Cost Efficiency and Feed Grain Production in Kansas

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Abstract

This paper examined the relationship between cost efficiency and feed grain production in Kansas. Using data from 2002 to 2011, corn production was significant and positively related to cost efficiency in eastern and western Kansas, while grain sorghum production was significant and positively related to cost efficiency in central Kansas.

Introduction

Corn and grain sorghum production in Kansas have exhibited opposite trends in recent years. Using Kansas Farm Management Association data for non-irrigated farms, the percentage of harvested acres comprised of corn increased from 11.6 to 27.4 percent in eastern Kansas, from 1.2 to 8.6 percent in central Kansas, and from 1.5 to 22.6 percent in western Kansas from the 1981 to 1985 period to the 2006 to 2010 period (Langemeier, 2012). In contrast, the percentage of harvested acres comprised of grain sorghum declined from 17.1 to 3.0 percent in eastern Kansas, 21.1 to 15.7 percent in central Kansas, and from 17.0 to 16.1 percent in western Kansas during the same time periods (Langemeier, 2012). The declines in grain sorghum acreage have been particularly evident during the last ten years (Langemeier, 2012). Given the increase in corn acres and the decline in grain sorghum acres in recent years, it would be interesting to examine the relative cost efficiency of farms that grow one or both of these crops.

The primary objective of this paper is to examine the relationship between cost efficiency and feed grain production in Kansas. Due to differences in cropping systems across Kansas, the relationship is examined for the entire state, and for eastern, central, and western Kansas. In addition to feed grain production, cost efficiency is related to hay and forage production, oilseed production, wheat production, and livestock production.

Methods

Cost efficiency was estimated using data envelope analysis (Färe, Grosskopf and Lovell, 1985; Coelli et al., 2005). Cost efficiency measures the extent to which cost, under constant returns to scale technology, can be reduced and still maintain the same level of output.

Cost efficiency is computed for each farm by dividing minimum cost under constant returns to scale by actual cost:

$$\rho_i = C_i\,(w, y, T_C) \,/\, w_i' \, x_i \qquad (1)$$

where C_i represents minimum cost under constant returns to scale, w represents a vector of input prices, x represents a vector of inputs, y represents a vector of outputs, T_c represents technology under constant returns to scale, and i is the firm of interest. For cost efficient farms, $\rho_i = 1$.

Solution of equation (1) requires the computation of minimum cost under constant returns to scale, $C_i\,(w, y, T_c)$. This cost is computed using the following linear program:

$$\begin{aligned} & C_i\,(w, y, T_C) = \text{Min } w_i' \, x_i \\ & \text{subject to} \quad x_{11} z_1 + x_{12} z_2 + \cdots + x_{1k} z_k \le x_{1i} \\ & \qquad\qquad\quad \vdots \\ & \qquad\qquad\quad x_{n1} z_1 + x_{n2} z_2 + \cdots + x_{nk} z_k \le x_{ni} \\ & \qquad\qquad\quad y_{11} z_1 + y_{12} z_2 + \cdots + y_{1k} z_k - y_{1i} \ge 0 \qquad (2) \\ & \qquad\qquad\quad \vdots \\ & \qquad\qquad\quad y_{m1} z_1 + y_{m2} z_2 + \cdots + y_{mk} z_k - y_{mi} \ge 0 \end{aligned}$$

where k is the number of farms, n is the number of inputs, m is the number of outputs, and z is an input intensity vector which relates to the weighting of each farm in the formation of the cost frontier ($z_i \ge 0$).

Equation (2) depicts the general case with n inputs and m outputs. In this paper, two outputs and five inputs are used to compute cost efficiency for each farm. Outputs include crop and livestock production, which are created by dividing income by price indices. Inputs are divided into five categories: labor, crop inputs, fuel and utilities, livestock inputs, and capital. The outputs and inputs are described in more detail below.

To analyze differences among farms, gross farm income and income sources are summarized by cost efficiency quartiles. Regressions are also used to examine the relationship between cost efficiency, and gross farm income, and crop and livestock income sources. Figures are used to depict the relationship between cost efficiency and the percentage of income derived from feed grains in eastern and central Kansas, the two regions with the largest shifts in feed grain income sources.

