DISCRIMINANT ANALYSIS OF SEASONAL AGRICULTURAL LOAN REPAYMENT BY SMALL-SCALE FARMERS IN TRANSKEI

W H Lugemwa
Department of Economics, University of Natal, Pietermaritzburg

M A G Darroch
Department of Agricultural Economics, University of Natal, Pietermaritzburg

A linear discriminant model is used to identify loan and borrower characteristics associated with successful and default seasonal agricultural loans at the Agricultural Bank of Transkei in 1991. Results indicate that small-scale farmers with a proven credit history, higher repayment ability and collateral, and relatively more off-farm income were less likely to be default risks.

DISKRIMINANT ANALISE VAN TERUGBETALINGS VAN SEISOENSLENINGS DEUR KLEINBOERE IN TRANSKEI

'n Liniêre diskriminant model is gebruik om eienskappe van lenings- en leners te identifiseer wat geassosieer kan word met suksesvolle en agterstallige seisoenslenings van die Transkei Landboubank. Resultate dui daarop dat kleinboere met 'n beproefde kredietgeskiedenis, beter terugbetaal vermoë en groter kollateraal en ook hoër nie-landbou-inkome nie geneig is om te versuim om hulle lenings terug te betaal nie.

1. Introduction

Formal credit for small-scale farmers in South Africa has been provided as an element of the Farmer Support Programme (FSP) begun by the Development Bank of Southern Africa in 1987 (Coetzee *et al*, 1993). The Agricultural Bank of Transkei was formed in 1990 to take over the agricultural finance functions of the loans division of the Transkei Agricultural Corporation which implemented the FSP in Transkei. Non-performing loans had been a major problem for the Transkei Agricultural Corporation, with estimated default rates of 40 % and above in the 1980's. Specialised rural lending institutions elsewhere in Africa, the Middle East and Latin America also had high default rates over this period with some 30% to 95% of portfolios in arrears (Braverman & Guasch, cited by Aguilera-Alfred and Gonzalez-Vega, 1993). The Agricultural Bank of Transkei aimed to offer short-term and long-term credit and enforce loan repayment based on banking principles.

In a credit relationship, the lender (the principal) is considered to contract with the borrower (the agent) to productively utilise and repay (with interest) the lender's funds (Barry *et al*, 1995). Research on the factors associated with successful small-scale farm loans or loan defaults can provide lenders such as the Agricultural Bank of Transkei with information to (1) better screen loan applicants and reduce loan default risk (avoid adverse selection problems) and (2) reduce agency costs associated with credit control, monitoring and supervision. This research may also assist the present Commission of Inquiry into the Provision of Rural Financial Services "to make recommendations for policy, legislative and institutional measures to improve financial services for rural households, farmers and other entrepreneurs" (Commission of Inquiry into the Provision of Rural Financial Services, 1995).

Many credit scoring models for agriculture have been developed in the United States of America (USA) and Canada to predict the credit-worthiness of commercial farm loans. These studies were motivated primarily by a large number of farm failures and loan defaults among borrowers in the USA and Canada during the 1980's (see Turvey, 1990 and citations therein). The literature on small-scale farm financial markets has recently attempted to measure the magnitude and identify determinants of the loan repayment problems faced by specialised rural lending institutions (see Adams *et al*, for a review of studies). However, applications of credit scoring models to identify factors associated with small-scale farm loan success or default are limited.

Lyne and Ortmann used discriminant analysis to distinguish low risk applicants from those more likely to default on seasonal loans made by KwaZulu Finance Corporation (KFC) in 1991. The level of off-farm income (ability to service debt) and renting of farm land from other households (commitment to farming) significantly differentiated between these groups. Goyal *et al* (1993) studied the repayment capacity of borrowers in co-operative societies in Haryana State, India. Non-defaulters had relatively higher average yields of major crops, higher farm asset values, higher total cash returns of the household and larger repayment capacity. Defaulters used a larger proportion of their total earnings for consumption purposes, thereby leaving less for investments in production processes and reducing repayment capacity. Higher total cash returns and larger repayment capacity amongst non-defaulters accords with Lyne and Ortmann's finding that low risk loan applicants have more off-farm income which increases ability to service debt. Older applicants (longer customer relationship) with larger asset bases (more collateral) were less likely to have repayment problems. Land tenure status did not significantly affect repayment performance. Aguilera-Alfred & Gonzalez-Vega (1993) applied multinomial logit analysis to identify loan defaulters at the Agricultural Development Bank of the Dominican Republic as having provisional titles to land, less total assets and loans sourced from government funds.

