PN-ABL-606
ISN 77935

Economics and Sociology
Occasional Paper No. 1776

LOAN REPAYMENT IN RURAL FINANCIAL MARKETS: A MULTINOMIAL LOGIT ANALYSIS

by

Nelson Aguilera-Alfred

and

Claudio Gonzalez-Vega

November 1990

Paper submitted to
International Association of Agricultural Economists
for presentation at
XXI International Conference of Agricultural Economists
Tokyo, Japan, 22-29 August 1991

Agricultural Finance Program
Department of Agricultural Economics
and
Rural Sociology
The Ohio State University
2120 Fyffe Road
Columbus, Ohio 43210-1099

Abstract

This paper analyzes the repayment performance of loans disbursed by a typical developing country specialized lender, the Agricultural Development Bank of the Dominican Republic. It shows that loans in default are just one dimension of the repayment problems faced by specialized lenders and that rescheduling and payment with arrears should not be ignored. It also shows that, by following through time the status of loans disbursed in a particular period, the factors determining repayment performance may be better identified. It also shows how the results from the Multinomial Logit analysis can be used by the lenders for analyzing the various types of potential repayment problems that they encounter.

LOAN REPAYMENT IN RURAL FINANCIAL MARKETS: A MULTINOMIAL LOGIT ANALYSIS

by

Nelson Aguilera-Alfred and Claudio Gonzalez-Vega

I. Introduction

Specialized rural lending institutions (SLs), including public agricultural development banks, were created in the developing countries during earlier decades, with the purpose of supplying, either the longer-term credit that commercial banks were not prepared to offer, or loans to costly and risky clientele, such as small farmers, who were provided access to formal credit services, even in advanced of demand, for social and political reasons (Patrick). These SLs have received the largest share of their funds from governments and international donors and have granted targeted loans, usually at subsidized interest rates, to beneficiaries who have not always been creditworthy. An early concern with the performance of these SLs (Bourne and Graham) has been followed by increasing preoccupation with their lack of viability, reflected mostly by the decline in the real value of their loanable funds, as a consequence of inflation, poor loan collection, and operational losses (Gonzalez-Vega).

The literature on rural financial markets has recently attempted to measure the magnitude and identify the determinants of the repayment problems faced by SLs. Indeed, a major cause of the financial difficulties of SLs has been the large proportion of non-performing loans in their portfolios (World Bank). An estimated 30 to 95 percent of these portfolios have been in arrears in Africa, the Middle East, and Latin America (Braverman

and Guasch). A number of analytical studies have attempted, in turn, to predict the probability of loan default by using Probit, Logit, or Discriminant Analysis (Luftburrow et al; Mortensen et al).

Both analytical studies and officially reported information on loan delinquency have focused on the proportion of the total portfolio in arrears. This indicator is not adequate, however, for a meaningful analysis of repayment performance at the SLs. First, it fails to accurately measure performance, since rapidly-growing and long-term portfolios lead to an underestimation of the extent of existing and potential problems. Thus, the rising delinquency rates observed in many countries since the early 1980s may have reflected a slowdown in new lending (decreasing denominator) and the maturing of long-term loans granted earlier (increasing numerator), as well as potentially reduced incentives to repay, since the expectation of receiving future loans has declined.

Second, while this index considers only the proportion of the portfolio in total or partial default at any point in time, the rescheduling of loans and loans paid after having been in arrears constitute important dimensions of the problem, as well. Because of their impact on the SL's liquidity management and operational losses, a meaningful analysis must examine these other dimensions of their repayment performance. Thus, to avoid distortions in the measurement of delinquency, as a result of different maturities and portfolio growth rates, the SL's performance must be monitored, by following through time the evolution of the repayment status of loans disbursed in each particular period.

This paper illustrates these issues with an analysis of the repayment performance of the Agricultural Development Bank of the Dominican Republic (BAGRICOLA). Since the

repayment difficulties experienced by BAGRICOLA are multidimensional, the paper attempts to predict these problems by estimating a multinomial logit model, using as explanatory variables characteristics of the borrowers and of the loans, as well as regulatory instruments.

