Costs, Distribution of Costs, and Factors Influencing Profitability in Cow-Calf Production

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it is a simple economic fact that the average producer is just going to "break even" in the long run. In this competitive industry there are no long run average "economic profits" where selling price exceeds the average total cost of production. Therefore, the individual producer must strive to be better than average at some aspect of business management or marketing. The cost (profit) variability issue has two distinct dimensions, cost (profit) variation over time, and cost (profit) variation between producers.

Example Beef Cow Enterprise Budget (1998)

Net Accrual Adjusted Revenue Per Cow	$330.85

Variable Costs Per Cow	
Hired Labor	9.06
Interest Paid	21.34
Machinery Repair	22.63
Feed	239.66
Machine Hire	3.12
Publications	3.85
Vet/Drugs	13.27
Marketing/Breeding	7.46
Gas/Fuel/Oil	8.34
Property Tax	1.05
Insurance	3.87
Utilities	6.21
Misc	1.41
Total Variable Cost	$341.26

Fixed Costs per Cow	$131.94
Depreciation, Interest, Taxes, and Insurance on breeding stock, buildings, and equipment, and unpaid operator labor	

Average profit and cost variability over time

Measures of average costs and average net returns to cow-calf production over time result from broad factors influencing costs (feed prices, weather, etc), and overall cattle price levels resulting from the cattle cycle and seasonal variations. Figure 1 presents average returns over variable cost (remember this is only one component of a true measure of profitability) for Kansas cow-calf producers providing cow-calf enterprise data into the Kansas Farm Management

Association data bases. When you consider the fact that fixed costs can easily exceed $100.00 per cow per year, Figure 1 implies the low level of average profits to cow-calf production. Most of the year-to-year variability in a state average measure is, of course, the result of fall calf price variability across the respective years.
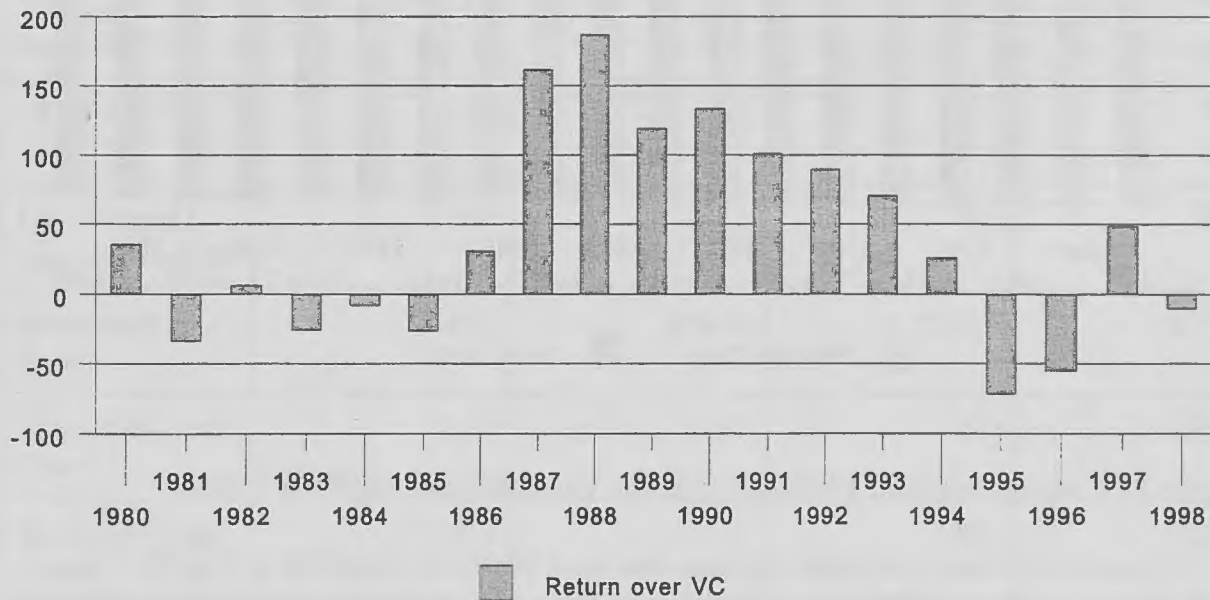
Figure 1. Kansas Cow-Calf Per-Head Average Return Over Variable Cost

A smaller amount of the year-to-year variability in this measure is the result of factors that impact average costs of production across years. Figure 2 presents variable costs per cow over the same time period for cow-calf production in Kansas. Also included in figure 2 is a measure of average total feed costs over time, to illustrate that the largest share of variable cost variability over time is due to feed cost variability. Keep in mind that in order to get closer to a true measure of average profitability, fixed cost components would need to be accounted for, but the fixed cost components do not vary nearly as much as the variable cost component. Fixed costs are not the focus of this discussion.

