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Structural Changes in Farmer Cooperatives

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Structural Changes in Farmer Cooperatives

Abstract

Since 1990, the farmer cooperative landscape has experienced a significant structural shift. Steep consolidation, elevated competition, and surging commodity prices have elevated the need for co-ops to be mindful of their cost structure and efficiencies. To test for this structural shift, this study estimated technical, allocative, scale, economic, and overall efficiencies for a set of grain marketing and farm supply cooperatives using a unique financial database. Chow test statistics for overall efficiency model show one structural shift in 2002 and 2003. Cooperatives are more likely to reduce costs by focusing on technical efficiency rather than adjusting the scale of operation. Nearly all efficiency trend lines, except for allocative, follows the business cycle patterns of the 1990s and 2000s. Our regression results shows capital constraint was one reason an average cooperative was off the technical frontier.

Introduction

Since 1990, the farmer cooperative landscape has experienced a significant amount of change. Most notably is the significant amount of consolidation within the industry. According to USDA data, from 1990 to 2012, the number of grain, oilseed and farm supply cooperatives or farmer co-ops has been cut in a half. While at the same time, gross sales have nearly doubled and a larger portion of these sales is more concentrated in a few very large co-ops with sales over \$500 million. Furthermore, this time frame has seen a number of joint ventures and strategic alliances between farmer co-ops and between farmer co-ops and investor owned firms (Reynolds, 2012). As a result, the economics of consolidation and their implications for farmer co-ops is the focus of this research.

Might the cause of this significant amount of change and consolidation occurring in the farmer cooperative industry be due to structural change? While it can be difficult to prove structural change, the farmer co-op industry has experienced it in the past. Dahl (1991) argued that from the 1970s to early 1990s, farmer-owned cooperatives experienced a significant amount of structural change. Some reasons he cited included a grain export boom, the tumultuous 1980s in agriculture, government programs in the mid- to late-1980s ending their purchasing or storing grain program, and inefficient cooperatives merging or being acquired by other cooperatives or businesses.

As a result, the objective of this article is twofold. First, the article will empirically examine the structural changes in the farm supply and grain marketing cooperative industry during 1995 to 2010 using a unique financial database. Annual time series financial records from 1995 through 2010 were obtained from the CoBank database. The CoBank data contains complete balance sheet and income statement data, taken from audited financial statements of farmer co-ops. The next objective of this paper is to explain the factors that affect the structural changes and to relate them to explanatory variables.

It is likely that the farmer cooperative industry has experienced structural change today. Some reasons for why structural change is possible and worth examining during this period are the population and income growth of emerging developing economies; the continued globalization of agriculture; ethanol policy; technological gains of producers harvesting a bigger crop quicker and needs for more storage.

Framework

Similar to Featherstone and Rahman (1996), the objective of the individual cooperative was assumed to be cost minimization. Input prices faced by cooperatives can be represented as $w = (w_1, w_2, \dots, w_n) \in \mathbb{R}^+$. Similarly, output prices faced by cooperatives can be represented as $p = (p_1, p_2, \dots, p_m) \in \mathbb{R}^+$. The transformation set formed by the $n \times k$ input matrix (X) and $m \times k$ output matrix (Y) can be written as follows;

$$(1) S^t = \{(x, y): y \leq Yz, Xz \leq x, z \in \mathbb{R}^+\}.$$

Note that the transformation set corresponds to a total product curve under constant returns to scale, and it shows the minimum feasible inputs for given levels of outputs. Overall efficiency (ρ_i) represents the minimum cost of producing output vector y_i , given input prices and a constant returns to technology and can be measured as:

$$(2) \rho_i = C_i(w, y, S_c) / w_i x_i.$$

The denominator $w_i x_i$ is the cost the i^{th} cooperative incurred to produce the output vector y_i . The numerator is the minimum cost of producing outputs given prices and constant returns to scale technology and can be determined by the following linear program (LP):

$$(3) C_i(w, y, S_c) = \text{Min } w_i x_i$$

s.t.

$$\sum_{k=1}^K x_{nk} z_k \leq x_{ni}$$

$$\sum_{k=1}^K y_{mk} z_k - y_{mi} \geq 0$$

$$Z_k \geq 0$$

Where Z_k is the intensity of use of the k^{th} cooperative's technology. The subscript k represents the number of cooperatives, i denotes the cooperative of interest, n is the number of inputs, and m is the number of outputs. The intensity variables (z 's) construct the frontier technology set. The solution of this LP problem is divided by the cooperative's actual cost to determine overall efficiency. Technical efficiency for each cooperative can be measured using the following LP

$$\begin{aligned}
 (4) \quad & \text{Min } \lambda_i \\
 & \text{s.t.} \\
 & \sum_{k=1}^K x_{nk} z_k \leq \lambda_i x_{ni} \\
 & \sum_{k=1}^K y_{mk} z_k - y_{mi} \geq 0 \\
 & Z_k \geq 0
 \end{aligned}$$

