A CREDIT SCORING MODEL FOR DEVELOPMENT BANKS: 
AN AFRICAN CASE STUDY*

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1. Object of the Research

1.1 Introduction

This paper derives from a wider research on theoretical, methodological and empirical issues related to credit risk evaluation in developing countries [Vigano (1992)].

Many Authors focussed their research on loan repayment problems in LDC's. The quality of loan portfolios has been related to weaknesses in development banks management and to the way rural credit programs are implemented. These issues are thoroughly addressed by the literature [Adams, Graham and von Pischke (1984); Masini (1987 and 1988); Von Pischke, Adam and Donald (1983); Von Pischke (1991)].

Some Authors did specific studies on loan repayment and the different causes for defaults. They found mainly certain the borrower's characteristics, the financial institutions performance, loan contractual conditions and government interventions [see, among others, Adero (1987); Aguiler and Gonzalez-Vega (1990); Aguiler, Gonzalez-Vega and Graham (1990); Baker and Dia (1987); Barry, Baker and Santini (1981); Khalil and Meyer (1990); Nelson and Cruz-Letona (1991); Njoku and Obasi (1991); Njoku and Odi (1991); Sandorany (1986 and 1989); Stickley and Tapsoba (1980); Yabie (1987)].

The results of these studies suggest that loan portfolio quality could improve through a suitable creditworthiness analysis specifically designed to adapt to the particular LDC's context. In a broader perspective, an effective control of credit risk is a crucial aspect of bank management, especially in a development setting. This also applies to the Caisses Nationales de Credit Agricole of Burkina Faso where the model proposed in this paper is tested.

Two major problems concerning loan analysis are evident:

1. the difficulty and the high cost of collecting relevant information on borrower-customers businesses;
2. the absence of benchmark procedures by loan analysts consistent with bank lending policy.

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As regards the first point, loan evaluation procedures can be improved through a more efficient diffusion and use of the information necessary to estimate the probability of repayment.

The paper identifies the relevant information and defines the criteria through which it can be weighed in the loan evaluation process referring specifically to rural customers, i.e. agricultural, commercial, handicraft micro enterprises that are the most difficult to evaluate.

Two hypotheses are offered. The first assumes there are some factors affecting the borrower's behavior that are likely to increase the probability of default. In certain situations the way the loan contract is presented to customers affects their perception of the loan obligation and their willingness to repay. This hypothesis relates to the classic principal-agent problem [Jensen and Meckling (1976)]. Empirical results confirm this hypothesis. Second, the problem of the quality of information, is explored. It is assumed that some mistakes can be made in credit risk evaluation related to the difficulty of obtaining the commonly used information on the customers' ability and willingness to repay.

To overcome the widespread absence of correct information, in this article evaluation models are used to identify symptoms of the borrower's performance and behavior. For this purpose symptomatic variables are employed to create indicators of the borrower-customers' ability and willingness to repay.

As concerns the second point — the credit evaluation procedures — besides weaknesses related to the quality of information, there is often a need for shared decisional frameworks and coordination between the head office and bank branches in order to avoid arbitrary decisions.

For this purpose an application of a quantitative model for creditworthiness based on multivariate discriminant analysis is proposed; input variables are factors obtained from a wider set of variables.

The use of relatively simple credit scoring techniques in development banks has some advantages related to the issues just mentioned.

According to the proposed approach, these models help the analyst to obtain a more complete picture of the borrower's characteristics through the use and elaboration of symptomatic variables.

Moreover, quantitative models allow for the adoption of common evaluation criteria in bank branches that make branch lending policies more consistent with the general objectives of the bank. The quantification of the judgement in a score is also important because it gives responsibility to loan officers for the decisions they take according to the score or for an alternative choice. This last aspect is very important in development banks, where accountability of loan officers is often a problem.

The proposed model is also relevant for the theoretical interpretation of credit risk determinants. The degree of credit risk is the result of the interaction of objective circumstances — personal or firm specific —, the ability of the bank to correctly evaluate these circumstances and the bank capacity to establish loan conditions to reduce uncertainty. A mistake in the evaluation of the borrower's characteristics or the introduction of inappropriate loan conditions may increase the total risk of the transaction.

The proposed model demonstrates that the theoretical Framework just presented is applicable in an LDC's context 1. This clear relationship between theory and the interpretation of results can be an important tool in improving portfolio management for development banks and the bank personnel decision making and learning processes.

1.2 Theoretical Framework

Credit risk evaluation is a complex process which implies a careful analysis of information concerning the borrower in order to estimate the probability that the loan will be regularly repaid.

The probability of regular repayment depends on objective factors related to the borrower's operating environment, the borrower's personal attitude towards the obligation, and the bank's ability to evaluate these two aspects through the information it has and to control credit risk specific contractual conditions.

As concerns the first aspect, the borrower's operating environment, the complexity of the analysis increases when the borrower's activity is more diversified. Determining creditworthiness requires investment of time and resources to evaluate firm-specific

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1. Another model presented in the original research quantifies the effects of profitability, willingness to repay, quality of information and the bank control of credit risk on the probability of regular repayment (Ch. Viganò, (1992) ). This model has more theoretical than practical implications.
and industry-wide variable — structural or cyclical — by analysts with specific professional skills.

Complexity, however, is not necessarily against the quality of the judgement since more sophisticated analyses make the final judgement potentially more precise, given the various elements upon which they are based. On the contrary, relatively simple situations where data are immediately and directly available may be dangerous. In some cases the simplicity of the information collected is an indicator of the borrower's inability to generate more meaningful data or bank's inability to obtain these data. Other critical situations highlight the limitations of the information gathering process because of the unreliability of the data collected, as suggested by many Authors [see Bathory (1987), Koch (1988)].

The low quality of the information which may derive from the situations just described increases credit risk because it inserts another element of uncertainty in the evaluation. In these cases risk depends not only on the real borrower’s performance but also on the ability to evaluate this performance through available information.

This may occur due to the difficulty of interpreting the data or as a consequence of the actions of the borrower who may hide some relevant information. The borrower might not be seriously motivated to establish a responsible relationship with the bank especially if an eventual default does not create serious consequences.

The bank can change this behavior through demanding contractual conditions that induce the borrower to respect the obligation. The introduction of various penalties or collateral guarantees in the form of liens on properties that the borrower considers important will likely induce responsible repayment.

Five groups of factors affecting credit risk can be summarized:

1. the customer's ability to repay
2. the customer's willingness to repay
3. the presence of favourable external conditions (economic and environmental)

4. the quality of the information upon which the analyst bases the judgement
5. the bank's ability to insure the customer's willingness to repay through an incentive compatible contract.

The results of this analysis can be interpreted within this framework since all the factors obtained and especially the most powerful ones for discrimination can easily be related to points 1-5. Point 3 was not explicitly considered since it was not useful for discrimination, given the common geographical and economic origin of the sample customers. External conditions, however, have repercussions on the ability to repay (#1).

2. The Research Implementation

2.1 The CNCA of Burkina Faso

The Caisse Nationale de Crédit Agricole — CNCA — du Burkina Faso is a development bank created in 1979 with the aim of promoting rural financial development. The most important shareholder is the Government of Burkina Faso [CNCA, (1988-89)].

