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Consumer Installment Loan Risk: A Discriminant Analysis

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CONSUMER INSTALLMENT LOAN RISK:

A DISCRIMINANT ANALYSIS

BY

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This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable as meeting the thesis requirements for this degree. Acceptance of this thesis does not imply that the conclusions reached by the candidate are necessarily the conclusion of the major department.

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INTRODUCTION

Purpose of the Study

All lending institutions are faced with the fact that a portion of their outstanding loans will not be repaid. A loan officer, or other designated individual, is normally charged with the responsibility of evaluating loan applicants in terms of their comparative risks in order to reduce this inherent cost of doing business.

Consumer loans, those loans made for the purchase of commodities and services for personal consumption or to refinance debts incurred for such purposes, comprise approximately 22 percent of the net private and public debt.[1] Installment loans to consumers, loans to be repaid in two or more payments, comprise 81 percent of the total consumer debt or approximately $127.3 billion in 1972.[2]

The loan officer has traditionally evaluated consumer installment loan applicants using the three C's rule: character, collateral and capacity to repay, as his guideline for evaluating risk. The information required for this type of evaluation came from the data on the loan application, a credit check and character references.

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[1]1973 Finance Facts Yearbook, ed., S. Lees Booth, Washington: National Consumer Finance Association, 1973, p. 49.

[2]1973 Finance Facts Yearbook, p. 49.

The subjective nature of an appraisal of risk based on character, or degree of collateral required to secure the loan, or an estimate of the individual's income/expense ratio to ascertain his ability to repay, is clearly undesirable. However, without any alternative means of evaluation, the loan officer had to make do with the information available and his feelings predicated on past experience.

This study attempts to give a more objective alternative means of evaluating risk in consumer installment loans. It is believed that there are shared characteristics of individuals who repay loans and a different set of shared characteristics for those who do not. If these sets of characteristics are significantly different, future applicants could then be evaluated to see if their characteristics are more like those of the group which repaid their loans or to the group who did not.

In order to accomplish this study, one particular lending institution was chosen whose principal business is that of consumer installment loans. Discriminant analysis was employed as the statistical tool used to determine if a sample of loans that were repaid and those which were not could be separated into two groups solely on their shared characteristics. The discriminant analysis allows the researcher the means of accomplishing this separation and ascertaining the degree of certainty that the two groups are dissimilar, as well as evaluating which factors are most important in the discrimination process.

If indeed we do find that it is possible to separate borrowers into two distinct groups, repayers and defaulters, based on shared characteristics and we know which factors are most influential in placing the individual in one group or the other, policy recommendations for the loan officer could then be made.

Therefore, the purpose of this study can be briefly summarized through the following questions:

(1) Is it possible to distinguish between persons who have repaid their consumer installment loans and those who have not by comparing shared characteristics of sampled individuals from each group?

(2) With what degree of certainty can we say that the two groups are different?

(3) Which characteristics are most important in determining group affiliation?

(4) With what degree of certainty can we classify a future borrower as a repayer or defaulter?

(5) Can we make policy recommendations to the loan officer which differ from the present policies being utilized to evaluate consumer installment loan risk and if so, what are they?

The Credit Union Movement and the Ellsworth Air Force Base Federal Credit Union

The Ellsworth Air Force Base Federal Credit Union, the lending institution chosen for this study, was chartered in

April 1955, in accordance with the Federal Credit Union Act
of 1934 (Chapter 14 of Title 12 of the United States Code).
The express purpose of this act was:

> . . . to establish a Federal Credit Union
> system, to establish a further market for securities
> of the United States and to make more available to
> the people of small means credit for provident pur-
> poses through a national system of cooperative credit,
> thereby helping to stabilize the credit structure of
> the United States.[3]

A credit union is owned by its depositors who hold shares
in proprotion to their savings. Dividends are paid regularly
on these savings/share accounts and all deposits in federally
chartered credit unions (which amount to approximately one-
half of all credit unions in the United States) are insured
up to $20,000 per account.

Credit unions are not indigenous to the United States
nor are they a recent phenomenon. The first credit union was
founded in the mid-nineteenth century by Bavarian farmers who
pooled their savings in order to make low cost loans. Since
that time credit unions have encircled the globe with over
23,000 presently established in the United States alone and
representing 28 million members. Credit union membership is
expected to grow at a rate of 1 million new members a year.[4]

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[3]The Federal Credit Union Act and Related Statutes,
Washington: National Credit Union Administration, 1972,
Section 1752.

[4]Carroll Smith, Assistant Administrator for Administra-
tion, National Credit Union Administration, in a speech before
the Defense Credit Union Council, Las Vegas, Nevada, September
16, 1974.

The Ellsworth Air Force Base Federal Credit Union (here-
after referred to as the Ellsworth FCU) has experienced a
rapid growth in its membership while its field of potential
members has remained fairly stable.[5] After its first full
year of operation, 695 accounts were opened out of a field
of membership of approximately 7,000. By the close of calen-
dar year 1973, 9127 accounts were opened out of a field of
membership of approximately 9500.[6] While the total number of
active duty military personnel has been declining since its
peak in 1968 (3.5 million), the number is expected to stabil-
ize at near 2 million. In addition, there are over 2 million
Department of Defense retirees who are also eligible for cred-
it union membership.[7]

The growth in membership at the Ellsworth FCU follows a
similar growth pattern in all credit unions in the United
States. This growth is partly attributable to the free ser-
vices afforded credit union members and the convenience of

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[5]Field of membership has been defined as military per-
sonnel stationed at Ellsworth AFB and their dependents, Depart-
ment of Defense civilians working permanently at Ellsworth AFB
and their dependents, and military retirees.

[6]1973 Annual Report of the Ellsworth AFB Federal Credit
Union.

[7]John Umbarger, Director, Directorate for Banking and
Finance, Office of the Assistant Secretary of Defense (Comp-
troller), in a speech before the Defense Credit Union Council,
Las Vegas, Nevada, September 17, 1974.

payroll deductions as well as the lower rates on consumer installment loans.[8]

Representative Wright Patman, Chairman of the House Banking and Currency Committee, a long-time champion of credit unions, has stated on a number of occasions that "next to the church, credit unions do the greatest good for the people of any institution".[9]

Consumer Installment Loans

A study by the National Consumer Finance Association in 1973 estimated that approximately 90 percent of consumer expenditures on automobiles and 50 percent of these on other consumer durables (furniture, appliances, etc.) were financed through consumer installment loans.[10]

Credit unions are emerging as strong competitors in this giant consumer loan market. According to Federal Reserve Board statistics, credit unions now hold about 13.4 percent of the $148.8 billion in consumer credit outstanding (loans for household or other personal expenditures but excluding real estate loans). In 1960 they held 9 percent and in 1950 only 4 percent of the credit outstanding.[11]

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[8] James Carberry, "Credit Unions Gain in Members and Money, Plan to Expand Their Activities", Wall Street Journal, Midwest ed., August 19, 1974, p. 20, col. 1-4.