II. The Multinomial Logit Model

The statistical analysis of models with qualitative dependent variables can be viewed as the problem of predicting probabilities for the various possible values (responses) of the dependent variable. Probit and Logit are well-known techniques for the case when there are only two responses, typically the occurrence or non-occurrence of some event. For a case with more than two responses, Theil developed a Multinomial Logit Model that allows for both discrete and continuous right-hand side variables. The maximum likelihood estimation of this model is discussed by Maddala and by McFadden.

For a comprehensive analysis of the repayment performance of loans disbursed by BAGRICOLA in 1987, special emphasis was placed on obtaining a primary data set from individual customer dossiers. The data refer to 2,204 loans disbursed in 1987 by 18 of BAGRICOLA's branches. The systematic random sample represented 6.0 percent of the total number of loans disbursed by selected branches during that year. The repayment status of these loans as of August 31, 1989 was classified into four categories: (1) *without repayment problems*, if the loans or installments of long-term loans were not yet due or had already been paid within 30 days of the due date; (2) *rescheduled*, if the period of the loans had been extended, without altering the amount of principal and interest outstanding; (3)

paid with arrears, for loans with completed maturity, when the loans or installments due had been paid but over 30 days after the due date; and (4) *in default*, if the loans or installments of long-term loans were still unpaid 30 days after their due date.

The effects on the loans' repayment status of three groups of exogenous variables: (1) borrower features, (2) loan characteristics, and (3) regulatory variables is examined in this paper, in order to predict their impact on the SL's repayment performance. These variables are described in Table 1 of the annex.

If P_j ($j=1,...,4$) are the probabilities associated with each one of the four repayment status, for estimation the multinomial logit model can be written as:

$$\log_e\left(\frac{P_j}{P_1}\right)_i = \beta_j+\beta_{j2}BORR_i+\beta_{j3}LOAN_i+\beta_{j4}REGUL_i+\mu_{ji} \qquad (1)$$

$$for\ j=2,3,4;\ and\ i=1,\ldots,n$$

where P_1 is the probability of loans *without repayment problems*, P_2 of *rescheduled* loans, P_3 of loans *paid with arrears*, and P_4 of loans *in default*, and n is the number of observations. The vectors of explanatory variables BORR, LOAN, and REGUL are sets of borrower features, loan characteristics, and regulatory variables, respectively. The β are parameters to estimate, and the μ error terms. Equations for alternative comparisons can be derived, as well. For instance, since:

$$\log_e\left(\frac{P_4}{P_3}\right)_i = \log_e\left(\frac{P_4}{P_1}\right)_i - \log_e\left(\frac{P_3}{P_1}\right)_i, \qquad (2)$$

we have:

$$\log_e\left(\frac{P_4}{P_3}\right)_i = (\beta_{41}-\beta_{31})+(\beta_{42}-\beta_{32})BORR_i+(\beta_{43}-\beta_{33})LOAN_i+(\beta_{44}-\beta_{34})REGUL_i \qquad (3)$$

III. Estimation Results

The estimated coefficients and their t-statistics are shown in Table 2 in the Annex. To facilitate the interpretation, Suit's dummy variable coefficient transformation was employed, by adding an appropriately chosen constant. In the first three columns, the results are normalized with respect to loans *without repayment problems*. A positive sign indicates, in general, that the probability of observing one repayment status (in the numerator) is greater than that of observing another (in the denominator).

As expected, loans disbursed to agrarian reform beneficiaries with provisional titles (REFOR) are more likely to be *in default* than in any one of the other repayment categories. This may reflect more the characteristics of the credit lines available to these borrowers than the incidence of land tenure. Indeed, loans disbursed to non-agrarian reform occupants of public lands, without well-defined property rights (OCCUP), are more likely to be *without repayment problems* than *in default*. In the case of private landowners with established property rights (PRIVA), on the other hand, the difference between these two repayment status is not statistically significant. Instead, private owners are more likely to have paid their loans *with arrears*. These are counterintuitive results. One would have expected occupants without title to have a significantly poorer repayment performance than landowners. Property rights may not affect repayment performance, however, in view of the limited use by BAGRICOLA of mortgages as collateral (one percent of the loans), which

in turn reflects the high transaction costs of legal procedures and the lack of political feasibility for generalized foreclosing (Aguilera et al).

