OBJECTIVE EVALUATION FOR AGRICULTURAL LENDING

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One of the more significant changes in the U. S. agricultural industry in recent years has been the increased use of credit to finance production and capital expenditures. Since 1970, outstanding farm debt has more than doubled, rising at an average annual rate of 9.3 percent. However, because net farm income has not increased as fast, the debt burden for farm operators has become relatively higher (Melichar and Waldheger).

This increase in debt load has made financial evaluation more difficult for lenders. Narrow profit margins and increased average loan size have made financial institutions more aware of the need to determine, for their loan portfolio, how borrower and agricultural business characteristics relate to debt repayment ability and loan quality.

A study was designed to develop an objective credit evaluation technique based on loan repayment ability characteristics of farm borrowers. Such a technique would aid lenders in discriminating between borrowers who would be acceptable and those who would possibly turn out to be weak and have problems in repayment.

PREVIOUS RESEARCH

Numerous methods have been devised to evaluate relative financial and personal characteristics of borrowers; however, the most commonly used and widely accepted technique has been multiple discriminant analysis. Discriminant analysis has been applied to the classification of agriculturally related loans by Bauer and Jordan, Johnson and Hagan, and Dunn and Frey.

Bauer and Jordan collected data on good and problem loans for the period 1958-69 from two eastern Tennessee Production Credit Associations. No attempt was made to identify subsets of the data that might have affected the overall effectiveness of the analysis. Stepwise regression analysis was used to find the most significant variables and multiple discriminant analysis was used to find coefficients for these variables. Variables found to be significant were: total debt divided by total assets, reasonable farm value, total liabilities, marital status, family living expense as a percentage of total farm expense, and current liabilities divided by current assets. Statistical analysis suggested the function should correctly classify 85 percent of the loans.

Johnson and Hagan evaluated the financial position and progress of acceptable and problem borrowers from three central and northwestern Missouri Production Credit Associations. A linear discriminant model was developed containing three significant ratio variables: loan repayment made plus marketable inventory divided by loan repayment anticipated (called a repayment index), current assets divided by current liabilities, and total debt divided by the total assets. The model correctly classified 62 percent of the loans analyzed. This model has been used by the Federal Intermediate Credit Bank of St. Louis to assist in classifying loans for the Sixth Farm Credit District.

Dunn and Frey developed a credit scoring model using acceptable and problem loans from Production Credit Association loan applications for the cash grain area of central Illinois. The data were taken from applications of borrowers who were new loan applicants between 1964 and 1968 and who still had loans outstanding in 1971. Multiple discriminant analysis was used to determine that there was no significant difference between data from different years; however, differences between any possible subgroups, of data were not considered. Stepwise discriminant analysis was then used to determine the variables and their respective coefficients that most significantly distinguished between acceptable and problem loans. The final model contained four significant variables: total liabilities divided by total assets, amount of credit life insurance, amount of note divided by net cash farm income, and acres owned. The model correctly classified 90 percent of the acceptable loans and 60 percent of the problem loans.

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DATA ASSIMILATION

Data used in our study were collected from all Alabama Production Credit Associations and thus gave a cross-sectional sample of the Alabama farm borrower. Because a broad range of farm sizes and enterprises was included, the sample gives a good representation of the characteristics of borrowers throughout the Southeast (Table 1). Each association president was asked to select a sample of 40 loans including both acceptable and problem cases. Of the total 220 usable observations obtained, 145 were classified by the PCA as acceptable and 77 as problem.

TABLE 1. SAMPLE MEANS FOR BORROWER CHARACTERISTICS BY MAJOR ENTERPRISES[a]

Borrower characteristic	Row crops[b]	Soybeans	Cotton	Peanuts	Beef cattle	Dairy cattle	Swine	Poultry	Other[c]	Total
Number in sample	29	31	31	16	59	12	11	34	7	230
Age (in years)	47	43	48	42	48	52	43	45	37	46
Acres owned (acres)	400	347	316	270	405	410	202	141	133	320
Acres rented (acres)	478	634	759	351	232	205	297	35	0	363
Percent of borrowers full-time farmers	72	74	90	94	32	83	55	55	50	61
Current assets	185,937	254,409	223,873	100,426	154,208	263,849	188,339	169,440	97,163	189,639
Current liabilities	61,944	119,051	126,218	72,935	65,754	89,828	112,842	100,183	41,410	90,009
Total assets	462,949	427,198	420,977	195,279	285,925	428,868	336,065	295,880	217,074	355,995
Total liabilities	131,474	161,615	174,094	90,552	101,651	122,210	149,637	128,539	66,536	130,486
Net worth	331,130	265,582	247,857	104,737	176,150	315,853	200,418	168,335	150,672	224,781
Net farm income[d]	8,815	10,358	4,813	Not Av.	12,524	42,209	15,847	16,643	20,472	14,684
Gross farm income[d]	116,400	117,309	145,199	71,507	36,432	155,043	76,846	95,201	51,238	93,251
Gross non-farm income[d]	10,132	8,289	2,303	4.169	16,832	2,208	12,118	4,317	17,010	9,400
Percent of gross farm income retained[e]	8	9	3	Not Av.	34	27	21	18	40	16

