TOWARD AN APPRAISAL OF THE FMHA FARM CREDIT PROGRAM: A CASE STUDY OF THE EFFICIENCY OF BORROWERS IN SOUTHERN ILLINOIS

S. Mehdian, Wm. McD. Herr, Phil Eberle, and Richard Grabowski

Abstract

A production frontier methodology is used to measure the overall efficiency of a sample of farms obtaining credit from the Farmers Home Administration (FmHA) compared to nonparticipants. The study did not find evidence that the efficiency of FmHA farms improved between 1981 and 1984. Results indicate that the overall efficiency of FmHA borrowers is associated with selected financial characteristics of the farms.

Key words: Farmers Home Administration, frontier production function, overall efficiency, financial structure.

A policy tool often used by government to improve the income and productivity of the farm sector is supplying supervised and subsidized agricultural credit to farmers who lack access to sufficient credit. This policy attempts to direct farmers to purchase and employ modern production technology and advanced marketing practices in order to enhance efficiency. Unfortunately, measuring the impact of subsidized agricultural credit programs on farm efficiency has received little attention in the agricultural finance literature.

A considerable body of literature concerning Farmers Home Administration (FmHA) exists, but most describes FmHA programs and characteristics of borrowers rather than directly focusing on the overall efficiency of farms financed with FmHA credit. David and Meyer discuss difficulties of measuring the impact of agricultural credit programs on resource allocation and farm efficiency. However, they indicate that "efficiency gap models are conceptually appealing, and future analysis might be extended to estimate loan impact on farm production or income" (p. 93). A recent study of this nature by Taylor et al. estimated a frontier production function as well as technical and allocative efficiency of two samples of farms in an area of Brazil. One sample consisted of participants of a credit program while the other sample was composed of nonparticipants. The empirical results indicated that credit programs had no effect on the technical efficiency of participants; however, a negative effect on the allocative efficiency of the borrowers was found.

The major objective of this study is to determine whether the farm credit programs of the FmHA improve the overall output efficiency of FmHA borrowers in an area of southern Illinois. This is accomplished by comparing the change in the efficiency of FmHA borrowers relative to the change in efficiency of a control group of farmers between 1981 and 1984. A second objective was to analyze the relationship between the overall efficiency of FmHA borrowers and selected farm characteristics.

Efficiency, rather than profitability, was chosen as the performance criterion for the study for several reasons. First, a condition for maximum profits is that farms be efficient. Second, profitability is impacted by prices and other factors which are beyond the control of the manager, whereas efficiency is more directly influenced by the manager. Third, from society's perspective, if significant inefficiences exist, then society as a whole can benefit by policies aimed at reducing the inefficiencies.

Efficiency, as defined by Farrell, has two components: technical efficiency and allocative efficiency. Technical efficiency is the ability of the firm to employ the "best practice

S. Mehdian is an Assistant Professor, Department of Finance, Temple University; Wm. McD. Herr is a Professor and Phil Eberle is an Assistant Professor, Department of Agribusiness, Southern Illinois University; and Richard Grabowski is an Associate Professor, Department of Economics, Southern Illinois University.

in an industry" such that not more than the necessary amount of a given set of inputs is used in producing the best level of output. Allocative efficiency is defined as the choice of the optimum combination of inputs consistent with relative factor prices. According to Farrell, a firm is overall efficient if the firm is allocatively efficient as well as technically efficient.

A variety of methods are used for measuring and computing technical efficiency; most of them involve the construction of a best practice frontier and the measurement of inefficiency relative to this frontier. These various methods can be divided into four approaches: the deterministic nonparametric (Farrell), the deterministic parametric (Aigner and Chu), deterministic statistical (Greene), and stochastic (Aigner et al.; Meeusen and van den Broeck). These approaches differ mainly in the method used to determine the shape and placement of the frontier and the interpretation given to deviations from the frontier.

The nonparametric approach in this study uses linear programming techniques to construct the production frontier. This approach constrains all points in output space to lie on or below the frontier. This method is appealing because it does not impose any specification on the production technology and avoids any unrealistic and restrictive distribution assumptions concerning the stochastic term. This method also avoids econometric problems arising from multicollinearity among inputs. In addition, as noted by Färe and Gosskopf, this type of approach allows one to relax the assumption of the production technology being a continuously twice differentiable production function. Furthermore, Färe et al. developed techniques by which some restrictive assumptions of nonparametric models can be relaxed. However, because these models are not statistical, tests for how well the production process is portrayed cannot be made and the problem of outliers remains.

