Cost-Size Relationships of Utah Cattle Ranches[1]

JOHN P. WORKMAN AND JACK F. HOOPER[2]

Assistant Professor, Range Resource Economics, Department of Range Science, Utah State University, Logan, Utah; and Vice-President, Armendaris Land Development Corporation, Kansas City, Missouri.

Highlight

Regression analyses of per cwt. beef production costs of four sizes of Utah cattle ranches indicate that no size of Utah range cattle operation up to 500 head is capable of covering all costs. When all production costs were taken into account, the 1968 optimum sized Utah cattle ranch from the ranch owner's viewpoint was 392 head of breeding cows. The weighted average beef price necessary for the optimum ranch size to meet all costs was $30.95 per cwt. When interest on investment in land, livestock, and improvements was ignored, the optimum sized cattle ranch from the owner's viewpoint was one with a capacity of 414 breeding cows. In order to meet all costs except interest on investment, the optimum ranch size would require a weighted average beef price of $17.77 per cwt.

Information concerning cattle ranch economies of size (phenomena which cause reductions in per unit costs as firm size increases) is important to potential investors in cattle ranch property and ranch owners interested in expansion. As pointed out by Faris and Armstrong (1963), cost-size relationships are of special concern to policy makers, as well as ranch operators. Both the formulation of efficient and equitable federal farm policy and sound ranch management depend upon knowledge of economies of size. In view of the need for cost economies information, a study was conducted in Utah beginning in 1967 to determine the cost-size relationships that exist in range cattle operations.

Methods

Investment, cost, and returns data for various sizes of Utah cattle ranches were obtained from rancher interviews and questionnaires throughout the state (Tables 1 and 2). The numerous observations were classified into four ranch groupings with average sizes of 50, 150, 300, and 500 head of breeding cows. Data for the 50, 150, and 300 cow ranches were taken from a study by Roberts and Gee (1963) while figures for the 500 cow ranch were collected by the authors. These data allowed the identification of (1) cash costs, (2) costs of depreciation, (3) operator and family labor costs, and (4) the costs of interest on investment for each of the four ranch sizes (Table 3). Two long-run average cost (LRAC) curves were derived from these data by regression analysis. These curves show the functional relationship between per cwt. beef production costs and the quantity of beef produced annually. Simply stated, the "long-run" is viewed by economists as a time period of sufficient length for all inputs to be variable. This concept is one of convenience and even the longest of "long-runs" probably has some inputs held constant (an example is the management ability of the rancher). The distinction between the long-run and the short-run (the short-run is usually defined as a production period during which at least one input is fixed) is arbitrary by any standards. What is actually involved is a *continuum ranging* from the shortest to the longest conceivable production periods.

Two distinct points were located along the production period continuum for the purpose of deriving two distinct LRAC curves. The first ($LRAC_1$) includes (1) cash costs, (2) depreciation, (3) opportunity costs of operator and family labor, and (4) interest on investment.

The second LRAC curve ($LRAC_2$) includes only (1) cash costs, (2) depreciation, and (3) the opportunity costs of operator and family labor. Interest on the rancher's investment in land, machinery, and improvements is excluded.

For the purpose of providing information to existing ranch operators or potential investors in beef production factors, it is probably more important to present both curves (letting the manager choose the one he considers relevant) than it is to attempt to justify one of the two as the correct curve. From the viewpoint of society, $LRAC_2$ (which includes all costs including a normal return on investment) is the relevant curve. Even though private operators may ignore the opportunity costs of interest on investment, these are real costs that society cannot afford to ignore.

Results and Discussion

The regression equation for $LRAC_1$ took the form

$$LRAC_1 = 81.260 - 0.000569P + 0.0000000016P^2$$

where P = the pounds of beef produced. The R^2 value was 0.89 and the t-values were significant at the 60 percent level for pounds and the 50 percent level for pounds squared.[3] The graphical form of $LRAC_1$ is shown in Figure 1.

The regression equation for $LRAC_2$ took the form

$$LRAC_2 = 60.501 - 0.000524P + 0.0000000016P^2$$

where P = the pounds of beef produced. The R^2 value was 0.92 and

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[3] The cost data taken from Roberts and Gee (1963) were published in pooled form. Thus, only four observations were available for each of the two regression analyses. This explains the low level of significance associated with the regression coefficients despite the impressive R^2 values.

Table 1. Summary of investment (dollars) for typical ranches, Utah, 1968.