[9] Carberry, p. 20.

[10] 1973 Finance Facts Yearbook, p. 53.

[11] Carberry, p. 20.

Credit unions and other similar lending institutions[12] held 15 percent of the installment credit on automobiles, 25 percent of the credit on personal loans and 4 percent of the credit on other consumer durables in 1972.[13]

The primary business of the Ellsworth FCU is to provide for low cost consumer installment loans through the pooling of members' savings. At the close of 1973, members' savings totalled in excess of $6 million and over 6,000 loans were made in that year alone. Since its organization in 1955, over 77,000 loans were made with a dollar value in excess of $49 million.[14]

Uncollectible Loans

Since its organization, the Ellsworth FCU has written off as uncollectible $283,988 of its loans. While this figure represents only .54 percent of its total loan dollars, the proportion of its loan dollars uncollectible to total loan dollars per year has been increasing for the past five years. In 1972, uncollectible loans to total loans, in dollars, was .78 percent. In 1973, this figure is almost doubled to 1.39 percent. Table 1 shows the percent of loans charged off since organization as well as the average for military credit unions.

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[12]Credit unions, mutual savings banks and savings and loan associations are normally grouped together as 'other financial lenders' in Federal Reserve statistics.

[13]1973 Finance Facts Yearbook, pp. 47-51.

[14]19th Annual Membership Meeting Report of the Ellsworth AFB Federal Credit Union, February 8, 1974.

Table 1

Percentage of Uncollectible
Loans Since Organization*
1955 - 1973

Year	Ellsworth AFB FCU	Military Credit Unions
1973	.54	.32
1972	.41	.31
1971	.39	.30
1970	.37	.29
1969	.37	.30
1968	.39	.30
1967	.42	.31
1955-1966	.45	.31

*in dollars

Source:

National Credit Union Association, Report of Operations, (Washington: Government Printing Office, 1973).

Delinquent accounts, those accounts on which no payment has been made in more than two months, is an indicator of future collection problems. Table 2 shows that at the close of business 1973, 1.8 percent of the outstanding loans at the Ellsworth FCU were delinquent. The average for all military credit unions was 1.5 percent.

In both number of loans delinquent to total loans outstanding and loans charged off as uncollectible to total loans, the Ellsworth FCU has in recent years exceeded the average for military credit unions.

Outline of the Study

Discriminant analysis is the statistical tool used to analyze the shared characteristics of those individuals who repaid their consumer installment loans and those who did not. A brief theoretical explanation of discriminant analysis is contained in Chapter 2. The remainder of the chapter is devoted to a description of the population, sample, data gathering techniques and selection of variables used in the discriminant analysis model.

Results of the anlaysis and an interpretation of these results in light of the present loan policies at the Ellsworth FCU are found in Chapter 3.

Chapter 4 is the concluding chapter of this study. It is a summary of the results of the discriminant analysis model, recommendations for future loan policies and suggested areas for further study.

Table 2

Percentage of Delinquent Loans*
1966 - 1973**

Year	Ellsworth AFB FCU	Military Credit Unions
1973	1.8	1.5
1972	3.0	1.5
1971	2.1	1.7
1970	1.3	1.7
1969	0.6	1.8
1968	0.5	1.9
1967	0.6	1.8
1966	0.5	1.8

*No payment for two consecutive months.

**In dollars.

Source:

    National Credit Union Association, Report of Operations, (Washington: Government Printing Office, 1973).

Chapter 2

FORMULATION OF THE MODEL

The Analytic Technique

Individuals in this study fell into two mutually exclusive and exhaustive groups, either they repaid their loans or they defaulted. Discriminant analysis was employed as a predictive tool to provide the loan officer with objective measurements of new applicants' characteristics to see if these measurements are more similar to those of one group or the other.

The discriminant function is a linear combination of independent variables which is most effective in separating the two groups. Discriminant analysis is the process of taking a sample from the two populations and setting up a function, based on measurements of the sampled individuals, which will enable the new applicant to be assigned to the population which is most similar to his measurements.

Discriminant analysis is basically the linearization of the two p-dimensional distributions where p is the number of independent variables or measurements for each individual. This can be visualized geometrically as two sample clusters in a Euclidean p-space. The two clusters are projected orthogonally onto a line so that the variation between the two projected samples is as large as possible relative to the

variations within the two projected samples. Linearization is finding the direction of the projection which accomplishes this.[1]

The solution to the discriminant function problem involves determining the weight to be given each of the p-original measurements in order that the resulting composite score will have the maximum utility in distinguishing between members of the two groups.[2]

The process begins by assuming that there is some unknown set of weighting coefficients which will define a composite score providing maximum discrimination between the groups. The desired discriminant function is usually written in the following form:

$$Y_i = a_o + a_1 X_1 + a_2 X_2 \cdot \cdot \cdot \cdot a_p X_p$$

where:

$a_1, a_2, \cdot \cdot \cdot a_p$ are the weighting coefficients to be applied to the p-original measurements for each individual and a_o is a constant term.

The discriminant function is then generalized for each group so that a set of g linear discriminant functions are produced:

$$Y_k = a_o + \sum_{i=1}^{p} a_i X_i$$

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[1]Samuel S. Wilks, Mathematical Statistics, (New York: John Wiley & Sons, 1962), p. 573.

[2]Wilks, pp. 573-574.

where:

Y_k = the value of the function in the kth category
($k = 1, 2 \ldots g$)

a_o = a constant term

X_i = the value of the ith independent variable

a_i = the ith discriminant function coefficient

g = the number of groups or categories

p = the number of independent variables

The problem is to determine the optimal values for the weighting coefficients such that the difference between mean scores for the two groups will be maximized relative to the variation within the groups. Thus, the weighting coefficients would be derived such that the t-statistic or the F-ratio between groups would be maximized.

A generalized expression for the maximization of the t-statistic or F-ratio is the following:

$$\int(a_1, a_2 \ldots a_p) = \frac{n_1 n_2}{n_1 + n_2} \frac{(a_1 d_1 + a_2 d_2 \ldots + a_p d_p)^2}{\Sigma\Sigma c_{ij} a_i a_j}$$

where:

a_i = the ith discriminant function coefficient

d_i = mean difference of the ith independent variable

n_1 = number sampled in group 1

n_2 = number sampled in group 2

$\Sigma\Sigma c_{ij} a_i a_j$ = within groups variance of a linear combination in which a_i is the weighting coefficient.[3]

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[3]John E. Overall and James C. Kleet, Applied Mathematical Analysis, (New York: McGraw-Hill, 1972), p. 244.