The firm is technically efficient if $\lambda_i = 1$. If $\lambda_i < 1$, the firm is technically inefficient. Allocative efficiency examines whether a firm is using the optimal input mix. Allocative efficiency (γ_i) can be determined by dividing the minimum cost under variable returns to scale technology by the actual cost adjusted for technical efficiency:

$$(5) \quad \gamma_i = C_i(w, y, S_v) / w_i \lambda_i x_i.$$

The minimum cost under variable returns to scale technology is solved by the following LP:

$$\begin{aligned}
 (6) \quad & C_i(w, y, S_v) = \text{Min } w_i x_i \\
 & \text{s.t.}
 \end{aligned}$$

$$\sum_{k=1}^K x_{nk} z_k \leq x_{ni}$$

$$\sum_{k=1}^K y_{mk} z_k - y_{mi} \geq 0$$

$$\sum_{k=1}^K z_k = 1$$

$$z_k \geq 0.$$

Allocative efficiency is determined by dividing the minimum cost from the above LP by the actual cost multiplied by technical efficiency. Scale efficiency (θ_i) is determined by:

$$(7) \theta_i = C_i(w, y, S_c) / C_i(w, y, S_v).$$

Scale efficiency is estimated by dividing the minimum cost from model (3) by the minimum cost from model (6). Overall efficiency is the product of scale, allocative, and technical efficiencies. This relationship can be shown by using equations (2), (4), (5), and (7).

$$(8) \rho_i = C_i(w, y, S_c) / w_i x_i = \lambda_i * \gamma_i * \theta_i$$

Ordinary least square (OLS) models were used to examine the relationship between cooperative performance ratios and efficiencies.

Data

Annual time series financial records from 1995 through 2010 were obtained from the CoBank database. CoBank is part of the Farm Credit System and is a primary lender to many farmer cooperatives across the U.S. These CoBank data contain complete balance sheet and income statement data, taken from audited financial statements of farmer cooperatives.

To investigate efficiencies and productivity, input and output quantity data or indices and firms' input and output prices or indices are required. Given the data are financial nature, some adjustments are necessary. First, to account for inflation, the data were converted to constant 1995 dollars using the gross domestic product chain type price deflator (Bureau of Economic Analysis, U.S. Dep. of Commerce).

Next, adjustments were made to expense data to arrive at the quantity values. There were two available input quantities available in the expense data, labor and capital. Total labor expense was converted to labor input by adjusting by the seasonally adjusted average hourly earnings for manufacturing sector (Bureau of Labor Statistics, U.S. Dep. of Labor). Capital expenses were defined as the sum of annual depreciation, cost of capital (total assets times seasonally adjusted bank prime loan rate), rents, and leases.

The final adjustment was to convert the output sales data into output quantities. Output sales included three product categories; grain sales, farm input supply sales, and other product sales. Producer price index of crude foodstuff and feedstuff (Bureau of Labor Statistics, U.S. Dep. of Labor), producer price index for crude materials for further processing (Bureau of Labor Statistics, U.S. Dep. of Labor), producer price index for finished goods (Bureau of Labor Statistics, U.S. Dep. of Labor), and chain type gross domestic product price deflator (Bureau of

Economic Analysis, U.S. Dep. of Commerce) were used to transform grain sales, farm input supply sales, and other product sales into output levels.

A fairly representative set of farmer cooperatives were used from the CoBank data. A total of 344 cooperatives were selected from the available because they had continuous data for the sixteen-year period on the input and output data described above. Table 1 provides the summary statistics of the data. The reported 2010 mean statistics are similar to those reported by the USDA. For example, average total sales in 2010 were roughly \$50 million, and in the USDA data the average farmer cooperative had total sales of about \$50 million.

Results

Summary statistics of efficiencies for the individual years from 1995 to 2010 are presented in Table 2. Average technical efficiency for 16 year period varied from 0.53 in 2001 to 0.66 in 2004. The average technical efficiency measure of 0.66 implies that inputs could be decreased by 34% if all cooperatives produced on the frontier production function.

Allocative efficiency evaluates the optimal levels of the capital and the labor inputs in the production of grain, farm inputs, and other products. Average allocative efficiency for sixteen year period ranged from 0.77 in 2010 to 0.91 in 1996. The average allocative efficiency measure of 0.91 indicates that costs could be reduced 9% by modifying the input bundles.

