 lb group sold in the months of October and November. This price information was used to construct a Total Revenue Curve (TRC) for sales of small (450 to 500 lb) and large (550 to 600 lb) calves in October or November at the location in question. The process was repeated for calves sold in April or May for each location.

Results

Oklahoma City National Stockyards

The TRC for a spring calving herd (sold in October or November) and a fall calving herd (sold in April and May) were constructed for the Oklahoma City location. The TRC for the spring calving herd results in total revenue of $46,651.16 and has a constant rate of change equal to -1.126 (Figure 1). The end point solution is all small cows. The TRC for the fall calving herd results in total revenue of $50,151.53 and has a constant rate of change equal to -1.13. The end point solution is again for all small cows. Producing all large calves instead of all small calves reduces total revenue by 6.18% and 5.84% for the spring and fall calving herds respectively.

Carthage-Joplin Regional Stockyards

TRCs for a spring calving herd and a fall calving herd were constructed for the Southwest Missouri location. The TRC for the spring calving herd results in total revenue of $45,073.27 and has a constant rate of change equal to -1.123. The end point solution is all small cows. The TRC for the fall calving herd results in total revenue of $49,421.17 and has a constant rate of change equal to -1.13. The end point solution is again for all small cows. Producing all large calves instead of all small calves reduces total revenue by 6.39% and 5.85% for the spring and fall calving herds respectively. The results for the Southwest Missouri location are similar to those of the Oklahoma City location.

Cattleman's Livestock Commission Company

TRCs for a spring calving herd and a fall calving herd were constructed for the Texas Panhandle location. The TRC for the spring calving herd results in total revenue of $46,642.74 and has a constant rate of change equal to -1.092. The end point solution is all small cows. The TRC for the fall calving herd results in total revenue of $50,798.11 and has a constant rate of change equal to -1.107. The end point solution is again for all small cows. Producing all large calves instead of all small calves reduces total revenue by 8.99% and 7.78% for the spring and fall calving herds respectively.

Discussion

This analysis is based on the idea of measuring the resources available to a cattle operation in 1,000 lb animal units, and on the assumptions that each cow weans 50% of her body weight regardless of cow size and that each herd has a 90% weaning percentage regardless of cow size. If in fact larger cows wean a lesser percentage of their body weight than do smaller cows, then the end point solution is still for smaller cows but the percentage decrease in total returns from using large cows will be more than that reported here.

What, in this analysis would have to change to make the large cows the economically efficient choice? In the Oklahoma and Missouri markets 80 large calves would be required to garner the same total revenue as 90 small calves. This would require a 96% weaning percentage for the 1200 lb cows. In the Texas market 82 large calves would be required to garner the same total revenue as 90 small calves. This would require a 98% weaning percentage for the 1200 lb cows.

This analysis has compared only two of many possible choices a producer can select from regarding cow size. The results for three markets and two calving seasons are summarized in Table 1. The analysis can easily be extended to all possible calf sizes. Ten year average feeder cattle prices in Oklahoma City for October and November are displayed in Table 2 along with the number of calves that could be sold under our assumptions of 100 animal units, calves weaning 50% of their mothers body weight, and herds with a 90% weaning percentage. Total Revenue increases as more head of smaller calves are sold.

Conclusions

This paper outlines a simple economic framework to examine the cow size question. Over the most recent 10 years cattle prices at the Oklahoma City Nation Stock Yards, the

Carthage-Joplin Regional Stockyards and the Cattleman's Livestock Commission Company have encouraged cattle producers to use 1,000 lb cows rather than 1,200 lb cows. The prices paid by the three markets are very similar over the time period examined. Fall calving herds receive a premium at all three markets assuming their weaning weights and calving percentages can be maintained without additional resources. Smaller calves are the solution regardless of calving season or market location. Producers choosing to utilize 1,200 lb cows over the last 10 years rather than 1,000 lb cows have done so at a 6% to 9% reduction in sales.

Table 1. Ten year average feeder cattle prices and revenues for medium and large frame No. 1 steers and heifers.

