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Roger D. Stover
Iowa State University

R. Kenneth Teas
Iowa State University

Roy G. Gardner
Iowa State University

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Disciplines
Business Administration, Management, and Operations | Economic Theory | Finance and Financial Management
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The Commercial Lending Decision: A Multiattribute Analysis

Research on the commercial lending decision has had two primary focuses. Considerable study has been made of the role of the lending component in broader bank portfolio allocation models (Campbell [7], Deshmukh, Greenbaum, and Kanatas [11], Harris [15,16], Hester [18], Luckett [25], Sealey [28]. An additional major thrust has been the delineation of loan pricing vectors (Bartter and Rendleman [5], Campbell and Brendsel [8], Hawkins [17], James [20], Kolodny, Sealey and Polakoff [23]). Despite the extensive theoretical development in both areas, empirical examination of the lending process has exhibited distinct limitations. First, there has been a survival bias in that, by relying on published results, only granted loans are examined. Second, with the exception of Luckett [25], the reliance on Federal Reserve survey results (Harris [15,16], Hester [18], James [20]) limits the analysis to principally large money center banks that report such data.

In contrast to previous research utilizing aggregate bank portfolio models, this study examines the loan decision from the viewpoint of the individual bank lending officers when faced with multiple decision variables in the loan decision. Previous research on loan pricing together with the credit rationing literature ([14],[15],[25]) suggests that the interest rate is only one element among a more complete set of decision variables. Section II develops a theoretical construct for an expanded set of decision variables. Section III describes how this set of variables is tested, based on a sample of hypothetical loans generated from a set of factorially designed combinations of the decision variables. Section IV presents the results of the empirical testing.
II. Basic Theory

This paper studies the determinants of lenders' ranking of loans. Since the loan size is controlled, the discussion will focus on the loan of a dollar. By suitable scaling, the discussion will apply to any pool of loan applications, each for A dollars. The loan features examined in this study are: collateral, yield, management, repayment ability, market conditions, and loan purpose.

Denote by c the collateral on the loan, and by r, the yield. Let x be the cash payments from the borrower to the lender over the period of the loan. Then the return to the lender, R, can take either one of two forms. First, the loan does not perform, in which case the lender gets the collateral plus whatever cash payments, x, occur prior to default. Otherwise, the loan performs, and the lender gets back his principal 1 and interest r. Thus, the return function for the lender, R(x), equals the minimum of c + x and 1 + r. This is depicted in Figure 1. Note the crucial value of x = 1 + r - c; at this value, a loan is just on the verge of performing.

Now if x were certain it would be an easy matter for the bank to rank loans: good loans perform, bad loans do not. In most cases, however, x is random. Indeed, the randomness of x is typically contingent on the remaining four features: management, the borrowing firm's repayment ability, market conditions, and loan purpose.

Let z_1 = management capability of the borrowing firm; z_2 = repayment ability of the borrower; z_3 = market conditions facing the borrower; z_4 = compliance of the loan with the lender's loan policy. The conditional probability relationship for x given levels of the z' will be denoted by f(x/z_1,z_2,z_3,z_4). The z's are measured in such a way that an increase in any z should shift the
Figure 1

Loan Return Function

\[ R(x) = \min(x+c, 1+r) \]

Figure 2

Conditional Probability of \( x \) given \( z \)

a) \( f(x/z) \)

b) \( f(x/z') \) for \( z' > z \)
conditional probability to the right. Better management, for instance, should raise the probability that a loan will perform. This is depicted in Figure 2. To avoid trivialities, we assume that there is always some probability of non-performance. Denoting by \( F(x/z_1,z_2,z_3,z_4) \), the cumulative probability distribution, then, \( 1>F(1+r-c/z_1,z_2,z_3,z_4)>0 \).

To simplify the notation, let \( Z \) represent the vector consisting of the 4 z's. If \( Z' \) is greater than \( Z \) in at least one component, and at least as great as \( Z \) in all components, then \( F(x/Z)<F(x/Z') \), where \( F \) is the cumulative conditional probability function. For example, in Figure 2, \( F(x_0/Z) \) is positive, while \( F(x_0/Z') \) is zero.

