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Profit Efficiency of Farm Credit System Associations

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Abstract

Nonparametric profit frontiers are used to measure economic efficiency of Farm Credit System associations. Evidence of inefficiencies among Farm Credit System associations is evaluated by geographic regions. Results indicate that many associations are efficient given shortrun constraints imposed by fixed investments and nonaccrual loans. However, further consolidation of associations may result in savings to taxpayers and borrowers. Associations generally appear to be too small and too numerous for the system to attain longrun profit efficiency, despite considerable consolidation over the past decade. Legislative history of the Farm Credit System indicates that profit inefficiencies would be politically acceptable if they were the price of increased credit availability to the agricultural sector. However, profit-inefficient associations, except those in Texas, are not characterized by excessive lending, compared with profit-efficient associations.

Keywords: Farm Credit System, Production Credit Associations, Agricultural Credit Associations, Federal Land Credit Associations, efficiency, data envelope analysis

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Profit Efficiency of Farm Credit System Associations

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Introduction

The Farm Credit System (FCS) is a network of member-owned cooperatives, organized to provide credit and related services to agriculture, ancillary businesses, and rural home buyers. Its primary economic and political function is to supply reliable, low-cost credit to its owner-borrowers. Despite the vital role of the FCS in financing agriculture, analytical work is limited, especially regarding the performance of system associations.

This paper investigates the viability and efficiency of FCS direct-lending associations using data envelope analysis (DEA) and linear programming techniques to calculate nonparametric profit frontiers. These frontiers provide information concerning the relative efficiency of direct-lending associations within the FCS, using the most profitable associations as benchmarks. Measuring FCS efficiencies is necessary to determine whether the FCS channels all the benefits provided through government sponsorship to the targeted agricultural sector. Evidence that FCS institutions are neither maximizing loans outstanding (subject to acceptable quality) nor profits would indicate that some of these benefits are absorbed by the system, limiting benefits to the target sector and reducing the efficacy of government sponsorship.

The nonparametric approach employed here offers several advantages over parametric approaches. First, the nonparametric approach allows the estimation of a deterministic frontier without presuming the optimality of the observed data. Second, this approach imposes no prespecified functional form on the data, reducing specification error. Third, this approach shifts emphasis from a most likely relationship, reflecting mediocre performance, to a less likely relationship that focuses on extreme or best performance.

Background

The FCS is a network of member-owned cooperatives, organized to provide credit and related services to production agriculture, ancillary businesses, and rural home buyers.

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Although the system was originally capitalized by the Federal Government, initial government assistance was fully repaid in 1968. Following the widespread financial distress in production agriculture in the early to mid-1980's, the 1987 Agricultural Credit Act authorized a $4-billion line of credit with the Treasury Department to recapitalize distressed regional banks within the system. The part of the system primarily concerned with the provision of credit to farm business and households consists of regional Farm Credit Banks (FCB's), Production Credit Associations (PCA's), Federal Land Bank Associations (FLBA's), Agricultural Credit Associations (ACA's), and Federal Land Credit Associations (FLCA's). Except for the FLBA's, each type of association is chartered as a direct lender, generally holding loans they originate in their own portfolio. FLBA's originate loans for the portfolios of the regional banks, having no loan portfolio of their own. In addition, each type of association has a different mandate in terms of the types of loans (real estate or nonreal estate) it can originate. PCA's have nonreal estate lending authority; FLBA's and FLCA's have real estate lending authority; and ACA's have authority to originate both types of loans.

This paper concentrates on the associations with direct-lending authority in 1989: PCA's, ACA's, and FLCA's. We use data from a newly available source: call reports required by FCS's regulator, the Farm Credit Administration (FCA). These reports contain detailed accounting information on associations, district Farm Credit Banks, and other entities of the FCS.

We calculate profit frontiers for these associations. This approach is used because of available data and not because we believe these associations are profit maximizers. This study provides evidence on two important issues. The first issue concerns the viability of these institutions. If they are able to achieve positive accounting profits, they may be regarded as viable, at least in the short run.

The second issue relates to the question of how well they may be achieving their politically-stated goal of providing maximum service at minimum cost subject to maintaining longrun viability, that is, meeting minimum loan quality and profitability standards.[1] If management of these member-owned cooperatives were consistent with this goal, the ratios of observed notes-payable expense to profit-maximizing notes-payable expense should be greater than 1. Observation of ratios less than 1 would be inconsistent with inefficient associations sacrificing profit efficiency to attain greater loan volume.

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[1]The Farm Credit Act Amendments of 1986 include the following passage:

SEC.1032.POLICY.

