An Examination of the Relationship Between Overall Efficiency and Farm Experience

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Abstract

This paper examines the relationship between overall efficiency and years of farm experience for a sample of Kansas farms. In addition to years of farm experience, overall efficiency is significantly related to farm size, percent of time devoted to farming, and percent acres owned.

Introduction

Previous research has focused on the relationship between efficiency, and farm size and type. Economic research that has examined the learning curve suggests that experience can also have a large impact on per unit cost which is directly related to overall or cost efficiency. Research related to the learning curve reveals a positive relationship between firm experience and per unit costs (Mansfield et al., 2002). This research has primarily examined per unit cost for manufacturing corporations. The relationship between efficiency and experience of farm operators, particularly sole proprietors, is more difficult to predict for a couple of reasons. First, well managed farms with younger operators are often growing rapidly so experience is often related to farm size which is in turn positively related to overall efficiency. Second, many older farm operators may be hesitant to adopt new technologies and may actually be starting to downsize their operations. Thus, farm experience could be positively or negatively related to overall efficiency.

The primary objective of this paper was to examine the relationship between overall efficiency and years of farm experience for a sample of Kansas farms. The paper also explores the relative importance of farm size, farm type, percent of time devoted to farming, formal education, a farm's record keeping system, and percent acres owned in explaining differences in overall efficiency among farms.

Methods

Overall efficiency was computed for each farm using linear programming (Fare, Grosskopf, and Lovell, 1985; Chavas and Aliber, 1993; and Coelli, Rao, and Battese, 1998). Farms that are overall efficient are producing on the cost frontier and at the most efficient scale of operation. More specifically, an overall efficient farm is producing at the lowest cost per unit of output.

Overall efficiency estimates for each farm were summarized in two ways. First, farms were sorted by their level of overall efficiency to develop the quartiles. The average level of the farm characteristics was then computed for each overall efficient quartile. Farm characteristics and overall efficiency levels were subsequently compared across quartiles. Second, Ordinary Least Squares regression was used to explore the relationship between inefficiency and several farm characteristics. While overall efficiency is a useful benchmark that can be used by individual farms (Siems and Barr, 1998), it is also of interest to examine how specific farm characteristics impact efficiency differences among farms. Inefficiency is used as the dependent variable in the regression analysis so that factors that are contributing to efficiency problems could be identified.

Previous research by Tauer (1993); Ford and Shonkwiler (1994); Purdy, Langemeier, and Featherstone (1997); Rougoor et al. (1998); Mishra, El-Osta, and Johnson (1999); and Gloy, Hyde, and LaDue (2002) was used to develop the list of farm characteristics that were related overall efficiency in this study. Using previous research as a guide, the following relationship was explored:

(1) IE = f(GFI, EXP, TIME, EDU, REC, POWN, ORG, TYPE)

where IE is overall inefficiency, GFI is gross farm income, EXP is years of farm experience, TIME is percent of time devoted to farming, EDU is educational level, REC is record keeping system, POWN is percent acres owned, ORG is organizational type, and TYPE is farm type.

As mentioned previously, the relationship between inefficiency and farm experience could be negative or positive. A negative relationship would suggest that more experienced operators are more efficient. This result would be consistent with learning curve studies (Mansfield et al., 2002). A positive relationship would indicate that experienced operators may have slowed down the growth of their farms and may not be adopting new technologies.

Using previous research results, a negative relationship is expected between inefficiency and gross farm income, percent of time devoted to farming, and educational level. A negative relationship between inefficiency and gross farm income would be indicative of economies of size. Farm operators that devoted a larger proportion of their time to the farm operation and with higher levels of education were expected to be more efficient or less inefficient.

The record keeping system variable signifies whether a farm uses a manual record book or some computerized system. Farms with a computerized record keeping system would be expected to be relatively less inefficient.

The relationship between inefficiency and percent acres owned could be positive or negative. A positive relationship would suggest that farms that own a relatively higher proportion of their land are relatively inefficient. Conversely, a negative relationship would suggest that farms that own a relatively higher proportion of their land are relatively more efficient. Purdy, Langemeier, and Featherstone (1997) and Gloy, Hyde, and LaDue (2002) found a negative relationship between financial performance and percent acres owned. If this result holds in the present study, there will be a positive relationship between inefficiency and percent acres owned.

Data

Table 1 presents the average and standard deviation of the variables used to compute overall efficiency, and to explore the relationship between inefficiency and specific farm characteristics. The data in table 1 was obtained from two sources. The first source was the Kansas Farm Management Association databank. This source provided financial and production data for the members of the Kansas Farm Management Association (KFMA) for the 1999-2001 period. Specifically, gross farm income, input information, percent acres owned, organizational type, and farm type information was obtained from the KFMA databank. The second source was a survey of the KFMA members that was conducted in the winter of 2000. Approximately 650 of the 2,700 KFMA members completed the survey. Specific variables obtained from this survey included years of farm experience, percent of time devoted to farming, educational level, and record keeping system. The survey data was combined with the KFMA data for 1999-2001. Three years of KFMA data were used in this paper to help mitigate problems associated with estimating efficiency for a single year (Cotton, Langemeier, and Featherstone, 1998-99). After combining the two sources, data were available for 516 farms.