Next, consider the effects of the credit evaluation (screening) operations carried out by the branch managers. As shown by the sign and statistical significance of these variables, loans disbursed to applicants rated as *good* risks are more likely to be *without repayment problems* than *in default*, while loans disbursed to applicants rated as *bad* risks are more likely to be *in default* than having paid *with arrears* or be *without repayment problems*. These results suggest that the credit evaluation operations carried out by the branch managers are successful. BAGRICOLA is able to separate *good* from *bad* risk applicants. If the lender is able to recognize *bad* risks, then why are loans to these borrowers disbursed? The regulatory framework imposed upon the lender's screening operations, either by the Government and/or international agencies, provides an important part of the explanation.

Since different sources of funds impose different degrees of restrictions on the lender's creditworthiness evaluation, it is interesting to analyze repayment performance by the source of the funds. The results suggest that loans disbursed from less restrictive lines of credit, such as the SL's own funds and savings accounts (OWNR) and international non-targeted funds (AIDF), are more likely to be *without repayment problems* than in any other of the categories, while loans disbursed from more restrictive lines are more likely to present repayment problems. As suggested, loans from the agrarian reform lines (AGREF) are more likely to have been *rescheduled*, while loans from the SOCF funds are more likely to be *in default* than in any other repayment status. Loans from international targeted lines of credit (INTF) present the same probability of being *in default* than *without repayment*

problems. This last result should be interpreted with caution, since 46 and 24 percent of the loans disbursed with World Bank and Inter-American Development Bank funds, respectively, were not yet due by the end of August, 1989. Thus, the loan default potential of these international lines of credit is still high.

Loans for investment in machinery and equipment (MACH) are more likely to be *in default* than having been paid *with arrears* than to be without problems. Loans to finance non-industrial food crop activities (such as rice) are more likely to have been *rescheduled* and to have been paid with *arrears*. Loans to finance industrial food crops and agricultural exports (INDF) are more likely to have been paid with *arrears* than to be *without repayment problems* or *in default*. These results indicate that loans for agricultural activities that require industrial processing or complex marketing get paid but are more likely to be paid with arrears. Agroindustrial processors, rice millers, and exporters typically pay the farm-borrowers for their produce only after processing or exporting it and frequent delays are reflected in farmer payments to BAGRICOLA with arrears. This suggests the need to revise amortization schedules and to explore the demand of credit for marketing activities.

Larger borrower's assets make loans more likely to be *wihtout repayment problems* than in *default*, while larger loans are more likely to have been *rescheduled* than be in *default*. Finally, the signs and statistical significance obtained for the age variable indicate that older borrowers are more likely to be *without repayment problems* than having paid with *arrears* or be in *default*. If the borrower's age is a good proxy for the extent of the lender-customer relationship, this indicates that older borrowers have been able to establish a better relationship with the lender, as reflected by their repayment performance.

For effective portfolio management, SLs require detailed information about the various types of potential repayment problems that they encounter. To illustrate the rich ways in which the results from the Multinomial Logit model can be used, the probabilities that loans disbursed in 1987 be in each of the four repayment categories as of end of August, 1989 were evaluated, at the sample means for asset size (DR$ 31,003), loan size (DR$ 4,043), and borrower's age (45.3 years), for both *good* and *bad* borrowers investing in non-industrial food crops, for all permutations by source of the funds and land tenure type. The results, shown in Table 3 in the Annex, confirm the conclusions of the previous analysis. Agrarian reform beneficiaries, for example, have the highest probability of being delinquent, as compared to occupants of public lands without title and private owners, while the differences between these two are minimal. Loans from the less restrictive sources of funds are less likely to be in *default* than loans with funds from the more restrictive sources. Although the bank's own funds and deposits and the USAID non-targeted line of credit show a lower probability of loan default, they still present repayment problems, mainly in the form of payments with arrears. Finally, bad risk borrowers consistently present a poorer repayment performance than those rated as good risks during the screening process. Thus, the SL is successful in recognizing good from bad risks.