The mean value of the discriminant function for Group I can then be obtained by applying the weighting coefficients to the mean measurements for Group I of the original measurements. The mean value for the discriminant function for Group II can be obtained in a similar way.

$$\overline{Z}_1 = a_{1,0} + a_{1,1} \overline{X}_{1,1} + a_{1,2} \overline{X}_{1,2} \cdot \cdot \cdot a_{1,p} \overline{X}_{1,p}$$

$$\overline{Z}_2 = a_{2,0} + a_{2,1} \overline{X}_{2,1} + a_{2,2} \overline{X}_{2,2} \cdot \cdot \cdot a_{2,p} \overline{X}_{2,p}$$

The discriminant function equations can then be generalized into the following:

$$\overline{Z}_i = a_{i,o} + \sum_{j=1,p} a_{i,j} \overline{X}_{i,j}$$

where:

$\overline{Z}_i$ = the value of the discriminant function in the ith category (i = 1,2...g)

$a_{i,o}$ = the constant term in the ith function

$a_{i,j}$ = the jth discriminant function coefficient in the ith discriminant function

$\overline{X}_{i,j}$ = the mean value of the jth variable in the ith discriminant function

g = number of groups or categories

p = number of independent variables

The deviation of an individual discriminant function score from each of the group mean scores can be regarded as a unit-normal deviate or z-score. A unit normal distribution can then be used to obtain an estimate of the probability of a deviation from each group mean score as that represented by any particular z-score value.[4]

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[4]Overall & Klett, p. 246.

Implicit Assumptions of the Model

Certain assumptions are basic to the discriminant analysis model. Principally they are: that all groups are multivariate normal with mean vectors of M_1 and M_2 and covariance matrices V_1 and V_2; that V_1 and V_2 are equal; and that the explanatory variables are independent.[5]

Each individual measurement (X_i) is assumed to have a multivariate normal distribution within groups and therefore allowing the discriminant function derived from these measurements to also have normal distribution properties. The deviation of individual discriminant function scores from their group means can therefore be transferred into a unit normal score.[6]

Unequal covariance matrices leads to non-linear classification boundaries and requires a quadratic function for solution.[7] If we assume that the covariance matrices are equal we can avoid the difficulties of non-linear solutions.

Independence of explanatory variables allows for the isolation of the particular effects of each variable on the composite score. High degrees of collinearity makes interpretation on the individual contributions difficult to assess

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[5] A fourth assumption is that the estimated sample statistics are equal to the population parameters.

[6] Overall & Klett, p. 246.

[7] Phoebus J. Dhyrmes, Econometrics: Statistical Foundations and Applications, (New York: Harper and Row, 1970), pp. 67-68.

and the variances of the particular coefficients may be un-
necessarily large.[8]

Interpretation of Discriminant Analysis Models

Statistical significance. The generalized Maholanobis
D-Square statistic is used in discriminant analysis to deter-
mine if the two groups are significantly different or if their
separation could be ascribed to chance alone.

The D^2 statistic is basically a transformed F-ratio
which tests the difference between the p-dimensional vector
of each group. It is distributed as a chi-square statistic
with P(G-1) degrees of freedom where P is the number of vari-
ables and G is the number of groups.[9]

The generalized from of the Maholanobis D-Square sta-
tistic is:

$$\gamma = \sum_{i=1}^{m} \sum_{j=1}^{m} \lambda_{ij} \sum_{k=1}^{g} N_k (\overline{X}_{ik} - \overline{X}_i) (\overline{X}_{jk} - \overline{X}_j)$$

where:

  i,j = 1,2...m are the socioeconomic variables

  k = 1,2...g are the size of the operation groupings

  ij = the ith variable from the jth element of the p
          pooled covariance matrix

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[8] Donald G. Morrison, "On the Interpretation of Discrim-
inant Analysis", Journal of Marketing Research, VI, (May, 1969),
p. 162.

[9] A.A. Araji and R.M. Finley, "Managerial Socioeconomic
Characteristics and Size of Operation in Beef Cattle Feeding:
An Application of Discriminant Analysis", American Journal of
Agricultural Economics, LIII, 4, (1971), p. 648.

N_k = sample size of the kth group

$\overline{X}_{ik}$ = mean of the ith variable in the kth group

$\overline{X}_i$ = the overall mean of the ith variable

Evaluating variables. The impact each variable has on the composite discriminant function score is the product of the measured value of the variable and its corresponding discriminant coefficient. Since variables are measured on differing scales, the above product must be normalized to allow comparisons between variables.

Normalization, dividing the variables by their standard deviations, eliminates the disparities in the varying units of measurement. This procedure is justified "since we are discriminating on the basis of statistical distance between the two groups and statistical distances are measured in units of standard deviations".[10]

The purpose of the discriminant analysis is to find the differences in the mean values of the variables in the discriminant groups and by weighting these variables obtain maximum separation between the groups and minimum variance within the groups.

While the contribution measurements reveal the impact each variable has on the total discriminant score, another

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[10]Morrison, pp. 159-160; also, for a more elaborate discussion of alternate normalization procedures see James R. Prescott and William C. Lewis, "State and Municipal Locational Incentives: A Discriminant Analysis", National Tax Journal, XXII, 3, (1969), pp. 399-407.

measurement is required to enable the researcher to distinguish the relative importance of the variables in assigning an individual to one group or the other.

The technique used to accomplish the assessment of the importance of the variables in helping to determine group affiliation is to multiply the difference between the coefficients in the discriminant functions by the square root of the variance of their respective variable.[11]

Classification procedures. One of the most important means of evaluating the effectiveness of a discriminant analysis model is to see how well the model properly classifies individuals into their proper groups. It should be noted that using the same data to rate the procedures that were used to define the procedures will yield an upward bias. Corrections can easily be made to adjust for this problem.[12]

The normal measure of classification effectiveness is the n X n classification matrix. The matrix, an example of which is found in Figure 1, plots actual group membership against predicted group membership.

Correctly classified individuals are found on the diagonal while mis-classifications are found off-diagonal. The

[11]William J. Moore, Robert J. Newman and R. William Thomas, "Determinants of the Passage of Right-To-Work Laws: An Alternative Interpretation", Journal of Law and Economics, XVII, 1, (April 1974), p. 208.

[12]Morrison, pp. 157-158; also, Prescott & Lewis, pp. 382-383.

ratio of correct classifications to total classifications is $n_{11} + n_{22} \div N$ in this example.

Classified

	Group 1	Group 2
Actually Group 1	n_{11}	n_{12}
Group 2	n_{21}	n_{22}

Figure 1

A chi-squire test can be utilized to test the discriminatory powers of the model. A Q-statistic is defined as:

$$Q = \frac{(n-e)^2}{e} + \frac{(\bar{n}-\bar{e})^2}{\bar{e}}$$

where:

   n = correct classification

   $\bar{n}$ = incorrect classifications

   e = expected number of correct classifications

   $\bar{e}$ = expected number of incorrect classifications

The Q-statistic is distributed as a chi-square statistic with one degree of freedom and will give the probability that the classifications made by the model and chance selection could provide like results.

Population, Sampling Techniques and Choice of Variables

Population. The field of membership at the Ellsworth FCU was principally divided into 6 groups: active duty enlisted personnel, active duty officers, military retirees, Department of the Air Force civilians, civilian retirees, and dependents of the above individuals.