SOURCE OF DATA AND MODEL

In order to determine the impact of FmHA subsidized and supervised credit programs on farm efficiency, the efficiency of FmHA borrowers will be compared to a group of non-FmHA farmers at two different time periods. If the efficiency distribution of FmHA borrowers improves relative to non-FmHA farmers and the difference is statistically significant, the study would provide evidence to indicate that the FmHA credit program has had a positive impact on borrowers' efficiency.

The years chosen for the study were 1981 and 1984. A sample of FmHA and non-FmHA farmers was selected in both years. The data on FmHA borrowers were collected from fourteen FmHA offices located in southern Illinois. The data consist of information on fifty-eight cash grain farms in 1981 and 1984. A farm was defined as cash grain if 75 percent or more of the gross farm income was derived from the sale of grain, largely corn, soybeans, and wheat. Non-FmHA farmers were selected randomly from among grain farms belonging to the Illinois Farm Business Farm Management Service (FBFMS). To minimize the differences associated with farm location, attempts were made to have the same number of non-FmHA farmers and FmHA borrowers in each county.

The variables employed in this paper to calculate efficiency indices are the total value of output and the inputs of land, labor, equipment, chemicals, and seed. Total value of output (Y) represents the sale of crops plus the value of crops used on the farm plus or minus changes in inventory (no nonfarm income is included). Land (L) represents the number of crop acres cultivated excluding pasture, woods, waste, and other noncropped land. Labor (N) measures the total number of months of labor, including hired as well as family labor, devoted to crop production. Equipment (K) measures the total annual machinery cost including depreciation, machinery hired, fuel, oil, and repairs. Chemical inputs (C) consist of the amount of dollars spent on fertilizer, pesticides, spray material, and other chemical inputs. Seeds (S) is the dollar value of seed used in production.

The data set can be summarized as follows:

$$(1) \qquad X = \begin{bmatrix} N_1 & K_1 & C_1 & S_1 & L_1 \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ N_n & K_n & C_n & S_n & L_n \end{bmatrix}, \quad Y = \begin{bmatrix} Y_1 \\ \cdot \\ \cdot \\ \cdot \\ Y_n \end{bmatrix},$$

where n is 116 in 1981 and 1984 and represents the total number of FmHA and non-FmHA farms.

These measures of inputs are satisfactory for the purposes of this study, even though

differences in the quality of two of the five inputs are not directly measured. The inputs of seed, chemicals, and machinery are measured in terms of expenditures. Presumably, quality differences are reflected in prices and, hence, in the value of these inputs. On the other hand, the inputs of land and labor are measured in acres and months, respectively, and not adjusted for quality differences. Even though there are likely to be quality differences in the inputs of land and labor, this does not pose a serious problem to the analysis because the objective is to determine how the efficiency of FmHA farmers changed through time compared to the control or non-FmHA farm group. Adequate measurement of input quality could pose a more serious problem if the major objective had been a comparison of the efficiency level of FmHA borrowers with the absolute level of efficiency of non-FmHA loans.

A nonparametric production frontier is constructed to measure efficiency. Relative to this frontier, an overall efficiency index is obtained for each farm. The overall efficiency index (OE) of farm i is measured as

$$(2) \qquad OE = Y_i / Y_i^* \leq 1 ,$$

where:

Y_i is the observed output value of farm i; and Y_i^* is the maximum potential output value for farm i.

The maximum potential output for farm i (Y_i^*) is determined by solving the following linear programming problem:

$$(3) \qquad \text{Maximize } Y_i^* = Y'a$$

$$\text{Subject to: } X'a \leq X'_i$$

$$a \geq 0,$$

where:

Y' is a 1 x n vector of output values for n farms;

a is an n x 1 vector of weights assigned to each farm;

X' is a 5 x n matrix of inputs employed by n farms;

X'_i is a 5 x 1 vector of inputs employed by farm i; and

n = 116 farms for 1981 and 1984.

Because the production process is assumed to be linearly homogenous, if a farm or combination of farms is able to produce a greater value of output while employing an amount of inputs less than or equal to farm i, then farm i is inefficient. Farm i would have an efficiency index of less than one, which also suggests that farm i is able to increase its output by a factor equal to $Y_i^* = Y'_i$ or $1/OE$ given the inputs available to farm i.