		Price $/cwt	Revenue $/hd	# of hd sold	Total Revenue	Difference
OKC Oct-Nov						
	450-500 lbs	109.13	518.35	90	$46,651.16	
	550-600 lbs	101.50	583.60	75	$43,770.01	-6.18%
OKC April-May						
	450-500 lbs	117.31	557.24	90	$50,151.53	
	550-600 lbs	109.50	629.62	75	$47,221.72	-5.84%
Joplin, MO Oct-Nov						
	450-500 lbs	105.43	500.81	90	$45,073.27	
	550-600 lbs	97.83	562.55	75	$42,191.07	-6.39%
Joplin, MO April-May						
	450-500 lbs	115.61	549.12	90	$49,421.17	
	550-600 lbs	107.89	620.39	75	$46,529.52	-5.85%
Dalhart, TX Oct-Nov						
	450-500 lbs	109.11	518.25	90	$46,642.74	
	550-600 lbs	98.43	566.00	75	$42,449.72	-8.99%
Dalhart, TX April-May						
	450-500 lbs	118.83	564.42	90	$50,798.11	
	550-600 lbs	108.62	624.59	75	$46,843.99	-7.78%

Price data courtesy of USDA, AMS, LSP, Market News.

Table 2. Ten year average feeder cattle prices in October and November and revenues for medium and large frame No. 1 steers and heifers; Oklahoma City National Stockyards.

Weight	Price $/cwt	Revenue $/hd	# of hd sold[1]	Total Revenue
300-350 lbs.	$ 123.71	$ 402.06	129	$51,866.06
350-400 lbs.	$ 120.26	$ 450.99	113	$50,961.77
400-450 lbs.	$ 114.62	$ 487.15	100	$48,714.54
450-500 lbs.	$ 108.92	$ 517.37	90	$46,563.41
500-550 lbs.	$ 104.95	$ 551.01	82	$45,182.72
550-600 lbs.	$ 101.43	$ 583.23	75	$43,742.52
600-650 lbs.	$ 101.07	$ 631.68	69	$43,585.75
650-700 lbs.	$ 99.71	$ 673.03	64	$43,073.78
700-750 lbs.	$ 98.44	$ 713.72	60	$42,823.30
750-800 lbs.	$ 96.21	$ 745.60	56	$41,753.53

[1] Based on 100,000 animal units available to the farmer, a herd of same size cows that has a 90% weaning percentage, and calves that weigh 50% of their mother's body weight at weaning.

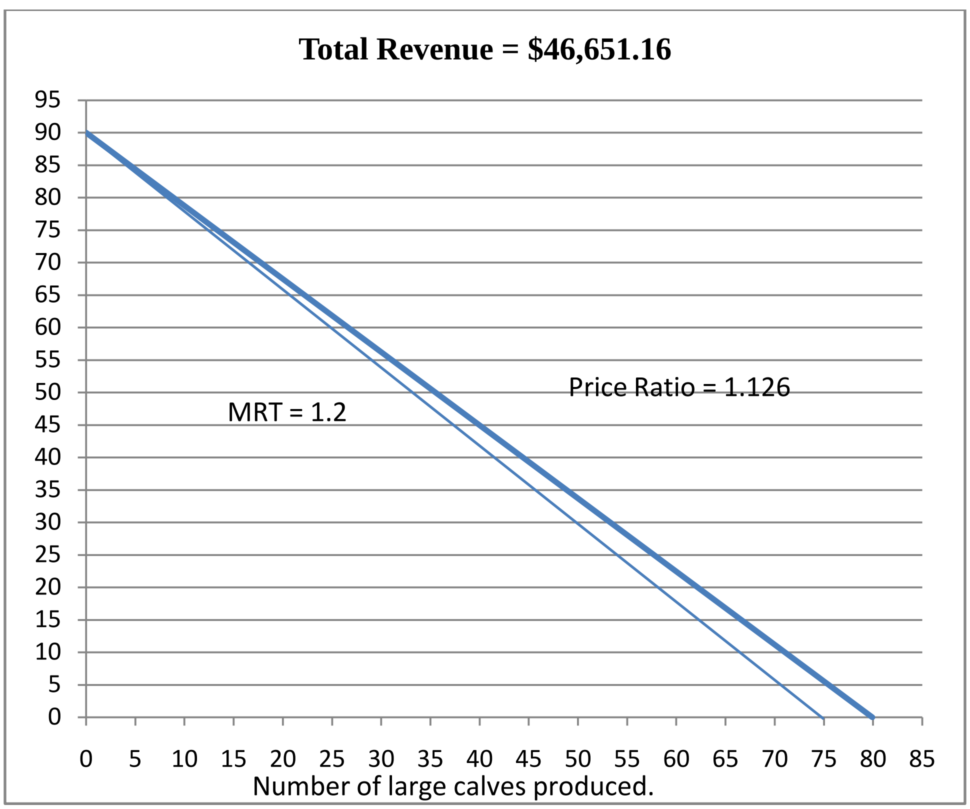

Figure 1. Product/Product graph of choice between producing 475 lb calves at weaning or 575 lb calves at weaning.

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