Data

The data for this study were obtained from the Kansas Farm Management Association databank (Langemeier, 2010). Farms represented in this databank are members of the Kansas Farm Management Association and generally provide the association with annual data. To be included in this study, a farm had to have ten years of continuous, usable data for the 2002 to 2011 period.

As noted above, two outputs and five inputs were used in the analysis. Outputs included crop and livestock. Implicit crop and livestock quantities were computed by dividing crop income and livestock income by Kansas crop price and livestock price indices (USDA-NASS). Government payments and crop insurance proceeds are included in crop income. Input categories included the following: labor, crop input, fuel, livestock input, and capital. All costs were annualized. Labor was represented by the number of workers (paid and unpaid) on the farm and labor price was obtained by dividing labor cost by the number of workers. Implicit input quantities for the crop input, fuel, the livestock input, and capital were computed by dividing the respective input costs by input price indices (USDA-NASS). Crop inputs consisted of seed; fertilizer; herbicide and insecticide; crop marketing and storage; and crop insurance. Fuel was comprised of fuel, auto expense, irrigation energy, and utilities. Livestock inputs included dairy expense; purchased feed; veterinarian expense; and livestock marketing and breeding. The capital input included repairs; machine hire; general farm insurance; property taxes; organization fees, publications, and travel; conservation; interest; cash farm rent; and interest charge on net worth (Langemeier, 2010).

Table 1 contains the summary statistics for gross farm income and percentage of income derived from crop and livestock production. Gross farm income over the study period averaged $385,493. The average percentage of income derived from corn and grain sorghum production was 14.7 and 6.5 percent, respectively. The average percentage of income derived from corn ranged from 7.6 percent in central Kansas to 18.9 percent in eastern Kansas while the average percentage of income derived from grain sorghum ranged from 2.3 percent in eastern Kansas to 11.4 percent in central Kansas.

Results

Table 2 presents the summary statistics by cost efficiency quartile. It is important to note that average cost efficiency was 0.665. Three farms were cost efficient (i.e., had a cost efficiency index of one). Cost efficiency for the first (bottom) and fourth (top) cost efficiency quartiles averaged 0.479 and 0.824, respectively. Cost efficiency for the top cost efficiency quartile ranged from 0.761 to 1.000.

Gross farm income and the percentage of income from corn were significantly higher for the top cost efficiency group than they were for the bottom cost efficiency group. The percentage of income from hay and forage and the percentage of income from wheat, on the other hand, were significantly lower for the top cost efficiency quartile. The percentages of income from grain sorghum, oilseeds, and livestock production were similar across cost efficiency quartiles.

Regression results relating cost efficiency and gross farm income and the percentage of income from crop and livestock production were generated for the state and for eastern, central, and western Kansas. The elasticities derived from these regressions are presented in Table 3. The asterisks in Table 3 indicate the significance of the underlying regression coefficients used to compute the elasticities.

Not surprisingly, gross farm income was significant and positively related to cost efficiency for the state and for each region in the state. These results point to the importance of economies of size during the time period. Also, interestingly, both corn income and grain sorghum income were significantly related to cost efficiency at the state level. Wheat income as well as hay and forage income, on the other hand, were negatively related to cost efficiency at the state level.

There were several differences in the results across regions in Kansas. The percentage of income from corn was significant and positively related to cost efficiency for eastern and western Kansas, but not for central Kansas. For central Kansas, the percentage of income from grain sorghum was significant and positively related to cost efficiency. This result was not found for eastern or western Kansas. The percentage of income from hay and forage, and oilseed production were significant and negatively related to cost efficiency for eastern Kansas.