The scale efficiency measure compares the optimally sized cooperative operation to all others. The optimally sized operation or scale efficient firm operates at the minimum point on the aggregate average cost curve. Average scale efficiency for 16 year period ranged from 0.79 in 2001 to 0.88 in 1996. The average measure of economic efficiency which is the product of allocative and technical efficiencies ranged from 0.45 in 2001 and 2010 to 0.54 in 1996 and 1999

for the sixteen year period. An average value of 0.54 indicates that total costs could have been reduced by an average 46% in 1996 and 1999 sets of cooperatives while maintaining the same level of output.

Average overall efficiency for the sixteen year period ranged from 0.34 in 2001 to 0.47 in 1996. An average overall efficiency ratings of 0.47 implies that cooperatives could achieve the same level of output with 53% less cost on average, if they produced on the minimum cost frontier at the point of constant returns to scale.

Time series mean efficiencies from 1995 to 2010 are highlighted in Figure 1. Graph shows that because of lower measures of technical efficiency throughout the sixteen year period, economic efficiency and overall efficiency were very low levels. Dunn et.al. (2002) reported that, after conducting a panel discussion on the challenges producer-owned cooperatives face at the dawn of the 21st century, research and development is capital intensive and financially risky and cooperatives have limited access to capital and are often adverse to assuming risk. This restricts their participation in this arena. As a result, they have less access. This might be the reason for lower values of technical efficiency.

In general, allocative efficiency and scale efficiency were substantially at high levels. Reynolds (2012) reported that most of the joint ventures formed in the farm supply and grain sectors to gain scale and allocative efficiencies. The types of businesses they organized in joint ventures were agronomy, fuel distribution, feed mills, grain terminals, bioenergy, and agents for purchasing and marketing.

All the efficiencies except allocative efficiency, we can clearly recognize evolving trend pattern (Figure 1). It is obvious that all the efficiencies except allocative efficiency were

mimicking the growth pattern of the economy. An entrepreneurial growth during the business cycle of the 1990s had stronger wage and salary job gains during the 2000-2007 business cycle. Our efficiency trend lines follow those business cycles of 1990s and 2000s. Economic downturns of 2001 and 2008 clearly translate into average efficiencies by way of two unparalleled dips. Henderson (2012) stated that economic growth during the business cycles of 1990s and 2000s encouraged reallocation of resources to their highest and best use. Higher levels of average allocative efficiency supports Henderson's observation. The immediate outcome of having this result is that this technique can be used to test for structural changes during the study period. It seems that there were no any violent swings.

To affirm these findings, we used chow test to confirm our observation in Figure 1. Chow test statistics for overall efficiency model did show one structural shift in 2002. It could be indicated that by the crossing each other of scale efficiency and allocative efficiency trend lines. Then we spliced total sample into two subsamples through year 1995 to 2002 and through year 2003 to 2010. For each subsample we pooled each efficiency estimates over eight year period. It resulted 2752 observations (344 cooperatives*8years) for each subsample.

Table 3 shows ordinary least square (OLS) regression results. We hypothesized that cooperative's profitability measures such as total sales to total assets ratio and return on assets ratio were positively related to the efficiency indices. To explain the liquidity situation we used current ratio. Ratios of net income to personnel expenditure and cost of goods to total inventory were used to explain how efficiently cooperatives were converting their labor and other inputs.

Total sales to total assets ratio was positively related to all the efficiency indices and statistically significant at 1% levels except allocative efficiency model during 1995 to 2002. It indicates efficiency in sales generation per unit of assets encourages cooperatives to be on the

production frontier, to use correct input bundles or control of marginal costs and marginal revenues, and to operate correct scale. Ratio of current assets to current liabilities or current ratio was positively related to efficiency measures and statistically significant at 1% level except scale efficiency model during 2003 to 2010 and Technical efficiency model during 2003 to 2010. Current ratio was negatively related and statistically significant at 1% in the scale efficiency model during 2003 to 2010.

Technical efficiency during 2003 to 2010 was not different from zero. Current assets are those assets which the cooperatives expect to turn into cash in the near future. Increase liquidity encourages cooperatives to be on the frontier as well as get the marginal prices right. Net income to personnel expenditure ratio was negatively related to allocative efficiency, economic efficiency, and overall efficiency at 1% significant level during both periods. Net income to personnel expenditure ratio was positively related to technical and scale efficiencies during 2003 to 2010. Efficiency of the net income generation per unit of personnel expenditure did not help cooperatives to be allocative efficient, so that it seems to us cooperatives were not getting under control of their marginal costs to be overall efficient.