At the beginning of its activity, the CNCA was conceived as a central body, based on public or foreign funding, coordinating credit distribution in rural areas. Some already existing public structures were entrusted with the field activity. These structures being the link between the bank and the rural clientele, in time bank-customer relationships became very distorted.

Rural customers did not perceive any change from the "direct distribution of government credit" to the CNCA structure. The intervention of the CNCA was at most considered merely a further step in credit disbursement. This attitude towards public credit, in which loans were often regarded as a grant, represented a heavy legacy for the CNCA and had serious consequences on the quality of its loan portfolio.

More importantly, the bank had no effective control over the administrative structures which were not given enough responsibility for loan disbursement, control and repayment.

Conflicts that arose between these structures and the CNCA eventually modified the bank's structure and organization through a decentralization of some branches and direct management of the lending process. At the same time the CNCA started a savings
mobilization policy in order to decrease its dependence on public/foreign financing.

Bank management was effective enough to face this change; this can be seen in effective control systems [L’Aot (1989)], permanent efforts for cost reduction, and continuous research aimed at improving the creditworthiness evaluation process.

The loan portfolio still suffers from past problems affecting the image of the CNCA but the situation is improving. The CNCA lends to individuals, village groups (GVs), and big enterprises, the latter being head office customers. Big firms represent a large percentage of the loan portfolio; however, the bank’s future strategy is to promote improved credit access for small entrepreneurs and GVs.

Bank profitability, except in the first year, is quite satisfactory, notwithstanding the heavy provision for loan losses. The CNCA’s market share is low in absolute terms but should be evaluated considering the distribution of other intermediaries. Being the only formal financial intermediary operating in many rural regions, the CNCA’s market share in these zones is much higher than the statistics indicate.

The CNCA could be restructured with success through a continuously improving lending policy. This research was stimulated by the acknowledgement that innovative credit evaluation techniques could be beneficial. The bank’s management goal is improved efficiency, in contrast to other development banks where costly administrative and bureaucratic procedures still prevail. This fact is very important for model testing since a bureaucratic and un-motivated bank personnel would invalidate the results, making the bank’s internal problems more relevant than other elements of credit risk.

2.2 Sampling

For this first application, the analysis is limited to loans granted to individuals operating small and micro-firms and a sample of 118 loans to individuals was retained. GVs (village groups) are very peculiar entities for whom it may be difficult to find a clear-cut correspondence with the theoretical framework presented here. Further research would be necessary to obtain a suitable model for GVs. However, the elaboration of a quantitative model for GVs would not be a problem, once the method first demonstrates its validity for individual loans.

The sample was extracted from the population of all the individual customers of the bank, respecting the population composition concerning regular loans and insolvenoes, maturities, and declared use of the loan. The sample is quite representative of the population. A problem encountered is the incompleteness of data for some observations. The original sample of 118 observations was then reduced to 100 more complete observations. In order to limit the reduction of observations [Zmijewski (1984)] the following two choices were made:

1. estimating one model with 100 observations, dropping the variables with many missing values;
2. estimating a second model for 31 observations using almost all the selected variables.

2.3 Collection of information

Information was collected through questionnaires and direct interviews with loan managers. Quantitative and qualitative information was obtained.

Quantitative data were included in their original form or after elaboration (i.e., ratios) that better fit the theoretical framework presented above. In this model context, qualitative information is sometimes much more relevant than quantitative data, given the absence or unreliability of book-keeping practices. The satisfactory results of the model confirm the relevance of qualitative data or symptomatic variables as they are symptoms of the borrower’s financial performance [Viganò (1992)] and (1992)]. These qualitative variables were included in the form of dummy variables.

The questionnaire covered all the common fields of investigations for loan analysis. It was divided in the following areas:

1. Customer’s Personal Characteristics
   The customer personal situation (age, sex, religion, marital status, education,...) and his/her professional activity (sector, place...).

2. Data on the Enterprise
   Kind of activity, the customer’s professional skills, ability to control the productive process, manpower employed, past performance of the firm, degree of technology, productivity, flexibility to productive changes. This information becomes crucial where the

4. Being aware of the problems created by the exclusion of rejected loans and self-selected customers [as reported in Eisenbeis (1981) and Ongier (1970)] the solutions proposed to overcome the problem are here considered too arbitrary.
common financial data are not available or reliable and play the role of symptomatic information.

3. Profitability
Revenue was divided into "main revenue" deriving from the customer professional activity and "secondary revenue" from other sources. Some indicators of revenue stability were included. The criteria the bank used to estimate these revenues (Upon customers declaration or personal verification) were also considered. It was not possible to estimate the family consumption expenses since in many cases rural families consume part of their agricultural products or barter them.

4. Assets Amount and Composition
The amount of total assets was computed including money and deposits. It was sometimes difficult to evaluate real assets given the absence of benchmark values. The assets amount is not considered too relevant for credit risk evaluation but a certain amount of properties is an indicator of the customer's self-financing and management abilities (symptomatic variable) and may become a buffer against liquidity constraints.

5. Financial Situation
Initial and current amount of loans received - divided by source of funding; amount of defaults; loans granted by the borrower. The assumption that the presence of already existing debts negatively affects repayment capacity is counterbalanced by the empirical finding that total lending is rather an indicator of the customer's creditworthiness in the banking system.

6. Investment Plans
Notwithstanding money fungibility, the presence of a well defined investment plan may be an indicator of the customer's seriousness and professional skills. The presence of other sources of financing for the same investment project was recorded.

7. Customer's Relationship with the CNCA
Historical data on the relationship were collected, as well as information on the way the contacts between the bank and the customer take place (at the bank, through some projects...). A clear understanding of the contractual obligation is easier if the two counterparties meet and discuss loans terms and conditions. Variables reflecting this aspect were considered as symptoms of the willingness to repay.

8. The Bank Control of Credit Risk
How funds are disbursed (in kind, with loan destination) and methods of repayment; contractual conditions on interest rate, maturities, repayment periodicity, collaterals and loan amount; loan amount determination criteria: these are elements that reflect the negotiating capacity of the bank and its ability to control credit risk.

2.4 Variable Selection
A first selection of original variables was determined by the number of observations for which they were available. If most observations presented missing values for a given variable, this variable was dropped. This elimination is also consistent with the theoretical framework since the lack of information is one area of credit risk that the bank has to address. The purpose of the research is to find a model that accounts for this lack of information and that allows the bank to evaluate credit risk given a limited amount of data on the customer.

A second selection of the variables from the original data set was based both on the relevant theory and on the variable correlation with insolvency. Given that in multivariate discriminant analysis univariate correlation with insolvency is not a sufficient criteria to eliminate variables (on the subject see Eisenbeis (1981)), pp. 144-148) variables almost not correlated with insolvency were dropped when they were not too relevant for the theoretical interpretation.

The remaining set of 53 variables was used according to the method described in the following paragraph. 18 observations out of 118 were dropped for incomplete data. The final sample contains some observations with incomplete information concerning the usual areas of investigation such as profitability. This is the rationale for the use of symptomatic variables. The model was also tested for a reduced sample of 31 observations for which more complete data on profitability, the financial situation, and asset composition were available and reliable.

