Impact of Farm Size and Type on Competitive Advantage

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Abstract

This study examined sustained competitive advantage for a sample of Kansas farms. Whole-farm data for 224 farms with continuous data from 1982-2001 were used. Overall efficiency was computed for each farm and year. Sixty farms exhibited significantly above average overall efficiency levels (top category) or had a competitive advantage. Seventy-six farms exhibited significantly below average overall efficiency levels (bottom category) or had a competitive disadvantage. Farms in the top category were significantly larger, received relatively more of their gross farm income from dairy and swine production, had significantly lower expense ratios, and had significantly higher profit margins.

Key Words: Competitive Advantage, Overall Efficiency, Resource-Based Theory

Introduction

In the neoclassical theory of the firm, competition tends to homogenize firms. Opportunities that result in profit are sought by others, and inputs and skills that are used to create an advantage are bid up in price or imitated. Thus, the classical picture of an industry is that of a group of firms, homogeneous except for scale. However, firms within an industry are often not homogeneous. For example, in production agriculture, outputs produced, inputs utilized, and firm performance vary greatly. Moreover, it is a widely established fact that profitability and per-unit costs vary significantly among farms and ranches (Babcock; Fox, Bergen, and Dickson). Are these per-unit cost differences due to random events such as weather or are these differences due to controllable factors such as managerial ability? If they are due to managerial ability, farms with a sustained competitive advantage or disadvantage should be relatively plentiful.

There are several dynamic competition theories that can be used to examine sustained competitive advantage (Ellig and Lin; Hunt). One of the most widely discussed theories that can be used to examine sustained competitive advantage is resource-based theory of the firm (Barney; Hunt). Two of the fundamental axioms of resource-based theory are the heterogeneity of resources among firms and imperfect mobility. Resource heterogeneity suggests that every firm has at least some resources that are unique. Imperfect mobility reflects the fact that some resources are difficult to imitate or purchase. Identifying and utilizing unique resources that are difficult for other firms to obtain is a key component of sustaining a firm's competitive advantage. Two of the telltale signs of competition under resource-based theory of the firm are heterogeneous firms and firms with above average performance (Hunt).

Previous research that examines sustained competitive advantage or persistence in agricultural and non-agricultural firm performance over time is lacking. The agricultural economics literature has focused on characteristics of successful farms rather than sustained competitive advantage (success over time). Studies that have examined farm success include Ford and Shonkwiler; Hadan and Johnson; Kauffman and Tauer; Mishra and Morehart; Plumley and Hornbaker; Purdy, Langemeier, and Featherstone; and Sonka, Hornbaker, and Hudson. None of these studies focused on maintaining success or sustaining a competitive advantage over time.

Hunt summarizes previous non-agricultural literature that has examined the impact of firm effects on performance. He notes that neoclassical theory predicts that industry effects (e.g., market power) should dominate firm effects. Conversely, resource-based theory suggests that firm effects are important determinants of firm performance. Mauri and Michaels; McGahan and Porter; Roquebert, Phillips, and Westfall; and Rumelt found firm effects to be important determinants of firm performance. None of these studies, however, focused on persistence in performance or sustained competitive advantage. Research that focuses on sustained competitive advantage of individual firms is critical to the examination of the applicability of dynamic competition theories.

This study fills the gap in the existing literature by examining sustained competitive advantage for a sample of Kansas farms. Overall efficiency measures are computed per farm and year. Farm characteristics of the group of farms with above average overall efficiency levels are then compared to those of the group of farms with below average overall efficiency levels. This study makes two contributions to the existing literature. First, this study clearly quantifies the extent to which a sample of farms exhibit competitive advantage and disadvantage. In the process, the characteristics of farms with a sustained competitive advantage will be documented and the impact of the competitive advantage on financial performance and cost control will be measured. Second, this study provides an indirect method of examining the relevance of dynamic competition theories.

Methods

The nonparametric efficiency approach developed by Fare, Grosskopf, and Lovell was used to estimate technical, allocative, and scale efficiency for each farm in each year. Annual observations for each farm were used to compute the efficiency measures in each year. Thus, an individual farm's efficiency in a particular year was measured relative to the efficiency of other farms in that particular year. Technical efficiency measures whether a farm is producing on the production frontier. Allocative efficiency measures whether a farm is using the optimal mix of inputs. Scale efficiency measures whether a farm is producing at the most efficient size. Overall efficiency represents the product of technical, allocative, and scale efficiency. Overall efficient farms have the lowest per unit cost of production.