Return on assets positively related to allocative efficiency, economic efficiency and overall efficiency and statistically significant at 1% level for both periods. Increase earning power of a cooperative enhances overall efficiency as well as cooperatives to get the marginal costs and marginal revenues correct. Cost of goods to total inventory ratio negatively related to overall, scale, and technical efficiencies and statistically significant at 5% level during 2003 to 2010. Aggregated patronage dividends in cash and patronage dividends in equity were used to mimic capital constraint. Richards and Manfredo (Fall 2003) suggested that a major motivation for cooperatives to engage in consolidation activities is to circumvent capital constraint.

Negative relationship between patronage dividends and overall efficiency and technical efficiency was observed and it was statistically significant at 1% level. On the other hand allocative efficiency and scale efficiency were positively related to patronage dividends and statistically significant at 1% level. Retention of earnings is a method of raising equity common to both cooperatives and investor owned firms. Cooperatives have devised a unique twist by allocating some of these retained earnings to their members based on patronage. Rather than use as a pool of capital it will pay out as patronage dividend. A cooperative's profitability has a direct effect on patronage dividends. So that we assumed operational efficiencies negatively related to patronage dividends. In today's business environment technical efficiency or operating on the frontier technology is critical to cooperative's success. Our regression results shows capital constraint was one of a major reason to be an average cooperative to be off the frontier technology. It is interesting to note that positive relation between scale efficiency and patronage dividends.

Time series mean Malmquist productivities and its' components (Scale change, Pure efficiency change, and Technical change) from 1995 to 2010 are highlighted in Figure 2. It turned out to be for most of the consecutive time periods Malmaquist productivity index was less than one indicating that there were no productivity improvements either from scale change or technical change. Technical change component of Malmquist productivity index involves the shifting of the production frontier. We observed that the highest value of 1.2694 of technical change during 1996 and 1997. During same time period we recognized that the lowest values of scale change of 0.9073 and pure efficiency change of 0.8261. Overall effect due to change in pure efficiency, change in scale and change in technology translates in to Malmquist productivity. Malmquist productivity index was 1.0486 indicating 4.86% progress during 1996

and 1997. Next, we highlighted that the time period during 2005 and 2006 and it recorded the highest Malmquist productivity index of 1.11348 (11.35%).

Conclusions

This study estimated technical, allocative, scale, economic, and overall efficiencies for a set of grain marketing and farm supply cooperatives from CoBank data base. The data set contained 344 cooperatives. Chow test statistics for overall efficiency model did show one structural shift in 2002 and 2003. Before the structural shift, during the time period from 1995 to 2002, the cooperatives were 57% technical efficient, 87% allocative efficient, 84% Scale efficient, 50% economic efficient, and 41% overall efficient for the 1995 to 2002 period. After the structural shift, 2003 to 2010, the cooperatives were 63% technical efficient, 80% allocative efficient, 83% scale efficient, 50% economic efficient, and 41% overall efficient. Although a substantial number of cooperatives could become more efficient by adjusting their technical relationships between their inputs and outputs, getting their marginal revenues and marginal costs right and adjusting their size. Cooperatives are more likely to reduce costs by focusing on technical efficiency rather than adjusting the scale of operation.

Our efficiency trend lines follow those business cycles of 1990s and 2000s. Economic down turns of 2001 and 2008 clearly translate into average efficiencies by way of two dips. It is obvious that all the efficiencies except allocative efficiency were mimicking the growth pattern of the economy. Next, Ordinary least square (OLS) models were used to examine the relationship between cooperative performance ratios and efficiencies. Total sales to total assets ratio was positively related to all the efficiency indices. It indicates efficiency in sales generation per unit of assets encourages cooperatives to be on the production frontier, to use correct input bundles or control of marginal costs and marginal revenues, and to operate correct scale. Current

assets are those assets which the cooperatives expect to turn into cash in the near future. Increase liquidity encourages cooperatives to be on the frontier as well as get the marginal prices right.

Efficiency of the net income generation per unit of personnel expenditure did not help cooperatives to be allocative efficient, so that it seems to us cooperatives were not getting under control of their marginal costs to be overall efficient. Increase earning power of a cooperative enhances overall efficiency as well as cooperatives to get the marginal costs and marginal revenues correct. We assumed operational efficiencies negatively related to patronage dividends. In today's business environment technical efficiency or operating on the frontier technology is critical to cooperative's success. Our regression results shows capital constraint was one reason an average cooperative to be off the frontier technology.