EMPIRICAL RESULTS

The entire group of FmHA borrowers and non-FmHA farmers was pooled into one data set for 1981 and one for 1984. Based on the pooled frontier for 1981, all farmers on average produced about 60 percent of their potential revenue in 1981 (Table 1). By comparing FmHA and non-FmHA farmers to the pooled frontier, it was found that as a group FmHA borrowers' average efficiency was 56

TABLE 1. DESCRIPTIVE STATISTICS FOR POTENTIAL OUTPUT, ACTUAL OUTPUT AND THE OVERALL EFFICIENCY INDEX FOR POOLED SAMPLE, FmHA BORROWERS, AND THE NON-FmHA FARMERS, 1981

Item	Pooled Sample	FmHA	Non-FmHA
Number of Observations	116	58	58
Potential Output ($)	170966	140920	201012
(Standard Deviation) ($)	(91222)	(85926)	(86997)
Actual Output ($)	102457	78343	126571
(Standard Deviation) ($)	(69425)	(59279)	(70900)
Output Lost ($)	68508	62577	74440
(Standard Deviation) ($)	(52512)	(46360)	(57814)
Efficiency Index	.598	.557	.638
(Standard Deviation)	(.225)	(.201)	(.241)
Median of Efficiency Index	.570	.516	.637
Borrowers Above Median of Pooled Sample (%)	50.0	36.2	63.8
Range of Efficiency Index	.858	.825	.858

TABLE 2. DESCRIPTIVE STATISTICS FOR POTENTIAL OUTPUT, ACTUAL OUTPUT AND THE OVERALL EFFICIENCY INDEX FOR POOLED SAMPLE, FmHA BORROWERS, AND THE NON-FmHA FARMERS, 1984

Item	Pooled Sample	FmHA	Non-FmHA
Number of Observations	116	58	58
Potential Output ($)	153258	136931	169584
(Standard Deviation) ($)	(79794)	(72610)	(83853)
Actual Output ($)	93328	75763	110893
(Standard Deviation) ($)	(63725)	(46318)	(73619)
Output Lost ($)	59929	61168	58690
(Standard Deviation) ($)	(42903)	(42380)	(43755)
Efficiency Index	.596	.557	.635
(Standard Deviation)	(.227)	(.214)	(.234)
Median of Efficiency Index	.600	.528	.687
Borrowers Above Median of Pooled Sample (%)	50.0	43.1	56.9
Range of Efficiency Index	.891	.810	.891

percent while the non-FmHA farmers averaged 64 percent. The 1984 results were virtually the same as in 1981 with the FmHA sample averaging about 8 percentage points below the average efficiency of the non-FmHA farmers (Table 2).

Farmers eligible for FmHA credit generally tend to have limited resources and/or poorer quality inputs than non-FmHA farmers. Therefore, the observed differences in average efficiency simply confirm expectations concerning the nature of differences in efficiency between these two groups of farms. Two statistical tests, analysis of variance and Mann-Whitney, indicate the differences are significant (Table 3). The next and more important step is to determine whether the overall efficiency of FmHA borrowers improved during the four year period, 1981-84, relative to the base group of farmers not using FmHA credit.

TABLE 3. RESULTS OF STATISTICAL TESTS ON DIFFERENCES IN OVERALL EFFICIENCY BETWEEN FmHA AND NON-FmHA FARMERS FOR 1981 AND 1984

Year	Analysis of Variance[a]	Mann-Whitney[b]
1981	3.78*	-2.07*
1984	3.49*	-2.00*

* significant at 5 percent

[a] The analysis of variance compares the variation of efficiency within FmHA and non-FmHA farms with the variation between the two groups. It assumes the populations are normally distributed.

[b] Mann-Whitney determines whether or not the two populations have identical relative frequency distribution. As a nonparametric test, it makes no assumption with regard to the distribution of the population.

However, before proceeding to the major part of the analysis, additional insight about the data is gained by observing how the distribution of FmHA farms compares to non-FmHA farms. Of the 11 farms which were actually on the 1981 frontier, 4 were FmHA borrowers and 7 were non-FmHA farmers. Moreover, among the 20 least efficient farms, about one-half were FmHA and one-half were non-FmHA farmers. These observations indicate that the range in efficiency of FmHA borrowers and non-FmHA farmers was not greatly different. Apparently, FmHA selected borrowers whose average efficiency was below the sample mean which is consistent with the agency's mission but did not select substantial numbers of borrowers whose efficiency was very low. This would have been indicated if, for example, a large proportion of the farms with the lowest efficiency had been FmHA borrowers. However, FmHA did make loans to some commercial farms which would not seem to qualify for subsidized credit based on efficiency criteria alone.

To determine whether the FmHA credit program improved the efficiency of borrowers in the period under study, the overall relative efficiency of FmHA borrowers versus non-FmHA farmers is compared in 1981 and in 1984. The results indicate little or no improvement in the efficiency of FmHA borrowers relative to non-FmHA farmers between these years. In 1981, the average efficiency of FmHA borrowers was 87 percent of the average level achieved by non-FmHA borrowers. In 1984, this had increased slightly to 88 percent of the average efficiency of non-FmHA farmers. However, as measured by the percentage of farms above the median of the pooled sample, the FmHA group showed more improvement. In 1981, only 36 percent were above the median, but in 1984, 43 percent were above the median of the pooled sample value.