2.5 The Model
Given the high number of variables, factor analysis was applied to the final set of variables for both the total sample and the reduced sample. 11 factors and 13 factors (see the appendices 1 and 2) were respectively obtained. The first test used all the 11 factors. A stepwise forward application run on the 11 factors would suggest to include the first six factors and the eighth. However, given the theoretical meaning of the factors (see Appendix 1) all factors were included, improving the discriminant power. 4 out of the
13 factors were selected through stepwise forward method for the second test. Factor analysis was used for two principal reasons. First, the description of complex situations through relatively simple basic information implied the use of a number of input variables overdimensioned compared with the number of observations. Factors allow a reduction of the number of input variables with no loss of relevant information. Second, these factors were related to the relevant aspects of credit risk set forth in the theoretical introduction (par. 1.2.). It would be more difficult to find this correspondence between theory and the variables that, taken individually, reflect only partial aspects of a complex phenomenon. The satisfactory discriminant power of the factors confirms the validity of the approach both from the theoretical and empirical points of view.

2.6 The Classification Results

The following tables summarize the results of discrimination for the total sample and the reduced one. Results reflect respectively the reclassification of the original samples and the application of the jack-knife method, which classifies iteratively all the observations through a discriminant function estimated using all the observations except the one to be classified [Lachenbruch, (1975)].

The best classification was obtained when the same sample used to compute the discriminant functions (original sample) was classified. Jack-knife results, however, are also satisfactory, especially considering the experimental character of the application and the difficulty to obtain reliable data.

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Table 1a

<table>
<thead>
<tr>
<th>Sample actual composition</th>
<th>Model sample classification</th>
<th>Total</th>
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<td></td>
<td>Regular</td>
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<tr>
<td>Regular</td>
<td>32</td>
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<tr>
<td></td>
<td>(62.75)</td>
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<tr>
<td>Default</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(8.16)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>36</td>
<td></td>
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<tr>
<td></td>
<td>(100.00)</td>
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</tbody>
</table>

Total error: 23.00%

Prior weighted error: 26.78%

ECgpr2: 3.31%

ECmax: 25.20%

ECperr: 53.68%

Table 1b

<table>
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<tr>
<th>Sample actual composition</th>
<th>Model sample classification</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Regular</td>
<td></td>
</tr>
<tr>
<td>Regular</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(60.75)</td>
<td></td>
</tr>
<tr>
<td>Default</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(20.61)</td>
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<tr>
<td></td>
<td>42</td>
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<td></td>
<td>(100.00)</td>
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</tbody>
</table>

Total error: 25.00%

Prior weighted error: 31.19%

ECgpr2: 6.89%

ECmax: 25.20%

ECperr: 17.63%

ECperr2: 41.09%

5. ECgpr, ECmax, ECperr are various measures of total classification costs. The first is the error cost of the classification obtained while the others are benchmark error costs computed according to the Maximum Chance model and the Proportional model [Joy e Tollefsen, (1975)].
The results of this first classification show a better model accuracy in locating defaults. This follows, at least partially, from the computing of the cutoff point that penalized Type I errors through the weighting misclassification cost $C_{12}$ (see Appendix 2).

The original sample classification is particularly satisfactory for defaults as it correctly classifies 92% of the observations. The jack-knife method does not worsen the Type II reclassification error but shows a loss of quality for default loans that are correctly classified in 80% of cases.

The comparison of the discrimination error costs $EC_{DF}$ with the benchmarks $EC_{max}$ and $EC_{prop}$ shows a superiority of the proposed model particularly compared with the "Maximum Chance" model, given the basis of its computation.

The classification on the reduced sample, which only includes the observations for which most variables were available, gives the following results:

<table>
<thead>
<tr>
<th>Sample actual composition</th>
<th>Model sample classification</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Regular</td>
<td>Default</td>
</tr>
<tr>
<td>Regular</td>
<td>13</td>
<td>6</td>
</tr>
<tr>
<td>Default</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>Total error</td>
<td>25.58%</td>
<td></td>
</tr>
<tr>
<td>Prices weighted error</td>
<td>3.41%</td>
<td></td>
</tr>
<tr>
<td>$EC_{DF}$</td>
<td>36.3%</td>
<td></td>
</tr>
<tr>
<td>$EC_{max}$</td>
<td>17.63%</td>
<td></td>
</tr>
<tr>
<td>$EC_{prop}$</td>
<td>51.72%</td>
<td></td>
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</table>

Table 2b
DISCRIMINATION ON 31 OBSERVATIONS WITH 4 FACTORS. RESULTS OF JACK-KNIFE CLASSIFICATION (6% values in brackets)

<table>
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<tr>
<th>Sample actual composition</th>
<th>Model sample classification</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Regular</td>
<td>Default</td>
</tr>
<tr>
<td>Regular</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>Default</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>Total error</td>
<td>25.81%</td>
<td></td>
</tr>
<tr>
<td>Prices weighted error</td>
<td>36.3%</td>
<td></td>
</tr>
<tr>
<td>$EC_{DF}$</td>
<td>17.63%</td>
<td></td>
</tr>
<tr>
<td>$EC_{max}$</td>
<td>44.83%</td>
<td></td>
</tr>
</tbody>
</table>

The introduction of variables usually included in the creditworthiness evaluation process, such as revenue measures or total assets evaluations, causes a slight improvement in the classification on the original sample for regular loans, as compared to the discrimination on 100 observations. The classification of defaults does not change significantly. The jack-knife method shows a good stability for default classification (92%) and a worsening for regular loans.

Also in this second model the comparison of total error costs $EC_{DF}$ with $EC_{max}$ and $EC_{prop}$ shows a superiority of the proposed model.

3. Conclusions

The two discriminant models respectively applied on the total sample and on the reduced one have a quite good predictability, particularly as concerns the elimination of Type I errors. In spite of the limited available information, these results show that credit scoring techniques can be used even in very simple realities, very far from the typical credit scoring applications.

The major problem encountered, the absence of the usual profitability and financial measures on the customers, finds an interesting solution in the use of factor analysis.
In rural areas of LDC's it is quite difficult and costly to collect reliable information on the customer's profitability. The limited average amount of loans may not justify time and personnel investment for its estimation.

In contrast, the model use very simple information on the customer, that the analyst can easily and quickly get. These data may not be very meaningful when considered individually — since they could play a minor role in credit risk determination. They are often symptoms of a more complex situation and need to be combined each other to become important indicators of repayment probability. Factor analysis represents an easy way to combine these symptoms together in a way that they become crucial for the theoretical interpretation.

Some major aspects of credit risk were focused on: the customer's profitability, financial situation and wealth, the customer's attitude towards the financial obligation, the bank's ability to control credit risk through contractual conditions, the quality of information upon which the bank formulates the judgement. The factors obtained express these peculiar areas. The analyst can perceive the relative weight of each of them on credit risk and take ad hoc measures to control the aspect that seems more significant.