Table 1: Summary Statistics of Cooperatives' Real Values of Inputs and Outputs 1995 to 2010

	Labor Expenses (\$ million)	Capital Expenses (\$ million)	Grain Sales (\$ million)	Farm Input Sales (\$ million)	Other sales (\$ million)			Labor Expenses (\$ million)	Capital Expenses (\$ million)	Grain Sales (\$ million)	Input Sales (\$ million)	Other sales (\$ million)
1995							1996					
Mean	0.94	7.43	10.14	5.54	1.38		Mean	0.86	7.46	9.95	4.82	1.26
Std. Dev.	1.00	9.45	15.69	6.78	2.53		Std. Dev.	0.94	11.13	17.86	6.13	2.39
Median	0.61	4.49	4.96	3.47	0.72		Median	0.54	4.21	4.41	2.77	0.65
1997							1998					
Mean	1.08	8.65	12.69	6.41	1.58		Mean	1.22	9.84	13.58	7.42	1.97
Std. Dev.	1.22	11.53	22.05	8.22	2.80		Std. Dev.	1.36	12.87	22.99	9.52	3.83
Median	0.68	5.06	5.73	3.75	0.80		Median	0.76	5.64	6.73	4.41	0.90
1999							2000					
Mean	1.50	12.33	14.25	7.84	2.46		Mean	1.76	12.83	15.55	7.99	2.82
Std. Dev.	1.62	15.12	22.25	9.69	5.84		Std. Dev.	1.91	15.87	24.89	10.24	7.30
Median	0.95	7.24	6.64	4.89	1.15		Median	1.10	7.51	7.08	5.02	1.22
2001							2002					
Mean	1.71	16.56	13.49	8.17	2.72		Mean	1.97	28.57	17.03	9.74	2.98
Std. Dev.	1.93	22.23	23.27	11.10	7.71		Std. Dev.	2.29	39.51	30.35	12.84	7.48
Median	1.00	9.30	5.73	4.95	1.11		Median	1.17	15.46	7.28	5.75	1.33
2003							2004					
Mean	1.83	30.39	17.26	7.43	2.67		Mean	1.60	25.28	14.49	5.93	2.35
Std. Dev.	2.23	44.23	33.00	10.03	6.75		Std. Dev.	1.96	36.41	27.16	8.21	5.82
Median	1.07	15.63	6.45	4.45	1.17		Median	0.92	13.27	5.39	3.59	0.95
2005							2006					
Mean	2.04	23.34	17.11	7.08	2.97		Mean	2.31	22.17	19.34	8.21	3.50
Std. Dev.	2.53	33.98	32.31	10.05	7.44		Std. Dev.	2.89	34.06	35.78	11.45	10.21
Median	1.15	11.96	6.46	4.20	1.17		Median	1.31	10.80	7.09	4.75	1.31
2007							2008					
Mean	1.83	21.70	16.12	6.23	2.88		Mean	1.99	46.57	22.57	6.73	3.23
Std. Dev.	2.44	36.93	32.19	9.63	8.87		Std. Dev.	2.66	83.19	45.24	10.98	10.01
Median	1.00	9.55	5.46	3.34	0.96		Median	1.07	17.69	7.05	3.52	1.01
2009							2010					
Mean	2.81	74.13	37.77	12.64	4.41		Mean	2.62	75.08	25.97	8.27	3.51
Std. Dev.	3.96	122.79	82.30	20.89	13.41		Std. Dev.	3.71	127.80	52.82	13.64	9.55
Median	1.47	33.60	9.64	6.23	1.48		Median	1.39	32.40	6.20	3.99	1.20
adjusted for inflation by converting to 1995 constant dollars												

Table 2: Summary Statistics of Individual Efficiency Models from 1995 to 2010

(TE = Technical Efficiency, AE = Allocative Efficiency, SE = Scale Efficiency, EE = Economic Efficiency, and OE = Overall Efficiency)

