CREDIT RATIONING AND LOAN DEFAULT IN FORMAL RURAL CREDIT MARKETS

DISSERTATION

Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy in the Graduate School of The Ohio State University

By

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DEDICATION

To Giannina, Luciano, and the memory of my father.
ACKNOWLEDGEMENTS

I wish to express my deep gratitude and indebtedness to my advisor Dr. Douglas H. Graham. Over several years, I have benefited from Professor Graham's comments, questions, and counterarguments, as I have tried on him ideas on this dissertation and several other studies carried out in different countries.

Sincere thanks are due to Dr. Claudio Gonzalez-Vega for providing not only technical, but also financial support for carrying out this dissertation, from his project on Rural Financial Services in the Dominican Republic. Dr. Gonzalez-Vega provided valuable suggestions on the presentation of the work.

I have received detailed and very helpful written comments on the whole manuscript from Dr. Richard Meyer. Dr. Meyer's comments helped to improve several important aspects of this study.

I have also benefited from comments and suggestions from Dr. Leroy Hushak. His insights improved several economic and econometric techniques used throughout this dissertation.

I wish to thank Dr. Maria Ines Mansinho for prompting my enthusiasm in studying credit rationing and loan default in rural credit markets. The regular discussions during the development of her own dissertation on Portugal were the source of intellectual stimulation and pleasure.

Giannina, my dear wife, not only borne the hardships of student life with fortitude, but also contributed with her knowledge in logic and philosophy of science to
sharpen the methodological approach used in this dissertation. Our son Luciano was the light that gave me strength to continue in so many moments of weariness.

The much needed financial assistance, provided by the agricultural finance program during these five years, is sincerely appreciated. I also want to acknowledge the collaboration of the staff of the Banco Agricola de la Republica Dominicana for their assistance in data collection. Special thanks to Mrs. Barbara Lee for her cooperation with my work during all these years. The Instruction and Research Computer Center at The Ohio State University furnished the computational and documental facilities.
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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEDICATION</td>
<td>ii</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENTS</td>
<td>iii</td>
</tr>
<tr>
<td>VITA</td>
<td>v</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>xi</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>xiii</td>
</tr>
</tbody>
</table>

## CHAPTER

I. INTRODUCTION ............................................. 1  
1.1 Statement of Purpose ............................... 5  
1.2 Organization .......................................... 6  

II. CREDIT RATIONING AND LOAN DEFAULT IN RURAL CREDIT MARKETS ................................. 7  
2.1. Modeling Borrowing Behavior ...................... 10  
2.1.1 The Non-Borrowing Cash Flow .................... 11  
2.1.2 The Borrowing Cash Flow ......................... 12  
   (a) The Honest Borrowing Cash Flow ................. 12  
   (b) The Dishonest Borrowing Cash Flow ............ 13  
2.1.3 The Agricultural Firm Maximization Problem .... 14  
2.1.4 The Agricultural Borrower Loan Demand and ho-Utility Curves .......................... 16  
2.1.5 The Borrower Honest/Dishonest Choice .......... 18  
2.1.6 Summary of Borrowing Behavior ................. 20  
2.2. Modeling Lending Behavior ....................... 21
4.3 The Hypotheses ........................................ 90
4.4 The Econometric Technique ............................ 91
4.5 The Results and Analysis of the Empirical Tests ...... 94
   4.5.1 Variable Definitions ............................... 94
   4.5.2 The System of Equations ......................... 102
   4.5.3 The Results ...................................... 102

V. SUMMARY AND CONCLUSIONS .............................. 110

APPENDICES

A. APPENDIX TO CHAPTER II ............................... 117
   A1. Iso-Utility Curve Properties ....................... 117
   A2. Iso-profit Curve Properties ....................... 118
   A3. First-Order Conditions ............................. 121
   A4. Second-Order Conditions ......................... 124

B. APPENDIX TO CHAPTER III ............................... 126
   B1 Comparative Statics: The Technique .................. 126
   B2 Comparative Statics: The Propositions ............. 131
      B1.1 Effects of Changes in the Interest Rate Ceiling in
           Credit Markets .................................. 132
      B1.2 Effects of Changes in Lender's Costs of Funds ... 136
      B1.3 Effects of Regulations on Credit-Evaluation
           Operations ..................................... 138
      B1.4 Effects of Regulations on Collection Operations .. 139
      B1.5 Effects of Regulations on Collateral Requirements .. 141

C. APPENDIX TO CHAPTER IV ............................... 143
   C1 The Empirical Results ............................... 143
   C2 The Correlation Matrix ............................. 151

BIBLIOGRAPHY ................................................ 154
# LIST OF TABLES

<table>
<thead>
<tr>
<th>TABLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Marginal Direct Effects of Regulations on Optimal Decision Variables.*</td>
<td>54</td>
</tr>
<tr>
<td>2. Impact of Regulations on Loan Default and Rationing.*</td>
<td>56</td>
</tr>
<tr>
<td>3. Nominal Agricultural Portfolio</td>
<td>64</td>
</tr>
<tr>
<td>4. Real Agricultural Portfolio</td>
<td>65</td>
</tr>
<tr>
<td>5. Loan Default Index of the Agricultural Bank</td>
<td>66</td>
</tr>
<tr>
<td>6. Selected indicators of Loan Activity</td>
<td>68</td>
</tr>
<tr>
<td>7. Number and Volume of Approved and Disbursed Loans</td>
<td>69</td>
</tr>
<tr>
<td>8. Sample Distribution by Type of Borrower</td>
<td>73</td>
</tr>
<tr>
<td>9. Sample Distribution by Type of Land Tenure</td>
<td>74</td>
</tr>
<tr>
<td>10. Sample Distribution by Type of Investment</td>
<td>76</td>
</tr>
<tr>
<td>11. Sample Distribution by Source of Funds</td>
<td>79</td>
</tr>
<tr>
<td>12. Sample Distribution by Type of Collateral</td>
<td>80</td>
</tr>
<tr>
<td>13. Sample Distribution by Loan Size</td>
<td>81</td>
</tr>
<tr>
<td>14. Sample Distribution by Client Credit Rating</td>
<td>82</td>
</tr>
<tr>
<td>15. Repayment Performance of Loans Disbursed in 1987</td>
<td>85</td>
</tr>
<tr>
<td>16. Repayment Performance by Source of Funds</td>
<td>87</td>
</tr>
<tr>
<td>17. Repayment Performance by International Source of Funds</td>
<td>88</td>
</tr>
<tr>
<td>18. Variables Used in the Empirical Study</td>
<td>100</td>
</tr>
<tr>
<td>19. Means and Standard Deviation of Variables</td>
<td>101</td>
</tr>
<tr>
<td>20. Regression Coefficient Estimates</td>
<td>103</td>
</tr>
<tr>
<td></td>
<td>Predicted and Observed Signs of Regulatory Parameters</td>
</tr>
<tr>
<td>---</td>
<td>------------------------------------------------------</td>
</tr>
<tr>
<td>22</td>
<td>Heteroscedastic Coefficient Estimates. Dependent Variable: LOAN</td>
</tr>
<tr>
<td>23</td>
<td>Heteroscedastic Coefficient Estimates. Dependent Variable: COLL</td>
</tr>
<tr>
<td>24</td>
<td>Heteroscedastic Coefficient Estimates. Dependent Variable: T-I</td>
</tr>
<tr>
<td>25</td>
<td>Probit Coefficient Estimates. Dependent Variable: DEF</td>
</tr>
<tr>
<td>26</td>
<td>Homoscedastic Coefficient Estimates. Dependent Variable: LOAN</td>
</tr>
<tr>
<td>27</td>
<td>Homoscedastic Coefficient Estimates. Dependent Variable: COLL</td>
</tr>
<tr>
<td>28</td>
<td>Homoscedastic Coefficient Estimates. Dependent Variable: T-I</td>
</tr>
<tr>
<td>29</td>
<td>Correlation Matrix - Dependent Variables</td>
</tr>
<tr>
<td>30</td>
<td>Correlation Matrix - Independent Variables</td>
</tr>
</tbody>
</table>
# List of Figures

<table>
<thead>
<tr>
<th>FIGURE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Loan Demand and Iso-Utility Curves</td>
<td>17</td>
</tr>
<tr>
<td>2. The Borrowing Population Income Distribution (I)</td>
<td>27</td>
</tr>
<tr>
<td>3. The Borrowing Population Income Distribution (II)</td>
<td>28</td>
</tr>
<tr>
<td>4. Loan 'Offer' and Iso-Profit Curves</td>
<td>34</td>
</tr>
<tr>
<td>5. The Borrowing Population with infinite penalty</td>
<td>37</td>
</tr>
<tr>
<td>6. Equilibrium with Type I Rationing Case I</td>
<td>43</td>
</tr>
<tr>
<td>7. Equilibrium with Type I Rationing Case II</td>
<td>45</td>
</tr>
<tr>
<td>8. Expected Revenue and Expected Cost Relationship (Given $r$)</td>
<td>120</td>
</tr>
</tbody>
</table>
CHAPTER I
INTRODUCTION

During the past three decades rural development programs in low income countries (hereafter called LICs) shifted their emphasis to rural credit. Governments and international organizations recognized that small farmers are potentially productive producers. They believed that by facilitating the access of small rural producers to agricultural loans, the use of agricultural inputs, the number of hectares cultivated, agricultural production, and rural employment would increase, while rural income distribution would improve.

In order to reach these objectives, many LICs adopted supply-leading financial strategies. These strategies essentially consisted of creating specialized agricultural lending institutions, to provide small rural producers with loans at subsidized rates of interest in advance of demand.\(^1\) It was believed that by providing small producers with cheap credit they could be induced to use modern technologies which, in turn, would accelerate agricultural growth. It was also believed that small farmers, after becoming familiar with modern technologies, would increase their demand for loans. Thus, as real agricultural growth occurred, supply-leading finance would become less important, and demand-following responses would become more important.