Factor analysis on the total sample of 100 observations is very satisfactory in this respect since 10 out of 11 factors are strictly related to the mentioned credit risk areas [see Appendix 1 for the explanation of factor meanings]. They can be grouped as follows:

- Area of the customer's performance: the factors describing profitability (three factors ≠ 2, 4, 5), financial situation (one factor, ≠ 3), total assets (two factors, ≠ 6, 7).
- Area of the customer's attitude: one factor (≠ 1) related to the borrower's attitude towards the transaction (commitment), one factor (≠ 8) describing the borrower's morality and character, one factor (≠ 11) related to the borrower's behavior as bank customer.
- Area on the bank control of credit risk: one factor including variables on the loan agreement (≠ 9).
- Area on available data: one factor related to the quality of information (≠ 10).

Most of total variance is explained by factors related to the customers' attitude, i.e. willingness to repay. Notwithstanding the positive restructuring that took place in the CNCA, the bank is still bearing the legacy of its past image, when it interacted with the administrative structures charged of loan disbursement.

The customer's performance is mainly estimated through symptomatic variables rather than by quantitative data, seldom available. Several factors relate to this aspect. One factor clearly relates to the control of credit risk through contractual conditions and another one to the quality of information. The mentioned four areas of credit risk are clearly covered by this analysis.

The factors obtained on the reduced sample of 31 observations [see Appendix 1 for comments], for which reliable data on profitability were available, can be grouped as follows:

- Area of the customer's performance: profitability (four factors ≠ 3, 5, 10, 13), financial situation (one factor, ≠ 8), total assets (two factors, ≠ 2, 12).
- Area of the customer's attitude: two factors (≠ 1 and, partially ≠ 6) related to the borrower's attitude towards the transaction (commitment), one factor (≠ 9) describing the borrower's morality and character, one factor (≠ 7) related to the borrower's behavior as bank customer.
- Area on the bank control of credit risk: three factors (≠ 4, 10, 11).
- Area on available data: one factor (≠ 6).

Stepwise forward method selected factors 3, 5, 6, 10. Factors 3 and 5 are indicators of the customer's economic performance and of revenue variability. Factor 10 is still related to profitability but also to credit risk control through the loan amount determination. The sixth factor relates to the quality of information.

In these factors there is not a specific one related to the borrower's attitude which proved to be important for the discrimination on the total sample. It might be inferred that those customers that can provide the bank with correct information on their revenue and assets can also correctly evaluate the bank-customer relationship and the importance of their financial obligation. For this group of customers commonly used evaluation criteria prevail, even if supported by symptomatic variables. Profitability and revenue stability variables, as well as credit risk control measures linking loan amount to profitability, become more important than in the first discrimination. However, the sixth factor includes the customer's attitude; in this case the bank-customer relationship mainly exerts its effects on the quality of information [see the explanation of factor 6 in Appendix 1].

Another interesting observation emerging from the comparison of results on the total sample and the reduced one concerns the role of total assets on credit risk. In the total sample variables related to total assets are rather symptomatic of investment opportunities.
and ability to save and reinvest rather than indicators of the presence of real guarantees. These variables become symptoms of the customer's economic performance. Wealth variables loose their importance for the reduced sample, since in this case quite correct information on revenue is available. This confirms the theory stating that ability to repay depends on profitability and not on real properties.

In both the analyses symptomatic variables are very important. Of course, the introduction of precise revenue measures for the reduced sample increases the model performance. However, the results of the discrimination on the total sample are quite satisfactory particularly in relation to the low collection cost of symptomatic variables. The use of these models is consistent with a strategy of maximization of the loan expected value [as reported in Eisenbeis (1981), Masini (1975)] suggesting that lending decisions depend on the loan expected value related to the interest rate, information and evaluation costs and the probability of default.

Even in case of high predicting performances, discriminant models should always be a support for the decisions, the final judgement being the analyst's concern. In this respect, credit scoring models may become an important control tool and a means to give responsibility to loan analysts especially for decentralized branches. The relevance of these models derives from the possibility they offer to conduct the loan analysis according to a logical and theoretical framework and to avoid arbitrary decisions.

A new application of this analysis, taking advantage of this first experience, could give very interesting and useful results. In particular, the introduction of this method in the Caisse Nationale de Crédit Agricole du Burkina Faso, where this first test was run, would be quite easy.

This bank is well organized and is using a computer network. They are also aiming both at widening their loan portfolio towards those customers often rejected by commercial banks and at controlling loan portfolio risk. The proposed evaluation method, based on a quantitative model and on symptomatic information, helps the bank reaching these apparently conflicting objectives since it rationalizes the evaluation process and allows customers that cannot demonstrate to be creditworthy upon traditional standards to become eligible borrowers.

4. Appendix 1: Theoretical Interpretation

4.1 Meaning of the Original Variables

Using factors as inputs for the discriminant model does not allow the estimation of the individual effect of each variable on credit risk. The correlation of these variables with insolvency may help the analyst in the interpretation of factors. This correlation was computed for the original variables separately on the total sample (100 observations) and the reduced sample (31 observations). Correlations have almost always the same sign in both samples except in some cases where the difference is particularly significant from the theoretical point of view. Table 1 in the appendix shows the correlation for the selected variables. For the second sample some variables selected for the first sample were dropped but a few were kept when their theoretical meaning was strong in order to allow for a comparison with the results of the first test.

**Customer's Characteristics**

*Women* are better customers than men, because they are more entrepreneurial, as it will be shown later on. Being *married* is also a quality that, coupled with age, is a symptom of stability and contributes to a reduction of credit risk. The *proximity* to the bank also reduces risk given the stronger bank/customer relationship. Being *retired* reduces credit risk, in the same sense as age.

**Enterprise Characteristics and Customer's Activity**

Working in *agriculture*, where revenue variability is very high, is positively related
did while livestock breeding and trade are negatively related to insolvency. The degree of *technology* and the *flexibility* to adjust to market changes reduce the probability of insolvency while dependence on *weather conditions* increases it. All these variables are related to profitability and revenue stability and are symptoms of these economic properties.

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6. Any time the analyst decides to grant a loan that obtained a low score, he/she has to demonstrate the reasons for his/her decision and becomes responsible for bad performance. The usefulness of quantitative models to evaluate the managers' performance in a different context is stressed by Overstreet and Kemp (1986).

7. In the reduced sample this positive correlation is lower. This might depend on a higher quality of information and book keeping of these customers that allow for a better control of credit risk.
Profitability and Revenue Stability

Variables related to profitability showed controversial results. All the variables linked to total revenue have a positive or null correlation with insolvency while variables expressing the minimum revenue show a negative correlation. This controversy could be attributed to the higher reliability of minimum revenue measures that are almost always related to permanent incomes, such as salaries or pensions.

Revenue measures were included in the reduced sample. Given the ambiguity of these measures, however, only measures that appeared to be more reliable were chosen. For the total sample only symptomatic variables related to profitability were used; among them, the following ones.

Information on sources and type (monetary or in kind) of revenue confirms that insolvency risk decreases in case of permanent revenue (i.e. salaries, pensions) and for monetary revenues. Regular repayment is also higher for customers that are free to choose their markets and to fix their prices, in opposition to the presence of public or project interventions. These results might also be related to participation in public or foreign projects which have a heavy impact on credit risk, as it will be shown later.