In order to have a representative sample of both repaid and uncollectible loans, it was necessary to restrict the sampled population to active duty enlisted personnel. The number of civilians, dependents and retirees was too small in both loan categories and the number of uncollectible loans by officers was too small to be sampled accurately. The percentage of civilians, dependents, and retirees who have accounts at the Ellsworth FCU was only 5 percent of the total active accounts and the percentage of uncollectible loans by officers was less than 1 percent.

The elimination of all but active duty enlisted personnel still allowed for 75-80 percent of the loans at the Ellsworth FCU to be represented in the population sampled.

Sampling techniques. Data on repaid loans at the Ellsworth FCU was available only for 1973. Approximately 6000 loans were either repaid or refinanced during 1973 and of these loans a random sample of 150 was taken. Of the 150 sampled loans, 23 (15.3 percent) had to be rejected because they did not represent active duty enlisted personnel. The

remaining loans were again sampled randomly until 150 loans were selected representing only active duty enlisted personnel.

Data from these 150 loans indicated that the loans were approved during the period 1970 through 1973. In order to have a similar time span for the sampled uncollectible loans, a random sample of 150 uncollectible loans from 1970 through 1973 was taken. The number of uncollectible loans from this period were 417. After the first sample was completed, 14 loans (9.3 percent) were rejected because they did not represent active duty enlisted personnel. Again the remainder of the loans were randomly sampled until 150 uncollectible loans were selected.

Choice of variables. The purpose of this study was to analyze all data available to a loan officer trying to separate low and high risk loan applicants. Therefore, only in rare instances as noted below was available data altered or rejected.

The following data was felt to have a priori importance and was included in this study:

(1) Approving authority for the loan - either the loan officer or the credit committee;

(2) Amount of the loan;

(3) Age;

(4) Service Rank;

(5) Months of active duty military service;

(6) Months stationed at Ellsworth Air Force Base;

(7) Number of dependents;

(8) Repayment method - either payroll deduction or direct payments;

(9) Collateral - yes or no?

(10) Gross income per month;

(11) Number of monthly payments required to repay the loan;

(12) Monthly repayment amount;

(13) Was it a new or used car loan - yes or no?

(14) Was it a debt consolidation loan - yes or no?

(15) Amount of outstanding consumer debt prior to loan approval;

(16) Number of months prior to projected discharge from active duty that the loan will be repaid.

Car loans and debt consolidation accounted for over 60 percent of declared loan purposes in 1973. Although the sampled loans included 14 other loan purposes, these purposes were not included in the analysis of variables due to program restraints.

The only other data on the loan application not included in this study were home of record and type of work. These items were not included due to space restraints and it was felt that they contained sociological factors not germane to this fundamentally economic study.

Chapter 3

RESULTS OF THE STUDY

Discriminant Model 1

Discriminant Model 1 is the presentation of the results of an analysis of a random sample of 150 repaid loans and 150 uncollectible loans. For the purpose of simplifying this presentation, repaid loans will be referred to as Group I and uncollectible loans as Group II. In addition, each variable will be assigned a representative number. Table 3 lists each variable by description, unit of measurement or scale and the representative number.

The mean value of each variable by group is presented on Table 4. Group II, those individuals whose loans were uncollectible, were on the average younger and had less income, service, rank, and months of service in the military. Group II also had less time on Ellsworth AFB, fewer loans secured with collateral and less time available to pay off the loan prior to their projected discharge date from the military. While Group II loans were more likely to be for debt consolidation than Group I, the amount of declared consumer debt outstanding for Group II was less than that of Group I.

The Maholanobis D-square statistic was 101.4 which with 15 degrees of freedom indicated that the two groups were significantly different. The chance that the two groups came from the same parent population was less than .001.

Table 3

Variables Employed in the Discriminant Models
and the Scale/Unit of Measurement

Number	Description	Scale/Unit of Measurement
1	Approving authority for loan	Loan Officer = 0; Credit Committee = 1
2	Amount of loan	Dollars
3	Age	Years
4	Service rank	31 through 39
5	Active duty service	Months
6	Stationed at Ellsworth Air Force Base	Months
7	Dependents	Number in family
8	Repayment method	Payroll deduction = 0; Direct payments = 1
9	Collateral	No = 0; Yes = 1
10	Gross income per month	Dollars
11	Repayment amount	Dollars/month
12	Outstanding consumer debt	Dollars
13	Number of payments on installment contract	Months
14	Purpose of loan - car (new or used)	No = 0; Yes = 1
15	Purpose of loan - debt consolidation	No = 0; Yes = 1
16	Repayment prior to projected discharge	Months

Table 4

Means of Variables in Discriminant Groups I and II

Variable	Group I Mean	Group II Mean	Common Mean
1	0.04667	0.02667	0.03667
2	754.94000	679.20667	717.07333
3	24.49333	22.05333	23.27333
4	33.82000	32.96667	33.39333
5	61.52000	35.40000	48.46000
6	11.71333	6.84000	9.27667
7	1.38000	0.90667	1.14333
8	0.09333	0.05333	0.07333
9	0.20667	0.08667	0.14667
10	377.95333	281.34000	329.64667
11	54.54667	48.04000	51.29333
12	970.42000	604.64000	787.53000
13	14.08667	15.19333	14.64000
14	0.19333	0.26000	0.22667
15	0.08000	0.15333	0.11667
16	15.68000	12.98000	14.33000

The n x n classification for this analysis (Figure 2) has a 71.6 percent correct classification and the accompanying Q-statistic (28.17) with one degree of freedom indicates a probability of less than .001 that chance or random selection could have achieved these results.

Classified

	Group I	Group II
Actually Group I	108	42
Group II	43	107

Percent of total loans classified correctly = 71.6

D^2 statistic = 101.40

Q statistic = 28.17

Figure 2

The contribution of each variable to the discriminant function was then analyzed. Two measures of importance were utilized, the first was a measure of the average contribution each variable made to the total discriminant function score and the second a measure of the relative importance of each variable after it was normalized to account for differences in scale.

The average contribution to the total discriminant score was computed by finding the product of the mean of each variable and its respective discriminant function coefficient

$(a_i\bar{X}_i)$.[1] Normalization, previously discussed in Chapter 2, for the second measurement of importance was achieved by finding the product of the standard deviation of the variable and its respective discriminant function coefficient $(a_i\sigma_{\bar{X}_i})$.[2] Both the normalized and the average contribution measurements were fairly similar in their ranking of the importance of the variables' contribution to the discriminant function score. Table 5 ranks each variable by the two measurements described above.

The importance of variables in assigning an individual to one group or another is measured by the product of the difference of the coefficients in function I and II and the standard deviation of the respective variable $|\sigma_{\bar{X}_i}(a_{1,i}-a_{2,i})|$.[3]

Table 6 ranks each variable according to this measurement of importance. Rank, loan pay-off prior to projected discharge date, income and collateral were ranked highest in importance.