Given the importance of corn production to eastern Kansas and grain sorghum production to central Kansas, the relationship between cost efficiency and feed grain production for these two regions warrants further discussion. Figure 1 presents the relationship between cost efficiency and percentage of income from corn for northeast and southeast

Kansas. Figure 2 presents the relationship between cost efficiency and percentage of income from grain sorghum for north central and south central Kansas. Though there is a substantial amount of variability in efficiency for a given percentage of income derived from corn in eastern Kansas and grain sorghum in central Kansas, there does appear to be a positive relationship between cost efficiency and the percentage of gross farm income derived from corn in Figure 1 and between cost efficiency and the percentage of gross farm income derived from grain sorghum in Figure 2. To further examine these relationships, correlation coefficients were computed. The correlation coefficient between cost efficiency and the percentage of income derived from corn was 0.308 for northeast Kansas and 0.374 for southeast Kansas. Both of these correlation coefficients were statistically significant at the 1 percent level. For north central and south central Kansas, the correlation coefficients between cost efficiency and the percentage of income derived from grain sorghum were 0.235 and 0.161, respectively. The coefficient for north central Kansas was significant at the 1 percent level while the coefficient for south central Kansas was significant at the 10 percent level.

Summary and Implications

Corn and grain sorghum production in Kansas have exhibited opposite trends in recent years. Specifically, corn acreage has been increasing and grain sorghum acreage has been declining. Data envelope analysis was used in this paper to determine whether corn and grain sorghum production were significantly related to cost efficiency during the 2002 to 2011 period. Corn income was significant and positively related to cost efficiency in eastern and western Kansas, while grain sorghum income was significant and positively related to cost efficiency in central Kansas. Unlike the results for hay and forage, oilseed, and wheat production; neither one of the feed grain income sources were negatively related to cost efficiency for a given region. These results are consistent with the increase in feed grain production exhibited on Kansas farms in the last few years.

Results of this study have important implications for feed grain production in Kansas. First, at the state level, both corn income and grain sorghum income were positively related to cost efficiency indicating the importance of both crops to Kansas agriculture. Second, the positive relationships between cost efficiency and corn income in eastern and western Kansas suggest that corn production is likely to continue its expansion in these areas. Third, the positive relationship between cost efficiency and grain sorghum income in central Kansas, the only region of the state where grain sorghum represents a higher percentage of gross farm income than corn, suggests that grain sorghum is likely to remain an important crop in this area of Kansas. Finally, despite the positive relationships between cost efficiency and feed grain production, there are numerous farms that need to produce these crops, as well as other crops, more efficiently. Increasing efficiency on the relatively inefficient farms would lead to higher production and improved profits on these farms.

References

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Table 1. Summary Statistics for KFMA Farms, 2002 to 2011 Data.

Variable	Kansas	East	Central	West
Number of Farms	649	341	240	68
Gross Farm Income	385,493	395,817	360,926	420,430
Percentage of Income from Corn	14.73%	18.91%	7.63%	18.85%
Percentage of Income from Grain Sorghum	6.52%	2.34%	11.42%	10.19%
Percentage of Income from Hay and Forage	3.79%	3.36%	4.53%	3.28%
Percentage of Income from Oilseeds	19.79%	28.00%	12.66%	3.76%
Percentage of Income from Wheat	18.29%	7.24%	30.66%	30.06%
Percentage of Income from Livestock Production	21.06%	25.75%	16.78%	12.66%

Source: Kansas Farm Management Association Databank, 2011.

Table 2. Summary Statistics for Cost Efficiency Quartiles.

Variable	First	Second	Third	Fourth
Gross Farm Income	142,939	290,701	459,655	651,219
Percentage of Income from Corn	8.35%	12.16%	17.00%	21.48%
Percentage of Income from Grain Sorghum	6.10%	6.86%	6.58%	6.53%
Percentage of Income from Hay and Forage	5.13%	4.42%	3.61%	1.97%
Percentage of Income from Oilseeds	19.15%	19.25%	21.11%	19.67%
Percentage of Income from Wheat	21.46%	20.34%	16.44%	14.87%
Percentage of Income from Livestock Production	24.26%	21.19%	19.14%	19.61%
Cost Efficiency Index	0.4787	0.6359	0.7221	0.8235

Table 3. Elasticities for Cost Efficiency Regressions.

Variable	Kansas	East	Central	West
Gross Farm Income	0.104***	0.099***	0.149***	0.052**
Percentage of Income from Corn	0.045***	0.057**	0.014	0.094*
Percentage of Income from Grain Sorghum	0.035***	-0.004	0.092***	0.035
Percentage of Income from Hay and Forage	-0.008*	-0.015**	-0.001	0.000
Percentage of Income from Oilseeds	-0.026	-0.077**	0.015	0.025
Percentage of Income from Wheat	-0.032*	0.003	-0.057	0.040
Percentage of Income from Livestock Production	0.005	-0.019	0.034	0.033

Asterisks indicate that coefficients used to compute elasticities were significant at the 1% level (***), 5% level (**), or 10% level (*).