Asset Value and Composition

Estimates on asset values show a negative correlation with insolvency, the same as for the quantity of cultivated land and the presence of a telephone which is a wealth indicator. The variables used on the total sample do not include total asset value because of missing information. Only data on the amount of land and the telephone ownership could be included. Later on some other symptomatic variables related to asset value will be indicated.

Financial Situation

As concerns indebtedness, variables comparing this value with total assets or total revenue show a low correlation with insolvency. For the reduced sample test the ratios "total debt to total assets", "annual revenue/annual debt" were included. Both are positively related to default. In the first case the sign is consistent with expectations. In the second case one would expect a negative correlation. However total debt has a negative correlation with insolvency; it seems to affect probability of repayment for being a symptom of the customers' "potential eligibility" (the wealthier customers of the sample are already creditworthy in other banks), and not for the constraints that total debt puts on the customer's financial situation and on its ability to repay.

The total amount of repaid loans has a negative correlation with insolvency, being also a sign of the customer's seriousness.

Loan Use: Investment Project

Information on the sector financed was included to account for a widespread habit to invest in fields other than the main activity of the borrower. Results confirm a negative relation between repayment and the agricultural sector and a positive relation between the former and livestock breeding and trading activity.

If the use of funds constitutes a particular sector of a customer's more diversified activity, credit risk decreases since the loan amount is often more tailored on the customer's actual repayment capacity.

The link of the loan with other loans granted by the CNCA increases credit risk. The subdivision of the total loan into various parts can make it more difficult to correctly evaluate the customer's ability to repay and confuse the customer.

The percentage of self finance is negatively related to insolvency, highlighting the fact that the borrower's involvement in the project affects repayment.

There is almost no relationship between the specific project's profitability and regular loan repayment. This confirms the widespread opinion that the fungibility of money and the unity of the enterprise ([Dell'Amore (1965), Von Pischke and Adams (1980)] make it misleading and dangerous to put too much attention on the specific project to be financed instead of evaluating the firm's global performance.

Bank-Customer Relationship

A spontaneous loan application from a village group member affects positively repayment probability; this result might derive from the effect of a previous positive experience with a group loan. On the other hand, participation in a public/foreign project or a loan application originated by the presence of a project increase credit risk because they

8. The case of forced selling channels differs from the case where a project assures sales and exports as, for example, the CMOE of Mali described in Massi (1987).

9. Since sometimes the maturity of these loans was unknown, one should consider that for new loans not yet due, the customer's ability to repay has not yet been tested.
bias the customer's perception of the obligation. They may instil a certain confusion between the different roles of the bank and the project [Viganò (1992)]. In the same way, a direct contact with the bank fosters a greater willingness to repay: higher repayment rates were found for those customers that personally negotiated their loan with the bank and visited the bank in the disbursement and repayment phases of their loan activity.

The positive correlation between being member of a project and default is lower for the reduced sample. Customers with a record keeping system are probably more educated and more able to distinguish loan obligations and project grants transferred to individual clients. However, if the loan is encouraged by the project, credit risk is very high also in the reduced sample. One can infer that the customer might be less strict in evaluating his/her investment plans when he/she is backed by a project. Without the project the customer is more self-selective.

**Contractual Conditions and Credit Risk Control**

Customers requiring large loan amounts are better repaying customers in this sample, probably because they are already established bank customers. Comparing the minimum annual revenue to the loan amount or the revenue earned at each contractual maturity to the amount due at each maturity there is a strong negative correlation with default. This confirms the theory that relates revenues, loan amount and credit risk [Dematté (1974), Masini (1986), Viganò (1992), Von Pischke (1983)].

A loan smaller than the amount required may encourage the customer to divert funds to other purposes, increasing credit risk. In this analysis, however, it is evident that the higher the ratio amount granted/amount required, the higher is credit risk. This can be explained through the positive effects of a correct loan analysis that makes the bank more restrictive in its judgement. For the reduced sample the effect is lower for two reasons: the presence of reliable revenue information upon which to formulate the judgement reduces the bank's credit rationing and the customer himself might be more aware of his borrowing capacity.10

Loans in kind are higher risk, confirming that measures to control loan use are often ineffective. As concerns repayment, voluntary repayments or repayments through the deduction of salaries and pensions are lower risk than repayments through direct deduction from forced deposits of sales revenues.

In the total sample maturity is not related to credit risk while there is a strong negative correlation between the frequency of maturities and default. Small periodical repayments keep alive the customer's obligation and subtracts the customer's money from the loan/grant requests of other family members [as also noticed by Elsasser and Diop (1990)]. In the reduced sample this relationship is less strong but there is a higher positive correlation between maturity and default.

The longer the waiting period from application to disbursement the higher is the credit risk. This demonstrates the importance of timing in allowing the customer to implement his/her investment project on schedule.

The criteria to fix the loan amount used by the CNCA are: as a proportion of the investment, in accordance with documented or projected revenue or with sales. While the first criterion does not seem to be related to regular repayment, the other two criteria allow a better control of credit risk.

The interest rate, the most important element of explicit borrowing costs, has a low influence on insolvency as concerns the nominal rate while the effective rate (compound interest rate) has stronger effects. The effects of interest rates are more relevant for the reduced sample. These results might prove the existence of some credit rationing [Stiglitz and Weiss (1981)]. However, CNCA interest rates are often lower than market rates and other elements of implicit costs, such as delays in disbursement, are much more responsible for some adverse selection effects.

Collaterals in the form of mortgage reduce insolvency, given their correlation with wealth [McLeod (1991, p. 190); Baydas and Cuevas (1990, p. 372) who consider total assets as a proxy for investment opportunities; Nelson (1974)] and given the reinforcement of the obligation deriving from the risk of property loss. On the contrary, the pledge of goods is not so effective: when the CNCA gives loans in kind and requires a pledge on them, the customer may feel easier not to repay and let the bank sell the same goods if he/she is not really concerned with the investment.

**Personal guarantees** seem quite effective reflecting the apparent importance of social pressure in African society.

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10. The ratio "amount granted/amount solicited" is an indicator of credit rationing. It can be a function of the probability of repayment: 
\[
\alpha = f(r, C, L, p)
\]

where: 
- \( r \) = interest rate 
- \( C \) = value of collateral/loan amount 
- \( L \) = probability of repayment as a function of some borrower's characteristics (Lapper and Grisham (1988)). According to the interpretation presented in this paper, the ratio \( \alpha \) is a determinant of repayment probability.
The Customer's Banking Behavior

Past defaults, though determined by serious causes such as a drought, increase credit risk and indicate troublesome bank behavior. The existence of other current loans with the CNCA affects credit risk in the same sense. While being indebted with other banks is often a symptom of potential eligibility, an excessive exposure with the CNCA might hide the idea that the bank is a funds disburser rather than a lender.

Being a pre-existing depositor is slightly related to regular repayment and affects positively the bank-customer relationship.

Quality of Information

When the bank has complete data on the customer there is a higher repayment rate in the total sample where, in contrast, the intermediation of a development project in the information transmission increases credit risk. The relative insensitivity of the reduced sample to the quality of information might depend on the more complete data for all these observations.

