AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
http://ageconsearch.umn.edu
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

An Analysis of Efficiency of Midwestern Agricultural Cooperatives

by

Chatura B. Ariyaratne,

Allen M. Featherstone,

Michael R. Langemeier,

and

David G. Barton

March 20, 1997

Submitted for Consideration as a WAEA Selected Paper

Chatura B. Ariyaratne, Allen M. Featherstone, Michael Langemeier, and David Barton are graduate research assistant, professor, associate professor, and professor, Department of Agricultural Economics, Kansas State University.

An Analysis of Efficiency of Midwestern Agricultural Cooperatives

Abstract

This paper uses nonparametric analysis to examine the efficiency of a sample of grain marketing and farm supply cooperatives in the Great Plains. Although larger cooperatives were more efficient, in general, a cooperative is more likely to reduce costs by focusing on technical or allocative efficiency than by adjusting scale.

An Analysis of Efficiency of Midwestern Agricultural Cooperatives

Farmer Cooperative Statistics indicates that the total number of marketing and farm supply cooperatives declined from 5,477 in 1985 to 3,669 in 1994; a net decline of 1,808. Of those, 40.7% were dissolved, 24.8% merged, 17.7% were acquired by other cooperatives or investor-owned firms while the remaining 16.8% were removed for other reasons. The long term decline reflects, in part, the decreasing number of farmers in the U.S.

The future structure of the cooperative industry has been studied using efficiency studies or economies of scale studies. Akridge and Hertel compared the efficiency of Midwestern cooperative and investor-oriented grain and farm supply firms and concluded that investor-oriented firms were more efficient in their use of plant and equipment. Thraen, Hahn, and Roof examined processing costs, labor efficiency, and economies of size in fluid milk cooperatives and found that processing costs decline with increases in plant volume. Schroeder also found the existence of economies of scale and product specific economies of scale among farm supply and marketing cooperatives and indicated that this may lead to fewer cooperatives in the industry. Financial stress in agricultural cooperatives varies widely among individual cooperatives. Moller, Featherstone, and Barton, using a sample of grain marketing and farm supply cooperatives, found that a high percentage of financial stress, 54%, originated from inadequate profits. They found that small cooperatives were more likely to face profit problems than larger cooperatives.

Further research on the economic factors influencing the profitability of the input supply and marketing cooperative sector is necessary to better explain the current trends and future direction of the industry in the United States. It is also important to be able to identify which cooperatives may be more susceptible to financial difficulties. If a cooperative's objective is to minimize the cost of services that the cooperative provides to it members, how well the

cooperative minimizes costs determines the likelihood of long-run survival in a declining industry. Given this rationale, economic factors that cause higher costs and lead to inadequate profits, such as inefficient allocation of inputs, product mix, scale of operation, technology, marketing strategies, and other financial and managerial decisions are all indicators that affect overall firm efficiency. Overall firm efficiency may be broken down into several measures such as technical efficiency, allocative efficiency, and scale efficiency. Technical efficiency measures whether the producer employs the most efficient technology within the operation. Allocative efficiency examines whether the optimal levels of inputs at a given price are used in deriving the output. Scale efficiency examines whether a firm size is optimal. Cooperatives to a greater degree have the ability to control technical and allocative efficiency while having less ability to control the shape of the cost curve.

The objective of this manuscript is to measure efficiencies in grain marketing and farm supply cooperatives including pure technical efficiency, scale efficiency, allocative efficiency, and overall efficiency. Secondly, this research identifies differences among the grain marketing and farm supply cooperatives in the U.S., in terms of productivity, managerial expertise, and other key economic variables to explain factors that influence sub-optimal performance.

Procedures and Data

The nonparametric methods proposed by Färe, Grosskopf, and Lovell (1985), and used by Featherstone, Langemeier, and Ismet (1997) were utilized to measure efficiency. Four linear programs (LP) were solved for each of the 89 grain marketing and farm supply cooperatives. Based on these results, a measure of overall, allocative, technical, and scale efficiency for each of the cooperatives was calculated. It was also determined whether each cooperative was operating

at constant, increasing, or decreasing returns to scale. Finally, Tobit analysis was used to examine differences among the grain marketing and farm supply cooperatives, in terms of productivity, management, and other key economic variables.