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[1]James R. Prescott and William C. Lewis, "State and Municipal Locational Incentives: A Discriminant Analysis", National Tax Journal, XXII, 3, (1969), pp. 402-403.

[2]Donald G. Morrison, "On the Interpretation of Discriminant Analysis", Journal of Marketing Research, VI (May, 1969), pp. 159-160.

[3]William J. Moore, Robert J. Newman and R. William Thomas, "Determinants of the Passage of Right-to-Work Laws: An Alternative Interpretation", Journal of Law and Economics, XVII, 1, (April, 1974), p. 208.

Table 5

Ranking of the Contribution of Variables
to the Discriminant Score
in Model 1

| Variable | Rank Order Measurements | | | |
| | Group I | | Group II | |
	$a_i \bar{X}_i$ [a]	$a_i \sigma_{\bar{X}_i}$ [b]	$a_i \bar{X}_i$ [c]	$a_i \sigma_{\bar{X}_i}$ [d]
1	15	12	14	13
2	8	10	6	10
3	13	16	16	16
4	1	1	1	1
5	2	2	3	2
6	11	13	12	12
7	7	7	8	7
8	10	8	11	8
9	9	9	10	9
10	3	4	2	4
11	14	14	13	14
12	6	5	7	5
13	5	6	4	6
14	12	11	9	11
15	16	15	15	15
16	4	3	5	3

[a] Product of the mean values of Group I variables and
their respective discriminant function coefficients.

[b] Product of the standard deviations of Group I vari-
ables and their respective discriminant function coefficients.

[c] Product of the mean values of Group II variables and
their respective discriminant function coefficients.

[d] Product of the standard deviations of Group II vari-
ables and their respective discriminant function coefficients.

Table 6

Order of Importance of Variables in Model 1

Variable	Measurement $\lvert (\sigma_{X_i})(a_{1,i} - a_{2,i}) \rvert$	Ranking
1	0.181	10
2	0.161	11
3	0.308	7
4	1.064	1
5	0.332	6
6	0.384	5
7	0.103	12
8	0.094	13
9	0.415	4
10	0.534	3
11	0.055	14
12	0.047	15
13	0.039	16
14	0.239	9
15	0.266	8
16	0.764	2

An Implicit Assumption Violated in Model 1

As presented in Chapter 2, one of the implicit assumptions required for an accurate assessment of the individual contribution of variables is that all variables be independent. Additionally, the discriminant function is known to be more unstable when non-independence of variables exist.

The Air Force promotion system is predicated primarily on military service tenure and it was anticipated that the tenure related variables would prove to be highly collinear. The variables which were expected to display this tendency were age, rank, income and months of service.

The tenure related variables were ranked high in their contribution to the discriminant function score. Rank, months of service and income were ranked first, second and fourth in importance, respectively. Age, however, was an exception and was ranked last in importance.

All of the tenure related variables were important in helping to assign an individual to one group or another. Rank, income, months of service and age were ranked first, third, sixth and seventh in importance, respectively.

Table 7 is the covariance matrix for the variables in Model 1. The four tenure related variables exhibited high covariances with each other, ranging from .74 to .92. No other variables displayed a covariance over .70 however.

Several discriminant analyses were made deleting or retaining these four variables in an effort to establish a model

Table 7

Covariance Matrix for Discriminant
Groups I and II

Variable

Variable	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	-.02	-.01	-.08	-.05	-.17	.01	.01	.06	-.05	.01	-.12	-.01	.06	-.07	.05
2		.28	.32	.31	.13	.26	-.13	.47	.27	.69	.25	.53	.28	.10	-.22
3			.82	.92	.38	.66	.22	.08	.74	.34	.36	.14	-.05	.08	-.42
4				.83	.39	.61	.21	.12	.74	.35	.46	.14	-.08	.11	-.49
5					.37	.66	.16	.05	.75	.32	.42	.13	-.08	.11	-.40
6						.29	-.04	.05	.39	.17	.21	.07	-.12	-.02	-.33
7							.05	.08	.58	.18	.40	.29	-.04	.10	-.29
8								-.10	.13	.00	.05	-.15	-.08	-.06	-.14
9									.10	.39	-.02	.27	.45	-.07	-.11
10										.26	.44	.12	-.05	.08	-.34
11											.14	.06	.17	.07	-.20
12												.13	-.13	.18	-.13
13													.28	.01	-.35
14														.21	-.05
15															-.03

which gave a high percentage of correctly classified loans, maintained statistical significance between the groups and eliminated as many of the collinear variables as possible. Interpretation of the results of omitting variables proved extremely difficult however.

When age was omitted, the percentage of loans classified correctly dropped .3 percent but this was the result of a decrease of 1.4 percent correct classification for Group I and an increase of 1.4 percent correct classification for Group II. When both age and rank were omitted, the total percentage of loans classified correctly increased 2 percent, the result of no change in correct classification in Group I and an increase of 4.3 percent in correct classification in Group II.

The range of total loans classified correctly was from 69.3 percent to 73.6 percent and all the analyses were statistically significant. Table 8 summarizes the results of these discriminant analyses. While income, rank, months in service and age were in combination or individually important in helping to discriminate between Groups I and II, the attempted assessment of the individual contribution of these variables was not successful.

Discriminant Model 2: An Alternate Model

Since military tenure related directly to four of the sixteen variables employed in this study an alternate discriminant analysis was developed using months of military service

Table 8

Discriminant Analyses with Combinations of Tenure Related Variables Omitted

Variables Omitted	D^2-Statistic		Q-Statistic		Percent of Total Sample Classified Correctly	Percent of Group I Classified Correctly	Percent of Group II Classified Correctly
	Score	Statistical Significance	Score	Statistical Significance			
None	101.4	.001	28.17	.001	71.6	72.0	71.0
Age	100.5	.001	27.33	.001	71.3	70.6	72.0
Age, Grade	82.4	.001	33.77	.001	73.6	72.0	75.3
Age, Months of Service	95.1	.001	19.96	.001	70.0	66.0	74.0
Age, Months of Service, Grade	82.3	.001	33.77	.001	73.6	72.0	75.3
Age, Income	93.4	.001	18.25	.001	72.0	69.3	74.6
Months of Service	100.4	.001	28.17	.001	71.6	72.0	71.3

to divide Group I and II into what was thought to be two sep-
arate populations, career and non-career individuals.

The sampled loans were segregated into those represent-
ing individuals who exhibited career intentions by re-enlisting
after their initial tour of duty and those individuals who were
still serving their initial enlistment. Forty-eight months was
chosen as the length of military service which would divide
these groups since it was the time when the first enlistment
was usually terminated and it was also the common mean value
for the months of military service variable.