Item	Size of breeding herd			
	50	150	300	500
Land	40,500	72,250	148,250	218,100
Federal grazing permits	7,176	23,816	44,520	54,000
Buildings and improvements	7,300	16,865	30,160	53,620
Machinery and equipment	18,075	23,739	29,022	51,930
Livestock				
Cattle	15,280	41,860	83,900	131,760
Horses	300	450	750	1,050
Total investment	88,581	178,980	336,602	510,460

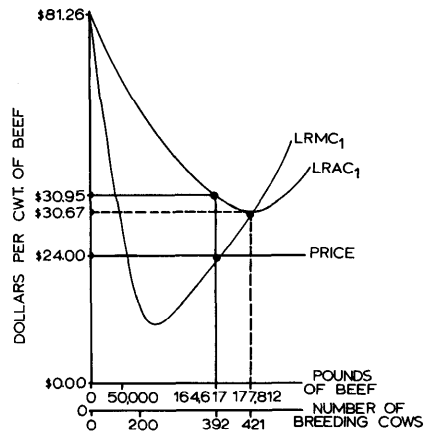

FIG. 1. Long-run average and marginal cost curves for beef production in Utah, 1968, when all costs are considered.

the t-values were significant at the 70 percent level for pounds and the 60 percent level for pounds squared. The graphical form of $LRAC_2$ is shown in Figure 2.

$LRAC_1$

Long-run average costs ($LRAC_1$) decrease as ranch size increases up to a ranch size of 421 head of breeding cows (Fig. 1). These size economies are due to the intensification of cattle numbers on the cash costs of taxes and insurance causing these costs to be spread over more units of production. A related source of cost economies is the spreading of the implicit costs of depreciation, operator and family labor, and interest on investment. The cost diseconomies which exist as ranch size becomes larger than 421 head appear to be due primarily to the intensification of investment in machinery and equipment on cattle numbers (Tables 1 and 3).

Multiplying $LRAC_1$ by P and taking the first derivative yields $LRMC_1 = 81.260 - 0.001138\,P + 0.0000000048\,P^2$, which is long-run marginal cost (LRMC) expressed as a function of pounds of beef produced (Fig. 1). Setting the first derivative of $LRAC_1$ equal to zero and solving for pounds gives the output corresponding to the minimum of $LRAC_1$ and also to the output where $LRMC_1 = LRAC_1$ (177,812 pounds or 421 head of breeding cows).

From the viewpoint of society (since it views efficiency in terms of quantity of output produced per unit of input) the optimum Utah ranch size is one capable of supporting 421 breeding cows. Substituting 421 head (177,812 pounds) into the equation for $LRAC_1$ reveals that the price per cwt. of beef would have to be $30.67 to cover all costs at the optimum cattle ranch size.

Imposing the 1968 weight average Utah price line of $24.00 per cwt. (Christensen and Richards, 1969) on the cost curves of Figure 1, reveals that no size of Utah cattle ranch is capable of covering all costs of production at current prices.

Table 2. Production and sales of cattle[1] of typical ranches, Utah, 1968.

Ranch size	No. sold	Average weight (lb.)	Total weight (cwt)	Price ($/cwt)	Value ($)
50 breeding cows					
cows	7	1000	70	16.60	1162
heifer calves	9	380	34	26.98	917
steer calves	8	400	32	28.62	916
yearling steers	12	600	72	24.00	1728
Total sales			208	22.71	4723
150 breeding cows					
cows	21	1000	210	16.60	3486
heifer calves	35	380	133	26.98	3588
steer calves	41	400	164	28.62	4694
yearling steers	18	600	108	24.00	2592
Total sales			615	23.35	14360
300 breeding cows					
cows	34	1000	340	16.60	5362
heifer calves	73	380	277	26.98	7473
steer calves	85	400	340	28.62	9731
yearling steers	37	600	222	24.00	5328
Total sales			1179	24.01	27894
500 breeding cows					
cows	50	1000	500	16.60	8300
heifer calves	171	380	650	26.98	17537
steer calves	175	400	700	28.62	20034
yearling steers	50	600	300	24.00	7200
Total sales			2150	24.68	53071

[1] Bulls are treated as capital items and accounted for in depreciation.

Table 3. Total and average (per cwt. beef) costs of beef production on typical ranches, Utah, 1968 (dollars).

Item	Size of breeding herd			
	50	150	300	500
Cash Costs				
Grazing fees				
BLM	88	365	771	825
FS	131	350	545	792
Labor hired	150	360	3200	6600
Feed purchased	161	307	2244	1100
Repairs and maintenance				
Buildings and improvements	175	458	831	1200
Machinery and equipment	922	1074	1541	2062
Veterinary services and supplies	41	59	439	500
Taxes	719	1351	2616	2900
Seed and fertilizer	236	590	1210	1322
Machine operating costs	625	1294	1659	2500
Machine hire	207	309	620	750
Insurance	101	133	133	200
Utilities	41	283	400	500
Irrigation water	224	389	873	1200
Miscellaneous	345	476	637	850
Interest on cash costs	166	312	664	932
Total cash costs	4332	8110	18383	24233
Total cash costs-value crops sold	2782	6631	14664	24233
Average cash costs (per cwt. beef)	13.37	10.78	12.44	11.27
Non-Cash Costs				
Depreciation				
Buildings and improvements	365	843	1508	2681
Machinery and equipment	2892	3798	5044	8309
Bulls	120	460	1150	1918
Horses	30	45	75	105
Total operating costs	6189	11777	22441	37246
Average operating costs	29.75	19.15	19.03	17.32
Operator and family labor	4800	6000	8000	9600
Total operating and labor costs	10989	17777	30441	46845
Average operating and labor costs	52.83	28.90	24.82	21.79
Interest on investment (5%)	3847	7960	15244	22715
Total operating and opportunity costs	14836	25737	45685	69560
Average operating and opportunity costs	71.33	41.85	38.75	32.35

The tendency for Utah cattle ranchers to remain in business despite the net losses which all ranch sizes are experiencing may be explained by certain costs included in the curves of Figure 1 not being viewed as real costs by ranchers. An example of such an item is the opportunity cost of interest on investment. Another possible explanation is that other values derived from the ranching business such as the "way of life," tax advantages, and land appreciation move the effective price line (as subjectively viewed by ranch owners) to a level in excess of $24 (Martin and Goss, 1963).