Figure 2. Kansas Cow-Calf Per-Head Average Variable Cost and Feed Costs

Looking at state or regional averages over time like those illustrated in Figures 1 and 2 can lead individual producers to the mistaken conclu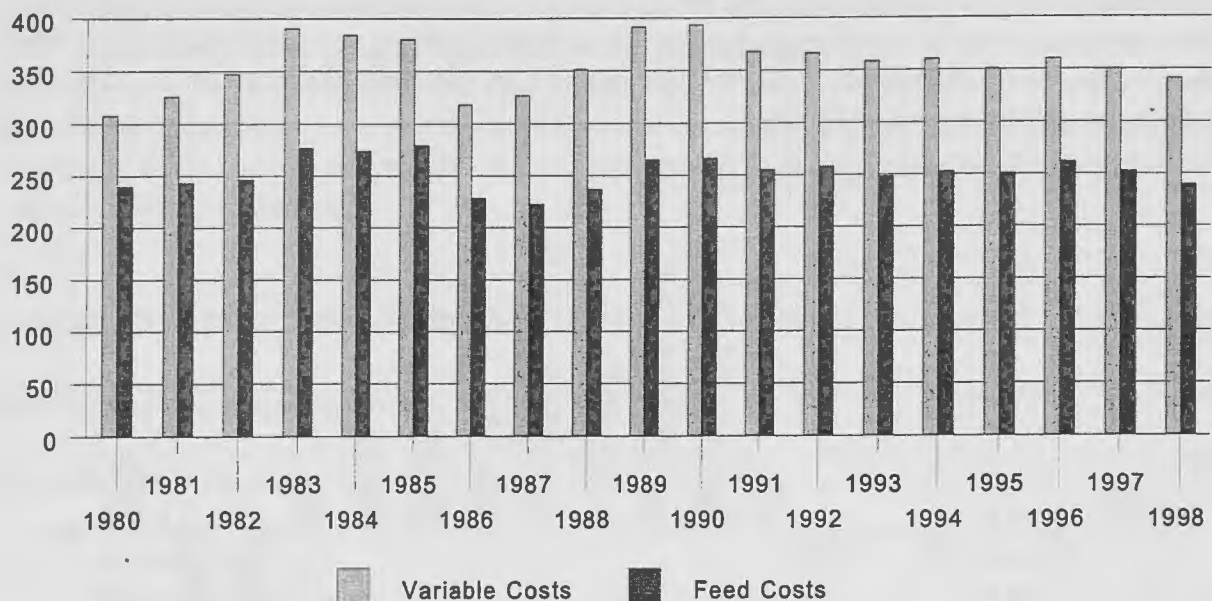sion that managing calf price risk and feed price risk will address the majority of their profit risk issues. While these components are obviously important, they may, in fact, account for only a small portion of the total profit variability in cow-calf production. Perhaps a more important consideration when examining cost variability, or profit variability of the cow-calf sector, is the large variation in cost between operations in a given year.

Average profit and cost variability across producers

A number of analysts using different data sources have documented differences in performance and costs among cow calf producers. Arguably the most comprehensive data is the national Standardized Performance Analysis data maintained for the NCBA by Texas A&M agricultural economists. Participating cow herds are primarily located in Texas, Oklahoma, and New Mexico. Table 1 summarizes the information from this Southwestern U.S. region for the 1991 through 1998 time period, sorted by profitability quartile (McGrann, 1999).

Many inferences can be drawn from the SPA data. However, the over-riding conclusion is that productivity and financial performance is highly variable between herds, and high levels of production do not insure high levels of net income. In fact, preliminary analysis suggests that only about 7 percent of the profitability differences can be explained by production factors (McGrann, 1999). Even during sustained periods of relatively low calf prices, herds in the top 25 percent, based on net income, generate a competitive return on investment.

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Table 1. Selected Cow-Calf SPA Measures Sorted By Profitability Quartile (1991 - 1998)

SPA Measure	Top 25%	2nd 25%	3rd 25%	Bottom 25%
Weaning Percent	85	85	81	82
Weaning Wt (lbs)	539	528	523	500
Lbs Weaned / Exposed Female	456	442	426	413
Investment / Cow	$3452	$3800	$2648	$3720
Production cost/ Cow	$308	$357	$384	$500
Production cost/ Cwt.	$55	$71	$86	$123
Market Value Return on Assets	7.56%	2.50%	-0.43%	-5.26%
Net Income / Cow	$140	$38	$-30	$-181

Another comprehensive data set that documents cost differences among cow-calf producers is maintained by Harlan Hughes, Extension Livestock Economist with North Dakota State University. Table 2 summarizes the differences between cow-calf producers in the Northern Plains for fiscal year 1997 (Hughes). The data in Table 2 are summarized in a slightly different way than in Table 1 in that date in Table 2 are sorted by cost categories rather than by net income categories.

Table 2. Northern Plains Cow-calf Results By Cost Groupings (1997)

Measure	Low Cost	Middle Cost	High Cost
Pregnancy Percent	97	95	95
Calving Percent	94	94	87
Calf Death Percent	8	16	7
Weaned Calf Crop Percent	88	86	89
Weaning Wt.	547	571	536
Lbs. Weaned / Exposed Female	470	488	441
Gross Income / Cow	$420	$422	$350
Feed Costs / Cow	$196	$256	$288
Livestock Cost/Cow	$68	$69	$105
Total Cost / Cow[1]	$307	$377	$465
Net Income / Cow	$114	$45	$-115
Unit Cost Of Production / ($/cwt.	$58	$79	$117

[1] Does not include opportunity cost of owned capital, or operator labor costs

The preliminary analysis by Hughes suggests that high cost producers tend to be high cost in all categories, and only about 35 percent of the $229.00 difference in net income per cow between the high-cost group and the low-cost group can be explained by production efficiency as measured by pounds weaned per exposed female . The remaining 65 percent is explained by cost differences. Another interesting observation by Hughes after tracking several years of Northern Plains cow-calf data is that big cows producing big calves tend to be profitable during periods of high calf prices, but they tend to be very un-profitable during periods of low calf prices.