Finally, the attitude of the lender towards risk must be considered. If the lender's utility function is linear, \( U(R) = R \) for return \( R \), then the lender is risk-neutral. On the other hand, if the lender's utility function is strictly concave, \( U(R) \) exhibits positive but diminishing marginal utility, and the lender is risk-averse. We will exclude the possibility of risk-seeking lenders. Then the expected utility of the lender is given by

\[
EU(R/Z) = \int_0^{\infty} U(R)f(x/Z)dx
\]

(1)

Note that the lender's expected utility depends on all 6 factors. It is explicitly conditional on \( Z \), and implicitly dependent on \( c \) and \( r \), as the following rewriting of (1) shows:

\[
EU(R/Z) = \int_0^{1+r-c} U(x+c)f(x/Z)dx + \int_{1+r-c}^{\infty} U(1+r)f(x/Z)dx
\]

(2)
For a risk-neutral lender, (2) becomes

$$E(R/Z) = \int (c+x)f(x/Z)dx + \int (1+r)f(x/Z)dx$$

$$0 \quad 1+r-c$$

(3)

$$= cF(1+r-c/Z) + \int xf(x/Z)dp + (1+r)[1-F(1+r-c/Z)]$$

$$0$$

The first term on the right-hand side of (3) is the expected value of the collateral, that is, the collateral times the probability of collecting the collateral when the loan does not perform. The second term is the expected default value of the project, given that the project does not perform as a loan and hence the lender collects all the proceeds prior to default. The third term is the expected value of the loan, given that it does perform, that is the principal plus interest times the probability of receiving them.

A similar interpretation applies to a risk-averse lender also:

$$EU(R/Z) = \int U(c+x)f(x/Z)dx + U(l+r)\int f(x/Z)dx =$$

$$0 \quad 1+r-c$$

(4)

$$l+r-c$$

$$\int U(c+x)f(x/Z)dx + U(l+r)[1-F(1+r-c/Z)]$$

$$0$$

The first term is the expected utility in the non-performance zone; the second, the expected utility of performance.
Mathematically we can show that increases in any of the 6 features increase the expected return to the lender; that is

$$\frac{\partial \text{EU}(R|z)}{\partial y_i} > 0 \text{ for } y_i = c, r, z_1, z_2, z_3, z_4.$$ \hspace{1cm} (5)

(5) is verified in the appendix.

This can be illustrated using the following special case. Let \( f(x/Z) \) be a uniform density, and only changes in a single one of the \( z \)'s are considered. In particular

$$f(x/z) = \frac{1}{1+a} \text{ for } z < x < 1+a+z,$$

$$0 \text{ otherwise.}$$

Then \( F(x/z) = 0 \) for \( x < z \)

$$\frac{x-z}{1+a} \text{ for } z < x < 1+a+z$$

$$1 \text{ for } 1+a+z < x.$$  

Computing the expected return according to (3), we have

$$\text{EU}(R) = c \frac{1+r-c-z}{1+a} + \int_{z}^{1+r-c} \frac{x}{1+a} \, dx + \left( 1 - \frac{1+r-c-z}{1+a} \right) (1+r) =$$

$$\frac{(1+r)^2 - (z+c)^2}{2(1+a)} + \left( 1 - \frac{1+r-c-z}{1+a} \right) (1+r).$$
Taking derivatives with respect to $c$, $r$, and $z$, we have

$$\frac{\partial \text{EU}(R)}{\partial c} = \frac{1+r-c-z}{1+a} > 0$$

$$\frac{\partial \text{EU}(R)}{\partial r} = \frac{a+c+z-r}{1+a} > 0$$

$$\frac{\partial \text{EU}(R)}{\partial z} = \frac{1+r-c-z}{1+a} > 0,$$

thus verifying (5) in this case.

III. Methodology

As specified in Section II, the loan officer examines multiple attributes of a potential loan. In this evaluation process, the relationships among the attributes and their effects on loan desirability are complex as shown in Equation 5. An important question, therefore, in the analysis of the loan evaluation process concerns the relative effects of various criteria on the loan application and the degree to which tradeoffs are made among criteria by the loan officer.

Due to the complexity of the lender's expected utility function (2), it is not possible to estimate it directly. Consequently, an appropriate methodology used in this study is conjoint measurement, which concerns the modeling of utility-based decisions. Conjoint measurement procedures are designed to decompose an individual's utility responses (5) to multiattribute stimuli so that the effects of stimulus attributes on the ultimate decision can be analyzed.¹

The development of the critical decision variables, as specified in Section II, was based on existing literature and interviews with senior lending
personnel. These variables and their respective treatment levels are shown in Table 1. Previous empirical research (Altman, Schlosser, and Vernommen [2], Harris [15], Hester [18], James [20], Luckett [25], Sealey [28]) has relied on proxies from reported financial data for these variables.

Industries that have exhibited a vulnerability to cyclical fluctuations in demand are likely to be less attractive to the lender than those with greater stability. Loan purpose also exerts an influence on the evaluation process. Harris [15] noted that banks may impose higher priorities for those customers who have the most "legitimate need for credit." Banks maintain both external and internal loan policies. A typical external policy is to focus on economically productive loans which promote growth and viability to the bank's market area. This external goal is supplemented by internal objectives which include the generation of a loan portfolio that is not only profitable but also consistent with the bank's overall strategy. Since banks are not observed to be single period profit maximizers, a productive loan can be considered as one in which a long-term profitable relationship with a borrowing customer is established or maintained.