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\(^1\) For a more extensive analysis of supply-leading financial strategies see Patrick [1966].
Contrary to these expectations, the available empirical evidence suggests that most rural credit programs implemented in the LICs have failed to reach their intended clientele, with credit being often diverted to the largest and most influential producers, thus worsening rural income distribution [Gonzalez-Vega, 1984b]. Moreover, most of the specialized agricultural lenders that have participated in these programs have fallen into increasing financial difficulties, due to a large percentage of non-performing assets [Deschamps et al, 1988]. In some cases, credit expansion has coincided with a decline in agricultural output, and an increase in agricultural imports and in rural unemployment [Bourne & Graham, 1984].

Recently, the rural financial markets literature has identified cheap-credit policies and high operational costs per unit of money loaned as some of the most important factors causing the disappointing results observed in formal rural credit programs. It has been argued that cheap-credit policies tend to create excess demand, thereby forcing formal agricultural lenders to ration credit through non-price mechanisms. Since operational lending costs and associated risks in servicing large rural producers are lower than those associated with small producers, the formal agricultural lender is motivated to favor the largest farmers in order to reduce per unit lending costs (Gonzalez-Vega, 1984a, Ladman, 1984). The main conclusion drawn from these studies is that interest rate deregulation would serve to alleviate discriminatory credit rationing, and would improve the financial viability of rural credit institutions.

Despite the recognized importance of these arguments and the number of studies engaged in understanding the disappointing results of rural credit programs in LICs, few attempts have been made in order to consider how the imperfect nature of information in rural credit markets and a role for a non-neutral financial intermediary

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2 For an extensive analysis of the impact of cheap-credit policies on rural credit markets cf. Adams, Graham, and Von Pischke [1984].
would help to explain these results.

Moreover, despite the fact that formal rural credit markets in LICs are highly regulated, and the amount of scholarly effort engaged in their study, no theoretical framework on the subject exists in the rural credit literature. As a consequence, much of the empirical work in this area has relied on hypothetical conjectures and artificial paradigms. Likewise, without the benefit of a theoretical guidance, a majority of the rural credit market regulations implemented in LICs have been established with little if any understanding of how much regulations would affect the main economic aspects (e.g. credit rationing, loan default) of rural credit markets.

More recently, Carter (1988) has argued that interest deregulation would be insufficient to guarantee better results in rural credit markets, if there are asymmetric information problems. Carter's conclusion, however, has been obtained through a model (that of Stiglitz and Weiss, 1981) which considers no role for a non-neutral financial intermediary using risk-reducing technologies. Furthermore, the market considered by Carter is perfectly competitive without regulations.

Therefore, in order to understand the disappointing results observed in formal rural credit markets in LICs, it is necessary to develop meaningful theories that not only consider the existence of asymmetric information problems, with a role for a non-neutral financial intermediary using risk-reducing technologies, but also show how different regulations affect credit rationing and loan default in rural credit markets.

It is important to recognize that information in rural credit markets is essentially incomplete. The formal agricultural lender cannot know with certainty the riskiness, ability, honesty, or effort of borrowers, nor can he control all the actions taken by borrowers with the borrowed money. Thus, the lender cannot know with certainty the borrower's ability or willingness to repay loans. Hence, the formal rural lender always
faces the possibility of loan default from some borrowers. Moreover, because of the incompleteness of rural credit market information, the risk of loan default faced by the agricultural lender may increase with more stringent terms of the loan contract for essentially two reasons. First, tightened terms of the loan contract may induce applicants with relatively safer projects (cfr. Stiglitz and Weiss, 1981, 1983, Wette, 1983), more responsible behavior (honest) (cfr. Jaffee and Russell, 1976), and/or higher ability as rural producers (cfr. Clemenz, 1986) to drop out of the applicants' pool or these terms may force a larger share of borrowers to default on their loan obligations. This is the *adverse selection problem*. Second, tighter terms of the loan contract may induce some borrowers to invest in riskier activities (cfr. Stiglitz and Weiss, 1981, 1983), and/or to devote less effort to their productive activities (cfr. Clemenz, 1986), thereby increasing the overall risk faced by the agricultural lender. This is the *incentive or moral hazard problem*.

The incomplete nature of information and the existence of asymmetric information problems in rural credit markets alert us to some problems in measuring agricultural loans in monetary units. Interest rate changes modify the probability of loan default (i.e., the *quality* of the loan). Similarly, an increase in loan size may change the risk to the lender and this risk cannot be compensated by an increase in the interest rate charged. Thus, for the lender it is of crucial importance to whom it grants a loan and what *actions* the borrower takes. For a baker, in contrast, it is immaterial to whom he sells bread and what the buyer does with it (as long as he pays immediately, of course). Hence, loans cannot be treated as homogeneous goods measured in monetary units. Neither the interest rate nor costs per loan can be considered to be the price or the cost of money lent, respectively (Clemenz, 1986). In short, loans are non-homogeneous goods.3

3 Non-homogeneous goods are goods whose consumption utility depends on some measurable characteristics or 'quality', in this case, the risk of loan default, (cfr. Griliches, 1971, Rosen, 1974).
It is also important to recognize that the aim of the agricultural lender is not only to find borrowers, but borrowers with a low probability of default (either because the borrower has a safe project, is honest, a high-ability producer, or has a valuable collateral). However, since information in rural credit markets is incomplete and the perfect identification of different classes of borrowers is not possible without additional information, the lender uses different risk-reducing technologies to separate borrowers into different classes, through informational or screening technologies, or to induce borrowers to reveal their own class, through incentive and signalling technologies. The lender formulates goals and policy guidelines for loan recovery strategies to collect from unrecognized loan defaulters, as well. All these risk-reducing strategies, however, are costly activities. Thus, it is important that the lender be aware of the marginal impact of these strategies on both revenues and costs.

Consequently, understanding how the different risk-reducing strategies operate as well as their impact on lender revenues and costs is essential for understanding the credit rationing process observed in rural credit programs.

1.1 STATEMENT OF PURPOSE

The purpose of this dissertation is to develop an analytical model that shows, in a more realistic manner, equilibrium credit rationing and loan default in formal rural credit markets and to provide, thus, the much-needed theoretical basis for empirical investigation. The model will analyze the borrower-lender relationship by considering the existence of asymmetric information problems, and the existence of an agricultural financial intermediary using different types of risk-reducing technologies. The necessary and sufficient conditions for equilibrium credit rationing and loan default will be analyzed in differing regulatory environments. These conditions will be tested by
examining the response of the equilibrium to various changes in exogenous and regulatory parameters.

This dissertation will also provide an empirical test of the validity of the economic model by estimating the effects of several regulatory variables on the endogenous variables of the model. The data used to calibrate the economic model will consist of a cross-section series of 3,455 loan applications processed in 18 branches of the Agricultural Development Bank in the Dominican Republic in 1987.

1.2 ORGANIZATION

In order to focus on the essential theoretical framework, virtually all descriptive material on rural credit in LICs will be avoided. Chapter II will begin with the development of a basic theory which explains credit rationing and loan default in an unregulated agricultural credit market. This theory will be extended in chapter III to incorporate regulations that affect equilibrium credit rationing and loan default. Chapter IV will be concerned with testing the validity of the model detailed in chapter III. The empirical analysis will be built upon data provided by the Agricultural Development Bank in the Dominican Republic. Finally, chapter V will offer a summary and the main conclusions of the dissertation.
CHAPTER II

CREDIT RATIONING AND LOAN DEFAULT IN RURAL CREDIT MARKETS

The existence of non-price rationing and loan default problems in formal rural credit markets in LICs are subjects not only of paramount importance, but of considerable controversy. Credit rationing was discussed by the earlier Economics literature as a situation where the demand for loans exceeds their supply at the quoted loan rate of interest. Conventional economic theory has traditionally viewed market clearing and market equilibrium as being one and the same. Consequently, a situation where supply does not equal demand has been perceived as a disequilibrium state which could persist only if forced on the economy through external factors such as price regulation. It is widely known, however, that lenders will not grant arbitrarily large loans even at high loan interest rates. It is known, as well as, that borrowers with known differences in relevant characteristics get different loan contracts. This point, however, has not always been recognized, and it was only recently that Keeton [1979] proposed a sharper distinction between different types of credit rationing:

1. **Type I, or Loan-Size Rationing**: Some or all loan applicants get a smaller loan than they desire at the quoted loan rate of interest.

2. **Type II, or Loan-Quantity Rationing**: Some loan applicants are denied a loan even though for the bank they are indistinguishable from accepted applicants.
For both types of rationing, it is required that applicants strictly prefer a larger loan, in the sense that they are ready to accept a higher rate of interest in order to secure a larger loan. Though these definitions represent an advance with respect to earlier treatment, the definition of quantity rationing does not help us to understand how quantity rationing actually takes place in credit markets. Normally, quantity credit rationing is assumed to be done by random rejection. However, this is rather unrealistic. Any theory that attempts to explain credit rationing must describe, therefore, how quantity rationing takes place in rural credit markets.

Having defined credit rationing, we now turn to an analytical model to study the necessary and sufficient conditions for the existence of type I and type II equilibrium credit rationing and loan default in formal rural credit markets. The material presented in this chapter stresses the importance of the imperfect nature of information in credit markets and of the risk-reducing information technologies available to the intermediary.

There are several important aspects of credit that this analytical model is designed to incorporate.

1. It recognizes the asymmetric character of information and the existence of adverse selection problems in rural credit markets.