Section 1.1 of the Farm Credit Act of 1971 (12 USC 2001) is amended by adding at the end thereof the following new subsection:

"(c) It is declared to be the policy of Congress that the credit needs of farmers, ranchers, and their cooperatives are best served if the institutions of the Farm Credit System provide equitable and competitive interest rates to eligible borrowers, taking into consideration the creditworthiness and access to alternative sources of credit for borrowers, the cost of funds, including any costs of defeasance under section 4.8(b), the operating costs of the institution, including the costs of any loan loss amortization under section 5.19(b), the cost of servicing loans, the need to retain earnings to protect borrowers' stock, and the volume of net new borrowing. Further, it is declared to be the policy of Congress that Farm Credit System institutions take action in accordance with the Farm Credit Act Amendments of 1986 in such manner that borrowers from the institutions derive the greatest benefit practicable from that Act: *Provided,* That in no case is any borrower to be charged a rate of interest that is below competitive market rates for similar loans made by private lenders to borrowers of equivalent creditworthiness and access to alternative credit."

The last assertion can be supported as follows. Notes-payable expense consists of interest on notes payable from direct-lending associations to district banks. Such notes payable are used to finance an average of 85 percent of lending. The remainder of loanable funds comes from association retained earnings. Thus, there are several determinants of notes-payable expense. These consist of the ratio of notes payable to retained earnings used to finance lending and the interest rate on the notes. If the most profitable associations are profitable because of low interest rates paid or because of high levels of retained earnings to fund lending, then their notes-payable expense will be lower relative to other associations; other less profitable associations will appear to be overlending relative to profit-maximization. So the bias should be toward finding overlending in inefficient associations.

Methodology

We analyze association performance based on the assumption of competitive profit maximization, using the activity analysis approach of Fare, Grosskopf, and Lovell. An example of a profit maximization model using activity analysis can be found in Fare, Grosskopf, and Lee. Studies of economic efficiencies in financial intermediaries include Ferrier and Lovell and Berger and Humphrey. Both of these studies concentrate on commercial banking and cost frontiers. Ferrier and Lovell compare nonparametric and econometric approaches, while Berger and Humphrey introduce parametric "thick frontier" methodology. In addition, both Hancock and Rossi have applied profit function analysis to issues of financial intermediation.

Following Fare, Grosskopf, and Lee, a nonparametric frontier technology formed by the observations may be written as the boundary of

$$T = \{(x,u) : \sum_{k=1}^{K} z^k u^k \geq u \qquad (1)$$

$$\sum_{k=1}^{K} z^k x^k_n \leq x_n,\ n=1,\ldots,N,\ z \in R^K_+,\ \sum_{k=1}^{K} z^k = 1\}$$

where there are $k = 1,\ldots,K$ observations of inputs x^k, $x^k = (x^k,\ldots,x^k_n,\ldots,x^k) \in R^N_+$ and one output u^k. These observations represent K Farm Credit System associations in the same cross-section. And, z^k is the intensity variable for activity k. The z variables serve to form convex combinations of the observed input and output data. The restriction that the z's sum to 1 implies that the frontier technology is not required to exhibit constant returns to scale.

While the economic objective of FCS associations may more reasonably be interpreted as cost minimization rather than profit maximization, the former objective cannot be modeled because the available data set lacks explicit price indices. Therefore, we calculated a cost-constrained profit frontier to reveal the relationship between efficient cost and loan production. More specifically, we specify a single-output, restricted-profit-maximization model in terms of total revenues and expenditures on variable inputs. The observations consist of $k = 1,\ldots,K$ observations on total revenue (interest plus noninterest income) and on expenditures on variable and fixed inputs. All associations in the data set are assumed

to face the same input and output prices.[2] Total revenue is denoted R, variable costs are denoted $C^k_v = (C^k_1,\ldots, C^k_i,\ldots,C^k_J)$, and fixed costs in the shortrun models are denoted $C^k_f = (C^k_{J+1},\ldots,C^k_N)$, where there are N total inputs of which J are variable and N-J are fixed. We also constrain average loan size (ALS) in all models so that it cannot be increased to improve profits. This constraint is necessary because it is less expensive per dollar loaned to make large loans than small ones, but the size of loans demanded is to a large extent dependent on institutions and environmental and economic factors beyond the control of lending associations.