[a]All numbers in dollars unless otherwise stated.
[b]Row crops category implies that no enterprise supplies the majority of farm income.
[c]Other category includes nursery, truck, and timber products; pecans and catfish.
[d]Means computed from data that was sixty percent of total sample.
[e]Percent retained equals net farm income mean divided by gross farm income mean for each enterprise.

Acceptable and problem loan classifications are used by credit analysts of the Federal Intermediate Credit Bank of New Orleans who examine Production Credit Association loans each year. Production Credit Association loans are also classified as vulnerable and loss loans. For our study, only acceptable and problem loans were requested because there were not enough vulnerable and loss loans to be considered important.

Acceptable loans are those of such high quality that they will require only normal supervision. This group includes loans ranging from those of the highest quality to those having such significant credit weaknesses that they must be backed by adequate member equity to assure repayment performance and to maintain or improve the quality of the loan.

Problem loans are weak loans in that they have serious credit deficiencies and require more than normal supervision either to improve repayment standards or to liquidate on schedule. These loan accounts may involve such factors as low equity position, unwise use of credit, adverse trends, or faulty management.

The borrower sample provided raw data necessary for construction of the 15 variables used for analysis. Three nonratio variables were drawn directly from the data:

1. Age of operator.

2. Acres owned.

3. Acres rented.

In addition, 12 financial ratios were developed:

1. Current assets divided by current liabilities.

2. Current liabilities divided by total liaities.

3. Total loan commitment divided by current assets.

4. Underlying security value divided by total loan commitment.

5. Total repayment made divided by loan repayment anticipated.

6. Loan repayment made plus marketable inventory divided by loan repayment anticipated.

7. Loan repayment anticipated divided by total assets.

8. Total liabilities divided by net worth.

9. Total assets divided by net worth.

10. Current liabilities divided by net worth.

11. Total loan commitment divided by net worth.

12. Total liabilities divided by total assets.

Many of the variables used in the study were found in previous research. Some were found to be significant in discriminating between acceptable and problem loans. Other variables have been presented in financial analysis literature as being useful in evaluating financial stability and success (Nelson et al.). Some variables were developed on the basis of data availability and the desires of the researchers to evaluate any factor having strong theoretical justification for potentially classifying acceptable loans.[1]

Operator's age was used to reflect the life stage of the farmer. This factor is a proxy of the farmer's view of credit use. Acres owned and acres rented were believed to be important because they reflect the size of the farming operation.

The 12 financial ratio variables may be viewed as measures of liquidity and solvency. Variables 1 through 7 are related to the capacity of the farm business to meet financial obligations as they come due. This ability is shown directly by the current ratio, current assets divided by current liabilities.

Current liabilities divided by total liabilities and total loan commitment divided by current assets given an indication of debt structure. These variables emphasize the amount of debt due and the amount that can be covered in the current time period. Underlying security value divided by total loan commitment is a measure of the ability of the collateral to liquidate the loan.

Variables 5, 6, and 7 all include loan repayment and serve as a measure of performance. These variables are directly related to income-generating ability.

Total liabilities divided by net worth is one of the most often used indicators of solvency, or the ability of all assets to cover all debts. It is commonly referred to as the leverage ratio. As the amount of borrowed capital increases in relation to equity capital, risk for the lender generally increases.

Variables 9, 10, and 11 are also related to the amount of owner's equity and give a measure of the owner's relative amount of financial commitment in the operation. The final variable, total liabilities divided by total assets, a direct indicator of solvency, shows the ability of the value of the total farming operation to cover its debts and measures long-term financial strength.

Obviously, many of these variables are interrelated and a major correlation problem would have arisen had they all been used in a model concurrently. To minimize this problem, we gave special attention to correlation coefficients and removed any significantly correlated variables before final estimation of the model.