2. It accepts the non-neutral nature of the financial intermediation process carried out by the agricultural lender. The agricultural lender formulates goals and policy guidelines for credit evaluation and collection activities, as well as incentive and signalling mechanisms designed to reduce the risks of loan default.

3. It assumes the unique nature of the prices and quantity of loans in credit markets. Agricultural loans are considered to be non-homogeneous goods whose quality, i.e., the probability of default, depends upon the level of the interest rate and/or loan size.
A number of simplifications have been made to ensure that the focus remains on the above characteristics.

1. Both borrowers and the agricultural lender are risk neutral firms that have a finite planning horizon of two periods.

2. At the beginning of the first period, the agricultural lender determines its lending capacity and formulates goals and policy guidelines for its credit evaluation, collection operations, penalty costs on loan default, and collateral requirements. At the end of the first and second periods, the lender receives payments from accounts due and attempts to collect from accounts overdue, and any loan not collected by the end of period two is considered a bad-debt loss.

3. Borrowers are agricultural firms seeking to finance investment projects in period one with expected repayment in period two.

4. The agricultural lender faces a number of risk-default classes, whose members are observationally indistinguishable without some external information.

5. The discount rate is zero.

6. A sufficient number of contracts are made to make the law of large numbers applicable.

This chapter is divided into three sections. The borrower optimizing behavior is presented first. A model of financial intermediary operations and loan supply is subsequently introduced; this treatment is similar to that of Keeton [1979], Stiglitz & Weiss [1981,1983], and Devinney [1986]. The equilibrium at which both the lender and the borrower fulfill their conditions for optimality, and the necessary and sufficient conditions for equilibrium credit rationing are presented in the third section.
2.1. MODELING BORROWING BEHAVIOR

The starting point of the analysis is to assume the existence of $N_k$ risk-neutral agricultural firms that meet the following conditions.

1. Each agricultural firm has a finite planning horizon of two periods. It also has a utility function, $U(C_1, C_2)$, defined over its consumption in the two periods and for which we assume quasi-concavity.

2. At the beginning of the first period, each agricultural firm has income $\{y_{i,j}\}$ which, while given, is different across individuals, $y_{i}^1 = y_j$, for all $j$. We also assume that each agricultural firm holds some amount of non-liquid assets $(A)$ which can be invested either in the firm as own funds or outside the firm in assets whose return $J(A)$ is considered as certain for simplicity. During this period each firm seeks to finance a one-period investment project $(L)$ whose outcome is a non-negative random variable represented by the continuous subjective density function $\gamma^1_{j}$. In addition, we assume that $\gamma^1_{j}$ is the first derivative of the cumulative distribution function $F(y_{j}, \epsilon)$, which is defined so that an increase in the shift parameter $\epsilon$ (the state-of-nature) increases the likelihood that the project's outcome of the $j$th agricultural firm will be low (cf. Virmani, 1982, and Tybout, 1984).

3. Each agricultural firm may finance the investment project either by investing its own funds (self-financing the project) or by borrowing from an agricultural lender that offers a set of loan contracts denoted as $\hat{J} = \phi(r, \hat{L}, \delta, \lambda, \hat{\rho})$, where $r$ is the interest rate on loans, which is assumed to be given; $\hat{L}$ is the loan amount; $\delta$ is a measure of the

4 Virmani (1982) considers that an increase in $\epsilon$ from $\epsilon_1$ to $\epsilon_2$ is defined as an increase in pessimism if

$$F(y_{j}, \epsilon_1) \leq F(y_{j}, \epsilon_2), \text{ for all } y_{j},$$

with strict inequality for at least one $y_{j}$. 
lender's loan recovery efficiency\(^5\); \(\hat{\lambda}\) represents the percentage of the loan obligation required as collateral; and \(\rho\) is penalty costs. Little will be said about the lender contract offer at present, since this is a topic to be explored later.

4. If the agricultural firm decides to borrow, two choices arise. First, the borrower will repay his loan obligation, \((1+r)\hat{L} = \hat{Z}\), if possible. That is, the agricultural borrower behaves honestly. Obviously, honest borrowers will default on their loans whenever \(\hat{Z} > \hat{y}_2^1 + J(A-\hat{\lambda}\hat{Z}) + \hat{K}\hat{Z}\), where \(\hat{y}_2^1\) is the certainty equivalent of \(\hat{y}_2\).\(^6\) \(J(A-\hat{\lambda}\hat{Z})\) is the return on assets; and \(\hat{K}\hat{Z}\) is the value of collateral. The borrower is honest but unlucky.

Second, the borrower will voluntarily default on his loan. The borrower will default although his second-period cash flow is high enough to repay his loan obligations. The borrower is lucky but dishonest.

5. Each agricultural firm's choice is based upon the expected utility associated with the cash flows from each choice.

### 2.1.1 The Non-Borrowing Cash Flow

If the agricultural firm decides to self-finance the investment project, the firm liquidates an amount \(L\) of non-liquid assets at a cost of \(\tau(L)\), where \(\tau\) are the unitary costs incurred in liquidating non-liquid assets. Thus, the non-borrowing firm's first-period cash flow is denoted as

\[
(y_1^f)' = \hat{y}_1^1 + L + J(A-L) - \tau(L)
\]  

and the second-period cash flow is

---

\(^5\) This can be interpreted as the borrower's probability of being caught in case of loan default.

\(^6\) The usual technique for converting the expected value of a subjective probability distribution regarding income into a certainty equivalent value is illustrated in Tobin (1968).
\[(y_2^s)^n = y_2^s - L + J(A)\]

Note that L has been reverted back to the status of non-liquid assets with no cost. The non-borrowing cash flow can be summarized simply as

\[(y_1^f)^s = (y_1^s, y_2^s)\]  \hspace{1cm} (2.2)

The superscript s stand for self-financing.

2.1.2 The Borrowing Cash Flow

If the agricultural firm decides to borrow from the agricultural lender, the first-period cash flow is given and independent of whether or not the firm decides to default. During the first period, borrowers receiving a loan of size L, at interest rate r, are forced to guarantee a percentage \(\hat{\lambda}\) of the loan, \(\hat{Z}\). Collateralization costs the borrower an amount \(\tau(\hat{\lambda}\hat{Z})\). If the borrower at the end of the second period defaults, \(\hat{\lambda}\hat{Z}\) is immediately received by the bank at no cost to itself. Thus, the first-period borrowing income may be denoted as:

\[y_1^s = y_1^s + \lambda(A - \hat{\lambda}\hat{Z}) + \hat{L} - \tau(\hat{\lambda}\hat{Z})\]  \hspace{1cm} (2.3)

On the other hand, the second-period borrowing income varies depending on whether the agricultural borrower chooses the honest or the dishonest course.

(a) The Honest Borrowing Cash Flow.

If the borrower chooses the honest course, two possibilities arise. First, for a given state-of-nature (\(\epsilon\)), the entire obligation cannot be met at the end of the second period, with the lender taking the entire second-period cash flow. In this case, the borrower is sufficiently unlucky that he will default on his loan despite his willingness to repay. This occurs with probability \(\alpha\).

\[\alpha = \text{Prob}(\hat{Z} > y_2^s + \lambda(A - \hat{\lambda}\hat{Z}) + \hat{\lambda}\hat{Z}; \epsilon)\]  \hspace{1cm} (2.4)
Second, the entire obligation can be paid with the second-period cash flow. This occurs with probability \((1-\alpha)\).

The second-period cash flow for the honest borrower may be summarized as

\[
(y^{j,h}_{2,j}) = \begin{cases} 
\hat{y}_{2}^{j} + J(A) - \hat{Z}, & \text{It occurs (1-\alpha) of the time.} \\
\hat{y}_{2}^{j}, & \text{It occurs \alpha of the time.}
\end{cases}
\]  

(2.5)

Consequently, the expected honest borrower's second-period income is

\[
E[y^{j,h}_{2}] = (1-\alpha)(\hat{y}_{2}^{j} + J(A) - \hat{Z}).
\]

(2.6)

In sum, the honest borrower cash flow may be denoted as

\[
(y^{j})^{h} = [y^{j}_{1}, (y^{j}_{2})^{h}].
\]

(2.7)

The superscript h stand for the honest borrower path.

(b) The Dishonest Borrowing Cash Flow.

If the borrower chooses the dishonest course, the second-period income varies depending on whether the loan defaulter is forced or not to repay his obligations. On the one hand, if the loan defaulter is caught by the agricultural lender, which occurs with probability \(\delta\), two possibilities arise. First, for a given state-of-nature \((\epsilon)\), the second-period income is sufficient to repay the loan obligation \((Z)\) and penalty costs \((\rho)\). This occurs with probability \(K_{1}\).

\[
K_{1} = \text{Prob}\{y^{j}_{2} + J(A - \hat{\lambda}Z) + \hat{\lambda}Z \geq \hat{Z} + \hat{\rho} ; \epsilon\}
\]

(2.8)

Second, the entire obligation can not be paid with the second-period cash flow. If this is the case, the lender takes the entire second-period cash flow. This occurs with probability \((1-K_{1})\).

The second-period cash flow of loan defaulters forced to repay may be summarized as

\[
(y^{j}_{2})^{d} = \begin{cases} 
\hat{y}_{2}^{j} + J(A - \hat{\lambda}Z) - (Z + \hat{\rho}) + \hat{\lambda}Z, & \text{It occurs } \delta K_{1} \text{ of the time.} \\
0, & \text{It occurs } \delta(1-K_{1}) \text{ of the time.}
\end{cases}
\]

(2.9)
The superscript \(d\) indicates that the borrower chooses the defaulting path, and the subscript \(\delta\) indicates that the loan defaulter is forced by the agricultural lender to repay either the total or part of the loan obligation plus penalty costs with the second-period income.