Repayment of principal is defined in terms of the ability of the borrowing firm to meet its debt service requirements which include both interest and principal. Specific repayment alternatives are more likely affected by the nature of the firm's financing need. The many alternative borrowing firm situations are difficult to assess effectively and hence are not tested in this study. For example, the wide range of loan structure options such as demand notes, revolving lines of credit, and term debt, preclude active consideration of each given the constraints of the study's fractional factorial design. Therefore, a more general definition is employed.
All-in-yield terms, which include both the base rate and compensating balances, and required collateral compose the pricing component of the decision process. According to Baltensperger [4], compensating balances may be considered as part of the loan-price vector. In contrast to Bartter and Rendleman [5], only variable rate pricing tied to the prime rate is considered in this study. Finally, the excess of the market value of pledged security over the loan amount, coupled with the liquidity of the collateral, determines the lender's margin of safety in case of default. Attractive collateral must first be liquidated quickly without depressing prices. In addition, the greater the fluctuation in its market value, the less desirable is collateral to the lender. Therefore, preference would be for greater liquidity and certainty of value.

Each attribute was measured on three levels, resulting in a total of 27 combinations based on a fractional factorial design [1]. The fractional factorial design was constructed so that all two-way interaction effects among price, management, and collateral could be estimated. The remaining interaction terms were confounded.

The six-attribute preference model related to the fractional factorial design is as follows:

\[ U = \bar{X} + M + I + P + R + C + Y + M \cdot Y + M \cdot C + Y \cdot C \]  

where:

- \( U \) = overall utility the respondent derives from the alternative that is characterized as having levels \( m, i, p, r, c, y \) for attributes \( M \) (management), \( I \) (industry market conditions), \( P \) (loan purpose), \( R \) (repayment), \( C \) (collateral), and \( Y \) (all-in-yield pricing).
- \( \bar{X} \) = mean utility of the set of alternatives
- \( M_m \) = main part-worth of level \( m \) of variable \( M \)
- \( I_i \) = main part-worth of level \( i \) of variable \( I \)
\[ P_p = \text{main part-worth of level } p \text{ of variable } I \]
\[ R_r = \text{main part-worth of level } r \text{ of variable } R \]
\[ C_c = \text{main part-worth of level } c \text{ of variable } C \]
\[ Y_y = \text{main part-worth of level } y \text{ of variable } Y \]
\[ M_Y M_Y Y_y = \text{M by } Y \text{ interaction part-worth} \]
\[ M_C C_C Y_y = \text{M by } C \text{ interaction part-worth} \]
\[ Y_y C_C = \text{Y by } C \text{ interaction part-worth} \]

OLS regression with effects coding, which is similar to dummy variable regression procedures for conjoint analysis, has been described in detail by Moore [26]. For each attribute, coded vectors similar to dummy variables are formed except that the coding is 1, 0, -1. For each coded vector, category membership is identified by assigning 1's with all others (except the last category) being assigned 0's. The last category is assigned -1's. Since each factor has 3 levels in this study, 2 effect coded vectors are used to represent each factor.

The regression equation corresponding to the conjoint measurement model in equation (7) is:

\[
Y = \beta_0 + \sum_{i=1}^{12} \beta_i X_i + \beta_{13} X_9 + \beta_{14} X_{10} + \beta_{15} X_9 + \beta_{16} X_{10} + \beta_{17} X_{11} + \beta_{18} X_{12} + \beta_{19} X_{11} + \beta_{20} X_{12} + \beta_{21} X_{11} + \beta_{22} X_{12} + \beta_{23} X_{10} + \beta_{24} X_{10} \tag{8}
\]

where \( \beta_0 = \bar{X} \) (the mean utility of the set of alternatives) and the x's represent the treatment effects of the effects coded attributes.

Using effects coding, \( \beta_0 \) in equation (8) equals the grand mean of the dependent variable. Each of the slope variables is equal to the deviation from
the mean of the group assigned 1's in the vector with which it relates to the grand mean. Therefore, each of these coefficients reflects a treatment effect or part-worth. Due to the need to use a fractional factorial design, the tested interaction effects in equation (7) were among the yield and collateral terms and the management variable as a summary measure of the credit consideration. To test whether non-zero interactions are sufficiently large to be attributed to other than random fluctuation is determined by using the standard hierarchical F-test of the significance of the increase in $R^2$ due to the inclusion of the interaction terms in the estimate. If the increment over the main effects component of the model in the proportion of variance accounted for by the interaction is not significant, it is sufficient to examine the main effects.