	TE	AE	SE	EE	OE		TE	AE	SE	EE	OE
1995						1996					
Mean	0.55	0.87	0.84	0.49	0.40	Mean	0.60	0.91	0.88	0.54	0.47
Std.Dev.	0.22	0.18	0.22	0.24	0.22	Std.Dev.	0.20	0.14	0.14	0.20	0.19
Median	0.50	0.94	0.95	0.45	0.36	Median	0.56	0.98	0.93	0.50	0.43
Min	0.15	0.12	0.08	0.05	0.03	Min	0.23	0.39	0.25	0.14	0.11
Max	1.00	1.00	1.00	1.00	1.00	Max	1.00	1.00	1.00	1.00	1.00
1997						1998					
Mean	0.55	0.90	0.82	0.49	0.39	Mean	0.59	0.86	0.84	0.51	0.42
Std.Dev.	0.20	0.15	0.17	0.20	0.16	Std.Dev.	0.20	0.16	0.17	0.20	0.17
Median	0.50	0.97	0.86	0.45	0.36	Median	0.53	0.92	0.90	0.46	0.38
Min	0.25	0.25	0.25	0.13	0.07	Min	0.26	0.26	0.29	0.13	0.08
Max	1.00	1.00	1.00	1.00	1.00	Max	1.00	1.00	1.00	1.00	1.00
1999						2000					
Mean	0.62	0.88	0.85	0.54	0.46	Mean	0.60	0.85	0.82	0.51	0.41
Std.Dev.	0.19	0.15	0.16	0.19	0.18	Std.Dev.	0.19	0.16	0.17	0.19	0.16
Median	0.58	0.95	0.91	0.50	0.41	Median	0.56	0.91	0.87	0.46	0.37
Min	0.26	0.23	0.26	0.17	0.12	Min	0.24	0.18	0.27	0.15	0.11
Max	1.00	1.00	1.00	1.00	1.00	Max	1.00	1.00	1.00	1.00	1.00
2001						2002					
Mean	0.53	0.86	0.79	0.45	0.34	Mean	0.57	0.83	0.85	0.47	0.38
Std.Dev.	0.20	0.18	0.18	0.20	0.15	Std.Dev.	0.20	0.18	0.19	0.20	0.17
Median	0.47	0.94	0.84	0.39	0.30	Median	0.51	0.89	0.94	0.41	0.36
Min	0.21	0.15	0.21	0.15	0.10	Min	0.24	0.22	0.25	0.15	0.09
Max	1.00	1.00	1.00	1.00	1.00	Max	1.00	1.00	1.00	1.00	1.00
2003						2004					
Mean	0.63	0.83	0.85	0.52	0.43	Mean	0.66	0.79	0.80	0.52	0.41
Std.Dev.	0.19	0.18	0.17	0.20	0.16	Std.Dev.	0.18	0.19	0.17	0.21	0.16
Median	0.59	0.89	0.93	0.50	0.41	Median	0.63	0.84	0.86	0.49	0.40
Min	0.28	0.19	0.30	0.16	0.11	Min	0.24	0.15	0.21	0.12	0.08
Max	1.00	1.00	1.00	1.00	1.00	Max	1.00	1.00	1.00	1.00	1.00
2005						2006					
Mean	0.65	0.81	0.81	0.53	0.42	Mean	0.62	0.78	0.85	0.49	0.40
Std.Dev.	0.18	0.17	0.18	0.20	0.15	Std.Dev.	0.18	0.21	0.19	0.20	0.17
Median	0.61	0.86	0.87	0.50	0.41	Median	0.59	0.85	0.93	0.47	0.40
Min	0.27	0.22	0.18	0.13	0.09	Min	0.28	0.15	0.17	0.07	0.05
Max	1.00	1.00	1.00	1.00	1.00	Max	1.00	1.00	1.00	1.00	1.00
2007						2008					
Mean	0.63	0.81	0.87	0.51	0.43	Mean	0.59	0.83	0.77	0.49	0.36
Std.Dev.	0.18	0.19	0.18	0.20	0.17	Std.Dev.	0.20	0.18	0.19	0.20	0.16
Median	0.60	0.88	0.94	0.50	0.42	Median	0.55	0.88	0.80	0.45	0.34
Min	0.28	0.20	0.17	0.09	0.07	Min	0.26	0.19	0.23	0.12	0.07
Max	1.00	1.00	1.00	1.00	1.00	Max	1.00	1.00	1.00	1.00	1.00
2009						2010					
Mean	0.64	0.82	0.86	0.52	0.43	Mean	0.58	0.77	0.87	0.45	0.37
Std.Dev.	0.20	0.18	0.16	0.20	0.15	Std.Dev.	0.20	0.20	0.18	0.21	0.15
Median	0.61	0.87	0.92	0.50	0.43	Median	0.55	0.82	0.96	0.41	0.36
Min	0.27	0.22	0.33	0.10	0.09	Min	0.22	0.18	0.21	0.09	0.09
Max	1.00	1.00	1.00	1.00	1.00	Max	1.00	1.00	1.00	1.00	1.00

Figure 1: An Average Grain Marketing and Farm Input Supply Cooperative's Operational Efficiencies during 1995 to 2010