On the other hand, if the defaulter is not forced to repay, he may have full use of the income from the second period, but he loses the collateral. This occurs with probability \((1-\delta)\). If this is the case, the second-period cash flow is

\[
(y^i_2)_F = \begin{cases} 
    y^i_2 + J(A-\hat{\lambda}\hat{Z}), \\ 
    \hat{Y}^i_2 + J(A-\hat{\lambda}\hat{Z}). 
\end{cases}
\] (2.10)

The subscript \((1-\delta)\) indicates that the lender was unable to force the borrower to repay his loan. In sum, the dishonest borrower's second-period cash flow yields

\[
(y^i_2)' = \begin{cases} 
    y^i_2 + J(A-\hat{\lambda}\hat{Z}) - (\hat{Z} + \hat{\rho}) + \hat{\lambda}\hat{Z}. & \text{It occurs } \delta K_i \text{ of the time.} \\
    0. & \text{It occurs } \delta (1-K_i) \text{ of the time.} \\
    \hat{y}^i_2 + J(A-\hat{\lambda}\hat{Z}). & \text{It occurs } (1-\delta) \text{ of the time.}
\end{cases}
\] (2.11)

Consequently, the expected second-period cash flow of those who choose the defaulting path is

\[
E[y^i_2]' = \delta K_i \{ y^i_2 + J(A-\hat{\lambda}\hat{Z}) - (\hat{Z} + \hat{\rho}) + \hat{\lambda}\hat{Z} \} + (1-\delta)\{ \hat{y}^i_2 + J(A-\hat{\lambda}\hat{Z}) \}
\]

\[
= [y^i_2 + J(A-\hat{\lambda}\hat{Z})] - \delta [ (1-K_i) (y^i_2 + J(A-\hat{\lambda}\hat{Z})) + K_i ( (1-\lambda)\hat{Z} + \hat{\rho}) ]
\] (2.12)

The dishonest borrowing firm's cash flow may be summarized as

\[
(y^d)^d = [y^d_1, (y^d_2)_F].
\] (2.13)

2.1.3 The Agricultural Firm Maximization Problem

Before advancing to the formalization of the behavior of the agricultural firm let us define \(\Sigma = [h,d]\) as an index of the honest \((h)\)/dishonest \((d)\) decision and \(\hat{\psi}_i = \Phi(0,0,0,0,0)\) as indicating the self-financing decision. The agricultural firm's choice now may be formally established as
\[
\text{MAX}_{\psi^2} \; \text{EU}[C_1, C_2]
\]

subject to

\[
\hat{\psi} = \begin{cases} 
\phi(r, \hat{I}, \hat{\delta}, \hat{\rho}), \text{ with borrowing} \\
\psi_k, \text{ with self-financing}
\end{cases}
\]

\[
(y^i)^+ = \begin{cases} 
(y^i)^d, \text{ if dishonest.} \\
(y^i)^h, \text{ if honest.}
\end{cases}
\]

\[
C_i = (y^i)^+, \; i=1, 2. \text{ All non-committed income is consumed.}
\]

Where EU represents the expected utility of borrowers; all other terms have been defined above.

The implicit solution to the above maximization problem is

\[
\bar{u}^i = u^i((y^i)^+, \hat{\psi}, \hat{\xi})
\]

Faced with an offer set, \( \hat{\psi} \), the agricultural firm has a two-fold choice. First, it must decide to borrow or not to borrow. It will choose not to borrow if

\[
\bar{u}^0((y^i)^h, \hat{\psi}) > u^i((y^i)^+, \hat{\psi} = \hat{\phi})
\]

where \( \bar{u}^0 \) is the reservation (self-finance) level of utility. It represents the agricultural firm's utility level when the choice has been not to borrow.

Second, if the agricultural firm chooses to borrow, it must decide between the default and the non-default path. For instance, if

\[
u^i((y^i)^d, \hat{\phi}) > u^i((y^i)^h, \hat{\phi}) > \bar{u}^0,
\]

the borrower will choose to default, otherwise he will choose the non-default course.
2.1.4 The Agricultural Borrower Loan Demand and iso-Utility Curves

I now turn to examine some of the more important properties of the borrower’s loan demand and iso-utility curves derived from the maximization problem specified above. Equation 2.18 defines implicitly the loan demand function for both honest and dishonest borrowers.

\[(L^D)^* = (r, \hat{y}_2, \delta, \rho, \lambda), \tag{2.21}\]

where \(r\) is the loan rate of interest; \(\hat{y}_2\) is the certainty equivalent of the investment project; \(\delta\) is the lender’s probability of collecting from loan defaulters; \(\rho\) are penalty costs; and \(\lambda\) is the percent of the loan that is collateralized.

The expected utility maximization implies \(L^D_{32} > 0\), but the effect of \(r\) remains ambiguous. In what follows we assume for convenience that \(L\) is not an inferior good, so that \(L^D_r < 0\). The impact of \(\delta\) and \(\rho\), on the borrowers’ loan demand takes place through their effects on the borrowers’ expected second-period income. Since the honest borrowers’ decision to borrow or self-finance their investment projects are independent of the level of \(\delta\) and/or \(\rho\), then \((L^D_D)^h, (L^D_D)^h = 0\). However, as shown in Equation 2.12, the dishonest borrower’s expected second-period income is greater the lower the probability of being caught (i.e., the lower \(\hat{\delta}\)), and/or the lower the penalty costs on loan default (i.e., lower \(\hat{\rho}\)). Thus, it is reasonable to expect that \(L^D_D L^D_D < 0\).

Finally, since collateral requirements impose a cost on the borrowers’ first-period income, it is reasonable to assume that increasing collateral requirements will have a negative effect on loan demand. That is \(L^D_{\lambda} < 0\).

The iso-utility curves of the honest borrower in \((L, r)\) space may be derived from the condition

\[U((L^h)^*, \hat{y}, \hat{\xi}) = U(\text{a constant}), \tag{2.22}\]
Figure 1: Loan Demand and Iso-Utility Curves. $U^1 < U^2 < U^3$
by varying $U$. Equation 2.22 defines a function $\theta(L, \hat{\psi}, \hat{\Sigma}; U)$ which for a given $L$, $\hat{\psi}$, and $\hat{\Sigma}$ indicates the value of the loan rate of interest that corresponds to the level of utility $U$. A family of such curves is shown in Figure 1 with the following properties:

1. When $r$ rises the expected utility of the agricultural firm falls.

2. The utility curves are positively sloped on the left-hand side, but negatively sloped on the right-hand side of $L^D$.

The shape of the iso-utility curves is the result of the properties of the utility function and a proof is given in the appendix A1. The remaining question is, what are the factors that affect the borrower's honest/dishonest choice. That is the task taken in the next section.

2.1.5 The Borrower Honest/Dishonest Choice

The defaulting decision of those who are unable to repay their loan obligations with their realized second-period income is trivial. They by definition will automatically default at the end of the second period. The more interesting case is that of borrowers whose income is larger than the loan obligation but who still voluntarily default (hereafter willing defaulters).

Since first-period income is a given in all cases, the voluntary defaulting decision will depend upon whether or not the expected return from defaulting behavior in the second period (Equation 2.12) is greater than the expected return from non-defaulting behavior (Equation 2.6). That is, if

$$E[\eta_2^d] > E[\eta_2^h],$$

(2.23)

the borrower will choose the defaulting path, otherwise he will be honest. With some simplification it can be shown that the borrower will benefit from defaulting and not repaying its loan obligations as long as
\[
\frac{\delta(K_{i-1})+(1-\delta)}{\delta(K_{i-1})}[(\hat{y}_2^i + J(A-\hat{\lambda}\hat{z})) - (1-\hat{\lambda})\hat{z}] > \frac{K_i}{K_{i-1}} \hat{\rho}
\]  

(2.24)

where the expression from the left-hand side is the expected gain from defaulting, and the expression on the right-hand side is the expected cost of defaulting. If the opposite is true, the borrower will not benefit from defaulting.

Three propositions follow from expression (2.24).

1. The probability of a randomly selected borrower choosing to be a willing defaulter depends upon the borrower’s probability of being caught, \( \delta \), penalty costs, \( \hat{\rho} \), and realized second-period cash flow, \( \hat{y}_2^i + J(A-\hat{\lambda}\hat{z}) \).

2. The number of high-income borrowers who choose the defaulting path increases with declining penalty costs (i.e., when \( \hat{\rho} \to 0 \)).

3. If there exist penalty costs, low-income borrowers will be the more likely willing defaulters. Thus, willing defaulters are the marginal good borrowers, those with second-period income close to the loan obligation.

Proposition (1) follows from the fact that if the loan obligation could be paid (i.e., \( K_i = 1 \)), expression (2.24) becomes

\[
(1-\delta)[\hat{y}_2^i + J(A-\hat{\lambda}\hat{z})] < \delta \hat{\rho}.
\]  

(2.25)

Proposition (2) can be proven by noting that whenever \( \hat{\rho} = 0 \), borrowers will choose the honest path as long as

\[
\frac{\delta(K_{i-1})+(1-\delta)}{\delta(K_{i-1})}[(\hat{y}_2^i + J(A-\hat{\lambda}\hat{z})) < (1-\hat{\lambda})\hat{z}.
\]

(2.26)

Now, as the probability of repayment becomes larger (i.e., as \( K_i \to 1 \)) for a given \( \delta \), equation (2.26) becomes

\[
(1-\delta)[\hat{y}_2^i + J(A-\hat{\lambda}\hat{z})] < 0,
\]  

(2.27)
which is impossible. Thus, if there are no penalty costs, the probability that farmers choose the defaulting path, for a given probability of being caught ($\delta$), increases with increasing income. In other words, it is more likely that larger farmers choose the defaulting path under these circumstances (Adams and Meyer, 1982). Empirical evidence of this phenomenon has been reported by Ladman and Tinnermeier [1977] in Bolivia, Kim [1978] in South Korea, Montiel [1983] in Costa Rica, among others.