Efficiency estimation required information on economic costs, output, inputs, and input prices. All income and expense items used in this study were computed on an accrual basis and were converted to 2001 dollars using the implicit price deflator for personal consumption expenditures (U.S. Department of Commerce). Economic cost was computed by summing cash costs, depreciation, an opportunity charge on unpaid labor, and an opportunity charge on assets. Unpaid labor included operator and family labor. The opportunity charge on assets included opportunity charges for purchased inputs, current crop and livestock inventories, breeding livestock, machinery and equipment, buildings, and land.

Output was measured using gross farm income. Ideally, output should be measured in units rather than dollars. If revenue and price information is available by enterprise, it is possible to develop an implicit output index. Given the diversity of the enterprises found in the sample farms and the lack of detailed revenue information, it was not possible to compute an implicit output index in this study. Average gross farm income for the sample of farms was $266,114.

The average input levels and input prices are reported in table 1. Three inputs were used in the analysis: labor, purchased inputs, and capital. Labor was represented by the number of workers (paid and unpaid) on the farm. Labor price was obtained by dividing labor cost by the number of workers. The purchased input and capital values in table 1 represent indices rather than specific quantities or dollar amounts. Purchased inputs included machinery and building repairs, feed, seed, fertilizer and lime, machine hire, organization fees, veterinary supplies, crop storage, crop and livestock marketing, fuel and utilities, personal property taxes, insurance, herbicide and insecticide, conservation, and auto expense. The purchased input index for each farm was computed by dividing purchased input cost by a USDA price index for purchased inputs. Capital included interest charges, depreciation, rent charges, real estate taxes, and cash farm rent. The capital input index for each farm was computed by dividing capital cost by a USDA price index for interest charges.

Years of farm experience was computed using information related to the year in which the primary operator started farming. On average, the operators in this sample had approximately 29 years of experience. Most of farms spent a majority of their time farming. On average, 90% of the primary operator's time was devoted to farming. The average number of years of formal education was 14 indicating that on average the primary operator had at least some college education. On average, the farms owned approximately 36% of the acres farmed.

The record keeping system, organization type, and farm type variables in table 1 represent dummy variables. Since the KFMA manual account book was the most common record system used, it was given a value of one for a farm that used this system. Any other record keeping system was assigned a zero value for that farm. On average, approximately 62% of the farms used the KFMA manual account book. The organizational type variable was given a one for farms that were sole proprietors and zero for farms that were organized as a partnership or corporation. Approximately 84% of the farms were organized as sole proprietors. The farm type variables presented in table 1 were used to identify specialized farms. If over one-half of an individual farm's gross farm income came from one of the enterprises depicted in table 1, that farm was classified as a specialized farm. Many of the farms were quite diversified and thus were not classified as one of the specific farm types depicted in table 1.

Results

Overall efficiency averaged 0.678. Inefficiency is computed by subtracting the overall efficiency index for each farm from 1.000. Inefficiency averaged 0.322. Using this level of inefficiency, cost per unit would be 32.2% lower, on average, if all of the farms were overall efficient.

Table 2 contains a summary of output, inputs, and farm characteristics by overall efficiency quartile. Discussion of table 2 will focus on the variables that were significant in the regression discussed below. The top quartile farms had an average overall efficiency index of 0.832. Average gross farm income for the top quartile was $447,396. This group of farms had approximately 24 years of farm experience, devoted 96% of their time to farming, and owned 29% of their acres. The bottom quartile farms had an average overall efficiency index of only 0.499. Using this value, per unit costs are approximately double for this group compared to what they would be if all of the farms in the group were overall efficient or produced on the cost frontier. Average gross farm income for the bottom quartile was $90,765. This group of farms had approximately 35 years of experience, devoted 79% of their time to farming, and owned 52% of their acres.

The regression results are reported in table 3. Gross farm income and percent of time devoted to farming were significant and negatively related to inefficiency. Years of farm experience and percent acres owned were significant and positively related to inefficiency. The remaining variables were not significantly related to inefficiency. The average level of inefficiency computed using the regression coefficients and variable means was 0.326 which is quite close to the actual average level of inefficiency.

The sensitivity of inefficiency to changes in gross farm income, years of farm experience, percent of time devoted to farming, and percent acres owned was explored by examining the impact on inefficiency resulting from a discrete change in each variable while holding all of the other variables constant. A one standard deviation increase in gross farm income (changing gross farm income from $266,114 to $536,549), while holding the other independent variables constant, would result in a 0.055 decrease in inefficiency. A one standard deviation increase in years of farm experience (changing years of farm experience from 28.93 to 41.17), while holding the other independent variables constant, would result in a 0.035 increase in inefficiency. If the percent of time devoted to farming was increased to 100%, inefficiency would decrease by 0.017. Finally, a one standard deviation increase in percent acres owned would increase inefficiency by 0.024. The results above indicate that inefficiency is quite sensitive to changes in any of the four significant variables. The relatively large change associated with gross farm income suggests that there are strong economies of size in the sample of farms.