RESEARCH PROCEDURE

A necessary assumption for the use of discriminant analysis in classifying data is homogeneity within the data set. Normally this condition is assumed on the basis of prior knowledge; however, cluster analysis may be used to determine whether specific data are heterogeneous and would require more than one credit discriminating function. The procedure was used in our research as suggested by Anderberg, Churchill et al., and Johnson to determine whether separate analyses needed to be done for full-time and part-time farmers and for each type of farm as designated by major enterprise. These tests indicated that the data were relatively homogeneous and thus a single credit scoring model should be sufficient.

After the homogeneity of the data set was verified, stepwise discriminant analysis was used to determine which borrower and agricultural business characteristics were important in differentiating between acceptable and problem borrowers. The basic objective of discriminant analysis is to form a linear combination of variables with associated weights which will divide the data into groups that are as statistically different as possible. The discriminant function is of the form:

[1]Variables related to projected gross and net income, which would have given measures of profitability, would probably have been important in the discriminating process; however, only 60 percent of the sample included such information. Elimination of 40 percent of the observations would have severely limited the amount of data available for analysis.

$$(1) \quad Y = B_1X_1 + B_2X_2 + B_3X_3 + \ldots B_kX_k$$

where

Y = the value of the linear combination of k variables,
B_i = the weight associated with each variable,
X_i = the value of each variable used for discrimination.

After the optimal discriminant function is formed, the cutoff point between the two sample group means must be determined if the function is to be useful in classifying an element outside the sample. Assuming equal significance of the two kinds of errors, that is, classifying a problem loan (group P) as acceptable and classifying an acceptable loan (group A) as problem, one can determine the cutoff point by the equation:

$$(2) \quad Y_c = \frac{S_p\overline{Y}_a + S_a\overline{Y}_p}{S_p + S_a}$$

where

Y_c = the calculated cutoff score,
S_p = the standard deviation of the Y-values for group P,
S_a = the standard deviation of the Y-values for group A,
Y_p = the mean Y-values for group P,
Y_a = the mean Y-values for group A.

If, however, misclassifications of problem and acceptable loans were not of equal significance, a different cutoff score would have to be derived. This value would more accurately reflect the relative seriousness of the potential classification errors. An error in classifying a problem loan could be assumed to be a very costly mistake.

With this concern, the cutoff score would be calculated by selecting the percentage of problem loan classification error that would be accepted, consulting a table of cumulative normal frequency distributions, and deriving the appropriate cutoff value through the following equation (Peters and Summers).

$$(3) \quad Y_e = \overline{Y}_p + (Z)\, S_p$$

where

Y_e = the problem loan classification error selected cutoff value,
Y_p = mean Y value for problem loan group,
Z = standard measure of normal distribution,
S_p = standard deviation for problem loan group.

RESEARCH RESULTS

With stepwise multiple discriminant analysis, only two of the 15 variables prove to be significant at the 95 percent confidence level—total liabilities divided by total assets (X_1) and annual loan repayment anticipated divided by total assets (X_2). The parameters of the discriminating function have an F-ratio that is significant at the 99 percent level and correlation between the two variables is not significant. The equation is:

$$(4) \quad Y_s = 186.0 - 460.8X_1 - 161.2X_2$$

where

Y_s = the calculated discriminant score which distinguishes between acceptable and problem loans,
X_1 = total liabilities divided by total assets,
X_2 = loan repayment anticipated annually divided by total assets.

Variable X_1, total liabilities divided by total assets, is a solvency measure indicating the overall financial stability and strength of the farm organization. Obviously, as the level of liabilities increases in relation to the total level of assets, financial risk for the business increases and would justify a lower credit score.

Loan repayment anticipated divided by total assets, variable X_2, is a liquidity-related concept and gives a measure of financial pressure on the production capacity of the firm. Again, as the value of this relationship increases, the credit score would be reduced and the risk associated with the loan would increase.

A critical cutoff value of Y is needed to classify agricultural loans with the developed discriminant function. With the assumption that misclassifications of acceptable and problem loans are of equal significance, the computed cutoff value (calculated with equation 2) indicates that those loans with Y value equal to or greater than -20.2 would be classified as acceptable loans, whereas those with Y values less than -20.2 would be classified as problem loans. Research results indicate that with this cutoff value, 81 percent of all loans would be classified correctly.

If problem loan misclassification is assumed to be the more serious error, different cutoff values are necessary. The values for specified error percentages and their effect on the original sample are given in Table 2.

