Debt and Input Misallocation in Farm Supply and Marketing Cooperatives:

A DEA Approach

Levi A. Russell, Brian C. Briggeman, and Allen M. Featherstone[1]

Selected Paper prepared for presentation at the Agricultural & Applied Economics Association's 2013 AAEA & CAES Joint Annual Meeting, Washington, DC, August 4-6, 2013.

June 11, 2013

[1] Authors are Ph.D. Candidate, Associate Professor and Director of the Arthur Capper Cooperative Center, and Professor and Director of the Masters of Agribusiness Program in the Department of Agricultural Economics at Kansas State University. For more information on the paper, please contact Dr. Briggeman at bbrigg@ksu.edu.

Introduction

The unique nature of the cooperative business form presents challenges to managers of agricultural cooperatives in terms of financing assets. Raising equity can be difficult, as cooperatives do not allow non-member investors as their for-profit counterparts do. One method of obtaining equity is through mergers, which can be an effective means of obtaining additional capital (Richards and Manfredo, 2001) or retained earnings by increasing profitability (Kenkel et al, 2003). Therefore, debt is an important tool for financing the operation and expansion of a cooperative.

According to USDA-Rural Development statistics, the use of debt increased dramatically in marketing, farm supply, and fishery cooperatives in the U.S. from 2005 to 2010. Increases in the use of debt (44%) outstripped increases in assets (39%) (Table 1). The number of cooperatives fell 20% from 2,896 to 2,314 firms. Pretax earnings increased from $2.5 billion in 2005 to $4.3 billion in 2010, an increase of 72%. The cooperative industry increased in profitability, concentration, and debt use over the study period.

Some negative effects of the use of leverage in cooperatives are noted in the literature. Leverage can have a negative impact on ROE (Boyd et al 2007), and was responsible for a significant portion of financial stress in cooperatives in the 1990s (Moller et al 1996). Recently, there is evidence that debt improves financial performance (McKee 2008).

An important impact of leverage on cooperatives is the potential for agency costs. Agency costs associated with leverage can result from losses due to incomplete contracts between borrowers and creditors, as well as monitoring and disposal costs borne by the creditor. Additionally, creditors may charge higher interest rates for those firms which present greater default risks. A firm with no debt may seek to lower its financing costs by taking on debt. This

effectively spreads the risk the firm faces to another party. As leverage increases, the creditor may begin to restrict additional credit by raising the interest rate. This increased rate compensates the creditor for the additional default risk it has taken. From 2005 to 2010, cooperatives in the US increased the value of debt financing from $27.1 bn. to $39 bn. The present work will examine the impact this increase in financial leverage has had on variable costs.

Featherstone and Al-Kheraiji (1995) find evidence of agency costs in a sample of 29 farm supply and marketing cooperatives from 1979 to 1988. They find that the use of leverage drives up variable costs and results in a decrease in the use of labor inputs suggesting that agency costs associated with leverage exist in farm supply and marketing cooperatives. Additionally, the authors examined the effect of debt financing on changes in total factor productivity. They found that debt had an overall positive effect on total factor productivity growth.

The objective of this study is to determine whether and to what extent agency costs exist in farm supply and marketing cooperatives. A more complete understanding of the indirect costs of leverage will add to our understanding of cooperative financial structure. The analysis is conducted in two stages beginning with a nonparametric estimation of variable cost efficiency. The second stage includes a regression of debt and inputs on variable cost efficiency. This two-stage process will provide us with results comparable to Featherstone and Al-Kheraiji (1995). This work adds to the literature by using a nonparametric estimation of the variable cost function. One advantage of nonparametric estimation is that the curvature of the cost function is guaranteed to conform to economic theory. In addition, recent work by Parman et al demonstrates the relative superiority of this method in obtaining estimates of economic measures.

Methods

Featherstone and Al-Kheraiji (1995) estimate a translog cost model and tests developed by Kim and Maksimovic (1990). Variable cost (defined as total expenses less depreciation, amortization, and lease expense) is estimated as a function of input prices, outputs, debt, and fixed capacity (defined as the value of buildings and equipment and the present value of leases). Variable cost elasticity of debt is calculated in order to determine whether agency costs are present. We conduct similar tests using a two-stage nonparametric and parametric approach.

First, a data envelopment analysis is conducted to determine the minimum variable cost under variable returns to scale for each observation. An efficiency score is then calculated as the ratio of the theoretical minimum variable cost to actual variable cost. In the second stage, the efficiency score is the dependent variable. To examine factors affecting cost efficiency, a Tobit model is used (Coelli et al 2005). Covariates include total debt, output quantities, and state and year dummy variables.