Discriminant Model 2 was an attempt to compare the
shared characteristics of those individuals under 48 months
military service who repaid their loans (Group IA) with those
individuals under 48 months who did not repay their loans
(Group IIA). It could then be used to compare the shared char-
acteristics of those individuals with over 48 months military
service who repaid their loans (Group IB) with those individ-
uals with over 48 months who failed to repay (Group IIB).

The respective sample sizes for Group IA and IIA were
99 and 128 and for Group IB and IIB, 51 and 22. Months of
service was omitted as an explanatory variable in Discriminant
Model 2 since it lost its importance when it was used to sep-
arate the populations into career (over 48 months military
service) and non-career or first term enlisted personnel
(under 48 months military service).

First enlistment loan applicants. The mean value of each variable by group in the discriminant analysis of Group IA and IIA is presented on Table 9. The only variables which evidenced a different relationship between groups than the relationship presented for Group I and II were number of dependents and amount of loan. Uncollectible loans in the under 48-month group had the average amount of the loan and the number of dependents greater than in the repaid population. As anticipated the mean values of age, income, and rank were less than in the comparable analysis of Group I and II.

The Maholanobis D-square statistic was 82.75 which with 14 degrees of freedom indicated that the two groups were significantly different. The chance that the two groups came from the same parent population was less than .001.

The n x n classification matrix (Figure 3) has a 70.9 percent correct classification and the accompanying Q-statistic (20.76) indicates a probability of less than .001 that chance or random selection could have duplicated these results.

Classified

		Group IA	Group IIA
Actually	Group IA	74	25
	Group IIA	41	87

Present of total loans classified correctly = 71.6

D^2 statistic = 82.75
Q statistic = 20.76

Figure 3

Table 9

Means of Variables in Discriminant
Groups IA and IIA

Variable	Group IA Mean	Group IIA Mean	Common Mean
1	0.06061	0.02344	0.03965
2	569.46465	587.65625	579.72246
3	20.77778	20.53906	20.64317
4	33.00000	32.64063	32.79736
5*			
6	8.51515	6.46094	7.35683
7	0.51515	0.60938	0.56828
8	0.09091	0.03906	0.06167
9	0.20202	0.07031	0.12775
10	302.01010	248.50000	271.83700
11	48.65657	45.79688	47.04405
12	520.43434	440.82813	475.54626
13	12.76768	14.52344	13.75771
14	0.21212	0.26563	0.24229
15	0.06061	0.11719	0.09251
16	18.68687	14.67969	16.42731

*Variable omitted.

An analysis of the ranking of variables after normalization (Table 10) showed rank, pay-off prior to projected discharge, number of payments in the installment contract and income to be the variables most important in contributing to the total discriminant function score.

Table 11 is the ranking of variables by importance in assigning group identification. Pay-off prior to projected discharge, rank, collateral and income were ranked highest in importance.

The degree of covariance between the tenure related variables in this analysis diminished markedly to between .34 and .53. The covariance matrix for the analysis of Groups IA and IIA is presented in Table 12.

Career loan applicants. A similar discriminant analysis was made for Groups IB and IIB and the mean values for each group are presented in Table 13. The variables which evidenced a different relationship between groups than the relationship presented for Group I and II were loan approving authority, amount of loan, and payment method. Careerists who failed to repay were more likely to have their loans approved by the credit committee, to borrow more money and to make more direct payments than career loan applicants who repaid their loans.

The Maholanobis D-square statistic was 29.66 which again indicated that the two groups were significantly different.

Table 10

Ranking of the Contribution of Variables
to the Discriminant Score in
Model 2, Groups IA and IIA

| | Rank Order Measurements | | | |
| | Group IA | | Group IIA | |
Variable	$a_i \bar{X}_i$[a]	$a_i \sigma_{\bar{X}_i}$[b]	$a_i \bar{X}_i$[c]	$a_i \sigma_{\bar{X}_i}$[d]
1	13	8	14	8
2	6	5	6	5
3	2	6	2	6
4	1	1	1	1
5*				
6	12	14	10	14
7	8	9	8	10
8	9	7	12	7
9	10	12	13	12
10	4	4	3	4
11	7	11	7	11
12	15	15	15	15
13	5	3	5	3
14	11	10	9	9
15	14	13	11	13
16	3	2	4	2

*Variable omitted.

[a]Product of the mean values of Group IA variables and their respective discriminant function coefficients.

[b]Product of the standard deviations of Group IA variables and their respective discriminant function coefficients.

[c]Product of the mean values of Group IIA variables and their respective discriminant function coefficients.

[d]Product of the standard deviations of Group IIA variables and their respective discriminant function coefficients.

Table 11

Order of Importance of
Variables in Model 2,
Groups IA and IIA

Variable	Measurement $\left\|(\sigma_{\overline{X}_i})(a_{1,i} - a_{2,i})\right\|$	Ranking
1	0.313	7
2	0.022	13
3	0.295	8
4	0.622	2
5*		
6	0.417	5
7	0.351	6
8	0.261	9
9	0.606	3
10	0.586	4
11	0.000	15
12	0.104	11
13	0.011	14
14	0.173	10
15	0.084	12
16	0.890	1

*Variable omitted.

Table 12

Covariance Matrix for Discriminant Groups IA and IIA

								Variable							

Variable

Variable	2	3	4	5*	6	7	8	9	10	11	12	13	14	15	16
1	-.02	-.08	-.11		-.23	.14	.03	.12	-.04	.01	-.10	-.04	.11	-.06	.07
2		.07	.13		.01	.14	-.12	.44	.03	.55	.03	.61	.42	.03	-.28
3			.53		.17	.29	.30	.16	.34	.32	.06	.02	-.02	.02	.32
4					.30	.21	.24	.14	.45	.28	.19	.03	-.06	.03	-.50
5*															
6						.05	.00	.05	.24	.14	.23	.07	-.24	-.02	-.34
7							.01	.18	.33	.05	.17	.22	-.03	.04	-.09
8								-.07	.06	.10	.06	-.15	-.13	-.01	-.15
9									.01	.26	-.08	.25	.40	-.10	-.16
10										.11	.36	.10	-.07	.03	-.17
11											.04	.10	.17	.03	-.26
12												.01	-.17	.09	-.12
13													.31	.03	-.24
14														.18	-.08
15															-.02

*Variable omitted.

40

Table 13

Means of Variables in Discriminant
Groups IB and IIB

Variable	Group IB Mean	Group IIB Mean	Common Mean
1	0.01961	0.04545	0.02740
2	1114.98039	1211.86364	1144.17808
3	31.70588	30.86364	31.45205
4	35.41176	34.86364	35.24658
5*			
6	17.92157	9.04545	15.24658
7	3.05882	2.63636	2.93151
8	0.09804	0.13636	0.10959
9	0.21569	0.18182	0.10548
10	525.37255	472.40909	509.41096
11	65.98039	61.09091	64.50685
12	1843.92157	1557.72727	1757.67123
13	16.64706	19.09091	17.38356
14	0.15686	0.22727	0.17808
15	0.11765	0.36364	0.19178
16	9.84314	3.09091	7.80822

*Variable omitted.