Sources of inefficiency

Profit variability is strongly related to per unit cost of production variability, which has been shown to be related to economic efficiency (Featherstone, Langemeier, and Ismet). Furthermore, cost differences between cow calf producers do not appear to be driven entirely by economies of size, since there has not been a rapid trend toward larger average herd sizes. An expanded discussion of economies of size is provided later in this paper. Recent work by Jones, Langemeier, and Eidson used a nonparametric efficiency analysis approach to determine the relative efficiency measures for a sample of Kansas beef cow producers. Regression analysis was then used to determine the sources of efficiencies (inefficiencies), and to identify the relationships between efficiency measures and profitability for beef cow producers.

Without going into a lot of technical detail, the nonparametric efficiency approach utilizes a series of math programming models to solve for a set of relative efficiency measures. Technical efficiency (TE) determines how close a firm is to producing on the production frontier in terms of output/input measures. Allocatively efficient (AE) firms are firms that have the ability to combine inputs and outputs in optimal proportions in light of prevailing prices. Scale efficiency (SE) measures whether or not a firm is operating at it's most efficient size. Economic efficiency (EE) is the product of technical and allocative efficiency. Firms that are economically efficient are producing on the total and average cost frontiers. Finally, overall efficiency (OE) is the product of technical, allocative, and scale efficiencies. Overall, efficient firms have the lowest per unit cost of production. All of the efficiency measures for each firm, and for each year, are scaled to a measure between 0 and 1, with 1 representing the highest degree of efficiency possible.

The data used in the study were acquired from the Kansas Farm Management database, and represented 46 Kansas cow-calf operations for a period of five years (1992-1996). Detailed enterprise cost data were aggregated into six cost categories. The labor cost category included hired labor and unpaid operator labor. Feed consisted of purchased and raised feed costs as well as pasture costs. Interest payments, repairs, depreciation, and machinery hired were included in the capital cost category. Fuel (and utilities) included purchased fuel and utilities used for beef production. Veterinary expenses were included as a separate category, and all other costs were aggregated into a miscellaneous category. Total pounds of beef produced was used as the output measure. This measure was created by combining pounds of beef produced from weaned calves and pounds of beef recorded from culled breeding livestock (cull cows and bulls). Profit was calculated as gross farm income from the cow-calf enterprise minus the sum of all cost categories. Reported farm types were used to categorized each farm regarding the degree of specialization or diversification.

Table 3 reports the summary statistics and distribution of the efficiency measures resulting from the math programming models. Technical efficiency averaged 0.77, ranged from 0.29 to 1.0, and had a standard deviation of 0.16. The average of 0.77 implies that the average output level could increase by 23 percent using the same level of inputs if all farms were

technically efficient. Thirty-seven observations (16 percent) operated on the production frontier at maximum efficiency.

Table 3. Summary Statistics and Distribution of 1992-1996 Efficiency Measures

Variable	TE	AE	SE	OE	EE
			Efficiency Measure		
Summary statistics (index)					
Mean	0.7714	0.8029	0.8400	0.5136	0.6145
Standard deviation	0.1659	0.1066	0.1088	0.1257	0.1451
Minimum	0.2903	0.3538	0.4876	0.1860	0.2573
Maximum	1.0000	1.0000	1.0000	1.0000	1.0000
Distribution of Farms			(%)		
Less than 0.20	0	0	0	0.43	0
0.2 to 0.30	0.43	0	0	3.9	0.43
0.3 to 0.40	0.87	0.43	0	13.0	5.2
0.40 to 0.50	5.7	0.43	0.43	28.7	13.9
0.50 to 0.60	7.8	3.9	2.2	32.2	26.6
0.60 to 0.70	20.0	10.9	10.4	15.2	29.1
0.70 to 0.80	22.2	27.8	19.1	4.8	11.3
0.80 to 0.90	18.3	38.7	32.6	1.3	4.3
0.90 to 1.00	9.6	14.8	34.8	0	3.0
1.00	16.1	3.0	0.43	0.43	3.0

The average allocative efficiency estimate of 0.80 implies that on average cost could have been lowered by 20 percent if the firms had used the optimal input mix. The range of the estimate was between 0.35 and 1.0, with 7 observations being allocatively efficient. Only 2 observations had allocative efficiencies below 0.5, while 82 percent (187) ranged between 0.7 and 1.0.