Based on the interaction effects, this study further tests the degree of interaction between the creditworthiness of the borrowing company and the pricing and collateral decisions. Specifically, the dependency of the pricing and collateral decisions on the level of management ability, as a proxy for the borrower's creditworthiness, is tested. Finally, the interaction effect of yield and collateral is examined to assess the nature of the pricing component.

IV. Empirical Analysis

A. Sample and Measurement Procedure

A total of 142 commercial lending officers from 58 banks of varying size and location were selected to participate in this study. The tests were conducted by mailing the card deck representing the 27 loan situations to each of the loan officers along with instructions regarding the required task. A usable sample of 119 responses was obtained. The following procedures were used in the initial test:
1. All 142 subjects were given a deck of 27 cards containing descriptions of hypothetical loans in terms of the six attributes. The descriptions, which were based upon the fractional factorial design, were identical for all subjects.

2. The frame of reference to be used was that an application for a commercial loan was being considered.

3. The subjects were told that the loans differed only with respect to the 6 attributes and were identical in all other factors.

4. The subjects were instructed to sort the cards in order of preference from the most preferred loan situation to the least preferred loan situation. Standard sorting instructions were given to the subjects.

As noted in instruction 3, all other aspects of the lending decision are held constant. Based on previous research, these other conditions include loan size, maturity, bank portfolio conditions, and whether the commercial borrowers were existing versus new customers.

B. Aggregate Results

Based on equation (7), OLS regression was used to estimate the aggregate utility model. These pooled regression results are presented in Table 2. With an $R^2$ of .747, the explanatory results indicate a highly acceptable amount of homogeneity among the participants. All of the main effects coefficients are significant at the .01 level. Furthermore, while the interactions among the collateral-price and management-price are marginally statistically significant, they add very little to the total $R^2$ (increased by only .006). Consequently, only the main effects are interpreted and discussed.

Using the coefficients for equation (8), the part-worths of equation (7) can be calculated. Table 3 shows the resulting part-worths and aggregate utility functions. Both the relative magnitude and direction of the aggregate functions can be observed.
The direction of the utility functions are consistent with expectations as specified in Section II. The preference is for high character and ability in the borrowing firm's management. However, it appears that poor management has a slightly greater negative influence on the loan decision than the converse effect of good management. In terms of industry market conditions, stability is preferred. The positive and negative influences appear to be equally weighted. With respect to loan purpose, a highly productive loan in full compliance with the bank's loan policy is preferred. Loans which are not productive and in possible violation of policy weigh more heavily than the opposite effect of favorable loans in this criterion. The participating loan officers also favored loans with a more assured secondary repayment source. Again, the evidence indicates that a lack of repayment assurance would more likely cause a loan officer to reject the application than, conversely, a strong repayment assurance would cause its acceptance. In the first of the pricing variables, greater liquidity and certainty of value in collateral is preferred. Consistent with the previous credit variables, the negative implications of collateral appear to be more important. Finally, a higher spread over prime is preferred.

The results suggest that the participating lending officers tended to weigh more heavily the negative influence of the above decision variables. While the rationale for this result is uncertain, several reasons can be suggested. First, loan officers reflect the bank's strategy of being cost effective. Typically, the default of a major loan is more costly than the opportunity cost of denying a good loan. Less obvious, but probably equally as important, career rewards and penalties may be asymmetrically biased toward the avoidance of problem loans. If so, the loan officer would attempt to avoid mistakes even though possibly excellent loan prospects may be denied. Third, given the limited
return for loans tied only to a debt rate, the officer must find a means to reject loan applications; thus, a negative variable takes on additional importance. Fourth, as Arnold [3] notes, there is an optimal strategy for the commercial borrower to present his or her case before the loan officer. Therefore, given that a majority of the information is positive, a negative factor takes on added importance. Finally, a good amount of commercial loan officers' experience and training focuses on avoiding non-productive loans. In essence, they are likely to be criticized for loans that turn bad which may enforce a better understanding of denying loan applications than accepting them. While these reasons have not been empirically validated, they are consistent with the role of negative information in the management literature.

The range of the part-worths for each attribute can be interpreted as an index of the relative importance of the attribute as a determinant of the utility of the stimuli. Examination of the part-worth ranges in Table 2 indicates the management variable is the most important attribute although it is not dominant. Repayment assurance and collateral are next in the influencing of the preference of the loan officers for specific credit situations. Both loan policy and yield are considerably less important. In the case of yield, a combination of reasons is plausible. First, given the influence of variables such as management capability and repayment assurance as well as competition with other financial institutions, it could become a foregone conclusion. Second, the range of yield alternatives is quite narrow given the set of alternative combinations of other variables. The importance of yield may have been more significant if the range of spreads over prime had been larger. However, competition among financial institutions tends to limit this range.
The magnitude of the part-worths illustrates that the influence of poor management can be offset by high repayment assurance and collateral. However, conversely, excellent management is not enough to compensate for insufficient evidence of good repayment ability and collateral. The nature of these relationships further confirms the lack of importance of pricing in this decision process. The role of yield has little influence on the outcome of individual decision processes.