Proposition (3) follows from the fact that the expected second-period cash flow (relative to income) of those borrowers who choose the defaulting path becomes

\[
\frac{\mathbb{E}[y_{2}^{\dagger}]^d}{y_{2}^{\dagger} + J(\lambda - \hat{\lambda})} = \begin{cases} 
1 - \delta & \text{if } K_1 = 1, \\
(1-\delta) & \text{if } K_1 = 0.
\end{cases}
\]

That is, the lower the probability of repaying the loan obligation plus penalties ($\lambda - \hat{\lambda}$), i.e., the lower $K_1$, the larger the relative second-period cash flow is. In other words, if there exist penalty costs, and for a given $\delta$, those borrowers with higher probability of repaying the loan obligation and penalties are more likely to remain honest and repay their loans. Empirical evidence of this phenomenon has been provided by Aguilera et al [1990] for the Dominican Republic.

### 2.1.6 Summary of Borrowing Behavior

Borrower behavior may be summarized simply. Agricultural firms attempt to maximize the expected utility of consumption in a two-period world. Facing a set of loan contract offers, $\psi$, they can first choose to either borrow or self-finance the investment project. If the agricultural firm decides to borrow, then it decides whether to be honest or dishonest.

Honest borrowers will repay their loans if possible. However, there still exists the possibility that honest borrowers unvoluntarily default on their loans because their
second-period cash flow is not large enough to repay their loans. These are the unlucky honest borrowers. Dishonest borrowers will voluntarily choose to default on their loans. Obviously, unlucky dishonest borrowers will automatically default on their loans. The more interesting case is that of those borrowers who are able to repay their loan obligations but choose to default (the willing defaulters).

The willing defaulter’s decision of voluntarily defaulting is a function of the probability of being caught (δ) and the penalty costs (ρ), conditional to the borrower’s expected income. Penalty costs play an important role as a deterrent to defaulting behavior. With zero penalty costs it is unlikely that many borrowers will remain honest. In this case, larger farmers are the most likely defaulting borrowers. With positive penalty costs in contrast, low-income borrowers are the most likely willing defaulters. Borrowers who can afford the full penalty are more likely to be more conservative and remain honest because their expected losses (relative to income), if they are caught, are larger than their expected gains, if they are not caught.

2.2. MODELING LENDING BEHAVIOR

It is now time to consider lender behavior in a situation where the lender finances the borrower’s investment projects. Let us assume the existence of a risk-neutral agricultural lender that meets the following conditions:

1. The lender offers a single, noninstallment, one-period agricultural loan at a fixed interest rate (normally imposed from outside).

2. The lender has a finite planning horizon of two periods. At the beginning of the first period, management determines the volume of available loanable funds to lend, formulates goals and policy guidelines for its credit evaluation and collection operations, and states collateral requirements and penalties on loan default. In the second
period, the lender receives payments from accounts due and attempts to collect from accounts overdue, and any loan not collected by the end of this period will be considered a bad-debt loss.

3. The agricultural lender's credit policy is based solely on the expected ability and willingness of loan applicants to fulfill their financial obligations.

4. The agricultural lender is exposed to two different types of uncertainty. The first source of uncertainty is exogenously determined by the environment (or state-of-nature), and, therefore impossible to reduce. This is the inherent (or initial) risk of loan default. It is clear that even within the safest group of borrowers there is some variance in the income stream. Therefore, there are always some borrowers who will be unable to repay their loans.

Under given environmental conditions (say \( \epsilon \)), the inherent risk of loan default \( \alpha \) may be defined as the probability that the loan obligation \( Z = (1+r)L \) be greater than the potential borrower's second period income \( (\tilde{y}_2^1 + J(A-\lambda Z)) \) plus the value of collateral \( (\lambda Z) \). More formally the inherent risk of loan default is defined as:

\[
\alpha = \text{Prob} \{ Z > \tilde{y}_2^1 + J(A-\lambda Z) + \lambda Z; \epsilon \}.
\]

The second source of uncertainty comes from the costly and incomplete nature of information in rural financial markets. The lender is only able to know the mean value and the variability of the outcome of the investment project of the borrowing population. The mean value and the variability of the outcome of each loan applicant's project is unknown to the lender. However, the lender may predict the mean value of the outcome of the investment project by considering the available information on each loan applicant. Since information is costly and incomplete, the perfect identification of bad or unqualified applicants (i.e., those unable or unwilling to repay their loan obligations) is not possible. Some of bad requests are unknowingly approved, \( (1-\omega_b) \) of
the time, while some of the requests from good or qualified applicants (i.e., those able and willing to repay their loans, honest applicants) are mistakenly rejected. This occurs \((1-\omega_g)\) of the time. The variable\(^7\) \(\omega_b\) may be interpreted as the lender’s probability of rejecting loan request from bad applicants; \(\omega_g\) is the lender’s probability of granting loans to good applicants.

5. The agricultural lender’s task as a rural financial intermediary is not only to lend money to rural producers, but to ensure that the money is lent to rural producers with a high probability of repaying their loans (i.e., good applicants). The lender’s task in reducing the risk of loan default is three-fold.

The first task is to dissuade bad applicants from requesting loans, by providing negative incentives, such as rigorous loan recovery procedures and stringent penalty conditions that would apply in case of default. For instance, the defaulter may be forced, if caught, to pay all collection costs plus some percentage of the loan obligation as pure penalty.\(^8\)

Secondly, failing the first task, the lender must attempt to separate good from bad applicants by screening each loan applicant or by using signalling mechanisms. Screening mechanisms, on the one hand, refer to lender’s activities oriented to predict the borrower’s income stream by analyzing a set of relevant information on each loan applicant. The available informational set on each loan applicant contains signals\(^9\) that allow the agricultural lender to predict the borrower’s income stream, thereby the risk

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\(^7\) \((1-\omega_b)\) and \((1-\omega_g)\) may be viewed as the type I and Type II errors in statistical hypothesis testing, respectively.

\(^8\) Exclusion from future loan activities is an important implicit penalty considered in financial markets, however, given the two-period nature of this model this type of penalty is not considered.

\(^9\) In real life, these signals would be information on the farmer’s experience, years working with the bank, land ownership, and the like.
of loan default. If a signal is a perfect predictor of risk, then, with more rigorous screening procedures, the signal becomes more accurate, and the probability of rejecting a loan to an unqualified loan applicant, $\omega_o$, and of granting a loan to a qualified loan applicant, $\omega_k$, would approach one. However, as a result of the imperfect nature of information in rural credit markets, signals are only imperfect predictors of risk, and thus $\omega_o$ and $\omega_k$ approach some upperbound threshold below one.\footnote{10}

Signalling mechanisms, on the other hand, refer to loan contract conditions oriented to force loan applicants to reveal their own risk class. For instance, the lender may offer loan contracts with different combinations of collateral. If the applicant is a bad applicant, he will be willing to accept a loan contract with lower collateral requirements and higher loan rates of interest, while a good applicant will be willing to accept a loan contract with higher collateral but lower rate of interest.

The third agricultural lender's task in reducing loan debt losses refers to activities designed to collect loan repayments from unrecognized bad borrowers and willing defaulters. If successful at collection, the agricultural lender receives from defaulting debtors either the total loan obligation plus penalty costs ($Z + \rho$), or the realized second-period income ($\bar{y}_2 + J(A - \lambda Z) + \lambda Z$), whichever is larger. More formally, the lender's return from successful collection may be represented as

$$P = \text{Min}\{\bar{y}_2 + J(A - \lambda Z) + \lambda Z; Z + \rho\} \tag{2.29}$$

6. In this model, credit rationing is linked to the lender's screening operations. The agricultural lender, after evaluating the available informational set about a potential borrower, decides on the maximum loan contract that he is willing to offer to this customer. If the loan contract is profitable, the loan transaction takes place. If it is not,

\footnote{10 More recently, a number of credit-scoring parametric techniques have been proposed as an aid to improve credit evaluation methodologies. For details, see Chhikara [1989] and Gustafson [1989], among others.}
then the loan request is rejected. Thus, the screening activities determine the number of loans granted. If \( \alpha \) is the initial proportion of the loan applicants that will be unable to pay their loans, \( \omega_g \) the proportion of good applicants that receive loans, and \( \omega_b \) the proportion of loan requests from bad applicants rejected, then the lender will grant \( (1-\alpha)\omega_g \) percent of the requests from good applicants, and \( (1-\omega_g)\alpha \) percent from bad applicants.

The importance of credit rationing is linked to the value of the screening operations as compared to the value of mechanisms that are alternatives to screening activities such as incentive and signalling devices. If the lender can do better through incentive and/or signalling mechanisms than through screening, then credit rationing would be unnecessary. This occurs either when these other mechanisms are highly efficient or screening is no better than random selection.

The conditions under which signalling and/or incentive contracts, i.e., loan contracts containing conditions that force bad applicants either to reveal their risk class or to leave the applicant's pool, respectively, would dominate screening contracts is a topic that is extensively discussed below. For the time being, we shall assume that screening contracts dominate signalling and incentive contracts.