IV. Conclusions

This paper analyzes the repayment performance of loans disbursed by a typical developing country SL: the Agricultural Development Bank of the Dominican Republic. It shows that loans in default are just one dimension of the repayment problems faced by SLs,

and that rescheduling and payment with arrears should not be ignored. It also shows that, by following through time the status of loans disbursed in a particular period, the main factors determining repayment performance may be better identified.

The restrictions on screening operations imposed by the different sources of funds of the SLs were found to have a strong impact on repayment. That is, among borrowers of equal assets, loan size, and age, more restrictive lines of credit were strongly associated with a higher probability of repayment problems. It was also found that the SL is able to recognize bad from good risks. Thus, the repayment problems faced by specialized lending institutions in developing countries cannot be explained merely by the lender's and borrowers' behavior, but most particularly by the restrictions imposed on the SL's screening operations by governments and/or international donors.

REFERENCES

Aguilera, Nelson, "Credit Rationing and Loan Default in Formal Rural Credit Markets," Doctoral Dissertation, The Ohio State University, 1990.

Aguilera, Nelson, Claudio Gonzalez-Vega, and Douglas Graham, "The Agricultural Development Bank of the Dominican Republic: A Loan Repayment Analysis," Columbus: The Ohio State University, Agricultural Economics and Rural Sociology Occasional Paper No. 1733, September, 1990.

Bernd, E., B.H. Hall, R.E. Hall, and J.A. Hausman, "Estimation and Inference in Nonlinear Structure Models," Annals of Economic and Social Measurement, October, 1974.

Bourne, Compton and Douglas H. Graham, "Problems with Specialized Lenders," in Dale W Adams, Douglas H. Graham, and J. D. Von Pischke, eds. Undermining Rural Development with Cheap Credit, Boulder: Westview Press, 1984.

Braverman, Avishay and J. Luis Guasch, "Rural Credit Reforms in LDCs: Issues and Evidence," Journal of Economic Development, Vol. 14, No. 1, June, 1989.

Gonzalez-Vega, Claudio, "On the Viability of Agricultural Development Banks: Conceptual Framework," Columbus: The Ohio State University, Agricultural Economics and Rural Sociology Occasional Paper No. 1760, April, 1990.

Luftburrow, J, Peter Barry, and Bruce Dixon, "Credit Scoring for Farm Loan Pricing," Agricultural Finance Review, 44, 1984.

Maddala, G.S., Limited Dependent and Qualitative Variables in Econometrics, Cambridge: Cambridge University Press, 1984.

McFadden, D., "Conditional Logit Analysis of Qualitative Choice Behavior," in P. Zdrembka, ed., Frontiers in Econometrics, New York: Academic, 1973.

Mortensen, T., David Watt, and F.L. Leistritz, "Predicting Probability of Loan Default," Agricultural Finance Review, 48, 1988.

Patrick, Hugh T., "Financial Development and Economic Growth in Underdeveloped Countries," Economic Development and Cultural Change, 1986.

Suits, Daniel B., "Dummy Variables: Mechanics Versus Interpretation," Review of Economic and Statistics, Vol. 66, 1984.

Theil, H., "A Multinomial Extension of the Linear Logit Model," International Economic Review, X, October, 1969.

World Bank, World Development Report 1989, New York: Oxford University Press, 1989.

ANNEX

Table 1: Variables Used in the Study

Dependent Variable:

DEF Polychotomus variable: 1 if the loan disbursed in 1987 did not present repayment problems by the end of August, 1989; 2 if it was rescheduled; 3 if it was paid with arrears; and 4 if it was in default.

Independent Variable Sets:

Land Tenure:

PRIVA	Dummy = 1 if private owner.
OCCUP	Dummy = 1 if occupant of public lands without title.
REFOR	Dummy = 1 if agrarian reform beneficiary with provisional title.