Technical efficiency under variable returns to scale (VRS) is computed by solving the following linear program for each observation or farm:

$$\text{Min } TE_j = \Theta_j \qquad (1)$$

subject to:

$$Xz \le \Theta_j x_j$$

$$y'z \ge y_j$$

$$z_1 + z_2 + \ldots + z_n = 1$$

$z_j \in \Re^+$

where Θ_j, a scaling variable used to adjust an input bundle to efficient scale for a fixed output level, represents technical efficiency for the j^{th} farm; X is a matrix of input levels for each farm; x_j is the j^{th} farm's input levels; z represents a column vector of variable weights; y is a column vector of fixed output levels; and y_j is output for the j^{th} farm.

Allocative efficiency (AE_j) indices are computed using the following equation:

$$AE_j = (CM_j^{\,v})/(C_j \ TE_j) \qquad (2)$$

where C_j is the actual cost of production for the j^{th} farm and CM_j^v is minimum cost to produce y_j under VRS. CM_j^v is derived by solving the following linear program for each farm:

$$\text{Min } CM_j^v = w_j' \, \bar{x}_j \qquad (3)$$

subject to:

$$Xz \leq \bar{x}_j$$

$$y'z \geq y_j$$

$$z_1 + z_2 + ... + z_n = 1$$

$$z_j \in \Re^+$$

where w_j is a column vector of input prices paid by the j^{th} farm, and $\bar{x}_j$ is a cost minimizing input bundle for the j^{th} farm. VRS is imposed by constraining the sum of z's (z-sum) to equal one. Other scale assumptions are imposed by altering the z-sum constraint. Under constant returns to scale (CRS) z-sum is unconstrained. Under decreasing returns to scale (DRS) z-sum is less than or equal to one, and under increasing returns to scale (IRS) z-sum is greater than or equal to one.

Scale efficiency (SE_j) measures are calculated by minimizing total cost under CRS and scaling the result using minimum cost when VRS is assumed:

$$SE_j = CM_j^c / CM_j^v \quad (4)$$

Minimum cost under CRS, CM_j^c, is obtained using model (3) with z-sum unconstrained.

Overall efficiency (OE_j) is the product of TE, AE, and SE:

$$OE_j = TE_j \times AE_j \times SE_j \quad (5)$$

Individual farm overall efficiency estimates over the 20-year period were used to separate farms into three categories: those with significantly above average overall efficiency (top category), those with overall efficiency that was insignificantly different from average, and those with significantly below average overall efficiency (bottom category). The characteristics of the farms in the top and bottom overall efficiency categories were compared. Farm characteristics compared included farm size, farm type, and financial performance. Farm size was measured using gross farm income. If economies of scale are prevalent, the farms with a competitive advantage will be on average larger than the farms with a competitive disadvantage. In addition to comparing gross farm income among overall efficiency categories, the percentage of farms in each of the following size categories was compared: gross farm income below \$100,000 (GFI1), gross farm income between \$100,000 and \$250,000 (GFI2), gross farm income between \$250,000 and \$500,000 (GFI3), and gross farm income above \$500,000 (GFI4). The percentage of income derived from crops, beef, swine, and dairy was used to compare farm types among the overall efficiency categories.

The financial total expense, economic total expense ratio, and the profit margin ratio were used to compare the ability to control costs and financial performance among the overall efficiency categories. The financial total expense ratio is widely used to benchmark farms. This ratio is computed by dividing cash operating expenses, interest paid, and depreciation by value of farm production. The financial total expense ratio excludes opportunity charges on operator labor and owned assets. The economic total expense ratio includes these opportunity charges as well as cash operating expenses and depreciation. It is computed by dividing total economic expense by value of farm production. The profit margin ratio is computed by dividing net farm income plus interest paid minus unpaid operator and family labor by value of farm production. We would expect the total expense ratios to be significantly lower and the profit margin ratio to be significantly higher for the farms with a competitive advantage.