The average scale efficiency measure was 0.84, and ranged from 0.49 to 1.0. The most efficient herd size was estimated to be 176 cows, while the average herd size in the data set was 114 cows. Twenty-six observations produced at decreasing returns to scale while 203 observations were producing at increasing returns to scale. A graphical representation of scale efficiency is seen in Figure 3. The points in Figure 1 that lie to the left of the scale efficient farm produce at increasing returns to scale while those farms that lie to the right of the scale efficient farm are producing with decreasing returns to scale. The scale efficient farm is represented by producing at the point of minimum average cost per pound ("min AC"), which was approximately $0.54 per pound. The farm that produces with the most efficient herd size produces with the lowest per unit costs of production.

Economic efficiency ranged from 0.26 to 1.0, with an average of 0.61. This suggests that the same average output level could have been maintained while reducing the input costs by 39

percent. Seven farms were economically efficient and the majority (59 percent) were between 0.5 and 0.7. Economic inefficiency is the product of technical and allocative inefficiencies. The averages of those two measures indicate that technical inefficiency contributed more to economic inefficiency than did allocative efficiency. However, both areas show significant room for improvement.
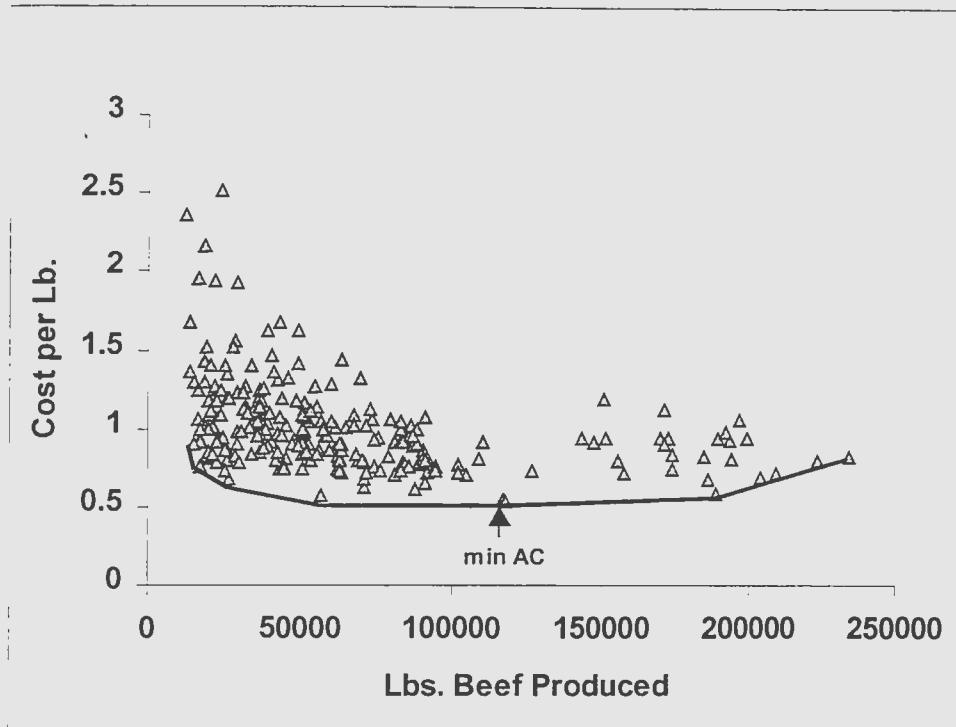
Figure 3: Kansas Beef-Cow Cost Curve (1992 - 1996)

Overall efficiency averaged 0.51, with a range of 0.19 to 1.0. This result implies that on average a 49 percent input cost reduction potential existed. Approximately 32 percent of the observations were between 0.5 and 0.6 overall efficient, while about 50 percent were below 0.5. Overall inefficiency can be attributed to technical, allocative or scale inefficiency or any combination of the three.

Regression models were employed to analyze and measure the sources of inefficiency. Since the relative efficiency measures cannot be greater than 1.0, Tobit models were employed. The first Tobit regression model examined the relationship between the five efficiency measures and farm characteristics as follows:

$$E_{ti} = \beta_0 + \beta_1 age + \beta_2 age^2 + \beta_3 size + \beta_4 size^2 + \beta_5 time + \beta_6 ccrop,$$
$$+ \beta_7 ccropbeef + \beta_8 ccropcow + \beta_9 general + e_i$$

Where E_{ti} denotes the tth efficiency index for the ith farm. The β's represent the estimated regression coefficients. The age in years for the *ith* producer (*age*), and the age of the *ith* producer squared are included to examine the relationship between age and efficiency. The *size* variable (number of cows in the herd) is included to address the obvious issue of economies of size. A time trend is represented by the *time* variable to test for efficiency changes over the time period of the study. The level of diversification, and the relative importance of the cow herd in the overall farming operation, is represented by the farm type dummy variables. The base farm type (not included in the regression) is the stock ranch-cowherd farm type with the cow-calf operation representing the most important enterprise for the farm. The *ccrop* farm type relies on cash crop enterprises for the majority of income, but did report some cow-calf enterprise income for the farm. The *ccropbeef* farm type reported both cash crop production and beef cattle (cow-calf, summer stocker, backgrounding, and/or finishing) as being important enterprises on the farm. The *ccropcow* farm type represents operations that reported both cash crop production and cow-calf production as significant enterprises on the farm. Finally, the *general* farm type represents highly diversified farms.