7. Screening and collection operations are costly activities. On the one hand, total expenditure in screening operations is represented by a cost function of the following form:

\[
EC = N_R g(\omega_o, \omega_g, L), \quad 0 < \omega_o, \omega_g < 1.
\]  

(2.30)

where \( EC \) represents expenditures in screening operations during the first period; \( N_R \) is the number of loan requests; \( L \) is the loan size; and \( \omega_o \) and \( \omega_g \) are the probabilities of rejecting bad borrowers and of accepting good borrowers, respectively. The function \( g \)
is assumed to be a strictly convex increasing function of the arguments.\textsuperscript{11}

On the other hand, total expenditure in collection activities may be described as

\[ CC = N_k (1-\omega_b) \alpha(1-\delta) d(\delta) \quad \text{with} \quad 0 \leq \delta \leq 1 \quad (2.31) \]

where \( CC \) represents expenditures in collection activities; \( N_k (1-\omega_b) \alpha(1-\lambda) \) is the number of uncollectable defaulting loans; and \( d \) is the cost per defaulting loan. The function \( d \) is also assumed to be a strictly convex increasing function of the probability \( \delta \) of collecting from a loan defaulter.

8. The agricultural lender may affect the inherent risk of loan default (\( \alpha \)) through incentives generated by the size of the loan (\( L \)), the interest rate (\( r \)), or collateral requirements (\( \lambda \)). Firstly, since collateral requirements in this dissertation are a proportion of the loan obligation (\( \lambda Z \)) that the lender receives once loan default occurs, increasing interest rate and/or loan size have two opposite effects (see Figure 2): (a) they directly increase the risk of loan default \( \alpha \) through increasing the size of the loan obligation (\( Z \)); and (b) they indirectly decrease the probability of loan default through their effects on the value of collateral. Thus, the net effect on this probability of an increase in loan obligation is ambiguous. However, it is reasonable to assume that direct effects will dominate indirect effects of increasing interest rate and/or loan size on the inherent risk of loan default (\( \alpha \)). Thus, increasing interest rate and/or loan size increase the adverse selection probability \( \alpha \).

Moreover, as pictured in Figure 3, increasing the proportion of the loan required as collateral unambiguously decreases the probability of loan default. For a given state-of-nature (\( \epsilon \)), \( \alpha \) is a cumulative distribution function determined by the loan obligation, and the borrowers’ expected income. More formally, the default probability, \( \alpha \), may be defined as

\textsuperscript{11} This assumption implies that the first and second partial derivatives are positive.
Figure 2: The Borrowing Population Income Distribution (I). Adverse Selection Probability, \( \alpha \): The case of increasing loan size and interest rate.
Figure 3: The Borrowing Population Income Distribution (II). Adverse Selection Probability, \( \alpha \): The case of increasing collateral requirements (\( \lambda \)).
\[ \alpha = F^b(r, L, \lambda; \epsilon), \]

such that \( \frac{\partial F^b}{\partial r} > 0, \frac{\partial F^b}{\partial L} > 0, \) and \( \frac{\partial F^b}{\partial \lambda} < 0. \)

### 2.2.1 The Agricultural Lender Profit Function

From the above discussion, the following definitions can be established

\[ GL = N_r (1 - \alpha) \omega_g \]
\[ BL = N_r (1 - \omega_b) \alpha \]
\[ S = [\omega_g (1 - \alpha) + (1 - \omega_b) \alpha] \]
\[ N_G = GL + BL = N_r S \]
\[ \bar{F} = \text{Min}\{Z, J(A - \lambda Z) + \lambda Z, Z + \rho\} \]
\[ EL = [(1 - \lambda)(1 - \delta)(1 + r)L - \delta \bar{F}] \]
\[ BDL = N_r (1 - \omega_b) \alpha [(1 - \delta)(1 + r)L - \delta \bar{F}] = (BL)(EL), \]
\[ CC = N_r (1 - \omega_b)(1 - \delta) \alpha d(\delta) \]
\[ EC = g(\omega_g, \omega_b, L) \]
\[ AC = N_r [\omega_g (1 - \alpha) + (1 - \omega_b) \alpha](1 + h)L \]

where

- \( N_r = \text{total number of loan requests.} \)
- \( \omega_g = \text{Probability that a loan requested by a good applicant be granted.} \)
- \( \omega_b = \text{Probability that a loan demanded by a bad applicant be rejected.} \)
- \( \alpha = \text{Probability that a loan request comes from bad applicants (inherent risk).} \)
- \( S = \text{Selection or acceptance rate of loan applications.} \)
- \( GL = \text{Number of loans extended to good applicants.} \)
- \( BL = \text{Number of loans extended to bad applicants (bad-debt loans).} \)
\( N_c \) = Total number of loans extended.

\( L \) = Loan amount.

\( r \) = Interest rate on loans.

\[ Z = (1+r)L \] = Loan obligation.

\( \delta \) = Probability of collecting from loan defaulters.

\( \rho \) = Loan penalty costs.

\( \lambda \) = Percentage of loan obligation required as collateral.

\( P \) = Expected amount collected from defaulting debtors.

\( EL \) = Expected losses per bad-debt loan.

\( BDL \) = Total value of bad-debt losses.

\( CC \) = Total collection costs from uncollectable loans.

\( EC \) = Total expenditure in screening activities during the first period.

\( h \) = Per loan cost of funds.

\( AC \) = Total cost of funds.

The expected profits of an agricultural lender facing a borrower population as described above with \( N_r \) loan demanders and zero discount rate is

\[ \Pi = N_r \omega \alpha (1-\alpha)Z - N_r \omega \alpha \left[ (1-\lambda \gamma)Z - \delta P \right] - N_r (1-\omega \alpha \gamma (1-\delta)Z - \delta \gamma) - N_r \omega (1-\omega \alpha) + (1-\omega \alpha) \gamma (1+h)L \]

or simplified

\[ \Pi = GL (1+r)L - BDL - CC - EC - AC \]

The expression \( GL (1+r)L \) represents the expected revenue of lending to \( N_r \) loan applicants, while the expression \((BDL+CC+EC+AC)\) represents the expected costs.
2.2.2 The Agricultural Lender Maximization Problem.

The agricultural lender follows the criterion of maximization of the expected profit function by choosing $L$, and formulating policy guidelines for credit evaluations and collection operations, and establishing penalties on loan default and collateral requirements, i.e., choosing $\omega_b$, $\omega_y$, $\delta$, $\rho$ and $\lambda$, respectively. So $r$, and $h$ are exogenous parameters to the agricultural lender.

Given these conditions, the decisions of management with respect to operational goals and policy guidelines for its credit evaluation and collection operations, collateral requirements, and penalties on loan default can be represented formally as the solution to the following problem:

$$\max_{L, \omega_b, \omega_y, \delta, \rho, \lambda} \Pi = N_R \omega_y (1-\alpha)Z - N_R (1-\omega_y) \alpha (1-\lambda \chi 1-\delta)Y - \delta F$$

$$-N_R (1-\omega_y) (1-\delta) \alpha d \delta - N_R g(\omega_y, \omega_y, L) - N_R [\omega_y (1-\alpha) + (1-\omega_y) \alpha] (1+h) L$$

(2.35)

The complexity of the form of the lender’s profit function should not be allowed to confuse the basic simplicity of the actions underlying this function. The lender is simply choosing a quantity $L$, and operational goals capable of rejecting at least $\omega_b$ of the requests from bad borrowers, of granting at least $\omega_y$ of the requests from good borrowers, and of recovering at least $\delta$ percent of its delinquent loans. At the same time, the lender formulates optimal penalties on loan default $\rho$ and establishes collateral requirements $\lambda$. It is the nature of the interactions between these choices which makes the lender’s problems interesting and, unfortunately, complex.

To obtain the necessary first-order conditions for a maximum $\Pi$, one can partially differentiate Equation (2.35) with respect to the decision variables, $L$, $\omega_y$, $\omega_y$, $\delta$, $\rho$ and $\lambda$, and set these derivatives to zero. These conditions suggest that each decision variable be increased up to a point at which its marginal contribution to the
profitability of the lender becomes zero (i.e., $\Pi_L, \Pi_{\omega_g}, \Pi_{\omega_b}, \Pi_{\rho}, \Pi_{\rho^2}$, and $\Pi_{\lambda} = 0$). For a detailed description of the first-order conditions see appendix A3.

The second-order conditions for a maximum $\Pi$ require that the principal minors of the relevant Hessian determinant alternate in sign. These imply that the profitability of the firm must be decreasing with respect to any further increases in any of the decision variables (i.e., $\Pi_{LL}, \Pi_{\omega_g}, \Pi_{\omega_b}, \Pi_{\rho}, \Pi_{\rho^2}, \Pi_{\lambda} < 0$). Such implications, on the other hand, require that the cost functions, $g$ and $d$, be strictly convex in the neighborhood of a point at which the first-order conditions are satisfied with $L, \omega_g, \omega_b, \delta, \rho$, and $\lambda > 0$ (if such a point exists). With the earlier assumptions of convexity, these second-order conditions are therefore fulfilled (see appendix A4).

With the (assumed) satisfaction of the first- and second-order conditions, a unique optimal set of $L, \omega_g, \omega_b, \delta, \rho$, and $\lambda$ can be obtained for a given $r$, and $h$. If the exact forms of the functions $g$ and $h$ were known, then the value of the optimal set $(L, \hat{\omega}_g, \hat{\omega}_b, \bar{\delta}, \bar{\rho}, \bar{\lambda})$ can be determined simultaneously with equations describing the first-order conditions.

The optimal number of loans granted follows the determination of the optimal set due to the definition

$$\hat{N}_G = N_R[1 - \alpha(r, L, \bar{\lambda}; \varepsilon)] \hat{\omega}_g + \alpha(r, L, \bar{\lambda}; \varepsilon)(1 - \hat{\omega}_b) = N_R \hat{S}, \quad (2.36)$$

If the selection rate ($\hat{S}$) is less than unity, loan-quantity (or type II) rationing will exist with the total number of loans rationed being equal to $T-II = N_R - \hat{N}_G = N_R (1 - \hat{S})$.