Luckett [25] concluded that, since loan rates tend to be sticky, banks will adapt to tight money by establishing an ordering system with nonprice variables. This compares with the findings of Harris [15] that banks ration capital based on both interest rate (and compensating balance requirements) and non-price variables. Baltensperger [4] raised the issue of the relative roles of adjusting the interest rate charged or the non-interest terms of the loan contract to reflect the rationing of credit. Further research suggests that, given sticky interest rates, the allocative efficiency of the capital markets would be reduced unless non-interest loan terms were allowed to play a role in the allocating of funds. The results of this study provide evidence that the non-interest loan terms appear to have a stronger and more consistent effect on the loan decision.

C. Subsample Analysis

The possibility of differences in utility functions among subsets of loan officers was investigated by comparing subsamples of respondents' utility functions. Both individual and lending environment variables were tested. In the latter category, the Herfindahl Index was employed to measure the effect of market concentration. Within subject analysis was used to obtain an individual
utility function for each respondent. While the methodology was identical to that used earlier in the pooled estimate, the measurement derives a unique set of part-worths for each lending officer. Part-worth ranges were then calculated for each of the attributes listed in Table 1.

Multivariate analysis of variance was used to test the null hypothesis of no significant differences in part-worth importance score vectors for the subsamples noted in Table 3. Only lending experience was significant. Those lending officers with high experience exhibited different factor importance range vectors than those with low experience. A univariate analysis, comparing the two groups' importance indices, is reported in Table 4. Statistically significant differences were found for the collateral and price attributes. The low experience group attached more importance to collateral and less to the yield attribute. In spite of these significant differences, the two groups' rank order of importance for the decision variables in Table 1 were very similar. These subsample comparisons indicate that considerable homogeneity exists among the individual utility functions. Consequently, the pooling of the responses for aggregate analysis was justified.

V. Summary

This study has empirically examined the decision process of the individual commercial lending officer. The principal objective has been to expand on previous research which has focused on either commercial lending in the context of bank portfolio allocation models or on a limited view of loan pricing. Furthermore, by concentrating on hypothetical loans, major limitations of previous empirical research have been avoided. After developing a multiattribute utility
function for the commercial loan officer, conjoint analysis was employed to examine the relative effects of the specified criteria on this process. The model exhibited not only a high degree of explanatory power but also an acceptable level of predictive validity. The main effects components dominated the model's explanatory power with all of the variables being significant and exhibiting the expected signs.

Based on the sample of this study, commercial lending officers are relatively homogeneous in terms of the respective decision criteria. The relative importance of these criteria was measured with the assessment of management and yield being the most important and least important, respectively. It also appears that the a priori inclinations of loan officers is to deny the loan. With the exception of industry market conditions and yield, the negative influence of the decision variables was prevalent. Several possible reasons for such a tendency were presented but, again, this highlights the potential for more research in this field. In essence, constrained by a maximum acceptable pricing level, creditworthiness of the firm and the liquidity of its collateral had a greater effect on the loan decision. The aggregate utility function suggests that additional research may be worthwhile on the role of loan pricing in the context of the other decision variables.
References


Footnotes

1. Recent empirical research indicates conjoint measurements are characterized by high predictive utility and measurement stability ([13],[14],[19],[26]).

2. The thrust of existing literature focuses on the rationality of compensating balances, with rationality defined as the relationship between the bank's interest income and the cost to the borrowing firm. Much of the conclusions as to whether compensating balances are rational depends on the assumptions regarding how the required balances are determined and the options available to the borrowing firm. Kolodny et al. [23] suggest that the rationality question must be resolved by examining the proportion of the borrowing firm's financing requirements which are held as voluntary balances.

This study does not directly address this issue. The underlying assumption is that the loan pricing reflects a risk equivalent combination of rate and balances. For example, Cramer and Sterk [10] note that a multiperiod pricing formula should be employed which allows for the present value of future income derived from expected balances when determining the base loan rate.

3. A fractional factorial design was necessary to make the number of treatment combinations small enough to be manageable. A full factorial design would have consisted of $3^6$ or 729 combinations.

The loan officers' preference ratings consisted of rank order judgments. The dependent variable, therefore, was measured on an ordinal scale. Recent evidence [19] indicates metric analysis of variance or ordinary least squares
(OLS) regression procedures are robust in conjoint measurement applications. Consequently, ordinary least squares (OLS) regression analysis using effects coding was used to estimate the part-worth functions in this study.