Table 4 reports the results of the Tobit models examining the relationships between the efficiency measures and selected farm characteristics. Herd size is negatively related to technical efficiency, while herd size squared is positively related to this efficiency measure. The time variable positively and significantly impacts technical efficiency, suggesting that cow-calf producers adopted new production technologies between 1992 and 1996, increasing technical efficiency each year by an average index of 0.0270. No other farm characteristic variables significantly affected technical efficiency.

Age of operator and time were significantly related to allocative efficiency at the .01 level of statistical significance. These results suggest that producers utilized cost minimization techniques more efficiently over time from 1992-1996, with yearly increases in allocative efficiency of 0.016. Age increased allocative efficiency up to the age of 53 years, with allocative efficiency decreasing for producers over 53 years of age. Experience (up to 53 years of age) appears to help producers allocate inputs more efficiently. Age of operator, herd size, and time were all positively related to scale efficiency and all were statistically significant at the .01 level. Efficiency gains associated with age and herd size reached a maximum as indicated by the significant negative coefficient on the quadratic terms associated with these variables. Size efficiency increased with age of operator up to the age of 47, and then declined on average. Increasing herd size increased efficiency up to a size of approximately 185 cows with larger and smaller producers having lower predicted size efficiency measures. Size efficiency improved over time, with average yearly increases of 0.005.

Table 4. Farm Characteristics Tobit Regression Results

Independent Variable	Dependent Variable				
	TE	AE	SE	EE	OE
Intercept	0.7340***	0.4089***	0.4261***	0.2638	-0.0435
	(0.2498)	(0.1393)	(0.0647)	(0.1787)`	(0.1496)
Age of Operator	0.0043	0.0134***	0.0051***	0.0134***	0.0139***
	(0.0088)	(0.0049)	(0.0023)	(0.0063)	(0.0053)
Age of Operator^2	-3.57e-05	-0.0001***	-5.51e-06***	-0.0001***	-0.0001***
	(7.99e-05)	(4.46e-05)	(2.07e-05)	(5.72e-05)	(4.79e-05)
Herd Size	-0.0023***	-0.0005	-0.0044***	0.0020***	0.0013***
	(0.0002)	(0.0003)	(0.0002)	(0.0004)	(0.0004)
Herd Size^2	6.42e-06***	2.33e-06***	-1.12e-05***	-6.39e-06***	-2.34e-06***
	(1.65e-06)	(9.08e-07)	(4.19e-07)	(1.16e-06)	(9.68e-07)
Time	0.0270***	0.0164***	0.0052***	0.0321***	0.0293***
	(0.0088)	(0.0048)	(0.0022)	(0.0062)	(0.0052)
Cash crop	-0.0123	0.0152	0.0007	-0.00497	0.0056
	(0.0498)	(0.0276)	(0.0128)	(0.0354)	(0.0296)
Cash crop - beef	-0.0220	0.0273	-0.0003	0.0065	0.0198
	(0.0506)	(0.0282)	(0.0131)	(0.0361)	(0.0302)
Cash crop - cow	0.0324	-0.0208	-0.0113	-0.0127	-0.0011
	(0.0504)	(0.0280)	(0.0129)	(0.0358)	(0.0299)
General farm	-0.0632	0.0518	0.0247	-0.0042	0.0204
	(0.0603)	(0.0336)	(0.0156)	(0.0431)	(0.0361)

Note: Numbers in parenthesis denote standard errors. One, two and three asterisks (*) indicate .10, .05, .01 level of statistical significance respectively. There were 230 observations.

Economic efficiency increased with age up to approximately 56 years of age, then decreased on average as evidenced by the negative and significant quadratic term. Economic efficiency also increased over the time period of the study by an average index of 0.032 per year. Increasing herd size tends to increase economic efficiency up to a herd of about 175 cows on average.

Age of operator, herd size, and time were significantly related to overall efficiency at the .01 level. Diminishing returns to overall efficiency with respect to age of operator and herd size existed, as indicated by the negative coefficient on age squared and size squared variables (.01 level of statistical significance). Given that the diversified farm type variables were not statistically significant, there is no evidence that economies of scope existed with regard to overall efficiency. Consistent with the other efficiency measure results, Kansas beef cow producers appear to have become more overall efficient over time, with the predicted overall

efficiency measure increasing by an average index of 0.029 per year. Increasing age slowly increases predicted overall efficiency up to an age of 54 years, with predicted overall efficiency decreasing slightly for producers older than 54.

Increasing herd size by 1 standard deviation from the mean herd size was estimated to increase overall efficiency by an index of 0.104. Predicted overall efficiency increased up to an approximate herd size of 289 cows, but there are not large additions to overall efficiency once herd sizes reach about 185 cows.

The averages for technical (0.77), allocative (0.80), and scale (0.84) efficiencies show that overall inefficiency is attributed to a combination of three inefficiencies. Technical was the lowest average efficiency measure, so knowledge and implementation of new production practices and technologies need to be considered to increase overall efficiency. However, cost minimizing (input allocation) strategies are also important. Since technical and allocative inefficiencies were the largest contributors, Kansas beef cow producers should focus on new production practices and an optimal input mix before considering increasing herd size by new investments to increase overall efficiency.