Borrower Credit Rating:

GOOD	Dummy = 1 if evaluated at least as a good risk.
BAD	Dummy = 1 if evaluated as a bad risk or a new borrower.

Use of the Funds:

MACH	Dummy = 1 if machinery or equipment.
NIND	Dummy = 1 if food crop production (e.g., rice, plaintain)
IND	Dummy = 1 if industrial food crop (e.g., tomatoes, melon) or agricultural exports (coffee, cacao).
LIVE	Dummy = 1 if livestock.

Source of the Funds:

OWNR	Dummy = 1 if bank's own or savings accounts funds.
AGREF	Dummy = 1 if agrarian reform or FIDE (*Fondo de Inversion de Desarrollo Economico*) funds.
INTF	Dummy = 1 if international targeted funds (World Bank and Inter-American Development Bank).
AIDF	Dummy = 1 if international non-targeted funds (Agency for International Development).
SOCF	Dummy = 1 if Government or international social funds (IFAD).

Independent Quantitative Variables:

ASSET	Borrower's total assets in (000) Dominican Republic Pesos (DR$).
AGE	Borrower's age.
LOAN	Loan Size in (000) Dominican Republic pesos (DR$).

Table 2: Multinomial Logit Coefficient Estimates

Independ. Variable	Dependent Variable (Natural Logarithm of)					
	(P2/P1)	(P3/P1)	(P4/P1)	(P3/P2)	(P4/P2)	(P4/P3)
	Coeff	Coeff	Coeff	Coeff	Coeff	Coeff
1. OCCUP	-0.244	-0.232	-0.204	0.012	0.040	0.028
	(-1.6)	(-0.8)	(-2.4)**	(0.1)	(0.3)	(0.29)
2. PRIVA	0.117	0.498	-0.072	0.381	-0.189	-0.570
	(0.7)	(6.2)**	(-0.8)	(2.3)**	(-1.1)	(-3.9)**
3. REFOR	0.127	-0.266	0.276	-0.393	0.633	0.542
	(0.6)	(-1.9)*	(2.5)**	(-2.2)**	(-1.1)	(-3.9)**
4. GOOD	-0.028	0.066	-0.238	0.094	-0.210	-0.304
	(-0.2)	(0.9)	(-3.4)**	(0.6)	(-0.8)	(-4.1)**
5. BAD	0.028	-0.066	0.238	-0.094	0.210	0.304
	(0.2)	(0.9)	(3.4)**	(-0.6)	(0.8)	(4.1)**
6. MACHI	-0.567	-0.564	0.262	0.003	0.828	0.826
	(-0.7)	(-1.7)*	(1.1)	(0.1)	(1.1)	(2.1)**
7. NINDF	1.279	0.276	0.176	-1.003	-1.103	-0.010
	(4.2)**	(1.8)*	(1.4)	(-1.7)*	(-3.5)**	(-0.1)
8. INDF	0.359	0.332	-0.319	-0.027	-0.678	-0.654
	(0.9)	(1.9)*	(-1.2)	(-0.1)	(-1.5)	(-1.7)*
9. LIVES	-1.072	-0.044	-0.119	1.028	0.953	-0.075
	(-3.2)**	(-0.3)	(-0.5)	(2.9)**	(2.5)**	(0.2)
10. OWNR	-0.363	-0.406	-0.443	-0.044	-0.080	-0.037
	(-1.3)	(-3.0)**	(-3.5)**	(-0.4)	(-0.3)	(-0.2)
11. AGREF	1.139	0.089	1.906	-1.049	-0.948	0.101
	(3.5)**	(0.4)	(1.0)	(-3.0)**	(-2.9)**	(0.4)
12. INTF	-1.545	-2.589	0.019	-1.044	1.564	2.608
	(-2.4)**	(-7.8)**	(0.1)	(-1.5)	(2.4)**	(7.6)**
13. AIDF	-0.731	-0.475	-0.904	0.257	-0.173	-0.430
	(-1.3)	(-1.5)	(-8.8)**	(0.4)	(-0.3)	(-1.1)
14. SOCF	1.500	-0.684	1.138	-2.184	-0.362	1.822
	(5.3)**	(-3.7)**	(7.1)**	(-7.4)**	(-1.3)	(8.3)**
15. ASSET	-2.0E-6	-2.0E-7	-2.1E-6	1.8E-6	-1.0E-6	-1.9E-6
	(-0.7)	(-0.3)	(-2.6)**	(0.6)	(-1.4)	(-0.2)
16. AGE	-2.1E-3	-0.012	-0.012	-9.6E-3	-9.5E-3	1.5E-4
	(-0.3)	(-2.7)**	(-3.0)**	(-0.9)	(-3.0)**	(0.1)
17. LOAN	1.1E-5	8.9E-6	1.0E-5	2.1E-6	2.1E-5	1.2E-6
	(0.9)	(1.0)	(1.1)	(0.1)	(2.2)**	(1.5)
18. CONST	-2.315	0.630	0.178	2.945	2.492	-0.453
	(-2.2)**	(2.0)**	(2.4)**	(3.0)**	(2.2)**	(-0.9)