4. As recommended by Cohen and Cohen [9] and others (Blom [6], Tukey [30]), the rank order data for the dependent variable were normalized by means of a probit transformation. This transformation results in the rectangular rank order frequency distribution being converted to a more bell-shaped frequency distribution. The probit transformation equation used was (Blom [6]):

\[
P_i = \frac{R_i - 3/8}{n + 1/4}
\]

where:

- \(P_i\) = Probit transformation of the \(i^{th}\) rank
- \(R_i\) = Inverse cumulative normal function
- \(R_i\) = The \(i^{th}\) rank with 27 representing the first choice
- \(n\) = Number of stimuli ranked (n=27)

5. The variables \(x_1\) through \(x_{12}\) are defined as follows:

\[
\begin{align*}
x_1 &= M_2 \\
x_2 &= M_3 \\
x_3 &= I_2 \\
x_4 &= I_3 \\
x_5 &= P_2 \\
x_6 &= P_3 \\
x_7 &= R_2 \\
x_8 &= R_3 \\
x_9 &= C_2 \\
x_{10} &= C_3 \\
x_{11} &= Y_2 \\
x_{12} &= Y_3
\end{align*}
\]

The treatment combinations are effect coded which results in two coded vectors per attribute. For example, \(x_1\) and \(x_2\) are used to reflect the \(M\) treatment levels where:

- \(x_1 = 0\) and \(x_2 = 1\) to represent \(M_3\) treatment level.
- \(x_1 = 1\) and \(x_2 = 0\) to represent \(M_2\) treatment level.
- \(x_1 = -1\) and \(x_2 = -1\) to represent \(M_1\) treatment level.
6. The banks represented in this study are located in the midwestern states. Both metropolitan and rural banks were included to permit analysis of this location impact. However, no significant differences in the decision process were found.

7. In pooled conjoint measurement, the response data are pooled across respondents and one aggregate utility estimate is obtained. If all the respondents evaluate identical stimulus objects, this pooled estimate can be interpreted as an average utility estimate for the group. A potential shortcoming of this procedure, however, is the "majority fallacy" [24], which is caused by heterogeneity of individual responses. However, when the group to be aggregated is relatively homogeneous, the predictive validity problem is reduced considerably (Moore [26]). Since the primary purpose of this study involves the question of how commercial lending officers in general evaluate loan applications, and since this group represents a relatively homogeneous group of decision makers, aggregate conjoint analysis procedures were used. The question of a potential "majority fallacy" was examined by evaluating the coefficient of determination of the estimate, by testing the predictive validity of the model for a sub-group of the respondents, and by examining subsample multiattribute utility function differences.

8. The predictive validity of the model was tested by using the aggregate model to calculate predicted utilities (predicted probit values) of the nine stimulus profiles ranked by each respondent in the re-test. For each individual, these predicted utilities were correlated with the actual utilities (actual probit values were calculated by assuming the top ranked card had an ordinal
value $R^1$ of 27). The average of the 23 correlation coefficients, which was calculated using standard Z-transformation procedures, was .645. This result compares favorably with previous research concerning the predictive validity of multiattribute models (Moore [26]).
Appendix

Recall (4),

\[ E(R/Z) = \int_0^{1+r-c} U(c+x)f(x/Z)dx + U(1+r)[1-F(1+r-c/Z)]. \]

In this appendix, we compute the derivatives of (4), namely \( \frac{\partial E(R/Z)}{\partial c} \), \( \frac{\partial E(R/Z)}{\partial z_1} \) and \( \frac{\partial E(R/Z)}{\partial r} \). Integrating the first term on the right-hand side of (4) by parts, we have

\[ E(R/Z) = U(c+x)F(x/Z) \left|_0^{1+r-c} - \int_0^{1+r-c} \frac{\partial u}{\partial x}F(x/Z)dx + U(1+r)[1-F(1+r-c/Z)]. \]

This simplifies to

\[ E(R/Z) = U(1+r) - \int_0^{1+r-c} \frac{\partial u}{\partial x}F(x/Z)dx, \]

since \( F(0/Z) = 0 \).

Now differentiating with respect to \( c \), we have

\[ \frac{\partial E(R/Z)}{\partial c} = \frac{\partial u(1+r)}{\partial x}F(1+r-c/Z) = \frac{\partial u(1+r)}{\partial x}F(1+r-c/Z) > 0, \]

since utility is increasing and there is some probability of non-performance.