From the viewpoint of the rancher (since for maximum profit he attempts to equate marginal cost with marginal revenue) the optimum Utah ranch size is one capable of supporting 392 head of breeding cows (Fig. 1). This value is calculated by setting the equation for $LRMC_1$ equal to price ($24) and solving for pounds. Substituting the result into the equation for $LRAC_1$, the beef price necessary to cover all

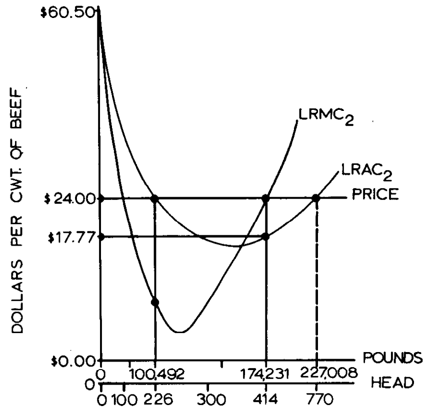

FIG. 2. Long-run average and marginal cost curves for beef production in Utah, 1968, when interest on investment is ignored.

costs at the rancher's optimum cattle ranch size is $30.95 per cwt.

$LRAC_2$

Since no size of Utah cattle ranch is capable of covering all long-run costs, regression analysis was used to generate a second LRAC equation ($LRAC_2$). This equation expresses the average of all costs except interest on investment (which the rancher may not view as a real cost) as a function of pounds of beef output. Long-run average costs decrease up to a ranch size of 390 head of breeding cows and then increase (Fig. 2). Explanation of the cost economies and diseconomies follows that given for $LRAC_1$.

Multiplying $LRAC_2$ by P and taking the first derivative gives

$$LRMC_2 = 60.501 - 0.001048\,P + 0.0000000048\,P^2,$$

which is the equation for long-run marginal cost when interest on investment is ignored. $LRMC_2$ appears in graphical form in Figure 2.

The optimum ranch size from the ranch owner's viewpoint (when interest on investment is ignored) is 414 head of breeding cows (Fig. 2). This output is determined by setting $LRMC_2$ equal to the 1968 Utah weighted average price ($24.00) and solving for pounds of beef. The beef price necessary to pay all costs for the ranch owner's optimum ranch size is $17.77 per cwt. This value is found by substituting 174,231 pounds into the equation for $LRAC_2$.[4]

By setting $LRAC_2$ equal to price and solving for pounds, it can be shown that a ranch supporting 226 head is the minimum size necessary to cover all costs (except interest on investment) at the 1968 weighted average beef price of $24 per cwt. The maximum cattle ranch size which yields positive returns, as shown in Figure 2, is 770 head. However, this 770 head figure represents a functional extrapolation. Data were available for cattle ranch sizes up to 500 head and for much larger ranches supporting 7500 head or more. In 1968, few ranch sizes existed in Utah between 500 and 7500 head of cattle. This in itself may be a commentary on cost economies of size and investment strategy. Perhaps cattle ranches with a capacity of 500 head or less are "family" ranches which manage to remain in business by ignoring the costs of family labor and interest on investment. Ranches larger than 500 head may be run by sophisticated investors seeking tax shelter and long term capital gain.

[4] It should be noted that from the viewpoint of society, the optimum ranch size is still that capable of supporting 421 head (Fig. 1) since $LRAC_1$ (which includes all costs) is the relevant curve in terms of social costs.

Summary and Conclusions

Analysis of long-run average and marginal cost curves derived from regression of data from four sizes of Utah cattle ranches revealed that no size of range cattle operation up to 500 head is capable of covering all costs. If all costs of production are taken into account, the optimum Utah cattle ranch sizes are 421 head from society's viewpoint and 392 head from the rancher's viewpoint. The weighted average beef prices necessary to cover all costs at these optima are $30.67 and $30.95 per cwt., respectively.

The data were also subjected to analysis under the assumption that ranch owners do not view interest on investment as a real cost. When interest on investment is dropped from the analysis, the resulting long-run average and marginal cost curves show that the optimum ranch size from the owner's point of view is one capable of supporting 414 head. The beef price necessary to cover all costs (except interest on investment) at this output is $17.77 per cwt. The minimum size of cattle ranch capable of paying all costs (except interest on investment) is 226 head in terms of 1968 prices.

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