In order to determine whether the changes in efficiency between 1981 and 1984 for FmHA farms and non-FmHA farms are statistically significant, three statistical tests are employed. The Student's t test, Sign, and Wilcoxon tests are designed for matched pair observations and indicate whether the changes in efficiency between 1981 and 1984 for the matched pairs of FmHA borrowers were significant. The same tests were applied to the non-FmHA farms. These statistical tests indicate that the data provide no evidence of significant changes in the levels of overall efficiency of FmHA borrowers in 1981 compared to 1984 (Table 4). Hence, based on these results for the specific time period, this study found no evidence that obtaining supervised FmHA credit improved the efficiency of FmHA borrowers relative to a group of non-FmHA farmers.

TABLE 4. TEST STATISTICS FOR DIFFERENCE BETWEEN OVERALL EFFICIENCY OF FmHA BORROWERS AND NON-FmHA FARMERS BETWEEN 1981 AND 1984[a]

	t Test for Paired Sample (t)	Sign Test (z)	Wilcoxon Matched-Pairs Signed Ranks Test (z)
FmHA Borrowers (1981-84)	.23	.394	-.0426
Non-FmHA Farmers (1981-84)	-.06	-.001	-.1867

[a] The comparison is between paired samples with equal size in 1981 and 1984 ($N_1=N_2=58$). None of the test results are statistically significant at the 10% level of probability.

Another view of how the efficiency of FmHA borrowers changed relative to changes in efficiency of non-FmHA farmers is obtained by constructing separate frontiers for FmHA borrowers and non-FmHA farms in 1981 and 1984. Thus, four separate frontiers were constructed and efficiency measures were calculated relative to these separate frontiers. The efficiency of each FmHA farm in 1981 was evaluated only relative to all other FmHA farms in 1981. The same is true for non-FmHA farms in 1981 and for both groups in 1984.

Applying the above procedure to the 1981 data gave an average efficiency ratio for FmHA farmers of 72 percent and for non-FmHA farmers of 64 percent. These results mean that FmHA farms tended to operate closer to their own separate frontier than did non-FmHA farms in 1981 but do not imply that FmHA farmers were more efficient. The results of applying the procedure to the 1984 data indicate that the average efficiency of FmHA farmers was 62 percent and of non-FmHA farmers 69 percent. This indicates that in 1984 non-FmHA farmers operated closer to their separate frontier than did FmHA farmers. More importantly, from 1981 to 1984 the performance of FmHA farms relative to their separate frontiers for those years declined while that of non-FmHA farmers improved.

One plausible explanation for the observed changes is that even though many FmHA borrowers may have improved their efficiency between 1981 and 1984, for most, gains were at a slower rate than for those defining the FmHA frontier. Thus, the overall average efficiency declined. On the other hand, among the non-FmHA farmers, many were able to emulate the efficiency of their best peers. This result provides some documentation of the perceived advantage of membership in farm management associations. This lends credence to the initial observation which found no evidence of a relative improvement in the efficiency of FmHA borrowers.

In summary, FmHA farm performance did not improve from 1981 to 1984 relative to our base group of farms. And the separate sample results indicate that between 1981 and 1984, most FmHA farmers were unable to achieve efficiency levels reached by the best FmHA farmers. In contrast, farmers having membership in a farm management association were more able to match the efficiency levels of their best peers.

THE RELATIONSHIP BETWEEN THE OVERALL EFFICIENCY INDEX AND SELECTED CHARACTERISTICS OF FmHA BORROWERS

A second objective of the study was to examine the association between the overall efficiency index and selected farm and operator characteristics. This part of the study is based on a production frontier derived from 98 FmHA borrowers in 1984. The sample includes the 58 FmHA borrowers used in the analysis examining the overall efficiency of borrowers through time. The sample also includes 40 additional FmHA borrowers for which comparable data for 1981 were not available.[1]

Correlation coefficients between selected characteristics and the efficiency index for the sample of FmHA borrowers were calculated. The highest correlation is between net return and the efficiency index (Table 5). Average net farm returns range from a negative amount in the low efficiency group to $34,200 in the most efficient group. A high negative correlation was found between the ratio of expenses to value of output with the efficiency index. Correlation coefficients also indicate that larger farms tend to be more efficient than smaller farms. This observation holds whether size of business is measured by total assets, equity, value of output, or acres of cropland.