The chance that the two groups were of the same parent population was less than .01.

The n x n classification matrix (Figure 4) shows a 73.9 percent correct loan classification and the accompanying Q-statistic indicates a probability of less than .005 that chance or random selection could have achieved similar results.

Classified

	Group IB	Group IIB
Group IB	38	13
Group IIB	6	16

Actually

Percent of total loans classified correctly = 73.9

D^2 statistic = 29.66
Q statistic = 9.03

Figure 4

An analysis of the ranking of variables after normalization (Table 14) showed rank, age, amount of outstanding consumer debt and income to be the variables most important in contributing to the total discriminant function score.

Table 15 is the ranking of variables by importance in assigning group identification. Debt consolidation loans, rank, age and repayment amount per month were ranked highest in importance.

The degree of covariance between the tenure related variables also diminished in this analysis but not as markedly

Table 14

Ranking of the Contribution of Variables
to the Discriminant Score in
Model 2, Groups IB and IIB

| Variable | Rank Order Measurements | | | |
| | Group IB | | Group IIB | |
	$a_i \overline{X}_i$ [a]	$a_i \sigma_{\overline{X}_i}$ [b]	$a_i \overline{X}_i$ [c]	$a_i \sigma_{\overline{X}_i}$ [d]
1	15	9	15	10
2	7	10	7	9
3	2	2	2	2
4	1	1	1	1
5*				
6	11	15	14	14
7	9	14	8	15
8	12	8	11	8
9	10	7	9	7
10	3	4	3	4
11	6	11	6	11
12	5	3	5	3
13	4	6	4	6
14	13	13	12	12
15	14	12	10	13
16	8	5	13	5

*Variable omitted.

[a]Product of the mean values of Group IB variables and their respective discriminant function coefficients.

[b]Product of the standard deviations of Group IB variables and their respective discriminant function coefficients.

[c]Product of the mean values of Group IIB variables and their respective discriminant function coefficients.

[d]Product of the standard deviations of Group IIB variables and their respective discriminant function coefficients.

Table 15

Order of Importance of
Variables in Model 2
Groups IB and IIB

Variable	Measurement $\|(\sigma_{\overline{X}_i})(a_{1,i} - a_{2,i})\|$	Ranking
1	0.426	7
2	0.653	5
3	0.957	3
4	0.968	2
5*		
6	0.413	8
7	0.110	14
8	0.297	10
9	0.180	12
10	0.293	11
11	0.754	4
12	0.128	13
13	0.021	15
14	0.326	9
15	0.979	1
16	0.615	6

*Variable omitted.

as for Groups IA and IIA. The covariance matrix for this analysis is presented on Table 16.

The Relative Importance of Variables in Discriminant Model 2

A brief outline of the role the variables play when differentiated by career as opposed to first term loan applicants is as follows:

(1) Age - The older the applicant the more likely the loan would be repaid. Age was more important for the career applicant than the first termer.

(2) Rank - Rank was an extremely important variable in both applicant groups. The higher the rank of the individual the more likely he would repay the loan.

(3) Income - In both applicant groups, the greater the income of the individual the more likely he would repay.

(4) Purpose of the Loan - Non-career applicants were more likely to have car related loans than careerists but the opposite was true in the case of debt consolidation loans. The most important variable in placing a careerist in the uncollectible loan groups was if he required a debt consolidation loan. Car related loans were not significant in either group.

(5) Collateral - The availability of collateral was higher in repaid loans than uncollectible loans. Collateral was important for first termers but not significant for careerists.

Table 16

Covariance Matrix for Discriminant
Groups IB and IIB

Variable

Variable	2	3	4	5*	6	7	8	9	10	11	12	13	14	15	16
1	-.04	-.01	-.06		-.14	.09	.06	.08	-.02	.09	-.16	-.12	.08	-.09	.02
2		.08	.02		.00	.07	-.25	.58	.07	.82	.18	.44	.31	.05	-.03
3			.69		.29	.35	.28	.02	.65	.17	.01	.21	-.03	.42	.28
4					.26	.29	.26	.07	.62	.18	.27	.16	-.06	.02	-.20
5*															
6						.23	.10	.19	.32	.09	.01	.06	-.03	-.11	-.23
7							.02	.09	.24	.03	.17	.13	-.10	.01	-.12
8								-.17	.14	.22	.01	-.22	-.06	-.20	-.09
9									.17	.63	-.09	.29	.57	-.07	-.03
10										.11	.10	.03	-.06	.06	-.19
11											.11	.16	.28	.04	-.09
12												.03	-.06	.19	-.19
13													.33	.05	-.41
14														.26	-.06
15															-.11

*Variable omitted.

(6) Number of Dependents - If the loan applicant was a first termer, the more dependents he had the less likely he would repay the loan. If the applicant was in career status, the opposite was true. The number of dependents was more important for non-careerists.

(7) Loan Pay-off Prior to Projected Discharge - The earlier the loan was scheduled to be repaid prior to the projected discharge date the more likely it would be repaid. This variable was paramount in importance in the first termer group.

(8) Amount of Loan - The amount of the loan was an important variable in the career group. It was found that the higher the amount of the loan the less likely it would be repaid.

(9) Months on Base - Months on base was not significant in the careerist group. However, it was important for the non-careerist.

(10) Repayment Amount per Month - The amount required to repay the consumer installment loan was important only in the career group. The lower the repayment amount per month the more likely the loan would not be repaid.

(11) The Remaining Variables - The amount of outstanding consumer debt, the approving authority for the loan, the repayment method and the number of payments in the installment contract were not important in helping to assign group affiliation.

The Two Models Compared

The first discriminant analysis presented, Model 1, used sample populations without regard to the tenure status of the individuals while the alternate analysis, Model 2, attempted to take tenure into account.

Both models were able to distinguish between their re-paid and uncollectible loan accounts with a high probability that the sample populations did not come from the same parent population. Additionally, both models were able to correctly classify over 70 percent of the total sample.

However, Model 2 was found to be superior because it was able to reduce the degree of covariance between the tenure related variables and detect differences in the ranking of variables within the career and non-career sub-groups of the sampled repaid and uncollectible loans.

Model 2 showed that there was in fact two separate populations within each group and that these separate popula-tions had significant differences in their characteristics. Model 1 was incapable of detecting these differences in char-acteristics between the first term enlisted personnel and the career enlisted personnel. Table 17 is a comparison of the relative importance of variables in Group IA and IIA, Group IB and IIB, and Group I and II.

Present Loan Policies at the Ellsworth FCU

Since approximately 75 percent of the loanable assets at the Ellsworth FCU are being loaned out, loans are not being

Table 17

Relative Importance of Variables
in the Discriminant Analysis
of Groups I & II; IA & IIA
IB & IIB

Groups	Variables															
	1	2	3	4	5*	6	7	8	9	10	11	12	13	14	15	16
I & II	9	8	3	1		6	10	15	5	4	11	13	12	14	7	2
IA & IIA	7	13	8	2		5	6	9	3	4	15	11	14	10	12	1
IB & IIB	7	5	3	2		8	14	10	12	11	4	13	15	9	1	6

*Variable omitted.

refused due to lack of funds. However, unnecessary or habitual borrowing is discouraged.