Data

Whole-farm data from the Kansas Farm Management Associations (KFMA) were used in this study. Specifically, farms with continuous data from 1982 to 2001 were included in the analysis. Computing overall efficiency requires information on inputs, outputs, and input prices. Inputs included labor, purchased inputs, and capital. The number of workers on the farm (operator and hired labor) was used as the labor input variable. Purchased inputs included seed, fertilizer, herbicide and insecticide, feed, repairs, insurance, chemicals, veterinarian expenses, fuel, oil, and utilities. The purchased input index was created by dividing real purchased input expenses by the real USDA prices paid index for items used for production. Capital included cash farm rent, depreciation, and an interest charge on owned assets. The capital input index was created by dividing capital expense by an index of real interest rates. The index of real interest rates used the real interest rate in 2001 as the base (1.00), nominal interest rates from the Federal Reserve Bank of Kansas City, and the implicit price deflator for personal consumption expenditures (Federal Reserve Bank of St. Louis).

Outputs included beef, milk, swine, crops, hay and forage, and miscellaneous income. The crop output primarily consisted of wheat, corn, grain sorghum, and soybeans. Hay and forage included hay and silage production. Miscellaneous income primarily consisted of custom work.

Table 1 presents the mean and standard deviation of inputs, outputs, and selected farm characteristics for the 224 KFMA farms with continuous data from 1982 to 2001. Average gross farm income was $252,626. Farms were divided into four gross farm income categories: those with less than $100,000 in gross farm income (GFI1), those with a gross farm income between $100,000 and $250,000 (GFI2), those with a gross farm income between $250,000 and $500,000 (GFI3), and those with a gross farm income above $500,000 (GFI4). Approximately 19.2% of the farms or 43 farms had an average gross farm income below $100,000. Approximately 7.1% of the farms or 16 farms had an average gross farm income above $500,000. Relatively more of gross farm income was derived from beef production than dairy or swine production. Also, the percent of income from grain, which primarily consisted of wheat, corn, and grain sorghum income, was approximately three times larger than the percent of income from oilseeds (soybeans and sunflowers).

The average financial and economic total expense ratios were 0.7841 and 1.1402, respectively. An economic expense ratio above 1.00 indicates that the farms on average had economic losses or were not covering all of their opportunity costs. The average profit margin ratio was 0.0910 or 9.10%.

Results

The average level of each efficiency measure is presented along with distributional information in table 2. Average overall efficiency was approximately 0.62 or 62%. Technical, allocative, and scale inefficiencies all contributed to overall inefficiency. Allocative inefficiency was less of a problem, however, than technical and scale inefficiency. Note the wide difference in overall efficiency among the farms. Approximately 20% of the farms had overall efficiency levels below 50%. Approximately 17% of the farms had overall efficiency levels above 75%. None of the farms was overall efficient in every year. However, there were four farms that were technically efficient in every year and two farms that were allocatively efficient in every year.

Statistical tests indicated that 60 farms had above average levels of overall efficiency (top category) and 76 farms had below average levels of overall efficiency (bottom category). The farms in the top category had a sustained competitive advantage. The farms in the bottom category had a sustained competitive disadvantage. The remaining 88 farms had overall efficiency levels that were insignificantly different from average. The incidence of farms with above and below average overall efficiency levels is much higher than we would expect if farm performance was random, due to weather, and normally distributed. Under this scenario, only 11 of the 224 farms would have exhibited overall efficiency levels that were significantly different from average. In this study, 136 of the 224 farms or approximately 61% exhibited overall efficiency levels that were significantly different from average. These results provide indirect support for dynamic competition theories such as resource-based theory of the firm.

Table 3 presents the characteristics of the farms in the top and bottom overall efficiency categories. Average overall efficiency was approximately 78% for farms in the top category and 48% for farms in the bottom category. All three of the components of overall efficiency were statistically higher for the farms with a sustained competitive advantage or the farms in the top category.

Farm size, measured using gross farm income, was a key characteristic that varied between the farms in the top and bottom categories. On average, farms in the top category were substantially larger. Average gross farm income for the top category was $395,650. In contrast, average gross farm income for the bottom category was $147,103. In addition to being relatively larger, farms in the top category derived a higher percent of their gross farm income from livestock production. Specifically, a substantially higher percent of gross farm income for the top category farms was derived from dairy and swine production. The percentage of gross farm income derived from beef production was not statistically different for the two groups of farms.

The average profit margin ratio for the farms in the top category and bottom category was 18.64% and -2.60%, respectively. The financial total expense ratio for the top category was approximately 0.10 lower than that for the bottom category. Similarly, the economic total expense ratio was 0.28 lower for the top category. The differences in financial performance and overall efficiency between the farms in the top and bottom categories reveal the large differences in managerial ability between the farms in the sample.