The second Tobit regression model was employed to examine the relationships between the six input categories (costs/cow) and the efficiency measures. The following regression model was applied to all of the efficiency measures (TE, AE, SE, OE, EE):

$$E_{ti} = \beta_0 + \beta_1 X_{1i} + ... + \beta_{ni} X_{ni} + e_i$$

Where E_{ti} denotes the tth efficiency index being tested for the ith farm. The β's represent the estimated regression coefficients, and X_1 through X_n are the cost category variables (labor, feed, capital, fuel, veterinary, and miscellaneous) for each observation (i). Increases in each input cost category are expected to negatively impact technical, scale, economic, and overall efficiency. A positive relationship may, however, exist between a cost variable and allocative efficiency. A positive sign on the estimated cost coefficient would indicate a general under-utilization of the input variable in question. Tobit elasticities were calculated for the input cost regression models.

The results of the Tobit regression models used to estimate the impact of the individual cost categories on the various efficiency measures are reported in Table 5. These estimated relationships provide an indicator of which input costs are more important when trying to improve the production efficiency measures. Both higher feed costs and higher miscellaneous costs significantly decreased technical efficiency. Reducing feed costs by $45.02 (one standard deviation) per cow would increase predicted technical efficiency by an index of 0.033 and decreasing the miscellaneous cost level by $8.73 (one standard deviation) would increase technical efficiency by 0.039. None of the other cost categories significantly impacted technical efficiency.

Table 5. Input Cost Tobit Regression Results

Independent Variable	Dependent Variable				
	TE	AE	SE	EE	OE
Intercept	1.1283***	0.9074***	0.9544***	0.9662***	0.8771***
	(0.0700)	(0.0413)	(0.0380)	(0.0511)	(0.0370)
Labor cost/cow	-0.0004	-0.0001	-0.0010***	-0.0003	-0.0008***
	(0.0031)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Feed cost/cow	-0.0007***	9.58e-06	0.0001	-0.0006***	-0.0005***
	(0.0002)	(0.0001)	(0.0001)	(0.0002)	(0.0001)
Capital cost/cow	-0.0005	-0.0009***	-0.0002	-0.0010***	-0.0010***
	(0.0004)	(0.0002)	(0.0002)	(0.0003)	(0.0002)
Fuel cost/cow	-2.0e-05	-0.0007	-0.0008	-0.0004	-0.0008
	(0.0011)	(0.0007)	(0.0006)	(0.0008)	(0.0006)
Vet. cost/cow	-0.0002	0.0016***	-0.0002	0.0009	0.0007
	(0.0011)	(0.0007)	(0.0006)	(0.0008)	(0.0006)
Misc. cost/cow	-0.0045***	0.0002	-0.0018***	-0.0033***	-0.0037***
	(0.0012)	(0.0007)	(0.0007)	(0.0511)	(0.0007)

Note: Numbers in parenthesis denote standard errors. One, two and three asterisks (*) indicate .10, .05, .01 level of statistical significance respectively. There were 230 observations.

Labor and capital input costs were estimated to be negatively related to allocative efficiency, indicating that on average allocative efficiency could be improved by better controlling labor and capital costs. Surprisingly, veterinary expenses were positively related to allocative efficiency at the .05 level of significance. This result indicated that, on average, spending more on this input would improve allocative efficiency.

Labor and miscellaneous were the only cost variables that were significantly (.01) related to scale efficiency. Both were estimated to be negatively related to scale efficiency. Decreasing labor cost by $26.33 (one standard deviation) per cow would increase the scale efficiency index by 0.0257, whereas a decrease in miscellaneous costs by $8.73 (one standard deviation) would increase scale efficiency by 0.0327.

Feed, capital, and miscellaneous expenses were negatively related to economic efficiency. Results suggested that decreasing each cost variable by one standard deviation (45.02, 31.80, and 8.73 respectively) would increase the predicted economic efficiency index by 0.0276, 0.0308, and 0.0287 respectively. Feed and capital expenses were the two most prominent expenses making up approximately 76.6 percent of the average total cost per cow, and therefore are arguably the most important cost categories to concentrate on in order to increase economic efficiency.

Four of the six cost categories were significantly negatively related to overall efficiency at the .01 level. Miscellaneous costs were estimated to have the largest negative impact with an estimated coefficient of -0.0037. Capital costs are also important, especially when one considers the magnitude of average capital costs per cow. Results suggest that decreasing capital expense by $31.80 (1 standard deviation) per cow would increase predicted overall efficiency by 0.031. Decreasing labor and feed costs by their respective standard deviations ($26.33 and $45.02) would increase overall efficiency by 0.021 and 0.022 respectively.

The Tobit elasticities relating the six cost categories to each of the five efficiency measures are reported in Table 6. Feed and miscellaneous costs (the only statistically significant cost categories impacting technical efficiency) had calculated elasticities of -0.2059 and -0.0742 respectively when considering their impact on technical efficiency. The Tobit elasticity calculations reveal that increasing labor cost by 1 percent would decrease scale efficiency by 0.0894 percent, and increasing miscellaneous costs by 1 percent would decrease scale efficiency by 0.0291 percent respectively. Calculated elasticities for cost factors impacting economic efficiency ranged from -0.2416 for the feed cost category to -0.0397 for the labor cost variable. A 1 percent increase in average labor cost, about $7.13 per cow, would decrease the overall efficiency measure by 0.1223 percent. The significant input cost category elasticities affecting overall efficiency ranged from -0.2442 for capital to -0.1051 for miscellaneous expense. These elasticities confirm that on average reducing input costs will improve both economic and overall efficiency of Kansas beef cow operations.