Next differentiating with respect to \( r \), we have

\[ \frac{\partial E(R/Z)}{\partial r} = \frac{\partial u(1+r)}{\partial x}F(1+r-c/Z) \frac{\partial u(1+r)}{\partial x}F(1+r-c/Z) = \frac{\partial u(1+r)}{\partial x}F(1+r-c/Z) > 0. \]

Finally, differentiating with respect to one of the \( z_1 \)'s, we have

\[ \frac{\partial E(R/Z)}{\partial z_1} = - \int_0^{1+r-c} \frac{\partial u}{\partial x}F(x/Z)dx > 0, \text{ since } \frac{\partial u}{\partial x}F(x/Z) < 0. \]

An increase in \( z_1 \) reduces the cumulative probability of any point \( x_0 \), as probability mass is shifted towards higher values of \( x \).
<table>
<thead>
<tr>
<th>Table 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decision Variables for Commercial Lending Model</td>
</tr>
</tbody>
</table>

1. **Borrowing Company's Management**
   - **High Character and Ability**
   - **Average Character and Ability**
   - **Low Character and Ability**

2. **Industry Market Conditions**
   - **High Rate of Change**
   - **Average Rate of Change**
   - **Low Rate of Change**

3. **Loan Purpose**
   - **Highly Productive Loan—Full Compliance with Loan Policy**
   - **Average Productive Loan—Full Compliance with Loan Policy**
   - **Speculative Loan—Marginal Compliance with Loan Policy**

4. **Repayment**
   - **Highly Assured Source of Repayment—Good Track Record**
   - **Average Assurance of Source of Repayment—Average Track Record**
   - **Uncertain Source of Repayment—No Track Record**

5. **Collateral**
   - **Highly Liquid with Certain Value**
   - **Average Liquidity and Average Certainty of Value**
   - **Illiquid and Uncertain Value**

6. **Pricing (all in yield)**
   - Prime Plus 4 Points
   - Prime Plus 2 Points
   - Prime
<table>
<thead>
<tr>
<th>Explanatory Variables</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Squares</th>
<th>F</th>
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<tbody>
<tr>
<td>Management</td>
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<tr>
<td>$X_1$</td>
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<tr>
<td>$X_2$</td>
<td>1016.61754</td>
<td>2</td>
<td>508.30875</td>
<td>2203.81$^a$</td>
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<td>Industry</td>
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<tr>
<td>$X_3$</td>
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<td>$X_4$</td>
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<td>2</td>
<td>15.89525</td>
<td>68.92$^a$</td>
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<tr>
<td>Purpose</td>
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<td>$X_5$</td>
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<tr>
<td>$X_6$</td>
<td>633.0343</td>
<td>2</td>
<td>316.51715</td>
<td>1372.28$^a$</td>
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<td>$X_8$</td>
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<td>304.23095</td>
<td>1319.02$^a$</td>
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<tr>
<td>$X_9$</td>
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<tr>
<td>$X_{10}$</td>
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<td>143.87985</td>
<td>623.80$^a$</td>
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<tr>
<td>Price</td>
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<tr>
<td>$X_{11}$</td>
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<tr>
<td>$X_{12}$</td>
<td>33.3965</td>
<td>2</td>
<td>16.69825</td>
<td>72.40$^a$</td>
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</table>