To estimate the variable cost function, data envelopment analysis is used to estimate the minimum variable cost of the cooperative firm under variable returns to scale. The model, developed by Färe et al (1985) is as follows:

$$Min\ \ w_i' x_i^* \tag{1}$$

$$subject\ to \qquad z_i\, x_i\ \leq x_k^* \tag{2}$$

$$z_i\, y_i \geq y_k \tag{3}$$

$$z_i = 1 \tag{4}$$

where w is a vector of input prices, x^* is a vector of cost-minimizing inputs for farm i, x is a vector of actual inputs, z measures the weighting of each firm in forming the frontier, and y is a

vector of outputs. Furthermore, it is assumed that the variables w, x, and y are strictly positive and z is greater than or equal to zero.

The theoretical minimum variable cost calculated above is used to calculate the variable cost efficiency score of each cooperative. Taken together, these scores establish the best-practice (i.e. lowest variable cost for a given level of output) frontier and the relationship of each observation to that frontier. The variable cost efficiency is defined as

$$CE_i = w_i' x_i^* / w_i' x_i \quad (5)$$

where CE is the variable cost efficiency score and the other variables are defined above $CE \in [0,1]$. A firm is considered efficient if the cost efficiency score is equal to one. That is, if a cooperative's actual variable cost is equal to the theoretical minimum variable cost as defined in equation (1), the firm is on the frontier.

In the second stage, the cost efficiency scores calculated in equation (5) are used to estimate relationships between the previously-mentioned covariates. A Tobit model is used to account for the upper and lower bounds on the cost efficiency scores. This regression estimates the relationships between debt, capacity, output, and cost efficiency. It is specified as follows:

$$CE = \beta_0 + \beta_D D + \beta_j Y_j + \sum_k \pi_k + \sum_l t_l \quad (6)$$

where CE is defined as above, D is total debt, Y is a vector of j outputs, π_k is a vector of k state-level dummy variables, and t_l is a set of l time dummy variables.

From these regressions, we are able to determine whether agency costs exist in agricultural cooperatives. Kim and Maksimovic (1990) define the marginal effect of debt on variable cost as an indication of the presence of agency costs. For our purposes, agency costs associated with debt exist when β_D is statistically significant. In order to determine the elasticity values, conditional marginal effects are used. Elasticities are defined as follows:

$$\varepsilon_m \equiv \frac{\partial E[CE|1>CE>0]}{\partial m} \frac{E[m]}{E[CE|1>CE>0]} \quad (7)$$

where ε_m is the elasticity of the mth covariate.

Data

Cost efficiency scores were estimated using financial statement data for farm supply and marketing cooperatives from 2005 to 2010 in 9 states: Iowa, Illinois, Indiana, Kansas, Minnesota, Missouri, Nebraska, Ohio, and Oklahoma. The data are obtained from CoBank and include balance sheet, income statement, and statement of owner's equity. Table 2 presents summary statistics for all variables described below.

Similar to Tonsor and Featherstone (2009) and Rowland et al. (1998), overall cost efficiency is estimated using a data envelopment analysis. Two inputs and three outputs are used in the calculation of minimum variable cost. Variable cost is defined as net sales less net income, depreciation, amortization, and lease expense. Labor cost is defined as payroll expense. Other variable cost is defined as variable costs less payroll expense. Debt is defined as the value of total liabilities. The prices of each input are the state-level manufacturing payroll wage and the GDP deflator, respectively. Wage data was taken from the Bureau of Labor Statistics *Employment and Earnings* report and the GDP deflator was taken from the St. Louis Federal Reserve FRED® Economic Data database. Input quantities are determined by dividing both costs by their respective price or price index. Output variables are defined as marketing revenue, farm supply revenue, and other revenue divided by their respective price indices. The marketing price index is composed of yearly average commodity prices for corn, wheat, soybeans, sorghum, and rice taken from the Bureau of Labor Statistics and is weighted by the state-level production of each commodity. State-level production data were taken from USDA-NASS. The farm supply price index is the average of fertilizer, agricultural chemical, gasoline, and animal feed prices

taken from the Bureau of Labor Statistics. The price index for other revenue is the producer price index for all commodities taken from the Bureau of Labor Statistics. Following Kim and Maksimovic (1990), the debt and output variables are scaled about their respective means. This allows for meaningful interpretation of the elasticities at the mean.