The aim of this paper is to supplement research on South African rural credit markets by using discriminant analysis to identify factors associated with seasonal loan

success or default amongst small-scale farm clients of the Agricultural Bank of Transkei in 1991. Results will be compared with those of the Lyne and Ortmann study of KFC clients, and could help financing institutions and policymakers to formulate credit policies to fund seasonal credit needs of small-scale and emergent commercial farmers.

2. Data source and research method

Data on seasonal input loan applications by 38 representative borrowers who received credit for the 1990/91 agricultural season from the Agricultural Bank of Transkei were obtained from application forms and monthly loan reports. Amounts borrowed ranged from R293 to R13994, with an average loan size of R3450. Loans repaid (not repaid) by the end of March 1992 were classified as successful (in default). Thirteen of the 38 loans were successful and 25 were in default. Factors associated with loan default or success were estimated by linear discriminant analysis (LDA).

The objective of LDA is to find a linear function

$$D_i = \sum_{j-i}^{n} \hat{B}_j X_{ij} \qquad (1)$$

which distinguishes between the two loan groups (success and default) using discriminating variables which measure characteristics on which the groups are expected to differ. This is by analysis of variance that maximises the between-group variance, while minimising the within-group variance. The standardised weighting coefficient estimates B_j are particularly important for policy analysis, since each shows the relative contribution of its associated variable (X_j) to the linear function. Discriminant scores D_i estimated for each applicant are compared to the mean score for each loan group and the applicant is then classified into the

group with the score most similar to his own. Success in discrimination between the two loan groups is assessed by observing the proportion of correct loan classifications and the Wilk's lambda statistic (Klecka, 1975).

The major problem with LDA is the assumption that independent variables in the two groups come from populations with a normal distribution. If the independent variables are not from normal populations, or the variance-covariance matrices are not equal, then the estimators are not consistent (Turvey, 1990). The LDA is, however, robust to departures from the normality assumptions (Lachenbruch, 1975:40-50). In addition, a weaker sufficient condition to justify the LDA is that the D_i be univariate normal (Truett *et al*, 1967). The ten variables given in table 1 were chosen *a priori* as loan and borrower characteristics which may distinguish between successful and default loans.

2.1 Loan characteristics

APPRDT : The loan approval date is a key determinant of good potential yields and hence repayment ability. The optimum planting time for maize in Transkei is November. Loans approved before the end of September are expected to be successful, compared with late loan applicants who may miss the optimum planting date.

PRVLN : Borrowers who previously had loans from the Agricultural Bank of Transkei have sufficient knowledge of the Bank's lending policy and know the costs of late repayment. The Bank is expected to have reliable information on its clients' past loan performances, and borrowers with a bad credit history are not financed. Bank policy is not to lend to individuals with unpaid loans, hence previous successful loan recipients (PRVLN =1) are expected to be more likely to repay their loans in time.

Table 1:   **Potential discriminating variables.**

APPRDT (X_1)	Loan approval date. A dummy variable equal to 1 for loans approved and utilised by September 1991 and 0 otherwise.
PRVLN (X_2)	Previous loans history. A dummy variable equal to 1 if borrower had received and repaid loans from the Agricultural Bank and 0 if not.
AGE (X_3)	Age in years.
GENDER (X_4)	A dummy variable equal to 1 for male borrower and 0 for female borrower.
PTFT (X_5)	Farmer status. A dummy variable equal to 0 for a part time farmer and 1 for a full time farmer.
AGRTRN (X_6)	Agricultural training of the borrower. A dummy variable equal to 1 for a trained farmer and 0 otherwise.
FMSIZE (X_7)	Farm size in hectares.
AREA (X_8)	Agro-ecological classification. A dummy variable equal to 1 for high potential area and 0 for low potential area.
ATL (X_9)	Assets to liability ratio.
DSTPROX(X_{10})	Distance from the borrowers residence (farm) to the nearest Agricultural Bank of Transkei branch in kilometres.

2.2 Borrower personal, resource and financial characteristics

AGE : If the borrower's age is a good proxy for the experience of the borrower, older borrowers are expected to have a better loan repayment performance, *ceteris paribus*.

GENDER : Past agricultural studies in Africa and Asia indicate that women are more credit-worthy (ILO, World Bank), as they are most involved with farm work in the rural areas and are more informed about repayment dates. Loans to women could be more likely to be successful than those made to male farmers

PTFT : Off-farm income is a source of liquidity, implying that part-time farmers may have lower default risk. Salaried borrowers can easily arrange to repay Agricultural Bank of Transkei loans by having stop or debit orders on their accounts. Farmers with off-farm incomes may thus be more likely to repay their loans in time, *ceteris paribus*.

AGRTRN : A borrower with training in agriculture and other related disciplines is more likely to successfully repay loans, as he/she is better equipped to achieve higher maize yields and incomes.