As mentioned above, farm size, as measured with gross farm income, was a key characteristic that varied among overall efficiency categories. In light of this, table 4 summarizes overall efficiency, the profit margin ratio, and the total expense ratios by gross farm income category. Overall efficiency for the smallest farm size category averaged approximately 50%. Conversely, average efficiency for the largest farm size category averaged approximately 74%. Even though it was possible for small farms to have a competitive advantage over the study period, it was considerably more common for these farms to have competitive disadvantage. Only 2 of the 43 farms with a gross farm income below $100,000 were in the top category while 10 of the 16 farms with a gross farm income above $500,000 were in the top category. Approximately 70% of the farms with a gross farm income below $100,000 were in the bottom category. None of the farms with a gross farm income above $500,000 were in the bottom category.

In summary, the larger farms had a substantial competitive advantage over smaller farms. This result is evident by examining the average profit margin ratio and total expense ratios for different farm size categories. The larger farms have, on average, substantially higher profit margins and substantially lower total expense ratios. In fact, the largest farm size category, on average, earned an economic profit.

Summary and Implications

This study examined sustained competitive advantage for a sample of Kansas farms. Results indicated that approximately 27% of the sample farms had significantly above average overall efficiency levels or a sustained competitive advantage. Another 34% of the farms had a sustained competitive disadvantage. Farms with above average overall efficiency levels were relatively larger and received a higher percent of their income from dairy and swine production. The results of this study clearly show that it is possible for some farms to have a sustained competitive advantage and provide indirect support for dynamic competition theories such as resource-based theory of the firm.

The difference in overall efficiency between the farms with a competitive advantage (top category) and those with a competitive disadvantage (bottom category) was 24%. This difference translates into large differences in profit margins and ability to manage costs. The economic total expense ratio was 1.02 for farms in the top category and 1.30 for farms in the bottom category suggesting that expenses were 28% higher in relation to the value of farm production for the bottom category farms. The profit margin ratio was 18.64% for farms in the top category and -2.60% for farms in the bottom category.

The results of this study have important implications. First, according to this study, a substantial proportion of small farms are at a competitive disadvantage. Small farms tend to be covering cash costs, but are not even coming close to covering opportunity costs. Large farms are much more likely to have a competitive advantage and in many cases are covering both cash and opportunity costs. Second, because some farms have a competitive advantage, it is important for farms to benchmark using the information from these farms. Benchmarking using average farm information will provide a false signal. For a farm to grow and prosper it will need to have a competitive advantage.

This paper also provides some insight into future research priorities. One of the biggest challenges to farms and ranches today is identifying and taking advantage of unique resources to create a competitive advantage. Most farms have some advantage that can be used to gain the upper hand. Farms without any unique resources will find it increasingly difficult to compete in tomorrow's agricultural industry. The next step in this line of research would be to further contrast the difference in characteristics and resources between farms with a competitive advantage and farms with a competitive disadvantage.

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Table 1. Summary Statistics for Sample of Kansas Farms, 1982-2001.

	Mean	Standard Deviation
Inputs		
Labor (Number of Workers)	1.68	1.06
Purchased Input Index	128,123	118,185
Capital Index	75,737	55,980
Outputs		
Beef (lbs)	74,126	210,971
Milk (lbs)	129,234	458,433
Swine (lbs)	63,429	226,042
Crops (bu)	23,906	20,934
Hay and Forage (tons)	284	392
Miscellaneous Income Index	11,112	18,156
Farm Characteristics		
Gross Farm Income (GFI)	$252,626	$213,734
GFI 1	19.20%	39.47%
GFI 2	45.09%	49.87%
GFI 3	28.57%	45.28%
GFI 4	7.14%	25.81%
% of GFI from Beef Enterprises	21.51%	24.67%
% of GFI from Dairy Enterprises	7.81%	22.35%
% of GFI from Swine Enterprises	9.20%	18.98%
% of GFI from Grain	29.77%	20.65%
% of GFI from Oilseeds	9.20%	12.73%
% of GFI from Hay and Forage	2.32%	5.95%
% of GFI from Government Payments	10.56%	5.92%
Aggregated % of GFI from Crops	43.32%	25.11%
Aggregated % of GFI from Livestock	38.51%	30.46%
Financial Total Expense Ratio	0.7841	0.1351
Economic Total Expense Ratio	1.1402	0.2242
Profit Margin Ratio	0.0910	0.1885

Table 2. Efficiency Measures for a Sample of Kansas Farms, 1982-2001.