Table 6. Input Cost Tobit Elasticities

Variable	TE	AE	SE	EE	OE
			Elasticity		
Labor cost/cow	-0.0327	-0.0095	-0.0894***	-0.0397***	-0.1223***
Feed cost/cow	-0.2059***	0.0028	0.0338	-0.2416***	-0.2259***
Capital cost/cow	-0.0753	-0.1352***	-0.0235	-0.2191***	-0.2442***
Fuel cost/cow	-0.0004	-0.0155	-0.0183	-0.0142	-0.0293
Vet. cost/cow	-0.0039	0.0290**	-0.0032	0.0233	0.0193
Misc. cost/cow	-0.0742***	0.0036	-0.0291***	-0.0770***	-0.1051***

Note: One, two and three asterisks (*) indicate the variables the elasticities represent had a .10, .05%, .01 level of statistical significance respectively. There were 230 observations.

Due to the large variability in profits among the farms in the data set, the relationships between profit per cow and the various efficiency measures were examined using three separate OLS regression models as follows:

$$\Pi/cow = \beta_0 + \beta_1 te + \beta_2 ae + \beta_3 se + e_i$$

$$\Pi/cow = \beta_0 + \beta_1 ee + \beta_2 se + e_i$$

$$\Pi/cow = \beta_0 + \beta_1 oe + e_i$$

where Π/cow denotes profit on a per cow basis. The β_0 represents the intercept term and the β's are the estimated regression coefficients. The variables te, ae, and se represent technical, allocative and scale efficiency measures respectively. In this study, technical, allocative, and scale efficiency measures were expected to positively and significantly impact profit. Economic and overall efficiencies were also expected to positively impact profit, since they are products of the other efficiency measures.

Table 7 reports the results of regressing profits per cow on the various efficiency measures. Profitability in the data ranged from -$631.56 per cow to $156.60 per cow. All of the efficiency measures were found to be positively related to profits and significant at the 1% level. The results indicate that increasing technical, allocative, and scale or size efficiencies each by 0.1 would increase profitability per cow by about $23.89, $31.72 and $33.63 respectively. An increase in economic efficiency by the same index of 0.1 could increase profit per cow by about $30.67. Considering these estimated relationships and the fact that all efficiency measures were quite variable for the farms in this data set, increasing efficiency could potentially have a significant positive impact on the profitability of the farms in this study. The estimated regression coefficient for overall efficiency on profit per cow is 404.22. This indicates that if average overall efficiency increased by 0.1, for instance from 0.514 to 0.614, profitability per cow would increase by $40.42 per cow.

Table 7. **Regression Results From Examining the Relationship Between Profit per Cow and Efficiency.**

Variable	Dependent Variable		
	Profit/cow	Profit/cow	Profit/cow
Intercept	-369.96	-833.83	-638.92
	(32.57)	(106.17)	(306.66)
Overall	404.22	---	---
	(61.61)		
Technical	---	238.94	---
		(49.06)	
Allocative	---	317.22	---
		(75.28)	
Scale	---	336.26	342.99
		(71.81)	(71.67)
Economic	---	---	306.66
			(53.73)
R^2	0.1551	0.1740	0.1737

Note: All variables were statistically significant at the .01 level. Numbers in parentheses denote the standard errors. There were 230 observations in each regression.

Economies of size in cow-calf production

The following comparison reveals the 1998 average cow-calf financial information from the Kansas Farm Management Associations (the same information presented in aggregate earlier) broken down by cow herd size. A quick look at this summary reveals that larger cow-calf operations tend to have slightly lower variable costs per cow, significantly lower fixed costs per cow, but perhaps somewhat lower revenues per cow as well.

Empirical studies of economies of size in cow-calf production reveal varying degrees of size advantage. For example, research utilizing early SPA data (1991 - 1992) by Langemeier, McGrann, and Parker examined differences in costs of production among different cow-calf herd size groups. The size categories examined included the following herd sizes: 1-49, 50-99, 100-199, 200-299, 300-499, 500-999, and 1000+ cows. Both average economic cost of production and average financial cost of production were significantly correlated with herd size. The most competitive herd size group was found to be 500-999 cows. Farms in the two smallest herd size groupings had average economic costs of production that were 32 and 24% above the average economic cost of production for the 500-999 cow herd size group. However, when the herds were sorted by profitability quartiles, there were herds of all sizes in all four quartiles. Thus, there are some producers with smaller herds who are doing a good job of controlling costs.