Annual time series financial records from 1988 through 1992 were obtained from the Cooperative Finance Association (CFA), a subsidiary of Farmland Industries. The CFA data contains complete balance sheet and income statement data, taken from audited financial statements. To investigate efficiencies, input and output quantity data or indices, and firms' output and input prices are required. Given only financial records were available, transformations of several data series were necessary. In addition, dollar values of the expenses and the annual sales are adjusted for inflation and indexed to 1992 dollars. Fiscal year differences in a coop's annual financial data records were accounted for, when the annual expenses and the annual sales values converted to the real dollar quantities. The six outputs of the cooperatives were grain, fertilizer, agro-chemicals, petroleum products, feed, and other goods, including antifreeze, tires, battery, automotive parts, and miscellaneous. Input expenses for the cooperatives were capital and labor (included management and personnel). Capital expenses were defined as the sum of annual depreciation, total assets times the Bank of Cooperative interest rate, and rents and leases.

A total of 89 cooperatives were observed each year over the five year period. Forty-seven of the cooperatives were not involved in grain marketing during at least some of the study period. Seventeen of the cooperatives did not sell fertilizers at least one year during the study period. Twenty-five, twelve, twenty-three, and six of the cooperatives did not sell agricultural chemicals, petroleum products, feeds, and miscellaneous merchandise respectively, during at least part of the study period. Summary statistics for the cooperatives by year are found in Table 1.

Efficiency Estimates

The cooperatives were pooled over time resulting in 445 observations (89 cooperatives time 5 years). The overall efficiency measures ranged from 0.008 to 1.00 (Table 2). The average estimate was 0.49 with a standard deviation of 0.20. By producing on the minimum cost frontier under constant returns to scale technology, cooperatives could achieve the same level of output with 51% less cost on average. The frequency distribution indicated that 22% of cooperatives were between 60% and 100% overall efficient.

Technical efficiency estimates ranged from 0.07 to 1.00 with an average of 0.69 (Table 2). Roughly 7% of the cooperatives operated were technically efficient. Input could be decreased by 31% if all cooperatives produced along the production function. The majority of cooperatives, 52%, exhibited technical efficiency measures greater than 60%. Allocative efficiency ranged from 0.10 to 1.00. The average and the standard deviation of the allocative measures were 0.77 and 0.18, respectively. Approximately 78% of the cooperatives exhibited allocative efficiency measures greater than 0.60.

The optimally-sized, or scale efficient firm operates at the minimum point on the aggregate average cost curve. On average cooperatives were 0.92 scale efficient with a standard deviation of 0.11 (Table 2). Scale efficiency estimates ranged from 0.18 to 1.00. Individual cooperative analysis indicates that 81.3% of the cooperatives operated in the region of increasing returns to scale, 3.2% of the cooperatives operated at constant returns to scale, and 15.5% of the cooperatives operated under decreasing returns to scale. Although the cost curve indicates that a substantial number of cooperatives could be more efficient by adjusting their size, the cost curve is very flat as indicated by the high level of scale efficiency. A cooperative is more likely to

reduce costs by focusing on technical or allocative efficiency than by focusing scale.

Tobit Results

Tobit models were used to determine which cooperative characteristics were related to inefficiency. An inefficiency index is derived by taking one minus the observed efficiency measure for each of the measures of efficiency. Selected cooperative financial characteristics obtained from the CFA data base and were regressed on inefficiency. Explanatory characteristics include Herfindahl index, current ratio, equity to asset ratio, average collection period, gross income to personnel expense, and total sales.

Total sales, and gross income to personnel expense were negatively correlated to technical inefficiency and statistically significant at the 1% levels respectively (Table 3). Those cooperatives that had more gross income to personnel expense and more sales were more efficient. The Herfindahl index was positively correlated to inefficiency and statistically significant at the 5% level. Those cooperatives which were more diversified were more technically efficient indicating that they are better able to spread labor and capital over broader sales.

Allocative efficiency measures how well a cooperative combines inputs relative to the cost minimizing input bundle. Allocative inefficiency was negatively related to the current ratio, gross income to personnel expense, and total sales (Table 3). This indicates that cooperatives with larger sales, higher sales to gross income and a higher current ratio are more efficient. Larger cooperatives with higher labor productivity and strong short term financial strength may have an ability to negotiate and take advantage of favorable terms of trade, such as cash discounts on purchases allowing them to be more allocative efficient.