Figure 1. Cost Efficiency and Percentage of Income from Corn, Eastern Kansas.

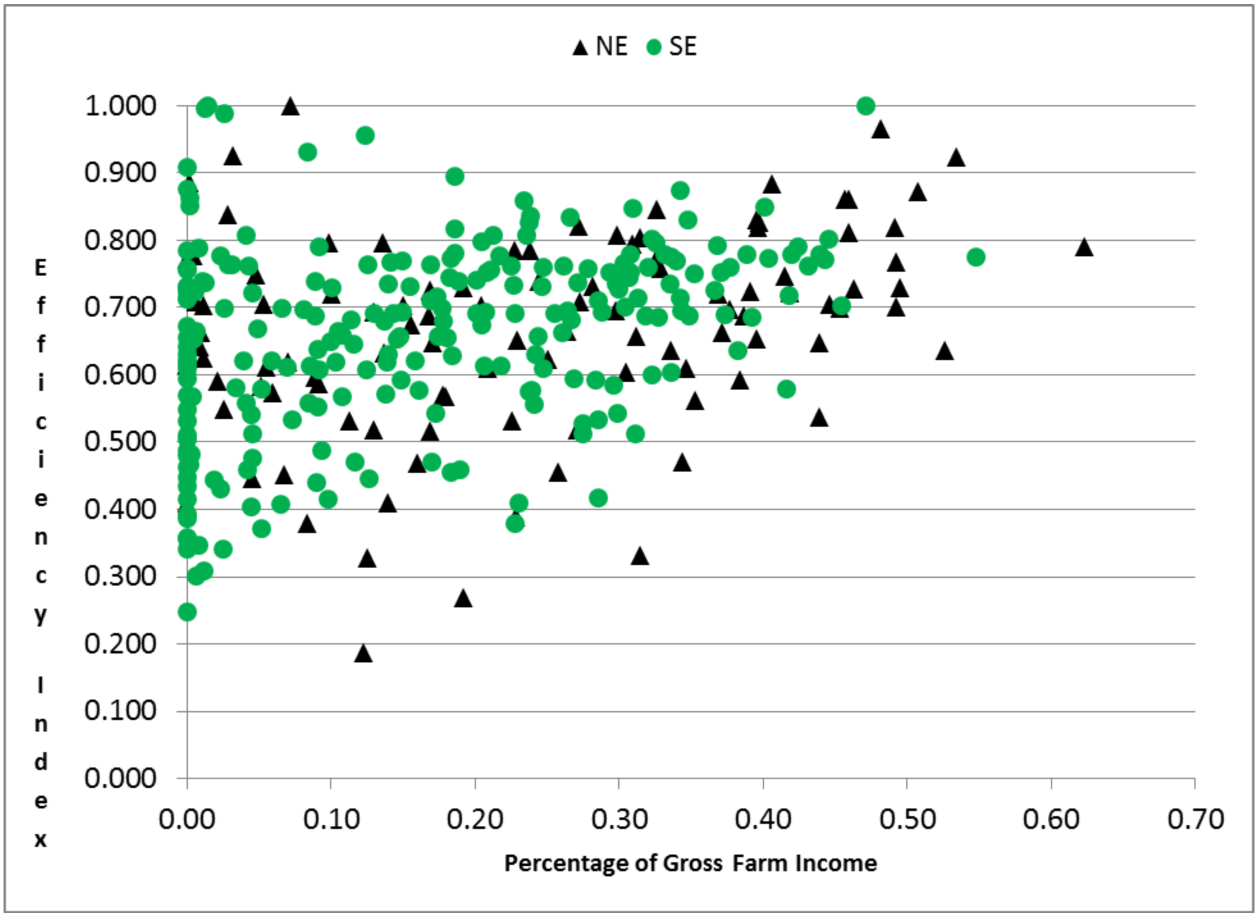

Figure 2. Cost Efficiency and Percentage of Income from Grain Sorghum, Central Kansas.