While there is no correlation between the farmer's debt/asset ratio and the efficiency index, the debt/asset ratio is higher for farmers in the lowest and highest efficiency groups and lowest for those in the middle efficiency group. Though the differences in the average debt/asset ratio between efficiency groups are not large, the observed results conform to the general understanding of the effects of leverage. High debt/asset ratios are beneficial (high net income) when the efficiency of the firm is good and act as a

[1]One might think that adding the 40 additional farms would result in inconsistencies between this larger sample (98) and the smaller one used in the previous section (58). However, this does not seem to be the case. The average efficiency level for the 58 FmHA farms in Table 2 was .557 with a standard deviation of .214. For the 98 FmHA farms used in this section, the corresponding statistics are .535 and .222, respectively. Thus the two samples would seem to be very similar in terms of efficiency results.

deterrent (in this case, negative net return) when high leverage is associated with firms having poor efficiency.

Finally, it should be noted that there was a negative correlation (-.35) between the efficiency index and the ratio of nonfarm to total income. This suggests that the more time devoted to earning income from nonfarm sources, the less productive are the farm operations likely to be.

SUMMARY AND CONCLUSIONS

A review of the literature shows that agricultural finance specialists have not been successful in evaluating whether FmHA programs improve the efficiency and income of eligible borrowers. Inadequate evaluation of the FmHA program occurs partly because of inadequate measures of efficiency and partly because of the difficulty of adequately determining the impacts of changes in the economic environment during the period of the loan. This study addressed these difficulties by utilizing a nonparametric production frontier technique to measure overall efficiency and a matched pair statistical procedure to measure how efficiency of farms receiving FmHA credit changed relative to a non-FmHA group of farmers.

The study found no evidence indicating FmHA credit programs improved the position of borrowers relative to a group of non-FmHA farmers in the same area. This finding could be due to the fact that a four-year period is too short to expect much relative improvement or that the effects of FmHA lending occurred prior to the time period under consideration. Also, during the period of study the farm sector was under financial stress. As a result, there was considerable pressure on FmHA not only to ease the loan eligibility requirements, but also to continue the borrower even though loan delinquency and other factors indicated a low probability of success. Liberal loan policies were based on the assumption that the financial crisis in the farm sector would not last long. This may have covered over progress which might occur among a sample of FmHA borrowers in a more normal period.

The second objective was to determine the relationship between overall farm efficiency and selected farm characteristics. This part of the study found that overall efficiency and net farm income have a strong association. Positive correlations between overall efficiency and various measures of size of business also exist. In addition, the observation

TABLE 5. SELECTED CHARACTERISTICS OF FMHA BORROWERS GROUPED BY THE FARMS' OVERALL EFFICIENCY INDEX AND THE CORRELATION BETWEEN CHARACTERISTICS AND FARM EEFFICIENCY (1984)

	Farm Efficiency Index Group			All FmHA Borrowers	
Item or Characteristics	Less than .40	.40 to .59	.60 and over	All Efficiency Levels	Correlation Coefficient Between Efficiency Index and Characteristic
Total Assets ($000)	250	335	485	371	.28**
Total Debts ($000)	143	174	278	206	.24*
Net Worth ($000)	107	161	207	165	.21*
Debt/Asset (%)	66	53	64	61	-.00
FmHA Debt Outstanding ($000)	44	37	96	62	.26*
Value of Output ($00)	316	726	1203	802	.66**
Expenses ($00)	452	634	861	673	.39**
Net Return ($00)	-136	92	342	129	.71**
Acres of Cropland	356	525	637	524	.31**
Acres Owned/Total Acres (%)	45	32	35	36	-.12
Expenses/Value of Output	1.44	.84	.74	.96	-.63**
Years of Education	11.5	11.6	12.1	11.7	.18
Ratio of Nonfarm Income/Total Income	--	--	--	.20	-.35**

* Significant at 5 percent level of probability.
** Significant at 1 percent level of probability.

was made that patterns of efficiency and debt/asset ratios found among FmHA borrowers produced differences in net income which are consistent with the general effects of leverage.

Though this was not a major purpose of the study, the results provide evidence that the FmHA serves a clientele of farmers for which it was designed. That is, farmers who obtained credit from the FmHA in 1981 and 1984 were on average less efficient than a group of non-FmHA farmers, but probably not so inefficient that there is little chance of benefiting from FmHA's program and becoming a viable farm.

We conclude that the research provides a methodology which can be employed in other areas and time periods to investigate the important policy question of whether government-operated credit programs, such as FmHA, improve the overall efficiency of eligible firms.

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