Results

Nineteen observations comprise the efficient frontier. Summary statistics for CE are presented in Table 3. The median is below the mean, indicating that the distribution is negatively skewed. Nearly 66% of the observations were above an efficiency score of 0.60, and 27% were above a score of 0.80. The mean efficiency score of 0.685 indicates that the average cooperative in the dataset would need to reduce its costs by 31.5% and maintain its current production in order to reach the best-practice frontier.

Agency costs are indirect costs to the firm incurred by the use of debt. They may be due to disposal or monitoring costs associated with certain classes of assets or to higher interest rates that compensate the lender for increased default risk. To determine whether agency costs are present, a regression was estimated which included debt, output, and state and time dummy variables. A Tobit regression was used to account the upper and lower bounds on the efficiency score.

The results of the Tobit estimation (Table 4) and conditional marginal effects (Table 5) show that the use of debt is working in favor of cooperatives. Table 5 shows that an increase in the use of debt is positively related to an increase in cost efficiency. This is the opposite conclusion from Featherstone and Al-Kheraiji (1995), who find significant agency costs of debt for 29 cooperatives from 1979 to 1988. The conditional elasticity of debt is 0.0028, indicating

that a 1% increase in total debt increases cost efficiency by 0.0028%. Though debt is a statistically-significant factor, the economic impact of debt on variable cost efficiency is small.

In addition to a statistically-significant effect of debt on efficiency, significant scale effects are found. Table 5 shows conditional marginal effects of the three output variables on cost efficiency. According to our results, there are economies of scale in the marketing output and diseconomies of scale in the supply and other outputs. Conditional elasticities of the marketing (0.00343) supply (-0.01825) and other (-0.00497) outputs indicate that economies and diseconomies of scale are slight.

Conclusion

This study determines the existence and the degree to which agency costs exist in a sample of farm supply and marketing cooperatives in the Midwest and Great Plains regions of the US. We find that the use of debt financing has a positive effect on variable cost efficiency, indicating that if agency costs are present, they are not significant enough to outweigh the beneficial effects of the use of debt on firm efficiency. One possible explanation of the positive relationship between debt financing and variable cost efficiency is that firms work to improve their efficiency in order to compete more effectively for debt financing (Alarcon 2007).

Our results are not consistent with the findings of Featherstone and Al-Kheraiji (1995). This is the only other study known to the authors that has examined the presence of agency costs in agricultural cooperatives. They find statistically-significant evidence of agency costs of debt in 29 farm supply and marketing cooperatives from 1979 to 1988. The discrepancy between the results found in this study and those of Featherstone and Al-Kheraiji (1995) may be due to a difference in the methods used to analyze the problem or to systemic economic differences in the

two time periods studied. Further work is necessary to determine which of these possible explanations is correct.

Future work will examine the existence of agency costs over a longer time period. The present method will be used in conjunction with an expanded dataset (1979-2011) to determine changes in the effects of agency costs over the past 3 decades.

References

Alarcon, S. 2007. "Debt Financing and Efficiency in Agricultural Firms." Presented at the Mediterranean Conference of Agro-Food Social Scientists. 103rd EAAE Seminar 'Adding Value to the Agro-Food Supply Chain in the Future of Euromediterranean Space'. Barcelona, Spain, April 23 – 25, 2007.

Boyd, S., Boland, M., Dhuyvetter, K., and Barton, D. (2007). Determinants of Return on Equity in U.S. Local Farm Supply and Grain Marketing Cooperatives. *Journal of Agricultural and Applied Economics, 39*, 201-210.

Coelli, T. J., Rao, D., O'Donnell, C., and Battese, G. (2005). *An Introduction to Efficiency and Productivity Analysis* (2 ed.). New York: Springer.

Färe, R., Grosskopf, S., and Lovell, C. (1985). *The Measurement of Efficiency of Production.* Boston: Kluwer-Nijhoff.

Featherstone, A. M., and Al-Kheraiji, A. A. (1995). Debt and Input Misallocation of Agricultural Supply and Marketing Cooperatives. *Applied Economics, 27*, 871-878.

Kenkel, P., Gilbert, A., and Spence, B. (2003). Post Merger Financial Performance of Oklahoma Cooperatives. *Southern Agricultural Economics Association Annual Meeting.* Mobile, AL.

Kim, M., and Maksimovic, V. (1990) Debt and Input Misallocation. *Journal of Finance, 45*, 795-816.