Younger firms in the large sample are more subject to default risk. This effect is attributable to the lack of historical information on their performance. The reduced sample, however, does not show the same effect perhaps, again, due to the more complete information obtained in this case.

4.2 The Factors Interpretation for the Total Sample

Input factors for discriminant analysis on the total sample are summarized in Table 2 of Appendix 2.

The first factor, explaining 26.3% of total variance, shows high loadings for some variables related to the presence of a development project and to the quality of the bank-customer relationship (e.g., direct negotiation). Given the preceding explanation of each variable, this factor is interpretable as an indicator of the borrower's attitude towards the financial transaction.

The second factor explains 19% of total variance. It has high loadings for variables reflecting profitability and revenue stability. The degree of productive flexibility, the dependence on weather conditions, the prevalence of monetary revenue, the sector of activity have the higher loadings. The degree of technology and the presence of a mortgage, symptoms of profitability, have quite high values. A high value also corresponds to the variable indicating that the loan amount was fixed according to revenue measures.

The third factor (13.9% of total variance) shows high loadings for three variables: percentage of unexpired CNCA loans, link of the loan with other loans granted by the CNCA, percentage of the project financed with the contribution of CNCA. Considering the almost exclusive relationship with the CNCA for many customers, one could interpret this factor as an indicator of the customer's financial exposure and of the customer's ability to manage several borrowing contracts. In fact, the variable indicating the degree of self financing has the opposite loading sign and reduces the customer's financial exposure.

The fourth factor only reflects the variables related to the livestock breeding sector, still connected with profitability and its variability.

The fifth factor reflects the stability of the customer's personal and economic situation. Important variables are the statuses of: retired (also a proxy for age), married, employed with a regular salary.

Factor number 6 is clearly related to the customer's general economic conditions, particularly as concerns assets amount and composition. Given the absence of exact measures of assets values, the variables such as: mortgages, total and annual indebtedness, loan amount are all symptoms of the dimensional and economic importance of the customer's activity. As mentioned before, variables expressing indebtedness should not be viewed as indicators of financial constraints but as a sign of the customer's eligibility for bank loans.

The seventh factor shows some variables already mentioned in the sixth factor such as total debts. It also shows high values for the presence of a telephone and repaid debts. This factor is still related to the customer's financial situation and wealth.

In factor number 8, the only important element is the variable "sex". Of lesser importance is the dummy indicating that the borrower belongs to a village group or cooperative. These two aspects find a common interpretation in the customer's attitude towards the obligation.

Being a GV member, having received a group loan with a group guarantee and applying for an individual loan for which the customer is the only responsible person: all these elements indicate a determination in contracting a real financial obligation. As concerns sex, in Burkina Faso, like in many other African countries, women depend on husbands'
authorities but have a certain power in managing some independent economic activities. Women are usually very dynamic in these activities since they want to demonstrate their managing ability and can use part of these revenues for their personal expenses.

The meaning of this factor differs from the first one's. Both reflect aspects related to the customer's psychology. However, the first one reflects the influence on the customer's attitude of external events such as the presence of a development project that may distort the bank image. The eighth factor is more related to personal borrower's characteristics, morality and determination, that may be independent from external conditions.

The ninth factor is related to some variables reflecting the bank ability to control credit risk. The interest rate and the ratio "amount granted/amount solicited" are relevant contractual conditions for this purpose.

In factor 10 two dummy variables are relevant: the one related to the quality of information and the one indicating if the financing is invested for the entirety of the customer's activities or just for a specific purpose. These are symptoms of the Information adequacy. While the first variable is easy to interpret, the second one requires some clarifications. When financing is related to the whole customer's activity credit risk increases because it is more likely that the loan amount is larger than the actual borrowing capacity. Moreover, the bank usually requires more information in the case of a specific investment. Even if the control of loan destination is not considered here as an effective measure of risk control there might be a positive effect on the quality of information. The loadings of the dummies "customer is a depositor" and "age of the firm" confirm the meaning of the factor.

In factor 11 the only important variable is the presence of past defaults which is an indicator of the quality of the customer's banking behavior.

The stepwise analysis run on these factors selected the first six factors and the eighth. Discrimination improved using all the factors.

4.3 The Factors Interpretation for the Reduced Sample

The factors obtained on the reduced sample of 31 observations are reported in Table 3 of the Appendix.

As in the case of the total sample, the first factor shows high loadings for variables indicating the customer's attitude towards the financial transaction. It explains 21.5% of total variance.

The second factor, explaining 14.8% of total variance, is related to the customer's wealth since the variables: total assets, total debt and annual debt have high values. The loading for the variable "loan amount" confirms this interpretation. The second factor, explaining 14.8% of total variance, is related to the customer's wealth since the variables: total assets, total debt and annual debt have high values. The loading for the variable "loan amount" confirms this interpretation. 11

Factor 3 (9.3% of the variance) is more complex and reflects complementary aspects. On one side, it shows high values for variables related to the customer's personal and economic stability, as in the fifth factor for the total sample (being retired, married, aged and perceiving a fixed monetary revenue are all important elements). On the other side, the factor is related to profitability (minimum revenue and freedom to choose markets and to sell production).

The fourth factor reflects the bank ability to control credit risk since it shows high loadings for interest rates and the ratio between minimum periodical revenue and loan amount.

The fifth factor still reflects profitability with high values for the dummies on the dependence on weather conditions, on the sector of activity and on the prevalence of monetary revenues, all symptoms of revenue and its variability.

Factor number 6 reflects two aspects: the customer's attitude towards the transaction (variables related to the presence of a development project 12) and the quality of information (the project intermediation in data transmission reduces the bank ability to control for their reliability; the variable on the loan destination confirms the factor meaning).

The seventh factor is difficult to interpret. The two important variables are the "presence of live stock breeding activity" and "regular repayment of past debts".

Factor 8 has the same meaning of the third factor on the total sample: the customer's financial exposure and the customer's ability to manage several borrowing contracts (variables related to total borrowing with the CNCA).

The ninth factor (5% of variance) expresses the borrower's seriousness in the loan transaction as in the eighth factor of the total sample. Belonging to a GV has a higher loading in this case.

The tenth factor still reflects profitability since it shows high loadings for the variables:

11. As stressed earlier, loan amount and total debt might be indicators of the customer's economic dimension.
12. For the interpretation see par. 4.1.
periodical revenue/loan amount, source of revenue/annual revenue/annual debt, land owned. A symptom of profitability is the variable expressing the level of technology used in the firm. The variable periodical revenue/loan amount is also an indicator of the bank ability to control credit risk since it is related to loan amount determination. The relative importance of the variable "loan destination" confirms a certain link with loan amount determination, as explained in par. 4.1. The presence of mortgages also has a high loading; the bank could be encouraged to increase loan amount if backed by a real guarantee.

Factor 11 has high loadings for loan amount and maturity, linked to the control of credit risk.

The meaning of the twelfth factor is still the customer's financial situation and wealth as it has high loadings for the variables total debt/total assets and quantity of land owned. In this case total debt loses its dimension of indicator that it has when used in absolute values and becomes an indicator of the customer's financial constraints.