The total number of bad-debt loans (BL) under optimal conditions, also follows the determination of the optimal set of decision variables due to the definition:

---

12 Throughout this study we adopt the convention of denoting partial derivatives by subscripts, e.g., $\Pi_L = \frac{\partial \Pi}{\partial L}$ and $\Pi_{LL} = \frac{\partial^2 \Pi}{\partial L^2}$. 
\[ B_L = N_k(1-\hat{\omega}_b)\alpha(r, L, \hat{\lambda}; \epsilon) \] (2.37)

That is, the total number of defaulting debtors, i.e., those unable to repay their loans with their second-period income, depends upon the lender’s ability of recognizing bad applicants \((\omega_b)\), the initial risk of loan default \(\alpha\), the adverse selection effects of \(r\), \(L\), and \(\lambda\), and the state-of-nature \(\epsilon\). Obviously, more stringent screening process, i.e., \((\omega_b \rightarrow 1)\), or small initial risk of loan default, i.e., \((\alpha \rightarrow 0)\), tend to decrease the total number of loan defaulters.

2.2.3 The Lender Contract Offer and Iso-profit Curves.

Before advancing to a discussion of the equilibrium conditions, we will examine, in the \((L, r)\) space, the main properties of the lender’s iso-profit and offer curves, given the optimal values of the other endogenous variables. Since agricultural loans are considered to be non-homogeneous goods, the lender’s iso-profit and offer curves in \((L, r)\) space present similar characteristics to those obtained by Rosen [1974] and Keeton [1979] as shown in the appendix A2.

Figure 4 shows a family of isoprofit curves in \((L, r)\) space \(\phi(L, \hat{\omega}_y, \hat{\omega}_b, \hat{\rho}, \hat{\lambda}, h, \hat{\Pi}, N_k)\), along which the total agricultural lender’s profits \(\Pi\) are held constant. The lender’s optimal offer curve \(L'(r, \hat{\omega}_y, \hat{\omega}_b, \hat{\rho}, \hat{\lambda}, h)\) is that for which the expected profit reaches its optimum (i.e., \(\Pi_L = 0\)) (Jaffee and Modigliani, 1969). The iso-profit curves are negatively sloped on the left-hand side of the optimal offer curve and positively sloped to the right-hand side. The expected profits of the lender increase along the optimal offer curve for successively higher loan rates of interest. The optimal offer curve represents the set of operational variables \((\hat{\omega}_y, \hat{\omega}_b, \hat{\rho}, \hat{\lambda})\) which satisfy equations (A.8)-(A.13) in the appendix A3., i.e., that maximize the agricultural lender’s total profits.
Figure 4: Loan 'Offer' and Iso-Profit Curves. $\Pi_3 > \Pi_2 > \Pi_1$. 
2.2.4 Screening Contracts versus Non-Screening Contracts

So far, I have assumed that screening technologies dominate non-screening technologies. However, as discussed earlier, incentive and signaling contracts are also alternatives available to the agricultural lender. In what follows I will analyze the conditions under which these other contracts may dominate screening contracts.

(a) Screening Contracts versus Incentive Contracts.

The question of the dominance of incentive contracts over screening contracts is linked to the uncertainty of second-period income. It is possible to show that:

1. A pure incentive contract \( (\psi_{ic}) \) defined as

\[
\psi_{ic} = \phi(r, \hat{r}, \omega_i = 1, \omega_b = 0, \delta, \rho = \infty, \lambda)
\]

will dominate a screening contract \( (\psi_{sc}) \), defined as

\[
\psi_{sc} = \phi(r, \hat{r}, \omega_i \neq 1, \omega_b \neq 0, \delta, \rho < \infty, \lambda),
\]

only if borrowers know with certainty their second-period cash flow.

2. If borrowers have both uncertainty about their future income and the possibility of self-financing (or borrowing elsewhere for) their investment projects, increasing penalty costs will drive good borrowers out of the market earlier than bad borrowers.

Proposition 1 follows from the fact that borrowers will never accept a contract knowing that they are unable to repay with their second-period cash flow. If they accept such a contract, the lender will force them, with probability \( \delta \) to repay their loan obligations with an infinite penalty. Thus, bad borrowers will never apply for loans. Under these circumstances, the agricultural lender will have no reason to screen applicants, since the penalty will ensure that only good borrowers will apply. The distribution of the borrowing population with borrowers knowing their future cash flow and
infinite penalty is pictured in Figure 5.

The logic behind proposition 2 is as follows: As the penalty is continually increased, it will first have the desired effect of dissuading bad borrowers from applying. However, at some penalty level, say $\rho^*$, good borrowers will be indifferent between borrowing or self-financing the investment project. Penalties above $\rho^*$ will drive good borrowers out of the market, and the market will collapse. Thus, screening contracts will always dominate incentive contracts when borrowers have uncertainty about their future income.
Figure 5: The Borrowing Population with infinite penalty and Borrowers Knowing with Certainty Future Income.
(b) Screening Contracts versus Signalling Contracts.

Another signal of quality considered in the economic literature is collateralization, i.e., shifting the risk back to the borrower (see Bester [1985,1987], Chan and Kanatos [1985], among others). It has been argued that a lender faced with clients with different probabilities of default may offer loan contracts with different combinations of collateral requirements in order to find out the type of each individual borrower. This model shows, however, that collateralization cannot be used as a signal if there is a cost associated with meeting a collateralization requirement, and there exists the possibility of self-financing or borrowing elsewhere. When there is a cost of collateralization, and there is some possibility of evading the lender's loan recovery activities (i.e., \( \delta < 1 \)), it may be shown that:

1. Borrowers will never accept a contract where \( \hat{\lambda} > 1 \).

2. Potential defaulters will always be willing to bear a larger level of collateralization than non-defaulters. As a result, non-defaulters will exit the market before than potential defaulters if collateral requirements increase.

Proposition 1 implies that no one, defaulter or not defaulter, will accept a contract with \( \hat{\lambda} > 1 \). This is so since when \( \hat{\lambda} > 1 \), the borrower's choice becomes independent of \( \hat{\delta} \), and if the self-financing rate is less or equal than \( r \), and an additional cost \( r(\hat{\lambda}Z) \) is being incurred, self-financing will have a greater utility than borrowing.

The logic behind proposition 2 is that defaulters will always have a higher propensity to pay a higher collateralization rate than non-defaulters because they have a positive probability of evading loan collection. Thus, as the collateralization rate is raised, the good borrowers will exit first. In other words, collateral has an adverse selection effect of its own (Wette, 1983). These two propositions imply that collateral cannot serve as a signal.
Collateral will serve as a signal under three circumstances. First, when bad borrowers have insufficient wealth to offer the amount of collateral required to obtain the loan; second, when marginal collateralization costs of good borrowers are lower than those from bad borrowers, and hence good borrowers will be willing to provide more collateral than bad ones; and third, when asset holdings are positively correlated with income. If this is the case, good borrowers may be willing to offer more collateral. If neither of these cases hold, collateral will fail to serve as a signal of the borrower's ability of repayment.

2.2.5 Summary of the Lending Behavior

This section has modelled a more realistic, albeit more complex formulation of the agricultural lender's behavior. In other models (e.g., Hodgman (1960, 1962), Jaffee and Modigliani (1969), Jaffee and Russell (1976), Keeton (1979), Stiglitz and Weiss (1981), etc.) the lender is a neutral financial intermediary subject to uncertainties about its revenue stream. In this dissertation's model, the agricultural lender is viewed as a non-neutral financial intermediary formulating goals and policy guidelines for its credit evaluation and collection operations, and providing incentives with the aim of reducing the risks of loan default.

The agricultural lender's task in reducing risks of loan default is three-fold. The first task is to attempt to dissuade potential loan defaulters from demanding loans; that is, to stimulate them to leave the applicant's pool. Second, failing the first task, the lender must attempt to separate good and bad applicants from the remaining applicant's pool (screening). Finally, the agricultural lender must formulate collection strategies, with the aim of collecting from those bad borrowers that the screening process fails to screen out, and from those willing defaulters that the incentive mechanisms failed to provide the adequate incentives not to default.
The selection or acceptance rate of a given population of loan applicants is associated with the lender's analysis (or screen) of the available information on each loan applicant. The lender, after analyzing the relevant information on each loan applicant, decides on the maximum loan contract that he is willing to offer. If the loan contract is profitable, the loan transaction takes place. Otherwise, the loan request is rejected. Thus, the importance of credit rationing is linked to the importance of the lender's screening technologies. If the lender can do better through incentive and/or signalling devices than through screening technologies, then credit rationing would be unnecessary. This occurs when these other mechanisms are highly efficient or screening is not better than random selection.

Screening contracts dominate incentive contracts, if borrowers have uncertainty about their future income, and there exists a positive probability that the agricultural lender will collect if they default on their loans.

Collateral will serve as a signal of the borrower's ability, if bad borrowers have insufficient wealth to offer the amount of collateral required to obtain the loan, or the marginal collateralization costs of good borrowers are lower than those from bad borrowers, or the borrowers' asset holdings are positively correlated with income.

Finally, the number of bad-debt loans is associated to the lender's ability of recognizing bad applicants, the initial risk of loan default, and the effects of changes in the interest rate, loan size, and collateral requirements on the initial risk.