This information can be used to form a nonparametric frontier technology that satisfies variable returns to scale (V) and strong disposability of inputs and outputs (S). We calculate both longrun and shortrun frontiers. The longrun profit maximization problem may be written as follows:

$$\pi_s(R^k, C^k \mid V, S) = \max_{R,C,z} \; R - \sum_{i=1}^{N} C \qquad (2)$$

$$\text{s. t.} \quad \sum_{k=1}^{K} z^k R^k \geq R,$$

$$\sum_{k=1}^{K} z^k C_i^k \leq C_i, \quad i=1,\ldots,N,$$

$$\sum_{k=1}^{K} z^k ALS^k \leq ALS^{k'}, \text{ and}$$

$$\sum_{k=1}^{K} z^k = 1, \; z \in R^K_+,$$

where k′ indicates the particular association under consideration.

To calculate the shortrun frontier, we add several constraints to the longrun model. First, we designate buildings and equipment and certain miscellaneous expenses as fixed in the short run. These expenditures cannot be increased in the short run to improve profitability. In addition, we impose a shortrun disposability constraint that nonaccrual loans (NAL) cannot be decreased to improve profits, since the resolution of troubled loans is a costly and time-consuming process.

The treatment of fixed assets may seem counterintuitive to readers unfamiliar with DEA. We use DEA here to measure efficiency given resource use. The constraint that fixed assets cannot be increased means that in constructing the efficient frontier each association is only compared with other associations or combinations of other associations that employ at least as many fixed assets. If such an association or such a combination exists that simultaneously enjoys higher operating profits, the association is not on the

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[2]These assumptions are clearly abstractions from reality necessary because of the lack of prices in the data set. The assumptions introduce two complications into the analysis. First, they make it impossible to distinguish between allocative and technical efficiency. Second, they bias results against associations that face high input prices or low output prices. In particular, systemwide average rates charged on long-term loans are lower than those charged on short-term loans by about 1 percentage point, suggesting that results are biased against long-term lenders (ACA's and FLCA's) in the nationwide models.

efficient frontier. It is not using its assets as well as they might be used. If such an association or such a combination does not exist or does not enjoy higher operating profits, then the association is on the efficient frontier.

The constraint on nonaccrual loans is used as a proxy for constraints on all nonearning assets. Unfortunately, information on other categories of nonearning assets, including other property owned, is not available at the association level at this time.

Variable profit for observation k = 1,...,K can then be calculated as the solution to the following linear programming problem.

$$\pi_s(R^k, C^k | V, S) = \max_{R,C,z} \; R - \sum_{i=1}^{J} C \qquad (3)$$

$$\text{s. t.} \quad \sum_{k=1}^{K} z^k R^k \geq R,$$

$$\sum_{k=1}^{K} z^k C_i^k \leq C_i, \; i=1,\ldots,J,$$

$$\sum_{k=1}^{K} z^k C_i^k \leq C_i^{k'}, \; i=J+1,\ldots,N,$$

$$\sum_{k=1}^{K} z^k ALS^k \leq ALS^{k'},$$

$$\sum_{k=1}^{K} z^k NAL^k \geq NAL^{k'}, \text{ and}$$

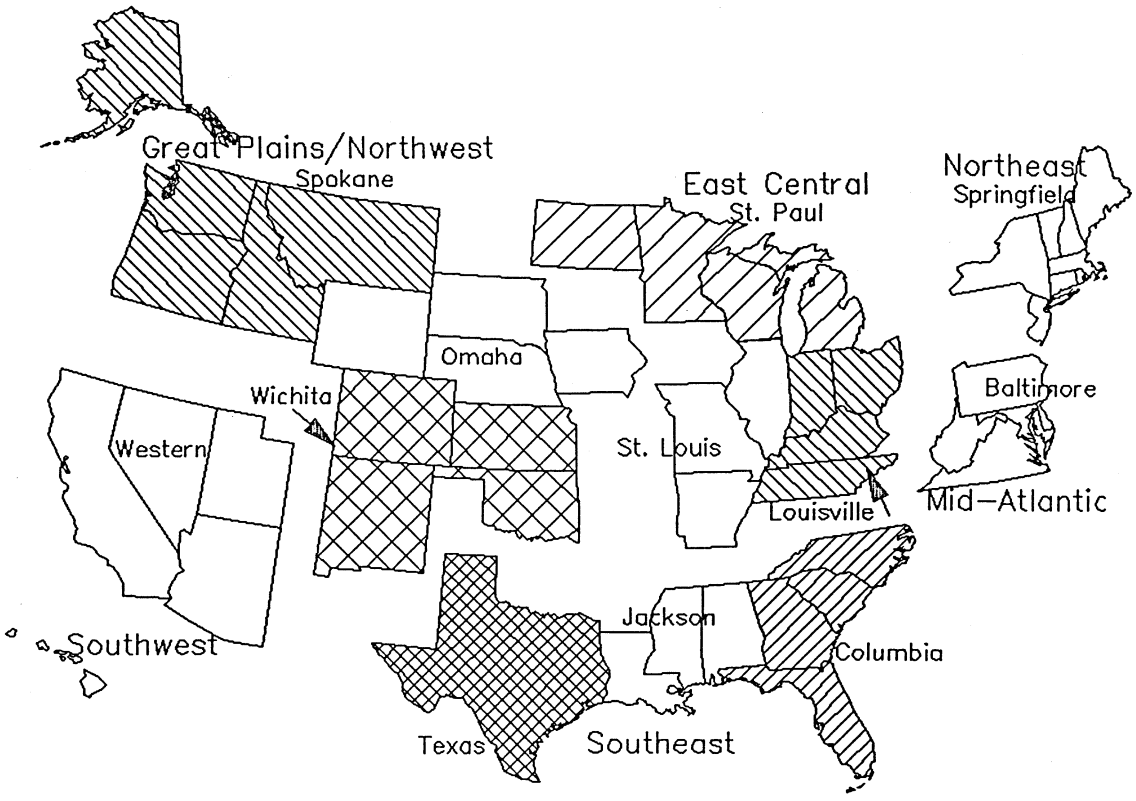
$$\sum_{k=1}^{K} z^k = 1, \; z \in R^K_+.$$