In the last factor (13) the variable "level of technology" could be a symptom of profitability. In opposition to the factor analysis run on the total sample, where each factor reflected particular aspects of credit risk, in this case some factors are not very meaningful and some others have not an exclusive meaning. For this reason some of them were selected through a stepwise forward analysis and four factors were kept: the third (revenue stability), the fifth (profitability), the sixth (customer's attitude and quality of information) and the tenth (profitability and credit risk control).

13. See par. 4.1.
### Table 2
FACTORs OBTAINED FOR THE TOTAL SAMPLE

#### Factor loadings

* (*: low values useful for the interpretation) *(in brackets: high values not related to the factor meaning)*

<table>
<thead>
<tr>
<th>Factors</th>
<th>F1</th>
<th>F2</th>
<th>F3</th>
<th>F4</th>
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<th>F6</th>
<th>F7</th>
<th>F8</th>
<th>F9</th>
<th>F10</th>
<th>F11</th>
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<tr>
<td>Variance explained by each factor</td>
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<td>19.00</td>
<td>13.90</td>
<td>7.10</td>
<td>6.90</td>
<td>6.80</td>
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<td>4.20</td>
<td>3.90</td>
<td>3.60</td>
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<td>-0.14</td>
<td>-0.20</td>
<td>-0.22</td>
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<td>0.07</td>
<td>0.05</td>
<td>0.01</td>
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<td>Total borrowing</td>
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<td>Loan destination: agriculture</td>
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<td>Loan destination: trade</td>
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<td>0.79</td>
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<td>Loan destination: whole enterprise</td>
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<td>Links with other bank loans</td>
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<td>Other B. Loans/Project amount</td>
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<td><strong>Belonging to a production group</strong></td>
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<td></td>
<td></td>
<td></td>
<td>0.31</td>
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</table>

- **Public foreign projects** | 0.89 |
- **Foreign donors initiative** | 0.81 |
- **Place first meeting** | 0.91 |
- **Donor intervention in 1st meeting** | 0.91 |
- **Application initiative** | 0.89 |
- **Place of negotiation** | -0.89 |
- **Place of disbursement** | -0.91 |
- **Place of repayment** | 0.91 |
- **Responsibility for disbursers** | 0.78 |
- **Loan amount** | 0.48 |
- **Amount granted/amount demanded** | 0.83 |
- **Loan in kind/crédito** | 0.84 |
- **Monetary repayment** | (0.71) |
- **Automatic repayment on sales** | 0.56 |
- **Automatic repayment on salary** | 0.71 |
- **Installment periodicity** | 0.94 |
- **Amount determination criteria** | 0.78 |
- **Compound interest rate** | 0.78 |
- **Mortgage** | 0.84 |
- **Pledge** | 0.56 |
- **Personal guarantee** | 0.56 |
- **Past defaults** | 0.84 |
- **Total bnr. actual balance/real bnl.** | 0.85 |
- **Savings account** | 0.65 |
- **Quantity of information available** | (0.65) |
- **Source of information** | (0.37) |
- **New enterprise** | -0.42 |
- **New enterprise** | (0.37) |
### 9.3 Table 3
FACTORs OBTAINED FOR THE REDUCED SAMPLE

<table>
<thead>
<tr>
<th>Factors</th>
<th>F1</th>
<th>F2</th>
<th>F3</th>
<th>F4</th>
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<th>F9</th>
<th>F10</th>
<th>F11</th>
<th>F12</th>
<th>F13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variance explained by each factor</td>
<td>21.50%</td>
<td>14.80%</td>
<td>9.26%</td>
<td>7.50%</td>
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5.4 Methodological Problems

In order to correctly evaluate the reliability of results we have considered the relevant issues concerning the use of discriminant analysis often discussed by the literature.

* Normality of the variables distribution
Multinormality of input variables is often considered very important for the goodness of discrimination results [Eisenbeis, (1981)2, p. 120].

Like many other Authors [as stressed by Correlli (1986)], we only tested for univariate normality of factors computing the Shapiro-Wilk W statistics proposed by SAS software [SAS (1985, p. 350)]. The results show that most of the factors are not normally distributed and may affect discrimination as described by Eisenbeis (1981)2, pp. 121-126.

* Multicollinearity
As did Eisenbeis (1977), we assumed that multicollinearity does not affect classification results [for a different view see Mensah (1984)].

* Equality of within group covariance matrices
The test run with by SAS [SAS/STAT (1987)] shows that these matrices are not equal. As a consequence, we used quadratic discriminant analysis [see Avery (1981), p. 40]; Lachenbruch (1975, p. 20-22).

* Definition of priors
We used the population proportions as priors. The definition of population is affected by the impossibility to include refused applications.

* Definition of the anomaly
In opposition to those that include loans paid with delay in the group of bad loans [Myers and Forgy (1963), Chesser (1974)], and even if the Author generally agrees with them, only those loans that became irrecoverable were considered as bad loans and all regular loans and loans periodically reimbursed with a "regular delay" were included in good loans. This choice is dictated by the particular bank economic environment, for some cultural and technical — i.e. lack of communications — reasons, completely regular repayments seldom occur.

* Time series, stationarity and accuracy of prediction
The sample is selected from all existing loans on September 30, 1990. The date they were accepted is not the same for all the loans, which implies pooling of data across several time periods. This may affect results according to Mensah (1984) and Eisenbeis (1981)2 and has some implications as concerns priors definition [Eisenbeis (1981)2].

* The cost of errors
Starting from Altman's formulae for the estimation of the costs of errors [Altman (1983, p. 185)], we modified them in order to include other factors that may affect these values in the specific context.

Altman's computation of C_12, i.e. the cost of classifying as good a loan which is actually a default is:

\[ C_{12} = 1 - \frac{a+b}{LB_i} \]

\[ a+b = \text{recovered part of the loan respectively prior and after chargeoff} \]
\[ LB_i = \text{debt balance at time } t \text{ prior to chargeoff} \]

We could modify this formula by including some other cost components, like those linked to loan management (percentage m), and recovery procedures (percentage p) [as suggested by Altman (1983, p. 180)] and the estimate of the increase in borrowing costs (in a percentage d) due to the degree of increase in loan portfolio risk perceived by depositors.

This last aspect could be very important if we consider that, even in relatively simple realities such as rural areas of LDC's, potential customers are often aware of the bad performance of development banks and choose other financial intermediaries15. Presently development banks do not pay too much attention to this aspect, given their strong dependence on foreign donors that are not so reactive to the increase in loan portfolio risk. However, many development banks are now running important savings mobilization campaigns; this might allow us to include the "cost of increased risk" in the estimate of C_12:

\[ C_{12} = 1 - q + m + p + d \]

The estimate of C_21, as proposed by Altman (1983) is the following:

14. Later we will indicate this ratio as q.
15. Deposit security and recoverability are two relevant factors determining the choice to deposit in financial institutions in African countries.
\[ C_{21} = r - i \]

where

\( r \) = effective foregone rate of return on the rejected loan
\( i \) = effective opportunity cost for the bank

Besides Altman's suggestions for improvement, in the case of development banks this value could also be increased in order to take into consideration the possible reaction of foreign donors to a bank's excessive caution in granting loans, as compared to the line of credit upon which their financings are based. This might lead to their partial withdrawal and imply the need for a stronger local savings mobilization, which is more expensive.\(^{16}\)

If we call this increase in cost \( f \) and if we assume that the decrease in foreign funds is a percentage \( f \) of liabilities, \( C_{21} \) becomes:

\[ C_{21} = r - i + f \]

In the practical application of these formulae, given the difficult estimation of the new components of \( C_{12} \), we applied the original Altman's proposal. For \( C_{21} \) we tried to estimate the new cost component assuming that all the donors ill withdraw from the bank. Even if we are aware that this is a very strong hypothesis, we want to allow for this increase in cost because we think that for development banks giving up loan grants has more serious consequences than in commercial banks, given the development objectives of these banks.\(^{17}\) Our estimates led to a value of \( C_{12} = 0.70 \) and \( C_{21} = 0.065 \).