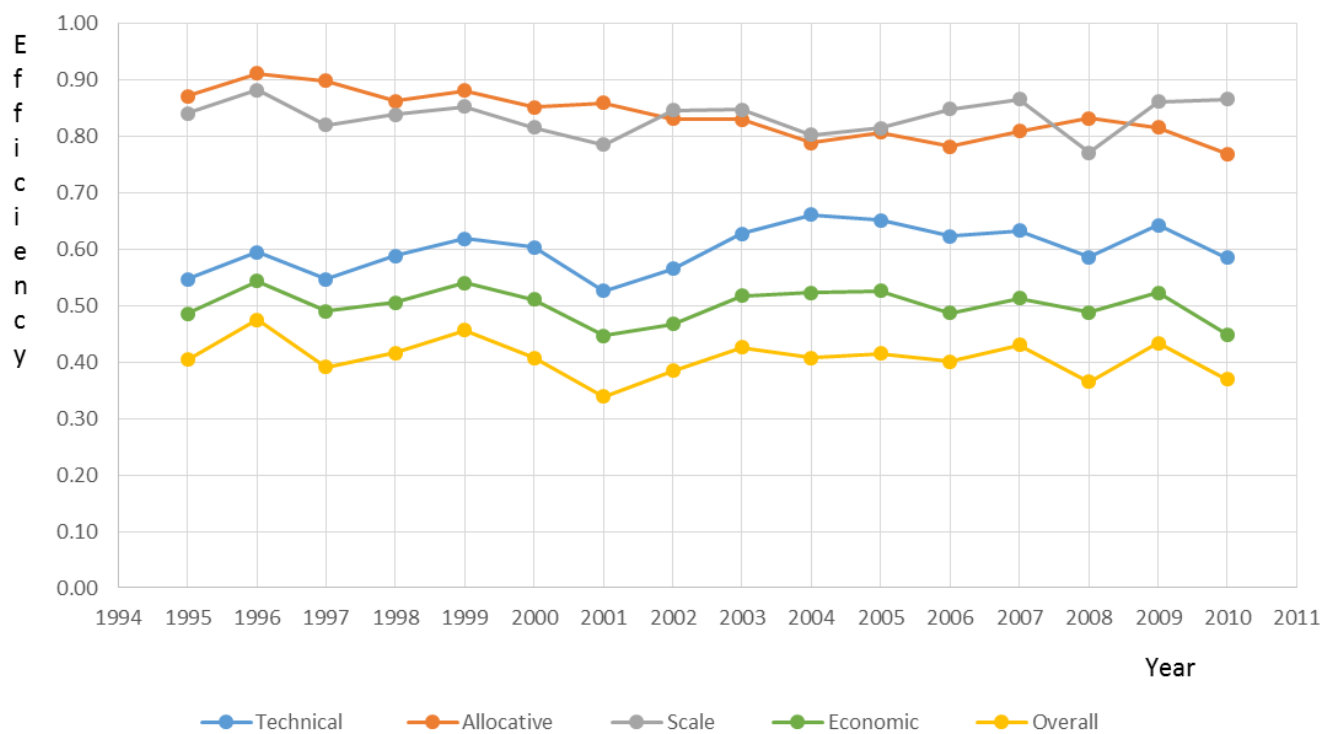
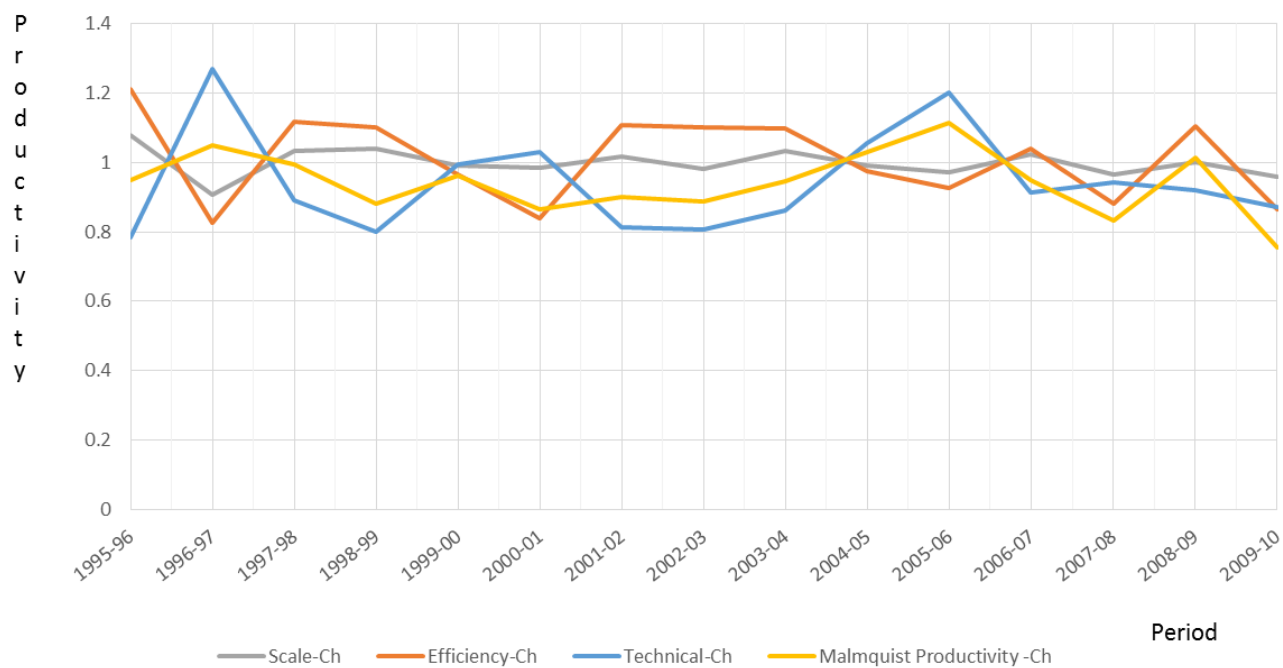