For both lengths of run, two types of frontiers are calculated. The first compares all direct-lending associations in the country (nationwide models); the second imposes regional and association-type constraints on the comparisons (regional models). The regional frontiers compare associations in "similar" agricultural regions (fig. 1). The constraints on region and association type were determined on the basis of available observations. Several districts have only one or two direct-lending associations, so some aggregation of districts into regions was required. These regions were chosen to ensure a minimum number of institutions in each group, while maintaining some similarity in the type of agriculture served. PCA's are compared with each other, but other direct-lending associations (ACA's, FLCA's) are ranked relative to all associations because of the small numbers of ACA's and FLCA's. Thus, the regional models add the following constraints to equations 2 and 3.

$$\sum_{k=1}^{K} z^k D_{PCA}{}^k \leq D_{PCA}{}^{k'}, \text{ and}$$

$$\sum_{k=1}^{K} z^k REG_j^k \geq REG_j^{k'}, \; j = 1,\ldots,J,$$

Figure 1--Regions used in study and FCS districts



where D_{PCA} is a binary variable that takes the value 1 if the association is a PCA and REG_j are binary variables designating each of the six regions used in the study.

It should be noted that some interdistrict variation exists in cost-sharing arrangements between Farm Credit Banks and related associations. Therefore, some of the differences in performance across districts in the nationwide models and in multi-district regions in the regional models may be unrelated to efficiency. We investigated this possibility for the Southeast region, which is dominated by observations from the Texas district. Little effect was found on shortrun regional efficiency measures for the Texas district. However, longrun efficiency measures changed considerably.

Data

The model is applied to 1989 data for a cross-section of 117 FCS associations, including 83 PCA's, 32 ACA's, and 2 FLCA's--all direct-lending associations for which a full year of data exists in the 1989 call reports and that are not in receivership. The data were obtained from call reports collected by the FCA. While agricultural conditions differ widely from region to region, FCS associations are subject to the same financial and legal standards. Hence, it is reasonable to assume that the same technology is available to all associations.

Data used in the analysis include total revenue (total interest income and noninterest income), expenditures on three variable inputs (salaries, notes payable, and services), and expenditures on two fixed inputs (buildings and equipment and on miscellaneous fixed items such as director's expense and expenses on acquired property).

Table 1 presents summary statistics for FCS direct-lending associations at the nationwide and regional levels of aggregation. There is considerable variation both within and across regions for most of these variables. Southwest region associations have the lowest mean total expenses, the highest mean nonaccrual loans, and the highest mean loan size. Mid-Atlantic region associations have the largest mean levels of assets and total revenues, while Northeast region associations have the lowest mean level of nonaccrual loans.