Loans are generally approved except under the following circumstances:

(1) The loan cannot be repaid at least 6 months prior to the applicant's projected discharge date;

(2) The loan is unsecured and over $2500;

(3) It is a car loan and the applicant does not have the required 10-25 percent downpayment;

(4) The applicant's outstanding debts make it improbable that he could repay the loan;

(5) It is a car loan for over $750 and the applicant refuses to allow the credit union to hold title to the vehicle.

The loan officer is directed to refer to the credit committee loan applications under the following circumstances:

(1) The applicant has not been stationed on base over 90 days;

(2) The applicant was previously refused a loan at the credit union;

(3) The applicant feels that the credit committee will approve the loan even though the loan officer would not.

As described earlier in this study, the loan officer and the credit committee usually use the fundamental "three C's rule": character, collateral and capacity to repay to evaluate the loan applicants.

Chapter 4

SUMMARY AND RECOMMENDATIONS
FOR FURTHER RESEARCH

Limitations of the Analysis

Before summarizing the results of this study, it would be appropriate to comment on the representativeness of the sampled data and the limitations in the application of the results.

The study sampled only enlisted military personnel at the Ellsworth FCU. Enlisted personnel account for over 75 percent of all loans granted by the lending institution and it is from the enlisted population that the greatest increase in uncollectible loans have been generated. From January through June 1974, enlisted personnel have accounted for over 90 percent of all new uncollectible loans.

Civilians, officers, dependents and retirees were not included in this study because explanatory variables such as months of service, rank, and date of projected discharge from military service were either not available, not appropriate, or too difficult to scale between the different populations. Therefore, all recommendations and conclusions drawn from this study are necessarily directed only to loans applied for by enlisted personnel.

This study did not differentiate between loans which were repaid or refinanced. Refinancing of loans at the Ellsworth FCU was not used as a means of preventing loans from

Loan Policy Recommendations

A significant problem at the Ellsworth FCU has been that many borrowers have been released from active duty well in advance of their projected discharge date. In many cases discharge prior to the loan payoff date has meant that loans subsequently became uncollectible.

This study confirmed that the earlier the loan was projected to be paid off the more likely it would be repaid. Repaid loans were on the average scheduled to be repaid 18.7 months prior to projected discharge for first termers and 9.8 months for careerists. Uncollectible loans were on the average scheduled to be repaid 14.7 months prior to projected discharge for first termers and 3.1 months for careerists.

Since the average uncollectible loan for first termers was scheduled for repayment 14.7 months prior to discharge the present 6-month requirement does not appear to be adequate. First term applicants should be scheduled to repay their loans at least 15 months prior to their projected discharge date to reduce this high-risk factor. However, the 6-month policy for careerists appears to be sufficient.

In order to accelerate the repayment period, the loan officer has two options, either to reduce the amount of the loan and thereby shorten the number of installment payments or to increase the repayment amount per month and leave the loan amount unchanged. This study has shown that the amount of repayment per month was not important for first term applicants.

This study has shown that tenure variables have consistently been important in all the discriminant models. It is therefore recommended that loan limits be established which are commensurate with the amount of tenure the applicant has.

The credit committee is currently interviewing all loan applicants who have less than 90 days on base. This study does not support the assumption of greater risk with newcomers to the base. However, it could support a policy of screening newcomers to the Air Force.

The discriminant models also showed that high consumer debt was not indicative of poor financial management but was rather an indication of increased borrowing power. However, the study revealed that first termers with more than the average number of dependents and careerists requiring consolidation loans should be screened carefully.

It is shown in the study that the discriminant function in Model 2 correctly predicted the future outcome of over 70 percent of the 300 sampled loans. All of these loans had been previously screened by the present loan policies and only 50 percent were correctly predicted.

While it must be granted that there is an upward bias testing the discriminant function with the same data used to build it, there nevertheless is a substantial proportion of future loans which could be evaluated more accurately with a discriminant analysis as opposed to the present loan screening process now being employed at the Ellsworth FCU.

becoming excessively delinquent by extending the repayment period. Rather, refinancing was viewed as a reward for faithful performance of the installment contract provisions. If the member desired to make additional loans without fully discharging his prior loan commitment, refinancing was available.

Additionally, there was no data available on loan applications submitted and subsequently disapproved. Therefore, the sample data represented only approved loan applications and not the total population of all loan applications.

Summary of the Study

This study determined that it was not chance which could account for a loan being repaid or becoming uncollectible. Rather, repayers and defaulters of consumer installment loans had significantly different shared characteristics which could be used to discriminate between the two groups.

It is noteworthy that no one variable could be used as the sole indicator of group affiliation but that the combination of all the explanatory variables appropriately weighted though a discriminant function was successful in correctly classifying over 70 percent of the loans sampled. The discriminant analysis allowed for the simultaneous weighting of all the explanatory variables so that even small differences in the mean values of the variables between groups could help in the discrimination process.

The study revealed that there were a separate set of shared characteristics for persons who repaid their loans and

a different set of characteristics for those who did not. Furthermore, each of these populations could be divided into career and non-career personnel. The relative importance of these variables for each group after normalization was summarized in Table 17.

The previous chapter concluded with guidelines which could be used in making particular risk assessment decisions for each population and suggested modifications to the pre-existing loan policies in view of the results of this study.

Suggested Avenues of Further Research

Some of the explanatory variables used in this study could be modified in future studies to increase their usefulness. Number of dependents could be changed to two separate variables, married or single to reflect marital status, and number of dependents to indicate family size. Additionally, purpose of the loan could be expanded to include consumer durables, consumer non-durables and recreation.

Another study could be made, if data was available, of the characteristics of those loans which were not approved to see if a sizable proportion of the loan applicants are unduly being denied loans predicated on the results of a statistical analysis such as the one presented in this study.

The efficacy of the credit committee was brought under question when it was determined that one of the three reasons that loans were referred to this body did not appear to be consistent with greater risk. An analysis of the actions

taken by the credit committee might help to evaluate its over-
all effectiveness in screening what was thought to be high-
risk individuals.

And finally, the costs of mis-classification in Groups
I and II were assumed to be equal. Rejecting a loan applica-
tion when in fact the loan would have been repaid results in
both a loss of goodwill and interest revenue. On the other
hand, the approval of a loan which would have subsequently
become uncollectible is a drain on the loanable assets of the
lending institution. The assumption of equal costs could very
likely be questioned.

The credit union might find it appropriate to loan
out relatively small amounts of money to high risk applicants
in order to maintain goodwill and yet minimize risk by re-
stricting the amount of the loan. Furthermore, the individual
would then have the opportunity to create a favorable credit
reference.

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