$R^2 = .747$

$^a p < .01$
Table 3: Part-Worth Estimates

<table>
<thead>
<tr>
<th>Explanatory Variables</th>
<th>Partial Regression Coefficient</th>
<th>t</th>
<th>Part-Worths</th>
<th>Part-Worth Range</th>
<th>Importance Rank</th>
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</thead>
<tbody>
<tr>
<td><strong>Management Variables</strong></td>
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<tr>
<td>X&lt;sub&gt;1&lt;/sub&gt;</td>
<td>0.160</td>
<td>13.362&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.760(M&lt;sub&gt;1&lt;/sub&gt;)</td>
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<tr>
<td>X&lt;sub&gt;2&lt;/sub&gt;</td>
<td>0.600</td>
<td>49.694&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.600(M&lt;sub&gt;2&lt;/sub&gt;)</td>
<td>1.360</td>
<td>1</td>
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<tr>
<td><strong>Industry Variables</strong></td>
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<tr>
<td>X&lt;sub&gt;3&lt;/sub&gt;</td>
<td>0.005</td>
<td>0.396</td>
<td>-0.124(I&lt;sub&gt;1&lt;/sub&gt;)</td>
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<tr>
<td>X&lt;sub&gt;4&lt;/sub&gt;</td>
<td>0.119</td>
<td>9.961&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.119(I&lt;sub&gt;2&lt;/sub&gt;)</td>
<td>0.243</td>
<td>5</td>
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<td><strong>Purpose Variables</strong></td>
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<td>X&lt;sub&gt;5&lt;/sub&gt;</td>
<td>0.145</td>
<td>12.09&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.335(P&lt;sub&gt;1&lt;/sub&gt;)</td>
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<tr>
<td>X&lt;sub&gt;6&lt;/sub&gt;</td>
<td>0.190</td>
<td>15.847&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.190(P&lt;sub&gt;2&lt;/sub&gt;)</td>
<td>0.525</td>
<td>4</td>
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<td><strong>Repayment Variables</strong></td>
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<tr>
<td>X&lt;sub&gt;7&lt;/sub&gt;</td>
<td>0.074</td>
<td>6.189&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.565(R&lt;sub&gt;1&lt;/sub&gt;)</td>
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<tr>
<td>X&lt;sub&gt;8&lt;/sub&gt;</td>
<td>0.491</td>
<td>41.010&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.491(R&lt;sub&gt;2&lt;/sub&gt;)</td>
<td>1.056</td>
<td>2</td>
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<tr>
<td><strong>Collateral Variables</strong></td>
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<tr>
<td>X&lt;sub&gt;9&lt;/sub&gt;</td>
<td>0.074</td>
<td>6.136&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.398(C&lt;sub&gt;1&lt;/sub&gt;)</td>
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<tr>
<td>X&lt;sub&gt;10&lt;/sub&gt;</td>
<td>0.324</td>
<td>27.086&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>0.722</td>
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<td><strong>Yield Variables</strong></td>
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<td>X&lt;sub&gt;11&lt;/sub&gt;</td>
<td>0.051</td>
<td>4.253&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.143(Y&lt;sub&gt;1&lt;/sub&gt;)</td>
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<tr>
<td>X&lt;sub&gt;12&lt;/sub&gt;</td>
<td>0.092</td>
<td>7.604&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.092(Y&lt;sub&gt;2&lt;/sub&gt;)</td>
<td>0.235</td>
<td>6</td>
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</tbody>
</table>

<sup>a</sup><sub>p</sub> < .01
<sup>b</sup><sub>p</sub> < .05
<sup>c</sup>Part-Worth Values: The part-worth values corresponding levels two and three of each attribute are equal to the partial regression coefficients corresponding to each of those attribute levels. The part-worth values for the level one of each attribute are calculated as follows: M<sub>1</sub> = (M<sub>2</sub> + M<sub>3</sub>); I<sub>1</sub> = (I<sub>2</sub> + I<sub>3</sub>); P<sub>1</sub> = (P<sub>2</sub> + P<sub>3</sub>); R<sub>1</sub> = (R<sub>2</sub> + R<sub>3</sub>); C<sub>1</sub> = (C<sub>2</sub> + C<sub>3</sub>); Y<sub>1</sub> = (Y<sub>2</sub> + Y<sub>3</sub>).
Table 4
Multivariate F Tests: Differences Among Groups' Importance Indices (Part-Worth Ranges)

<table>
<thead>
<tr>
<th>Criteria for Group Comparison</th>
<th>Multivariate F</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Individual Characteristics</strong></td>
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</tr>
<tr>
<td>Age&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.220</td>
</tr>
<tr>
<td>Banking Experience&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.388&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Commercial Loan Experience&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.093</td>
</tr>
<tr>
<td>Employment with Current Employer&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.446</td>
</tr>
<tr>
<td><strong>Lending Environment</strong></td>
<td></td>
</tr>
<tr>
<td>Average Loan Size&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.825</td>
</tr>
<tr>
<td>Bank Size: Total Deposits&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.327</td>
</tr>
<tr>
<td>Herfindahl Index&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.190</td>
</tr>
</tbody>
</table>

<sup>a</sup>Two groups formed by dividing the total group of respondents at the median value.

<sup>b</sup>Three groups formed with approximately 33 percent of the respondents in each group.

<sup>c</sup>p<.05
<table>
<thead>
<tr>
<th>Loan Decision Factors</th>
<th>Low Experience Group Means</th>
<th>High Experience Group Means</th>
<th>Univariate F</th>
<th>Significance of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management</td>
<td>1.35</td>
<td>1.37</td>
<td>0.080</td>
<td>.778</td>
</tr>
<tr>
<td>Industry Conditions</td>
<td>0.31</td>
<td>0.35</td>
<td>1.012</td>
<td>.316</td>
</tr>
<tr>
<td>Loan Purpose</td>
<td>0.80</td>
<td>0.58</td>
<td>0.000</td>
<td>1.000</td>
</tr>
<tr>
<td>Repayment</td>
<td>1.10</td>
<td>1.03</td>
<td>0.934</td>
<td>.336</td>
</tr>
<tr>
<td>Collateral</td>
<td>0.79</td>
<td>0.68</td>
<td>4.316</td>
<td>.040</td>
</tr>
<tr>
<td>Pricing</td>
<td>0.25</td>
<td>0.37</td>
<td>9.000</td>
<td>.003</td>
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</table>