1=without repayment problems, 2=rescheduled, 3=paid with arrears, 4=indefault. Figures in parentheses are the t-ratios of estimated coefficients to their standard errors computed from covariance of analytic first derivatives (Berndt et al).

* significant at 10 percent level.

** significant at 5 percent level.

Table 3. Probabilities of Being in Each Repayment Category, for Borrowers with Non-industrial Crops, by Source of Funds and Land Tenure. (Average Asset= DR$31,003; Average Loan = DR$4,043; Average Age = 45.3 years)

Source of Funds	Land Tenure	Repayment Categories: Without Problems	Rescheduled	Paid with Arrears	In Default	Total
Good Borrowers:						
OWNR	OCCUP	35.1	5.9	47.1	11.9	100.0
	PRIVA	28.0	12.1	49.1	10.8	100.0
	REFOR	38.3	9.3	31.3	21.1	100.0
AGREF	OCCUP	21.7	16.4	48.0	13.9	100.0
	PRIVA	15.3	29.6	44.0	11.1	100.0
	REFOR	22.4	24.5	30.0	23.1	100.0
INTF	OCCUP	57.4	2.9	8.7	30.9	100.0
	PRIVA	51.4	6.8	10.1	31.6	100.0
	REFOR	49.1	3.7	4.5	42.7	100.0
USAID	OCCUP	38.7	4.5	48.6	8.3	100.0
	PRIVA	31.4	9.4	51.5	7.7	100.0
	REFOR	43.9	7.4	33.5	15.2	100.0
SOCF	OCCUP	21.1	22.8	21.4	34.7	100.0
	PRIVA	14.3	39.8	19.0	26.9	100.0
	REFOR	17.1	26.8	10.6	45.5	100.0
Bad Borrowers:						
OWNR	OCCUP	34.5	6.1	40.6	18.8	100.0
	PRIVA	27.7	12.6	42.5	17.2	100.0
	REFOR	35.0	9.0	25.0	31.0	100.0
AGREF	OCCUP	21.0	16.7	40.6	21.6	100.0
	PRIVA	14.8	30.4	37.4	17.4	100.0
	REFOR	20.0	23.1	23.5	33.3	100.0
INTF	OCCUP	48.6	2.6	6.5	42.2	100.0
	PRIVA	43.4	6.1	07.5	43.0	100.0
	REFOR	39.0	3.1	03.2	54.7	100.0
USAID	OCCUP	39.0	47.8	42.8	13.4	100.0
	PRIVA	39.0	04.8	42.8	13.4	100.0
	REFOR	31.8	10.0	45.6	12.5	100.0
SOCF	OCCUP	17.6	20.1	15.7	46.6	100.0
	PRIVA	12.3	36.2	14.3	37.2	100.0
	REFOR	13.4	22.1	07.2	57.3	100.0