MEASURING SCOPE EFFICIENCY FOR CROP AND BEEF FARMS

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Summary

This study evaluated scope efficiency (the degree of efficiency gained from producing more than one product within the same farm) for a sample of crop and beef farms in Kansas. Scope and economic efficiency were estimated for each individual farm. Average scope efficiency was 0.25, indicating that joint production of crop and beef enterprises on the same farm reduced cost approximately 25%. Scope efficiency was significantly higher for smaller farms. Despite the relatively higher scope efficiency levels, economic efficiency (relative cost efficiency) was significantly lower for smaller farms. Economic efficiency is related to cost control and economies of size, which are both positively related to farm size.

Introduction

Both the percentage of income from livestock and the percentage of farms with livestock income in Kansas have declined over the last 30 years. Although this decline has occurred for beef, swine, and dairy, the percentage decline is not nearly as large for beef as it is for swine and dairy. Moreover, the majority of farms still have a beef enterprise. In 2003, approximately 51% of the farms in Kansas had a beef enterprise (Kansas Agricultural Statistical Service). The existence of economies of scope or scope efficiency for a combination of crop and beef enterprises would help explain the persistence of this farm type in the Great Plains. Scope efficiency exists when the total cost of producing two enterprises together on the same farm is less than the total cost of producing the enterprises on separate farms.

This study explores scope efficiency for crop and beef enterprises. There are three potential sources of scope efficiency. First, a farm may be able to more effectively utilize labor in winter months if they produce both crop and beef enterprises. Second, a farm may be able to more effectively utilize machinery and equipment if they produce both crop and beef enterprises. Third, beef enterprises can often utilize wheat pasture or crop aftermath with little or no loss in crop revenue. The use of these items would reduce the total cost of producing both enterprises, and would thus be associated with economies of scope.

Experimental Procedures

Scope and economic efficiency were estimated by using linear programming. Scope efficiency compares the cost of producing individual outputs separately with the cost of producing outputs jointly. If scope efficiency is greater than zero,

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there is an advantage associated with producing crop and beef enterprises on the same farm. Conversely, if scope efficiency is less than zero, there is a disadvantage associated with producing crop and beef enterprises on the same farm. Scope efficiency could lead to improvements in economic efficiency. Economic efficiency measures a farm's ability to produce at the lowest possible cost for a given level of output or on the cost frontier. Economic efficiency indices vary between zero and one, with one representing an economically efficient farm.

Scope and economic efficiency estimates were summarized for several farm-size categories. Specifically, three measures of farm size were used: gross farm income, total acres, and pounds of beef produced. Gross farm income categories included farms with a gross farm income less than $100,000, farms with a gross farm income between $100,000 and $250,000, farms with a gross farm income between $250,000 and $500,000, and farms with a gross farm income in excess of $500,000. The mean and standard deviation of total acres were used to categorize farms into three categories: farms with total acres more than one standard deviation below the mean, farms with total acres that are between one standard deviation below the mean and one standard deviation above the mean, and farms with total acres more than one standard deviation above the mean. The mean and standard deviation of pounds of beef produced were also used to categorize farms by size. The standard deviation of pounds of beef produced was larger than the average pounds of beef produced, so there were only two categories: farms with pounds of beef produced up to one standard deviation above the mean and farms with pounds of beef produced greater than one standard above the mean.

To determine whether scope efficiency by farm size category was significantly different from zero, t-tests were used. Tests were also conducted to determine whether scope and economic efficiency differed across farm size categories. On the basis of previous research, average scope efficiency was expected to be significantly different from zero, scope efficiency was expected to be inversely related to farm size, and economic efficiency was expected to be positively related to farm size.

Efficiency estimates were obtained by using a sample of farms that were members of the Kansas Farm Management Association. To be included in the analysis, a farm had to have continuous whole-farm data over the 1994 to 2003 period, and be typed as a dryland crop farm, as an irrigated crop farm, as a beef cow farm, or as a mixed crop/beef farm. Table 1 contains summary information for the sample of farms. Information is summarized for all of the farms with crop and/or beef enterprises, and for beef farms or farms that produced at least some beef. It is important to note that most of the beef farms also produced crop enterprises and received income from government payments, crop insurance, custom work, and/or patronage dividends (these sources of income are summarized in the output labeled "other"). It is also important to note that 10-year averages of the outputs, inputs, and input prices were used in the estimation of scope and economic efficiency. Using 10-year averages reduces the impact of weather in a particular year on scope efficiency.

Production costs were divided into three categories. Labor costs included unpaid operator and family labor and hired labor. Average family living expenses were multiplied by the number of operators on the farm to obtain an opportunity charge for unpaid operator and family labor. Purchased-input costs included feed, seed, fertilizer, veterinarian expenses, marketing expenses, herbicide and insecticide, and crop insurance. Capital costs included depreciation, repairs, fuel and utilities, machine hire, property taxes, general insurance, and an opportunity charge on assets. The opportunity charge on assets included opportunity charges for purchased inputs, current crop and livestock inventories, breeding livestock, machinery and equipment, buildings, and land.