State of Kansas economic comparison by size of beef cow herd, 1998

	Under 75 Cows	75-150 Cows	Over 150 Cows
Net Accrual Adjusted Revenue Per Cow	$336.69	$348.96	$320.75
Variable Costs Per Cow			
Labor Hired	2.74	7.67	11.99
Interest Paid	17.24	26.12	19.88
Machinery Repair	27.85	24.83	19.82
Feed	248.51	252.48	231.07
Machine Hire	1.24	1.19	4.93
Publications	4.54	5.43	2.70
Vet/Drugs	13.79	13.93	12.83
Marketing/Breeding	8.67	9.12	6.11
Gas/Fuel/Oil	7.82	9.24	8.02
Property Tax	1.29	1.28	0.83
Insurance	4.90	4.03	3.48
Utilities	8.54	6.57	5.30
Misc	2.40	1.28	1.19
Total Variable Cost	$349.54	$363.15	$328.16
Fixed Costs Per Cow	$159.60	$148.20	$114.35
Depreciation, Interest, Taxes, and Insurance on breeding stock, buildings, and equipment, and unpaid operator labor			

Figure 3 (on page 9) presents a scatter plot of the raw data utilized in the efficiency analysis discussed earlier. This graphical representation, sorted by size of the cow-calf operation, provides some insight regarding economies of size.

Clearly, if one were to fit a regression line through the set of points depicted in Figure 3 the line would slope downward, indicating that on average the larger producers tend to be lower cost producers. However, focusing on the minimum average cost frontier line shown in the figure suggests that moderate sized producers can compete with the larger producers from a cost standpoint.

Summary

One of the reasons for the loss of beef market share is that the retail price is higher than the price of competing meats and does increase relative to other meats in some time periods. Efficiencies are needed at all levels of the beef production system in order to address retail price

issues both in terms of level and how they are changing relative to the prices of competing meats. Feed, capital and labor comprise nearly 91 percent of the total average input costs per cow based on the data utilized in the empirical study reported in this paper. These three prominent input cost categories were found to be negatively related to overall efficiency, implying that on average Kansas beef-cow producers were over utilizing labor, feed, and capital inputs, resulting in relatively low productive efficiency measures. Consistent with findings from other studies, these results imply that focusing attention on better management of the three most prominent cost categories would significantly improve the efficiency measure and increase average profitability.

The calculated Tobit elasticities imply that capital inputs had the largest negative impact on overall efficiency. This finding is consistent with the conclusion reached by Harlan Hughes that cattle equipment and feed production equipment costs are dragging ranch profits down. As expected, profitability per cow was positively related to all five efficiency measures in the model. These results confirm that the low average profits were caused by the relatively low average efficiency measures, further illustrating the importance of being a low cost producer in the cow-calf business. While research based information comparing the cow-calf enterprise to other alternatives is limited, recent nonparametric efficiency studies of other enterprises suggest that on average the cow-calf enterprise is less efficient that many other traditional agricultural enterprises. McGrann has gone so far as to suggest that 90 percent of Texas cow-calf producers will not generate a true financial profit over the long run. The magnitude of inefficiency suggests that regardless of the marketing strategy pursued by the individual producer, cost management and cost efficient production should be a goal as decreasing costs is the most obvious way to improve profitability.

Even with above average production performance, high cost producers are at a competitive disadvantage. While there is some disagreement regarding the magnitude, on average there is clearly an indication of economies of size in cow-calf production. To remain in business in the long term, smaller operations will need to have costs of production that are similar to those of larger operations (Langemeier, McGrann, and Parker). Finally, even for the most cost efficient producers, the average return on investment in cow-calf production is such that beef cows will not generally support a lot of debt.

It is impossible for cow-calf producers to manage aspects of their operation that they do not measure, document, and evaluate. In order to better manage cost of production with the goal of improving profitability, producers need to evaluate their current production and financial situation and devise a plan for improvement. By the same token, if cow-calf producers are going to be paid the true value for the calves they produce, either when they are sold as feeders or if retained and finished, the producer will need to know how the cattle are likely to perform in the feedlot and in the packing plant. The key in either case is improved information. A list of information needs for improving profitability in cow-calf production would include, but not be limited to, the following examples.

- Cash accounting summary for preparation of tax information.
- Accrual adjusted balance sheet and detailed income statement allocated specifically to the

cow-calf enterprise.

- Inventories of resources used by the cow-calf enterprise, and inventories of cattle at critical production periods (breeding, calving, weaning, etc.).
- An annual production performance analysis summary consistent with SPA guidelines.
- An annual financial performance analysis summary consistent with SPA guidelines.
- A written list of production and financial changes to pursue.
- Individual cow genetic and production records to assist in culling decisions.
- Individual animal feedlot performance information that can be correlated back to the mother cow and sire. This information should include gains, feed conversions, and health information.
- Detailed kill sheet data for each individual carcass correlated back to the mother cow and sire. These data should include quality grade, yield grade, carcass weight, and any price premiums or discounts.

Many cow-calf producers will find that the benefits of acquiring, managing, and making production and marketing decisions based on more detailed information exceed the costs of that added information. After determining strengths and weaknesses, some producers will decide to be low cost commodity calf producers while others will strive to enhance the value of their production on a per-pound basis. One thing is certain--only those producers who are better than average at some aspect of production or marketing will be profitable in the long run. Those cow-calf producers who can acquire, interpret, and make management and marketing decisions based on more detailed financial, production, and product quality information will be in a better position to profit from this knowledge and are more likely to be the profitable producers in the long run.

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