Scale inefficiency was negatively related total sales and postively related to the Herfindahl index and the average collection period (Table 3). Larger cooperatives were more scale efficient than smaller cooperatives. Diversified cooperatives and those with better credit management polices were of a more correct size than those that are more specialized or those that have poor accounts receivable policies. A cooperative that does do well at managing accounts receivable may not able to expand the business to reach a more optimal

Overall inefficiency was positively related to the Herfindahl index and average collection period and negatively related to the average collection period and total sales (Table 3). Overall efficient firms tend to have a diversified portfolio of outputs and are larger using sales as a measure of size. Cooperatives with higher short term financial strength, and carry lower levels of accounts receivable are more efficient relative to others.

In general, larger cooperatives are technical, allocative, scale, and overall more efficient than smaller cooperatives. Cooperatives with higher gross income to personnel expenses are more technical and allocative efficient than those with a less productive labor force. Those cooperatives with more liquidity are more allocative and overall efficient. Those cooperatives with a more diversified output mix are were more technical, scale, and overall efficient compared to specialized cooperatives. Cooperatives with better accounts receivable policies are more scale and overall efficient than those with less effective. Finally, leverage (equity to assets) is not statistically associated with any of the efficiency measures.

Relationship between Profits and Efficiency Indices

The previous section identified characteristics related to efficiency. While these results helped to isolate financial characteristics that were associated with inefficiency, further analysis is

necessary to determine whether efficiency indices were correlated with profitability. Ordinary least square models were used to accomplish this task by regressing efficiency indicies on profitability ratios of return on assets (ROA) and return on equity (ROE).

Of the eight models estimated, only four models were statistically significant (Table 4). The models regressing scale and overall efficiency on both ROE and ROA were not statistically significant. This indicates that the statistical correlation between scale and overall efficiency and both ROA and ROE is not distinct from zero. Technical and allocative efficiency were statistically correlated to ROA with correlation coefficients of 0.14 and 0.13. An increase in technical efficiency of 0.1 increase ROA by 0.4%. Technical and allocative efficiency were also statistically correlated to ROE with correlation coefficients of 0.15 and 0.14. An increase in technical efficiency of 0.1 increases the rate of return to equity by .9%. ROA and ROE increase by 0.50% and 0.95% for a 0.1 unit change in the allocative efficiency measure. Profitability is statistically related to allocative and technical efficiency. In both cases, a unit increase in allocative efficiency increased the profitability measures more than the same increase in technical efficiency.

The importance of cost factors in explaining efficiency is reported in Table 6. Logged capital costs and logged personnel costs were regressed on logged efficiency indices. The estimates can be directly interpreted as elasticities. Results indicate that labor tended to be under-utilized while capital over-utilized. A 10% decrease in capital cost would increase technical efficiency by 5.3% but it would decrease allocative and scale efficiencies by 1.6% and 0.4%, respectively. Summing the elasticities of capital cost and labor cost across technical, allocative, and scale efficiency measures gives quantitative measure for overall efficiency. A 10% increase in

labor would increase technical efficiency by 6.29%, would decrease allocative and scale efficiency by 1.73% and 0.78%, respectively. Overall, a 10% decrease in capital cost would increase overall efficiency by 3.2% while a 10% increase in labor cost would increase overall efficiency by 3.9%.

Conclusions

This study used nonparametric and parametric approaches to measure efficiencies and to explain differences among the grain marketing and farm supply cooperatives in terms of financial characteristics. Technical, allocative, scale, and overall efficiency were estimated for each of the 89 cooperatives from 1988 to 1992. Measures of technical efficiency were less than either allocative or scale efficiency. On average, the cooperatives were 69% technically efficient, 77% allocatively efficient, and 92% scale efficient. Roughly 7% of the cooperatives were technically efficient. Individual cooperative analysis indicates that 81.3% of the cooperatives operated in the region of increasing returns to scale, 3.2% of the cooperatives operated at constant returns to scale, and 15.5% of the cooperatives operated under decreasing returns to scale technology in terms of cost. Although a substantial number of cooperatives could be more efficient by adjusting their size, the cost curve is very flat as indicated by the high level of scale efficiency. A cooperative is more likely to reduce costs by focusing on technical or allocative efficiency than by adjusting scale.