Table 1--Summary statistics by FCS regions

Region	Total revenue	Total operating expenses	Notes payable expense	Average loan size	Non-accrual loans	Total assets
			1,000 dollars			
All regions (117 associations):						
Mean	11,244	1,814	8,452	75	3,088	109,250
Standard deviation	14,649	2,977	10,321	40	5,520	142,370
Northeast region (District 1; 13 associations):						
Mean	13,827	1,827	10,615	52	175	121,964
Standard deviation	11,198	1,324	8,717	14	311	101,138
Mid-Atlantic region (District 2; 17 associations):						
Mean	15,233	1,534	12,896	74	1,033	152,155
Standard deviation	10,940	1,061	9,448	32	1,193	110,018
Southeast region (Districts 3, 5, and 10; 23 associations):						
Mean	10,590	2,351	6,810	72	3,961	102,201
Standard deviation	24,565	5,500	14,305	28	9,350	232,964
East Central region (Districts 4, 6, and 7; 27 associations):						
Mean	9,628	1,833	7,094	45	2,958	98,616
Standard deviation	10,494	2,419	8,064	13	2,999	112,312
Great Plains/Northwest region (Districts 8, 9, and 12; 19 associations):						
Mean	8,729	1,661	6,472	85	2,849	84,512
Standard deviation	14,578	2,879	12,179	30	5,900	145,645
Southwest region (District 11; 18 associations):						
Mean	11,526	1,513	8,918	128	6,468	110,617
Standard deviation	7,471	836	5,780	54	4,343	69,365

Results of the Profit Efficiency Analysis

The profit frontiers calculated for this study can be ranked from most constrained to least constrained as follows:

- Shortrun regional
- Shortrun nationwide
- Longrun regional
- Longrun nationwide

The fewer constraints imposed by the programming algorithm, the greater are the assumed similarities among associations and their business environments. Thus, in calculating the shortrun regional frontier, differences in the business environment among regions are assumed to be sufficiently large to make cross-region comparisons invalid. In addition, associations are not allowed to increase profits by employing more fixed assets than they already have or by carrying fewer nonaccrual loans than are already on their books. In calculating shortrun nationwide frontiers, all comparisons across regions and across institution type are permitted; however, average loan size is not permitted to increase on the assumption that local agricultural conditions largely determine this factor. In calculating longrun regional frontiers, all inputs are treated as variable and the constraint on nonaccrual loans is removed, while regional and institution-type constraints are maintained. For longrun nationwide frontiers, all inputs are treated as variable and the only other constraint is on average loan size.

As constraints are removed, potential profits increase and ever fewer associations are ranked as efficient and more are ranked as viable. For example, 69 of 117 associations are on the efficient shortrun regional profit frontier, while only 2 associations are on the longrun nationwide profit frontier. Simultaneously, all but three associations achieve positive variable profits in the shortrun regional models, and all associations achieve positive profits in the longrun nationwide model.

Nonparametric profit efficiency measures were calculated for each association by taking the ratios of actual profits to optimal calculated profits.[3] These ratios are bounded by zero and 1, with a ratio of 1 indicating that the association is on the efficient frontier. Ratios less than 1 indicate the portion of potential profit actually earned from operations. The ratios of actual notes-payable expense to optimal notes-payable expense[4] were also calculated. Notes-payable-expense ratios greater than 1 indicate that profit inefficiency may have resulted from politically acceptable overlending. Regional ratios were obtained by averaging association ratios for each region.

To assess the effects of added constraints on efficiency measures, we considered the ratio of potential profit in the most constrained frontier, the shortrun regional frontier, to the potential profit in the least constrained frontier, the longrun nationwide frontier. We decomposed this ratio to determine which constraints increased efficiency measures most.[5]

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[3]The ratio of actual operating profit to optimal operating profit is hereafter referred to as profit-efficiency ratios.

[4]The ratio of actual notes-payable expense to optimal notes-payable expense is hereafter referred to as the notes-payable-expense ratio and should not be confused with the ratio of notes-payable expense to total expense.

[5]Although adding constraints decreases potential profit, doing so increases the number of associations ranked as efficient, as noted above, by reducing the number of allowable comparisons. Thus, profit efficiency measures increase as constraints are added.

Many Associations May Be Efficient in the Short Run, But There is Substantial Room for Improvement in Longrun Efficiency

Table 2 presents national and regional average profit-efficiency ratios for the four frontiers, and table 3 presents average notes-payable-expense ratios. Addenda to table 2 indicate the numbers of efficient and nonviable associations for each frontier. An addendum to table 3 indicates the number of associations with greater than profit-maximizing loan activity (as measured by notes-payable expense) for each frontier.