McKee, G. (2008). The Financial Performance of North Dakota Grain Marketing and Farm Supply Cooperatives. *Journal of Cooperatives, 21*, 15-34.

Moller, L. G., Featherstone, A. G., and Barton, D. G. (1996). Sources of Financial Stress in Agricultural Cooperatives. *Journal of Cooperatives, 11*, 38-50.

Parman, B., Featherstone, A.G., Amanor-Boadu, V. (2013). A Comparison of Parametric and Nonparametric Estimation Methods of Production Frontiers and Multiproduct Scale, Product-Specific Scale, and Scope Economies. Working Paper.

Richards, T. J., and Manfredo, M. R. (2001). Post-Merger Performance of Agricultural Cooperatives. *American Agricultural Economic Association.* Chicago, IL.

Rowland, W.W., Langemeier, M.R., Schurle B.W., and Featherstone, A.M. (1998). A Nonparametric Efficiency Analysis for a Sample of Kansas Swine Operations. *Journal of Agricultural and Applied Economics, 30, 189-199.*

St. Louis Federal Reserve, FRED® Economic Data (2005-2010). *Price Indexes and Deflators*

Tonsor, G.T., and Featherstone, A.M. (2009). Production Efficiency of Specialized Swine Producers. *Review of Agricultural Economics, 31, 493-510.*

US Department of Agriculture, National Agricultural Statistics Service (2005-2010). *Data and Statistics*

US Department of Labor, Bureau of Labor Statistics (2005-2010). *Employment and Earnings*

US Department of Labor, Bureau of Labor Statistics (2005-2010). *Producer Price Indexes*

Table 1. Key Statistics: Marketing, Farm Supply, and Fisheries Cooperatives

	2010	2005	%Change
#Firms	2314	2896	-20%
Assets[a]	65	46.6	39%
Debt[a]	39	27.1	44%
Equity[a]	26	19.5	33%
Pre-Tax Earnings[a]	4.3	2.5	72%

[a] Billions of dollars.

Table 2. Summary Statistics for a Sample of Midwestern Cooperatives from 2005-2010

	Mean	Standard Deviation	Min	Max
Marketing Output	321199.8	4.90E+05	0.00	5102277
Supply Output	120171.1	175239.9	0.00	1342424
Other Output	81702.7	335860.1	0.00	5817257
Marketing Price Index	141.5	40.1	81.1	225.3
Supply Price Index	176.1	23.6	143.6	216.2
Producer Price Index	173.8	10.9	157.4	189.6
Labor Input	189132.3	250732.1	6237.6	2288761
Other Variable Cost Input	627939.7	859935.1	10203.7	8323140
Wage	17.2	1.35	14.3	19.9
GDP Deflator	106.5	3.789717	100.0	111.0
Debt	19400000.0	3.04E+07	82947	3.24E+08

Table 3. Summary Statistics: Variable Cost Efficiency Score

	Mean	StDev	Median	# = 1.00	# ≥ 0.80	# ≥ 0.60
CE	0.6847	0.1579	0.6708	19	537	1294

Table 4. Tobit Regression Results

Parameter	Coefficient	Standard Error	T	P-Value
Debt	-0.0052	0.0022	-2.28	0.023
Marketing Output	-0.0063	0.0020	-3.14	0.002
Supply Output	0.0334	0.0018	18.93	0.000
Other Output	0.0091	0.0007	13.49	0.000
Iowa	0.0052	0.0099	0.53	0.597
Illinois	0.0087	0.0097	0.90	0.366
Indiana	0.0122	0.0133	9.16	0.000
Kansas	-0.0093	0.0094	-0.99	0.322
Minnesota	0.0203	0.0098	2.07	0.038
Missouri	0.0267	0.0127	2.10	0.036
Nebraska	-0.0035	0.0113	-0.31	0.759
Ohio	0.0099	0.0113	0.87	0.382
2005	0.2492	0.0069	35.90	0.000
2006	0.1779	0.0069	25.85	0.000
2007	0.0310	0.0068	4.56	0.000
2008	-0.1103	0.0069	-15.9	0.000
2009	0.0249	0.0068	3.64	0.000
Constant	0.5827	0.0095	61.51	0.000

Table 5. Tobit Conditional Marginal Effects

Parameter	Marginal Effects	Standard Error	z	P-Value
Debt	0.0019	0.0009	2.26	0.024
Marketing Output	0.0023	0.0008	3.08	0.002
Supply Output	-0.0124	0.0010	-12.46	0.000
Other Output	-0.0034	0.0003	-11.19	0.000