Data for all of the sample farms were used to estimate scope and economic efficiency. To effectively measure scope efficiency, farms with various enterprise combinations are needed. Given the focus of this paper, scope efficiency results discussed later are presented only for the farms with a beef enterprise (i.e., beef farms).

Results and Discussion

The average scope efficiency index was 0.25, indicating that joint production of beef and crop enterprises on the same farm reduced cost approximately 25%. The average economic efficiency index was 0.7884, indicating that, on average, farms could reduce cost by approximately 21% by producing at the lowest possible cost for a given level of output or on the cost frontier.

Table 2 presents scope and economic efficiency indices by farm size category. Scope efficiency was significantly higher for smaller farms. Farms with a gross farm income less than $100,000 had an average scope efficiency index of 0.4873. In contrast, farms with a gross farm income between $250,000 and $500,000 had an average scope efficiency index of 0.1311, and farms with a gross farm income more than $500,000 had an average scope efficiency index of 0.1392. Similarly, farms with above-average total acres or beef output also had significantly lower scope efficiency indices, compared with indices of farms with below-average total acres or beef output. Smaller farms clearly have strong incentives to produce crop and beef enterprises on their farm. This result is intuitively plausible. Smaller farms often have higher labor and capital costs per unit of output. Producing both crop and beef enterprises allows smaller farms to spread these overhead costs over more output. As farms become larger, overhead cost per unit of output can be effectively reduced by expanding crop acres, if the farm is a crop farm, or by expanding livestock units, if the farm is a livestock farm.

Despite the relatively higher scope efficiency levels, economic efficiency was significantly lower for smaller farms. Thus, even though scope efficiency helps improve the relative competitive position of smaller farms, these farms still have considerably higher per-unit costs, on average. These higher costs could be the result of technical or allocative inefficiency. Technical inefficiency is related to technology adoption, whereas allocative efficiency is related to the mix of inputs used. Smaller farms typically have larger off-farm incomes, which may enable them to

continue to produce even under a scenario in which they are relatively inefficient.

Although not shown in Table 2, many of the large farms had both crop and beef enterprises. Scope efficiency was relatively small for these farms, so there must be other reasons why the larger farms are diversifying. The larger farms may be diversifying to reduce risk and/or to gain multiproduct economies of scale. Investigating the reason the larger farms are diversifying is beyond the scope of this paper.

Given the results in this study, we would expect the crop/beef farm type to continue to be a common farm type. There are significant cost advantages associated with producing both crop and beef enterprises on the same farm. These cost advantages are particularly strong for smaller farms, which use diversification to reduce per-unit capital and labor costs.

Table 1. Summary statistics for a sample of crop and beef farms

Variable	Units	All Farms	Beef Farms
Number of farms		473	377
Outputs		-------- Mean (standard deviation) --------	
Small grains	bushels	16,279 (35,612)	15,617 (16,670)
Feed grains	bushels	31,187 (35,612)	27,410 (32,527)
Oilseeds	bushels	7,831 (11,082)	7,202 (10,608)
Hay and forage	tons	205 (412)	217 (419)
Beef	pounds	64,796 (109,817)	81,296 (117,447)
Other	dollars	47,227 (44,834)	45,396 (45,754)
Inputs			
Labor	number	1.39 (0.71)	1.42 (0.75)
Purchased inputs	implicit index	113,248 (102,936)	113,333 (107,358)
Capital	implicit index	125,151 (85,607)	124,525 (87,430)
Input prices			
Labor	dollars	34,028 (5,092)	33,711 (5,051)
Purchased inputs	index	1.0305 (0.0152)	1.0328 (0.0144)
Capital	index	1.0261 (0.0174)	1.0269 (0.0170)
Farm size			
Gross farm income	dollars	236,309 (181,548)	235,473 (187,485)
Total acres	number	1,833 (1,203)	1,930 (1,258)

Table 2. Scope and economic efficiency by farm size category

Farm Type	Number of Farms	Scope Efficiency	Economic Efficiency
Gross farm income			
Less than $100,000	79	0.4873*[a]	0.6804[a]
$100,000 to $250,000	170	0.2177*[b]	0.7796[b]
$250,000 to $500,000	101	0.1311*[c]	0.8547[c]
Greater than $500,000	27	0.1392*[c]	0.9124[d]
Total acres			
Less than 673	32	0.5280*[a]	0.6669[a]
673 to 3,188	293	0.2309*[b]	0.7859[b]
Greater than 3,188	52	0.1530*[c]	0.8775[c]
Beef output			
Less than 198,743 lb	341	0.2523*[a]	0.7745[a]
Greater than 198,743 lb	36	0.1792*[b]	0.9208[b]

*An asterisk indicates that the scope efficiency index was significantly different from zero at the 5% level.
[a,b,c]A different superscript within a column indicates that the indices are significantly different across size categories.