Table 2--Profit efficiency ratios[1]

Region	Shortrun		Longrun		
	Regional	Nationwide	Regional	Nationwide[2]	
	Mean ratios (standard deviations)				
All associations	0.73	0.49	0.28	0.06	0.18
	(.41)	(.37)	(.64)	(.15)	(.28)
Northeast	.99	.62	.41	.08	.36
	(.04)	(.24)	(.35)	(.07)	(.30)
Mid-Atlantic	.69	.37	.38	.09	.23
	(.61)	(.37)	(.63)	(.24)	(.30)
Southeast	.56	.39	.10	.05	.06
	(.41)	(.40)	(.28)	(.21)	(.13)
East Central	.61	.54	.31	.06	.18
	(.41)	(.39)	(.45)	(.16)	(.32)
Great Plains/Northwest	.82	.52	.19	.01	.08
	(.33)	(.35)	(1.29)	(.05)	(.27)
Southwest	.90	.53	.36	.04	.23
	(.22)	(.39)	(.33)	(.05)	(.25)
Addenda:					
Texas	.53	--	.37	--	--
	(.52)	--	(.65)	--	--
		Number			
Efficient associations	69	28	15	2	3
Nonviable associations	3	1	1	0	0

-- = Not calculated.

[1]Observed profit divided by optimal profit for each frontier. The closer the ratio is to 1, the more efficient, on average, are the associations at maximizing profit relative to the most profit efficient associations.

[2]The first column reports results when all associations are included. The second column reports results when the dominant association is dropped because it may be an outlier and the frontier is recalculated without it.

The measures based on the shortrun regional frontier indicate that 69 of 117 associations (58 percent) are efficient under the assumptions of this model (table 2). Table 2 also shows that three associations are nonviable (unable to achieve positive variable profits), while table 3 shows that 14 associations are operating at greater than profit-maximizing levels of loan production (consistent with maximizing loan volume subject to a minimum profit constraint). Evidence of shortrun, intraregional inefficiency in the Northeast and Southwest regions is scant, while associations in other regions vary greatly in efficiency. The most intraregional variation is evident in the Southeast, the East Central, and the Great Plains/Northwest regions. As noted above, this could indicate significant interdistrict difference in bank/association relationships in these regions.

Table 3--Notes-payable-expense ratios[1]

Region	Shortrun		Longrun		
	Regional	Nationwide	Regional	Nationwide[2]	
	Mean ratios (standard deviations)				
All associations	0.94	0.66	1.00	0.18	0.36
	(.24)	(.36)	(3.57)	(.33)	(.61)
Northeast	.99	.85	.44	.22	.42
	(.04)	(.35)	(.34)	(.18)	(.32)
Mid-Atlantic	.89	.85	.90	.27	.51
	(.20)	(.29)	(.57)	(.23)	(.33)
Southeast	1.04	.49	.15	.11	.16
	(.38)	(.33)	(.28)	(.22)	(.23)
East Central	.89	.79	1.14	.27	.18
	(.18)	(.27)	(1.80)	(.58)	(.32)
Great Plains/Northwest	.91	.42	2.54	.10	.22
	(.27)	(.35)	(8.55)	(.20)	(.42)
Southwest	.96	.65	.74	.14	.31
	(.14)	(.35)	(.40)	(.09)	(.20)
Addenda:					
Texas	.93	--	1.43	--	--
	(.53)	--	(.66)	--	--
	Number				
Overlending associations	14	19	18	1	7

-- = Not calculated.

[1]Observed expenditures on notes payable divided by optimal expenditures on notes payable for each frontier. Ratios greater than 1 are consistent with greater than profit-maximizing levels of lending activity. Overlending would be a politically acceptable reason for not maximizing profits.

[2]The first column reports results when all associations are included. The second column reports results when the dominant association is dropped because it may be an outlier and the frontier is recalculated without it.

Relaxing the constraints on interregional and cross institution-type comparisons reduces the number of institutions on the shortrun nationwide efficient frontier to about one-fourth of the total (28/117 or 23 percent), reduces the number of nonviable associations to 1, and increases to 19 the number of associations operating at greater than profit-maximizing loan volume. Average notes-payable-expense ratios near unity in the Southeast and Great Plains/Northwest regions result from several associations operating at well above profit-maximizing levels. There is greater evidence of intraregional diversity compared with the shortrun regional frontier. Also, in contrast to the shortrun regional frontier, relative profit efficiency rankings change somewhat in the shortrun nationwide frontier with the greatest inefficiencies in the Mid-Atlantic and the Southeast regions. The Northeast region remains the most profit efficient.