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16. On the contrary, an increase in local deposits has some important positive effects on the banks performances [see Masini (1989) and Viganò (1992)]. It is however difficult to measure the impact of these effects on \( C_{21} \).

17. This does not mean that development banks should uniquely focus on the size of loan portfolios and not on loan quality but we think that they can bear a higher risk than commercial banks. We could say that they may not be profit maximizers but that their aim is at least to break-even [Viganò, (1992)].


Viganò Laura, 1992 (1), African Banks’ Funding Policies and Effective Lending. Università degli Studi di Bergamo, Quaderni del Dipartimento di Economia Aziendale, n. 4.


Viganò Laura, 1992 (3), The rural demand for financial services, the response of the informal financial market and the intervention of credit projects: Critical evaluation. Università degli Studi di Bergamo, Quaderni del Dipartimento di Economia Aziendale, n. 5.


Von Pischke J.D., 1983, The Quantification of Farm Debt Capacity, EDI Training Materials, IBRD.
Abstract
Loan portfolio quality could improve through a suitable creditworthiness analysis specifically designed to adapt to the particular LDC's context. In a broader perspective, an effective control of credit risk is a crucial aspect of bank management, especially in a development setting. This is the case of the Caisse Nationale de Crédit Agricole de Burkina Faso where the model proposed in this paper is tested.

Two major problems concerning loan analysis are evident:
1. the difficulty and the high cost of collecting relevant information on borrower-customers businesses;
2. the absence of benchmark procedures by loan analysts consistent with bank lending policy.
As regards the first point, loan evaluation procedures can be improved through a more efficient diffusion and use of the information necessary to estimate the probability of repayment. The paper identifies the relevant information and defines the criteria through which it can be weighed in the loan evaluation process.

Two hypotheses are offered. The first assumes that there are some factors affecting the borrower's behavior that are likely to increase the probability of default. Second, the problem of the quality of information is explored. It is assumed that some mistakes can be made in credit risk evaluation related to the difficulty of obtaining the commonly used information on the customers' ability and willingness to repay. To overcome the widespread absence of correct information, evaluation models are used to identify symptoms of the borrower's performance and behavior. For this purpose symptomatic variables are employed to create indicators of the borrower-customers' ability and willingness to repay.

As concerns the second point - the credit evaluation procedures - there is often a need for shared decisional frameworks and coordination between the head office and bank branches in order to avoid arbitrary decisions. For this purpose, an application of a quantitative model for creditworthiness based on multivariate discriminant analysis is proposed; input variables are factors obtained from a wider set of variables. The quantification of the judgement in a score is also important because it gives responsibility to loan officers for the decisions they take according to the score or for an alternative choice. This last aspect is crucial in development banks, where accountability of loan officers is often a problem.

The proposed model is also relevant for the theoretical interpretation of credit risk determinants: objective circumstances - personal or firm specific -, the ability of the bank to correctly evaluate these circumstances and the bank capacity to establish loan conditions to reduce uncertainty. The model demonstrates that the theoretical framework presented in the paper is applicable in an LDC's context. This clear relationship between theory and the interpretation of results can be an important tool in improving portfolio management for development banks and the bank personnel decision making and learning processes.

UN MODELE DE "CREDIT SCORING" POUR LES BANQUES DE DEVELOPPEMENT:
UNE ETUDE DE CAS AFRICAIN

RESUME
La qualité du portefeuille peut être améliorée à travers une analyse de la capacité de crédit appropriée au contexte des PVD. En général, un contrôle effectif du risque de crédit est un aspect fondamental de la gestion bancaire, surtout dans un milieu en voie de développement. Cela est vrai aussi pour la Caisse Nationale de Crédit Agricole du Burkina Faso où on a construit le modèle présenté.

On peut constater deux problèmes principaux dans l'analyse de crédit:
1. la difficulté et le coût élevé de la collecte des renseignements sur l'emprunteur et sur son entreprise;
2. l'absence de procédures standardisées en ligne avec la politique de prêt de la banque qui soient aisément disponibles pour les agents de crédit.

En ce qui concerne le premier point, les procédures d'évaluation peuvent être améliorées à travers la diffusion et l'utilisation plus efficaces des renseignements nécessaires pour estimer la probabilité de remboursement. Cette étude identifie les renseignements importants et définit les critères pour les peser au cours de l'évaluation.

On présente deux hypothèses. La première dit qu'il y a des facteurs affectant le comportement de l'emprunteur qui peuvent augmenter la probabilité d'impayé. La deuxième concerne le problème de la qualité des renseignements sur l'emprunteur. On pense que la difficulté d'avoir accès aux données usuellement utilisées pour estimer la capacité et la volonté de remboursement puisse entraîner des erreurs d'évaluation. Afin de sur
monter cette difficulté on propose un modèle d'évaluation basé sur les symptômes de la performance et du comportement de l'emprunteur. A cet égard on utilise des renseignements symptomatiques qui créent des indicateurs de la capacité et volonté de remboursement.

Quant au deuxième point – les procédures d'évaluation – il y a souvent un besoin d'un cadre décisionnel commun et de coordination entre le siège et les agences pour éviter une prise de décision arbitraire. A ce fin on propose l'application d'un modèle quantitatif pour l'analyse de crédit basé sur l'analyse discriminante multivariée. Les variables inputs sont représentées par des facteurs obtenus d'un nombre plus élevé de variables initiales. La quantification du jugement à travers un score est aussi importante parce qu'elle permet d'attribuer les responsabilités aux agents de crédit pour leurs décisions en accord ou en opposition par rapport au score. Cet aspect est très important dans les banques de développement.

Le modèle proposé est aussi important pour l'interprétation des facteurs déterminant le risque de crédit: les caractéristiques personnelles ou de l'entreprise de l'emprunteur, la capacité de la banque d'évaluer correctement ces caractéristiques et l'habileté de la banque d'établir des conditions sur le prêt qui contribuent à réduire le risque de crédit. Le modèle démontre que l'approche théorique présentée dans l'étude est valable pour le contexte des PVD. Cette relation évidente entre la théorie et l'interprétation des résultats peut devenir un instrument important pour améliorer la gestion du portefeuille des banques de développement ainsi que la capacité décisionnelle et le processus d'apprentissage du personnel bancaire.