	TE	AE	SE	OE
Summary Statistics				
Average	0.8198	0.8848	0.8526	0.6237
Minimum	0.5560	0.5448	0.4338	0.2942
Maximum	1.0000	1.0000	0.9850	0.9810
Distribution of Farms				
0.25 to 0.30	0	0	0	1
0.30 to 0.35	0	0	0	3
0.35 to 0.40	0	0	0	2
0.40 to 0.45	0	0	2	19
0.45 to 0.50	0	0	0	20
0.50 to 0.55	0	1	2	25
0.55 to 0.60	6	0	8	35
0.60 to 0.65	8	1	5	34
0.65 to 0.70	17	0	8	26
0.70 to 0.75	32	4	0	21
0.75 to 0.80	31	13	43	20
0.80 to 0.85	33	29	21	7
0.85 to 0.90	40	74	21	9
0.90 to 0.95	27	81	67	1
0.95 to 1.00	26	19	47	1
1.00	4	2	0	0

Table 3. Farm Characteristics of Kansas Farms with Above Average and Below Average Overall Efficiency, 1982-2001.

	Above Average 60 Farms	Below Average 76 Farms
Inputs		
Labor (Number of Workers)	2.32[1]	1.25[2]
Purchased Input Index	205,934[1]	72,894[2]
Capital Input Index	103,668[1]	56,331[2]
Outputs		
Beef (lbs)	137,869[1]	39,093[1]
Milk (lbs)	428,365[1]	1,494[2]
Swine (lbs)	169,900[1]	6,273[2]
Crops (bu)	28,310[1]	16,631[2]
Hay and Forage (tons)	547[1]	114[2]
Miscellaneous Income Index	17,494[1]	5,209[2]
Efficiency Measures		
Technical	92.44%[1]	73.16%[2]
Allocative	92.05%[1]	86.36%[2]
Scale	92.17%[1]	77.23%[2]
Overall	78.00%[1]	47.52%[2]
Farm Characteristics		
Gross Farm Income (GFI)	395,650[1]	147,103[2]
GFI 1	3.33%	39.47%
GFI 2	36.67%	48.68%
GFI 3	43.33%	11.84%
GFI 4	16.67%	0.00%
% of GFI from Beef Enterprises	17.08%[1]	24.12%[1]
% of GFI from Dairy Enterprises	22.65%[1]	0.07%[2]
% of GFI from Swine Enterprises	16.64%[1]	2.74%[2]
% of GFI from Grain	19.62%[1]	35.08%[2]
% of GFI from Oilseeds	9.54%[1]	18.26%[2]
% of GFI from Hay and Forage	1.60%[1]	2.76%[1]
% of GFI from Government Payments	7.27%[1]	12.23%[2]

Table 3. Continued.

	Above Average 69 Farms	Below Average 73 Farms
Farm Characteristics, Continued		
Aggregated % of GFI for Crops	29.15%^{1}	53.34%^{2}
Aggregated % of GFI for Livestock	56.37%^{1}	26.93%^{2}
Financial Total Expense Ratio	0.7368^{1}	0.8319^{2}
Economic Total Expense Ratio	1.0206^{1}	1.2964^{2}
Profit Margin Ratio	0.1864^{1}	-0.0260^{2}

Note: Unlike superscripts indicate that the means are statistically different at the 5% level.

Table 4. Overall Efficiency and Farm Performance by Gross Farm Income (GFI) Category.

	Less than $100,000	$100,000 to $250,000	$250,000 to $500,000	Greater than $500,000
Number of Farms	43	101	64	16
Average GFI	$74,910^{1}	$167,641^{2}	$361,189^{3}	$832,459^{4}
Average OE	49.71%^{1}	60.53%^{2}	68.25%^{3}	73.39%^{4}
Above Average OE (# of farms)	2	22	26	10
Below Average OE (# of farms)	30	37	9	0
Financial Total Expense Ratio	0.8460^{1}	0.7826^{2}	0.7464^{2}	0.7793^{2}
% FTER > 1	13.95%	4.95%	0.00%	0.00%
Economic Total Expense Ratio	1.4270^{1}	1.1216^{2}	1.0146^{3}	0.9886^{4}
% ETER > 1	100.00%	84.16%	59.37%	37.50%
Profit Margin Ratio	-0.1643^{1}	0.1157^{2}	0.1949^{3}	0.2047^{4}

Note: Unlike superscripts indicate that the means are statistically different at the 5% level.