Mean efficiency ratios calculated from the longrun regional frontier indicate that far fewer associations (15/117 or 12 percent) are efficient when constraints on reducing nonaccrual loans and increasing fixed asset expenditures are removed. One association is nonviable, and 18 are operating at greater than profit-maximizing levels of loan production. Considerable variation exists in notes-payable-expense ratios, however, and the means equal to or greater than unity occur solely because of a few extreme values. In this respect, the mean of the profit-efficiency ratio is more indicative of the overall longrun efficiency of these associations. Ample evidence of longrun, intraregional inefficiency is available in all districts with associations in the North-Central and Great Plains/Northwest regions showing the greatest diversity.

Further relaxing constraints on interregional and cross-institution-type comparisons leaves just two associations on the longrun, nationwide efficient frontier and just one association operating at greater than profit-maximizing loan volume. No associations are unable to achieve positive profits. Compared with results from other the frontiers, intraregional diversity falls dramatically, indicating that in most districts all associations are far from operating as efficiently as the two globally efficient associations. The greatest mean profit inefficiencies are in the Southwest and Great Plains/Northwest regions.

Judging Constraints

To judge the effects of adding constraints on efficiency measures, consider the ratio of potential profit in the most constrained frontier (shortrun regional) to the potential profit in the least constrained frontier (longrun nationwide). This ratio will be bounded by zero and 1 with a value of 1 indicating the added constraints have no effect on profit potential. To determine which constraints increase efficiency measures most, we decompose this ratio in two ways. The two possible decompositions are as follows:

$$\frac{\text{shortrun regional profit}}{\text{longrun nationwide profit}} = \frac{\text{shortrun regional profit}}{\text{shortrun nationwide profit}} * \frac{\text{shortrun nationwide profit}}{\text{longrun nationwide profit}}$$

$$\text{(total efficiency ratio} = \text{shortrun efficiency ratio} * \text{nationwide efficiency ratio)}$$

or

$$\frac{\text{shortrun regional profit}}{\text{longrun nationwide profit}} = \frac{\text{shortrun regional profit}}{\text{longrun regional profit}} * \frac{\text{longrun regional profit}}{\text{longrun nationwide profit}}$$

$$\text{(total efficiency ratio} = \text{regional efficiency ratio} * \text{longrun efficiency ratio)}$$

Table 4 contains regional averages for these ratios.[6] Ratios close to 1 indicate smaller losses in efficiency; those close to zero indicate larger losses in efficiency. As a rule, efficiency is lost either in the move between nationwide models in the first decomposition or between longrun models in the second decomposition. The exception to this rule is the Southeast region where efficiency is lost in the second decomposition in the move between regional models rather than between longrun models. These findings indicate that the efficient association in the Southeast region has a substantial effect on profit-efficiency ratios and may be an outlier.

As noted previously, interdistrict comparisons of efficiency may be distorted by differing relations between district FCB's and related associations. One region where the effect of interdistrict comparisons can be tested is the Southeast region. This region is composed of direct-lending associations from the Texas, Jackson, and Columbia districts. Of the 23 associations included in the region, 20 are affiliated with the Texas district, 2 are affiliated with the Jackson district, and 1, a very large association, is affiliated with the Columbia district. (The last association has since been broken up into 20 smaller associations.)

The anomalous behavior of ratios for this region indicate intraregional, interdistrict differences may be important in explaining the behavior of these efficiency measures. To test this diagnosis, independent ratios were computed for the Texas district. These ratios are presented as addenda to tables 2 and 3.

Comparing shortrun regional and district results indicates that the low shortrun profit efficiency of the Southeast region is not because of interdistrict comparisons, but because of variation in efficiency within the Texas district. Shortrun ratios changed little from the regional frontier, and variation in the Texas district is greater than variation in the Southeast region. This shortrun inefficiency cannot generally be attributed to greater than profit-maximizing loan activity, as only three associations have notes-payable-expense ratios greater than unity.

Longrun ratios show significant change in both means and standard deviations. They indicate that interdistrict comparisons distort the longrun regional results for the Southeast but not the shortrun regional results. The comparison with the large association from the Columbia district is the essential factor determining efficiency from the longrun regional frontier for this region and from the longrun nationwide frontier for all regions.

Longrun regional inefficiency in the Texas district is associated with greater than profit-maximizing loan activity. Thirteen of the 20 associations in the Texas district have notes-payable-expense ratios greater than unity when measured against the longrun district frontier. Indicating that Texas district associations, although profit inefficient, may be operating consistently with the goal of providing a greater than profit-maximizing amount of loans to their member-borrowers.