To use the table, one must choose an allowable percentage of problem loan misclassification. The corresponding computed cutoff value can then be used to classify loans with a probable assurance of misclassifying problem loans by no more than the selected values. For ex-

TABLE 2. CUTOFF VALUES AND CLASSIFICATION RESULTS OF TOTAL SAMPLE FOR SELECTED PROBLEM LOAN MISCLASSIFICATION PERCENTAGES

Problem Loan Misclassification Percentage Selected	Computed Cutoff Value	Percent Correct Classification		
		Problem	Acceptable	Total
50	-84.9	54.5	90.2	77.7
45	-73.4	55.8	87.6	75.9
40	-62.8	59.7	86.7	77.3
35	-50.4	64.9	86.0	78.6
30	-38.9	70.1	85.3	80.0
25	-25.6	81.8	81.1	81.4
23.3	-20.2	83.1	79.7	80.9
20	-10.6	84.4	79.0	80.9
15	7.1	89.6	69.2	76.4
10	28.4	92.2	60.8	71.8
5	60.2	93.5	44.8	61.8
2	96.5	97.4	26.6	51.4
1	121.3	98.7	11.9	42.3

ample, assume that only 5 percent of problem loans can be misclassified. The cutoff value would be 60.2. With this cutoff value, the discriminant function should misclassify at most 5 percent of the problem loans. As can be seen from the results of the classification test on the sample data, 93.5 percent of the problem loans are correctly classified, but only 44.8 percent of the acceptable loans are classified correctly. These findings illustrate the tradeoff between the correct classifications of problem and acceptable loans. An increase in the percentage of correct classification of problem loans will cause a decrease in the percentage of correct classification of acceptable loans.

The tradeoff of correct classifications can be seen better in Figure 1. The Y-axis measures the actual percentage of correct classification. The percentage of acceptable loans correctly classified increases for each decrease in the percentage of problem loans correctly classified. As the problem loan misclassification percentage increases, correct classification of the total sample increases, reaches a maximum, and then decreases. The intersection point of the three curves is the cutoff value for maximizing total correct classification.

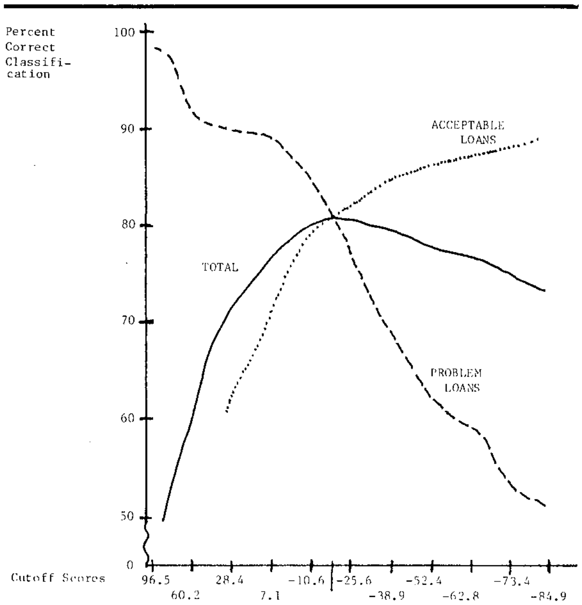

FIGURE 1. PERCENTAGE OF CORRECT CLASSIFICATION FOR ACCEPTABLE, PROBLEM, AND TOTAL LOANS AT VARIOUS CUTOFF SCORES

SUMMARY

The purpose of our study was to develop an objective loan evaluation technique that could be used in differentiating between acceptable and problem loans. Emphasis was directed toward evaluating agricultural loans made by the eight Production Credit Associations in Alabama; however, the overall results should also be interesting to and useful for other agricultural lenders and farm borrowers in the Southeast who deal with similar types of farms.

The analysis indicates that only two variables are significant, total liabilities divided by total assets and annual loan repayment anticipated divided by total assets. Total liabilities divided by total assets has been found to be significant in studies by Bauer and Jordan, Dunn and Frey, and Johnson and Hagan. The amount of loan repayment anticipated annually divided by total assets has not been included as a variable in other studies.

The level selected for the discriminant cutoff value has a direct effect on the number of loans correctly classified as either acceptable or problem. As the cutoff value is raised, indicating a relatively conservative lending policy, the percentage of problem loans correctly classified increases and the percentage of acceptable loans correctly classified decreases. Thus, the possibility of loss from bad loans is minimized but the potential gain from the misclassified good accounts is lost. Because of this obvious tradeoff, lenders should adjust the level of the cutoff score to reflect accurately the nature of their lending policy.

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