To identify the sources of inefficiencies, Tobit models regressing one minus the efficiency indices on cooperatives' financial characteristics such as Herfindahl Index, current ratio, equity to assets ratio, average collection period, gross income to personnel expense, and total sales were regressed. In general, larger cooperatives are technical, allocative, scale, and overall more

efficient than smaller cooperatives. Cooperatives with higher gross income to personnel expenses are more technical and allocative efficient than those with a less productive labor force. Those cooperatives with more liquidity are more allocative and overall efficient. Those cooperatives with a more diversified output mix are were more technical, scale, and overall efficient compared to specialized cooperatives. Cooperatives with better accounts receivable policies are more scale and overall efficient than those with less effective. Finally, leverage (equity to assets) is not statistically associated with any of the efficiency measures.

Ordinary least square models were used to explain relationship between efficiency indices and industry profitability ratios such as return on assets (ROA) and return on equity (ROE). Returns to assets and equity were positively correlated with technical and allocative efficiency. A cooperative could increase profits more by improving allocative efficiency than by improving technical efficiency by the same amount. These results further verify sub-optimal production technologies and sub-optimal input bundles are more important in determining financial health than sub-optimal scale.

Further studies on productivity changes during this period could provide a better explanation to the efficiency differences between years. Finally, because technical and allocative efficiency were lower for this sample of grain marketing and farm supply cooperatives than scale efficiency, the results suggest that cooperative managers should focus on using capital and labor more efficiently rather than increasing their size.

Table 1. Means, Standard Deviations, Minimums, & Maximums of Cooperatives' Real Values of Inputs & Outputs, 1988-92

	Capital Expenses ($ million)	Labor Expenses ($ million)	Grain Sales ($ million)	Fertilizer Sales ($ million)	Agro-Chemical Sales ($ million)	Petroleum Product Sales ($million)	Feed Sales ($ million)	Other Sales ($ million)
1988 Mean	4.85	0.41	1.73	0.96	0.55	1.60	0.51	0.61
Std. Deviation	4.28	0.32	3.71	0.98	0.70	1.96	0.67	0.66
Minimum	0.19	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	24.02	1.46	22.99	4.00	3.32	12.51	3.30	2.85
1989 Mean	5.40	0.50	1.54	1.05	0.59	1.55	0.50	0.69
Std. Deviation	4.65	0.40	3.18	1.10	0.80	1.78	0.67	0.84
Minimum	0.21	0.03	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	23.34	1.83	14.49	5.01	4.14	10.80	3.33	4.02
1990 Mean	5.08	0.52	1.49	1.07	0.62	1.52	0.57	0.71
Std. Deviation	4.46	0.43	2.99	1.14	0.79	1.56	0.72	0.87
Minimum	0.19	0.03	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	23.34	1.96	13.89	5.33	4.03	7.39	3.37	4.07
1991 Mean	4.25	0.54	1.45	1.08	0.69	1.72	0.65	0.73
Std. Deviation	3.70	0.45	2.92	1.13	0.85	2.08	0.91	0.84
Minimum	0.13	0.03	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	16.74	2.20	15.95	5.54	4.52	15.06	5.24	4.21
1992 Mean	3.27	0.56	1.45	1.12	0.72	1.63	0.67	0.73
Std. Deviation	3.08	0.47	2.92	1.21	0.87	1.57	0.97	0.80
Minimum	0.08	0.03	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	12.92	2.31	14.72	5.78	4.42	7.53	5.84	3.62

Table 2. Summary Statistics for Efficiency and Returns to Scale Measures for the Aggregate Model.

	Overall Efficiency		Technical Efficiency		Allocative Efficiency		Scale Efficiency	
Summary Statistics								
Mean	0.49		0.69		0.77		0.92	
Std. Deviation	0.20		0.21		0.18		0.11	
Minimum	0.008		0.07		0.10		0.18	
Maximum	1.00		1.00		1.00		1.00	
Distribution	No.	%	No.	%	No.	%	No.	%
≤ 0.2	10	2.3	4	0.9	1	0.2	1	0.2
0.2 < and ≤ 0.4	158	35.5	65	14.6	4	0.9	2	0.4
0.4 < and ≤ 0.6	178	40.0	143	32.1	94	21.1	6	1.3
0.6 < and ≤ 0.8	58	13.0	125	28.1	143	32.1	28	6.3
0.8 < and <1	27	6.1	79	17.8	169	38.0	394	88.5
1	14	3.1	29	6.5	34	7.6	14	3.1
Returns to Scale	No.		Percentage					
Decreasing	69		15.5					
Constant	14		3.2					
Increasing	362		81.3					

Table 3. Relationship between Inefficiency and Financial Variables
(C= Intercept, HFDI= Herfindahl Index, CR= Current Ratio, EA= Equity to Assets, ACP= Average Collection Period, GIPE= Gross Income to Personnel Expense, SLS= Total Sales)