Table 3: Relationship between efficiency Indices and Financial Variables

(STA = Total Sales to Total Assets ratio, CR = Current ratio, NIPE = Net Income to Personnel Expenditure ratio, ROA = Return on Assets, COGINV = Cost of Goods to total Inventory ratio, and PATDCEQ = Patronage Dividends Cash and Equity)

	STA	CR	NIPE	ROA	COGINV	PATDCEQ	Intercept	R-Square
Technical Efficiency Model during 1995 to 2002								
Estimate	0.02597**	0.0111**	0.014119	0.00082999	-0.00003	-0.05214**	0.40522**	0.0911
Std. Errors	0.00203	0.001843	0.01385	0.001137	0.00004	0.008466	0.007933	
Technical Efficiency Model during 2003 to 2010								
Estimate	0.05845**	0.0004095	0.03861**	-0.0004876	-0.000074*	-0.01904**	0.37174**	0.2613
Std. Errors	0.001994	0.001343	0.007524	0.0006917	0.0000303	0.002655	0.00669	
Allocative Efficiency Model during 1995 to 2002								
Estimate	0.000257	0.00595**	-0.42902**	0.02799**	0.00002	0.028509**	0.87395**	0.3824
Std. Errors	0.001546	0.001403	0.01054	0.0008658	0.00003	0.006446	0.006041	
Allocative Efficiency Model during 2003 to 2010								
Estimate	0.02812**	0.00683**	-0.34313**	0.02142**	-0.00002	0.03119**	0.74899**	0.4359
Std. Errors	0.002157	0.001454	0.008142	0.0007485	0.00003	0.002873	0.007239	
Scale Efficiency Model during 1995 to 2002								
Estimate	0.03476**	0.00846**	0.0093	-0.00281*	-0.00005	0.07971**	0.40592**	0.0983
Std. Errors	0.002243	0.002036	0.0153	0.001256	0.00005	0.009354	0.008766	
Scale Efficiency Model during 2003 to 2010								
Estimate	0.06774**	-0.00744**	0.03007**	-0.00269**	-0.000089*	0.049737**	0.40989**	0.2781
Std. Errors	0.002477	0.001669	0.009347	0.0008593	0.000038	0.003299	0.008311	
Economic Efficiency Model during 1995 to 2002								
Estimate	0.030523**	0.025488**	-0.23093**	0.012828**	0.00004	0.0399**	0.37963**	0.176
Std. Errors	0.002238	0.002032	0.01527	0.001254	0.00005	0.009335	0.008747	
Economic Efficiency Model during 2003 to 2010								
Estimate	0.0739**	0.011384**	-0.18752**	0.00991**	-0.00002	0.05518**	0.29693**	0.3717
Std. Errors	0.002435	0.001641	0.009191	0.000845	0.00004	0.003244	0.008172	
Overall Efficiency Model during 1995 to 2002								
Estimate	0.01684**	0.01379**	-0.28287**	0.0208**	-0.00003	-0.049245**	0.35673**	0.2224
Std. Errors	0.001924	0.001746	0.01312	0.001078	0.00004	0.008023	0.007519	
Overall Efficiency Model during 2003 to 2010								
Estimate	0.05886**	0.00619**	-0.16773**	0.013327**	-0.000069*	-0.011854**	0.25926**	0.4326
Std. Errors	0.001818	0.001225	0.006861	0.0006308	0.000028	0.002421	0.006101	
(** = Significant at 1% and * = significant at 5%)								

Figure 2: An Average Grain Marketing and Farm Input Supply Cooperative's Productivity Changes during 1995 to 2010



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