FMSIZE : Borrowers with relatively larger farm sizes are expected to be more able to repay loans as they can reap the benefits of economies of size (spread fixed costs associated with information, management and machinery investment or services over a larger area).

AREA : Borrowers from higher agricultural potential areas are expected to repay their loans in time, since the likelihood of crop failure is much lower. Marginal and low potential areas are higher risk areas and hence borrowers there have higher loan deposit requirements.

ATL : The assets to liability ratio is measure of solvency, showing the extent to which business assets can meet all liabilities in the event of bankruptcy. The higher this ratio, the more favourable the solvency position and the more collateral borrowers have to pledge against loans.

DSTPROX : The distance from the borrower's area to the nearest Transkei Agricultural Bank branch is used to estimate the transactions costs associated with loan repayment (actual expenditure on transport costs and time lost during travelling). Borrowers from more distant areas probably have higher transactions costs and hence are more likely to be in arrears (transactions costs are higher relative to the penalty for default).

3. Results

Discriminant analysis, with prior probabilities of group membership equal to group size, was performed by direct and step-wise procedures, imposing the condition that only variables with coefficients statistically significant at the 15 % level or below enter the estimated model. The chosen variables were not highly correlated and hence no problems associated with multi-collinearity are expected. Wilk's lambda (the ratio of within-groups sum of squares to the total sum of squares) was monitored, to show the proportion of the total variance in the discriminant scores not explained by differences among groups. Small Wilk's lambda values identify functions with much variability between groups and little variability within groups, implying effective classification ability. The estimated LDA was:

$$D = 0.491^{**}\text{ATL} + 0.6017^{*}\text{PRVLN} + 0.5117^{**} \quad (2)$$
$$\text{APPRDT} - 0.4404^{**}\text{PTFT}$$

where ** and * denote statistical significance at 5% and 10% levels respectively. Based on the standardised coefficients, PRVLN (credit history) is the major factor associated with seasonal agricultural loan success, followed by APPRDT (repayment ability proxy), ATL (collateral proxy) and PTFT (liquidity and repayment ability proxy). All signs agree with *a priori* reasoning. Seasonal loan repayment is more likely to be associated with individual borrowers who have repaid past loans, obtained loans before optimum planting time, are more solvent, and who are part-time farmers (have relatively more off-farm income). The LDA model correctly identified 76 % of failed loans and 69 % of successful loans. The overall classification accuracy of the LDA was 74%, while the relatively high Wilk's lambda of 0.72 indicates that a considerable amount of discriminatory information had not been accounted for by the selected variables. The D_i estimated for successful loans were univariate normally distributed, while those for default loans were positively skewed.

4. Conclusion

A proven credit history was the major characteristic of successful loan applicants. These borrowers are probably well aware of the seasonal agricultural credit policy of the Agricultural Bank of Transkei (application procedures, deposit requirements before loan approval and implementation), have an established principal-agent relationship and know repayment dates and the consequences of non-payment or arrears payments. Loans approved by the end of September (or up to the second week of October) were relatively more successful (in time for optimum maize planting date). The Agricultural Bank of Transkei does not approve late seasonal agricultural loans, as late planting results in poor maize yields. Bank policy, therefore, should be to advise farmers through extension officers, field staff or agricultural media services to apply for seasonal loans by the correct dates. Loan success was also positively associated with the assets to liability ratio, a collateral proxy. Lack of accurate information about the borrower's assets and liabilities could result in the Agricultural Bank of Transkei lending to non credit-worthy borrowers. Reliable information on borrowers' debt with other financial or trading institutions could reduce Bank default rates by enabling proper evaluation of seasonal loan client solvency.

Off-farm income improved the repayment ability of Agricultural Bank clients, supporting the Lyne and Ortmann and Goyal *et al* studies which found a positive association between non-defaulters and off-farm income. The Agricultural Bank of Transkei's seasonal loans policy should thus not necessarily exclude part-time farmers from this facility. Lender knowledge of the above variables will probably not be sufficient to reduce potential seasonal agricultural loan default problems at the Agricultural Bank of Transkei. Other important

factors needing attention are low penalties for loan default and arrear payments on seasonal loans which act as disincentives to repayment.

Study results are specific to small-scale seasonal credit users at the Agricultural Bank of Transkei, but show that future financiers of this credit group could partly contain loan default rates (and hence reduce agency costs) by obtaining reliable information on client credit histories and correct loan application dates, in addition to routine financial indicators of repayment capacity and solvency. Further research on rural credit markets in South Africa is needed to improve the screening methods and credit scoring models for small-scale farmers. Topics which could be addressed include credit access and agency costs in informal credit markets (if any) used by these farmers, group lending issues and the link between loan repayment performance and land tenure status of the borrower(s).

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