Taken together these results indicate the dominant PCA in the Southeast region may be an outlier. Because the longrun nationwide frontier has so few constraints it is particularly sensitive to extreme observations. To test the sensitivity of the longrun nationwide results to the possibility that they are dominated by a spurious observation the frontier was

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[6]The identity, shortrun efficiency ratio • nationwide efficiency ratio = longrun efficiency ratio • regional efficiency ratio, applies at the association level. Mean ratios as reported in table 4 across associations may not retain this property due to nonlinearities (Jensen's inequality).

Table 4--Relative efficiency ratios for judging constraints across frontiers

Region	Shortrun[1]	Nationwide[2]	Regional[3]	Longrun[4]
	Mean ratios (standard deviations)			
Northeast	0.63 (.24)	0.13 (.08)	0.47 (.40)	0.20 (.03)
Mid-Atlantic	.57 (.28)	.20 (.31)	.84 (.34)	.14 (.22)
Southeast	.65 (.27)	.14 (.24)	.11 (.24)	.92 (.25)
East Central	.89 (.15)	.15 (.15)	.83 (.36)	.17 (.13)
Great Plains/Northwest	.60 (.29)	.11 (.14)	.61 (.83)	.06 (.01)
Southwest	.58 (.37)	.11 (.05)	.52 (.40)	.13 (.05)

[1]Shortrun efficiency ratio = potential profit from shortrun regional scenario divided by potential profit from shortrun nationwide scenario.

[2]Nationwide efficiency ratio = potential profit from shortrun nationwide scenario divided by potential profit from longrun nationwide scenario.

[3]Regional efficiency ratio = potential profit from shortrun regional scenario divided by potential profit from longrun regional scenario.

[4]Longrun efficiency ratio = potential profit from longrun regional scenario divided by potential profit from longrun nationwide scenario.

recalculated without the most dominant association. Quantitative results change substantially as reported in the last column of tables 2 and 3. However, the conclusion that overlending does not tend to explain deviations from profit maximization remains unchanged. In addition, the longrun efficient frontier continues to be dominated by very few associations.

Conclusions

A nonparametric model of profit maximization for FCS direct-lending associations is presented and relative economic efficiency is measured for four different types of frontiers: longrun nationwide, longrun regional, shortrun nationwide, and shortrun regional. We recognize that the goal of these associations may not be profit maximization. However, this study provides evidence that many associations can improve either their profitability or increase the amount of credit they provide to agriculture by emulating other FCS associations. This evidence applies to both the short and long runs, but is most dramatic as shortrun constraints on nonaccrual loans and fixed assets are removed.

Our longrun results suggest that, in general, individual associations should lend more. Regional longrun results indicate that 18 associations are lending more than their profit

efficient amount, while 15 others are profit efficient. Nationwide longrun results indicate that one association is overlending, while two are profit efficient. If the most profitable association is dropped as an outlier and the nationwide longrun frontier reestimated, seven associations are overlending, and three are profit efficient.

Because the demand for agricultural loans is relatively fixed, as associations increase loan volume, the number of associations should decline. If this course is followed, the market will support far fewer FCS associations, suggesting that there is room for further merger and consolidation activity.

The shortrun regional and longrun nationwide frontiers represent extreme assumptions, and the actual level of efficiency probably lies somewhere between the measurements associated with these extremes. In particular, the longrun nationwide results are not strictly valid as measures of efficiency for several reasons: 1) interdistrict comparisons do not account for differences in bank/association relationships, 2) no aggregation constraint or market equilibrium conditions are imposed in the model, 3) cross-association-type comparisons may be problematic since long-term lending is generally less expensive than short-term lending, and 4) any differences in local conditions (price variations, risk considerations, intensity of competition, and others) are ignored.

Measured inefficiencies may also be the result of on-going structural changes within the FCS. Since 1980, the FCS has undergone far-reaching structural changes including widespread mergers among associations and reformulations of the cost-share relationships among associations and banks. Several districts have received financial assistance from the Farm Credit System Financial Assistance Corporation. One cost of such assistance to recipient districts is some loss of autonomy. The longrun efficiency measures indicate that managers can improve profits as shortrun constraints are removed. The speed with which these adjustments can be made depends on the general economic environment in which these associations operate.

Still, we believe the analysis supports the conclusion that considerable inefficiencies exist in the FCS at the association level that can be corrected only in the longrun, as nonperforming assets and fixed inputs are set at more optimal levels. Also, the general result that many associations are too small to achieve efficiency given the markets they serve seems plausible given results from the banking literature (see Clark).

Future research will aim at decomposing sources of inefficiency and validating assumptions including bank/association relationships and cross-institution-type comparisons. In addition, calculating minimum cost frontiers will become feasible as supplemental data are collected.

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