	C	HFDI	CR	EA	ACP	GIPE	SLS
Technical Inefficiency							
Estimate	.429**	.138*	-.0008	.029	.0008	-.080**	-.007**
Std. Error	.071	.054	.001	.066	.0005	.021	.002
Allocative Inefficiency							
Estimate	-.082	-.045	-.0006*	.035	.0003	-.142**	-.006**
Std. Error	.055	.042	.0002	.050	.0004	.016	.002
Scale Inefficiency							
Estimate	-.080**	.142**	-.0002	.042	.0012**	-.013	-.008**
Std. Error	.030	.023	.0002	.027	.0002	.009	.0009
Overall Inefficiency							
Estimate	-.318**	.147**	-.0009**	.086	.0009*	.024	-.002**
Std. Error	.060	.047	.0003	.055	.0004	.018	.0001

(** =Significant at 1% and * =Significant at 5%)

Table 4. Relationship between Efficiency and Profits
(TE=Technical Efficiency, AE= Allocative Efficiency, SE=Scale Efficiency, and OE=Overall Efficiency)

Return on Assets	TE	AE	SE	OE
Intercept	.037**	.106**	.078**	.065**
Standard Error	(.011)	(.014)	(.029)	(.009)
Return on Assets	.044**	.050**	-.012	.003
Standard Error	(.015)	(.018)	(.031)	(.016)
Correlation Coefficient	.14	.13	.02	.01
Return on Equity				
Intercept	.052**	.185**	.183**	.110**
Standard Error	(.020)	(.025)	(.052)	(.016)
Return on Equity	.086**	.095**	-.077	.004
Standard Error	(.027)	(.032)	(.055)	(.030)
Correlation Coefficient	.15	.14	-.07	.00

(** =Significant at 1%)

Table 5. Relationship among Efficiency Indices and Cost Factors
(TE=Technical Efficiency, AE= Allocative Efficiency, SE=Scale Efficiency, and OE=Overall Efficiency)

Logged Independent Variables	Logged TE	Logged AE	Logged SE	Logged OE
Intercept	1.04**	-.515**	-.175**	.353**
Standard Error	(.036)	(.091)	(.040)	(.121)
Capital Cost	-.533**	.161**	.049**	-.323**
Standard Error	(.017	(.042)	(.019)	(.065)
Labor Cost	.629**	-.173**	-.078**	.378**
Standard Error	(.019)	(.049)	(.022)	(.065)
R^2	.71	.03	.03	.07

(** =Significant at 1%)

References

Akridge, Jay T., and Thomas W. Hertel. "Cooperative and Investor Oriented Firm Efficiency: A Multi-Product Analysis." *Journal of Agricultural Cooperation*, (1992):1-14.

Chavas, Jean-Paul and Michael Aliber. "An Analysis of Economic Efficiency in Agriculture: A Nonparametric Approach." *Journal of Agricultural and Resource Economics*, 18(1993):1-16.

Färe Fare, Rolf, Shawna Grosskopf, C.A. Knox Lovell. *The Measurement of Efficiency of Production.* Kluwer-Nijhoff Publishing, MA, 1985.

Färe, Rolf, and Shawna Grosskopf. "A Nonparametric Cost Approach to Scale Efficiency." *Scandinavian Journal of Economics*, 87(1985):594-604.

Featherstone, Allen M., Michael R. Langemeier, and Mohammd Ismet. "A Nonparametric Analysis of Efficiency for a Sample of Kansas Beef Cow Farms." *Journal of Agricultural and Applied Economics*, Forthcoming July 1997.

Moller, Lynn G., Allen M. Featherstone, and David G. Barton. "Sources of Financial Stress in Agricultural Cooperatives." *Journal of Cooperatives*, (1996):38-50.

Richardson, Ralph M., et al. *Farmer Cooperative Statistics 1994*. Washington, DC: USDA, RB/CS, RBS Service report 49, Nov. 1995.

Schroeder, Ted C. "Economies of Scale and Scope for Agricultural Supply and Marketing Cooperatives." *Review of Agricultural Economics*, 14(1992):93-103.

Thraen, Cameron S., David E. Hahn, and James B. Roof. "Processing Costs, Labor, Efficiency, and Economies of size in cooperatively Owned Fluid Milk Plants." *Journal of Agricultural Cooperation*, (1992):40-56.