Summary

Results from studies that have examined the importance of the learning curve and firm experience in producing specific products have found significant declines in per unit cost as experience increases. This result may not hold in production agriculture. Most farms are operated by sole proprietors. As a sole proprietor reaches retirement age, he or she may be hesitant to expand their operation or adopt new technologies. This is particularly true for farms that will not be passed on to the next operation.

The objective this paper was to explore the relationship between overall efficiency and years of farm experience. The study also examined the relationship between overall efficiency, and farm size, percent of time devoted to farming, educational level, record keeping system, percent acres owned, organization type, and farm type.

Years of farm experience was found to be negatively related to inefficiency. Thus, less experienced operators were more overall efficient. It is important to note that most of the farms in the sample were quite experienced. The average years of farm experience for the sample of farms was approximately 29 years. Farms in the top quartile in terms of overall efficiency had an average experience level of 24 years. In contrast, farms in the bottom quartile had an average experience level of 35 years.

Inefficiency was negatively related to gross farm income, the measure of farm size used in this study, and positively related to percent of time devoted to farming and percent acres owned. The negative relationship between inefficiency and farm size indicates the importance of economies of size for the sample of farms examined. It is important to note that inefficiency was not significantly related to farm specialization.

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Table 1. Financial and Production Characteristics of a Sample of Kansas Farms.

Variable	Average	Std. Dev.
Gross Farm Income	266,114	270,435
Labor	1.56	1.31
Purchased Inputs	149,635	157,677
Capital	81,360	69,407
Labor Price	33,033	5,178
Purchased Input Price	0.984	0.000
Capital Price	1.074	0.000
Years of Farm Experience	28.93	12.24
Percent of Time Devoted to Farming	89.92%	20.01%
Educational Level	14.11	2.02
Record Keeping System	0.617	0.486
Percent Acres Owned	36.32%	29.80%
Organizational Type	0.843	0.364
Beef Farm Type	0.178	0.383
Swine Farm Type	0.023	0.151
Dairy Farm Type	0.035	0.184
Wheat Farm Type	0.103	0.304
Corn Farm Type	0.056	0.231
Sorghum Farm Type	0.006	0.076
Soybean Farm Type	0.025	0.157
Hay Farm Type	0.021	0.145

Table 2. Financial and Production Characteristics by Overall Efficiency Quartile.

Variable	First	Second	Third	Fourth
Gross Farm Income	447,396	302,705	223,589	90,765
Labor	1.95	1.67	1.57	1.04
Purchased Inputs	238,445	170,952	132,875	56,268
Capital	111,635	92,089	78,180	43,536
Labor Price	34,351	32,643	32,410	32,729
Purchased Input Price	0.984	0.984	0.984	0.984
Capital Price	1.074	1.074	1.074	1.074
Years of Farm Experience	24.41	27.69	29.02	34.60
Percent of Time Devoted to Farming	96.14%	94.73%	89.60%	79.19%
Educational Level	14.10	14.32	14.19	13.85
Record Keeping System	0.553	0.527	0.612	0.775
Percent Acres Owned	28.89%	29.53%	35.13%	51.72%
Organizational Type	0.783	0.822	0.853	0.915
Beef Farm Type	0.140	0.155	0.186	0.233
Swine Farm Type	0.054	0.031	0.008	0.000
Dairy Farm Type	0.023	0.054	0.047	0.016
Wheat Farm Type	0.062	0.093	0.116	0.140
Corn Farm Type	0.109	0.008	0.008	0.031
Sorghum Farm Type	0.000	0.000	0.000	0.023
Soybean Farm Type	0.016	0.016	0.008	0.062
Hay Farm Type	0.023	0.008	0.039	0.016
Overall Efficiency	0.832	0.730	0.649	0.499
Overall Inefficiency	0.168	0.270	0.351	0.501

Table 3. Relationship Between Inefficiency and Farm Characteristics.

Variable	Parameter Estimate	t-value	Significance Level
Intercept	0.3771	8.63	< 0.0001
Gross Farm Income	-2.03E-07	-10.04	< 0.0001
Years of Farm Experience	0.0029	6.55	< 0.0001
Percent of Time Devoted to Farming	-0.0017	-7.23	< 0.0001
Educational Level	0.0032	1.38	0.1692
Record Keeping System	-0.0048	-0.48	0.6296
Percent Acres Owned	0.0008	4.51	< 0.0001
Organizational Type	-0.0005	-0.04	0.9712
Beef Farm Type	0.0078	0.61	0.5398
Swine Farm Type	0.0490	1.50	0.1341
Dairy Farm Type	0.0171	0.69	0.4936
Wheat Farm Type	-0.0099	-0.62	0.5340
Corn Farm Type	-0.0327	-1.63	0.1045
Sorghum Farm Type	0.0185	0.31	0.7598
Soybean Farm Type	0.0200	0.68	0.4964
Hay Farm Type	0.0025	0.08	0.9359
R-Square	0.4290		