2.3. EQUILIBRIUM CONDITIONS

The previous two sections have outlined the basic factors affecting the demand and supply sides of the agricultural credit market. This section sets out the equilibrium conditions and discusses some of the implications about equilibrium credit rationing. Let the equilibrium values $L^*$, $\omega^*$, $\omega^*$, $\delta^*$, $\rho^*$ and $\lambda^*$ satisfy the following conditions:
an $L', \omega', \omega_0, \delta', \rho'$, and $\lambda'$ such that

1. \( \Pi(r, L', \omega', \omega_0, \delta', \rho', \lambda', h, N_R) > \Pi(r, L', \omega_0, \omega_0, \delta', \rho', \lambda' h, N_R) \)

and

\( U((y^*)_1, \psi, \Sigma') > U((y^*)_1, \psi, \Sigma') \)

2. \( U((y^*)_1, \psi, \Sigma') > U(y^*, \psi, 0) \)

3. \( \Pi(r, L', \omega', \omega_0, \delta', \rho', h, N_R) = 0 \)

where

* implies equilibrium quantity.

\( y^* \) is the borrower's income vector such that

\[
(y^*)_1 = \begin{cases} 
(y^*)_d & \text{if default} \\
(y^*)_n & \text{if non-default}
\end{cases}
\]

\( y^* \) is the self-financing borrowing cash flow.

\( (y^*)_s = [(y^*)_1, (y^*)_2] \)

where

\[
(y^*)_1 = y_1 + L + I(A-L) - r(L), \\
(y^*)_2 = y_2 + I(A)
\]

\( \hat{\psi} \) is the equilibrium contract.

\( \hat{\psi}_s \) is the non-borrowing choice.

\( \hat{\Sigma} \) is the default/non-default choice.

* implies an alternative quantity.

\( U^0 \) is the reservation level of utility.

Condition (1) ensures that in equilibrium, no other combination of variables exists such that one party could be made better off without the other party being made worse off. This condition implies that all the lender's optimal production and selection
decisions are being met simultaneously with the maximization of the borrower's utility of consumption over time. Equilibrium condition (2) states that the equilibrium contract conditions must be such that the expected utility of borrowing is greater than the expected utility of non-borrowing. This condition ensures that if a loan is offered it must be accepted by the more penalty-and-collateral-sensitive group, i.e., the non-defaulters. In other words, this condition ensures that good borrowers will remain in the market. If collateral requirements or penalty costs are set higher than the optimal level, good borrowers may exit the market, leaving the lender only with bad borrowers and hence \( \Pi_L < 0 \). If collateral requirements or penalty costs are set below the optimal level, the lender could increase his profitability by increasing these contract conditions, thereby violating condition (1). Equilibrium condition (3) imposes a zero-profit condition. The lender is not earning any excess return on the equilibrium contract.

I now turn to analyze the implications of these equilibrium conditions on type I and type II rationing, and loan default.

2.3.1 The Equilibrium Type I (Loan Size) Rationing.

Since loans have been considered non-homogeneous goods, i.e., goods with differential quality, the risk of loan default changes with changes in loan contract conditions, and the determination of the equilibrium loan size \( L^* \) is a case of hedonic equilibrium (cfr. Rosen, 1974, Kettke, 1979). The determination of the equilibrium loan terms is illustrated in Figures 6 and 7.

The equilibrium loan size \( L^* \) is determined as follows: Define \( \Pi^* \) as the lender's total expected profit in equilibrium, and \( \phi(L, \omega^*_e, \omega^*_b, \delta', \rho', \lambda', h, \Pi^*, N_R) \) and \( \theta(L, \psi', \Sigma') \) as the corresponding iso-profit and iso-utility curves, respectively. Given \( \Pi^* \) and considering the equilibrium condition (1) the equilibrium point will lie on the lender's iso-profit
Figure 6: Equilibrium with Type I Rationing Case I. $\phi_L > 0$
curve $\phi(L, \omega^*, \omega^0, \delta^*, \rho^*, \lambda^*, h, \Pi, N_k)$, at the point of tangency with a borrower's iso-
profit curve $\Theta(L, \psi^*, \Sigma^*)$. At the equilibrium point two possibilities arise.

First, if the marginal operational costs of the lender is low, $\phi_L$ will be positive in
equilibrium. If this is the case, $\frac{\partial U}{\partial L} > 0$ and $\frac{\partial \Pi}{\partial L} < 0$; borrowers prefer to receive larger
loans at the equilibrium loan rate and the lender would prefer to make smaller loans at
that rate (see Figure 6). But if $\phi_L$ is negative at the equilibrium point, the exact oppo-
site condition will exist: The borrowers will receive more credit than they desire at the
quoted loan rate ($\frac{\partial U}{\partial L} < 0$) and the lender will make smaller loans than are optimal at
that rate ($\frac{\partial \Pi}{\partial L} > 0$) (see Figure 7). Notice that only by accident will a customer receive
in equilibrium that loan size which maximizes his expected profits at the equilibrium
rate.

After having obtained the optimal loan size $L^*$, the magnitude of type I rationing
may be defined as

$$(T-I) = L^D(\hat{r}) - L^*,$$

where $L^D(\hat{r})$ is the loan size demanded at the quoted rate; and $L^*$ is the optimal loan size.

In sum, Type I, or loan size rationing, occurs because loans are non-homogeneous
goods with differential quality, i.e., the risk of loan default changes with changes in
loan contract terms due to the existence of asymmetric information problems. Hence,
we may conclude that the imperfect and asymmetric information problems in rural
credit markets are the necessary and sufficient conditions for type I rationing.
Figure 7: Equilibrium with Type I Rationing Case II. $\phi_L < 0$
2.3.2 The Equilibrium Type II (Loan Quantity) Credit Rationing.

In equilibrium the number of loans granted will be

\[ N'_G = N_R \left[ \omega (1 - \alpha (r, L^*, \lambda^*) ; \epsilon ) + (1 - \omega_0^*) \alpha (r, L^*, \lambda^* ; \epsilon ) \right] = N_R S' \]  

(2.39)

The magnitude of type II rationing formally may be written as

\[ (T-II) = N_R - N'_G = N_R (1 - S'), \]  

(2.40)

where \( N_R \) is the number of loan requests; and \( S' \) is the optimal selection rate. If the selection ratio \( S' \) is less than unity, type II rationing will exist with rationed loans being \( N_R - N'_G \).

The major implication of this equilibrium is that not only will adverse selection lead to the possibility of rationing, as argued by Stiglitz and Weiss, and Keeton, but that the effectiveness of the lender's evaluation activities may lead to rationing as well. On the one extreme, if there was adverse selection but the lender cannot implement evaluation or screening programs that allow him to distinguish good from bad borrowers (i.e., \( \omega_0 = 1 \), and \( \omega_0 = 0 \)), the selection ratio will be equal to unity. If this is the case, type II rationing will fail to exist. On the other extreme, if the lender's screening programs are such that good borrowers are perfectly separated from bad ones (i.e., \( \omega_0 = \omega_0 = 1 \)), the selection rate will be equal to \( (1 - \alpha) \). In this case, credit rationing will exist (i.e., \( S' < 1 \)), only if the initial risk of loan default and/or adverse selection effects are unimportant. Hence, screening is a necessary but not sufficient condition for type II rationing. Notice that screening is neither a necessary nor a sufficient condition for type I rationing.
2.3.3 Loan Default in Equilibrium

In equilibrium the number of bad-debt loans will be

\[ Bl^* = N_R (1 - \omega^*) \alpha (r, L^*, L^*, \epsilon) \]  \hspace{1cm} (2.41)

where \( N_R \) is the number of loan requests, \( (1 - \omega^*) \) is the probability that a loan be granted to bad applicants, and \( \alpha \) is the initial risk of loan default faced by the lender.

The major implication of this formulation is that the number of bad-debt loans depends on the lender's ability of correctly separating good from bad loan applicants, the initial risk of loan default, and the adverse selection effects of loan rates of interest (\( r \)), loan size (\( L \)), and collateral requirements. If the lender may screen all bad applicants out the market (i.e., if \( \omega^*_b = 1 \)), or the initial risk of loan default and adverse selection problems are insignificant (i.e., \( \alpha \to 0 \)), loan default problems will be insignificant.

2.3.4 Summary of Equilibrium Conditions.

This section has outlined the structure of equilibrium in the credit market model. The model shows the existence of equilibrium credit rationing without reliance on artificial restrictions or assumptions of risk aversion. The model implies that the actual phenomenon of loan-quantity (type II) rationing is, in reality, that of loan rejection. This is the result of clearing the market for loans, given the existence of a market for information. Each individual receives the correct marginal contract given publicly available information on that individual. Adverse selection is a necessary and sufficient condition for type I, or loan size, rationing. Screening is only a necessary condition for the existence of type II, or loan quantity, rationing. Screening and a positive probability of loan default are the necessary and sufficient conditions for type II rationing. Finally, the number of bad-debt loans under equilibrium conditions depends not only on the initial risk of loan default, but also on the lender's credit evaluation strategy, and the effects of interest rate, loan size, and collateral requirements on the
initial risk of loan default.

These results, however, have been obtained with specific values for the exogenous parameters, i.e., loan rate of interest, and lender's cost of funds, and no regulations. In order for the analysis to be meaningful, it must provide information concerning the way in which the optimal solution would change as a result of changes in the external market for factors and regulations. It is therefore essential to examine how changes in exogenous parameters and regulations would affect the optimal solution and credit rationing. This is the task undertaken in the next chapter.
CHAPTER III
REGULATIONS AND AGRICULTURAL CREDIT: A
THEORETICAL ANALYSIS

The regulation of the financial sector of LICs is not only a subject of primary importance, but of considerable controversy. Traditionally, economic growth has been the main justification for government intervention in financial markets. In particular, credit allocation to priority activities, groups, or regions has been the main justification for government intervention in rural credit markets. However, although government intervention in rural credit markets may appear to be justified, empirical evidence suggests that the long-term effects have run counter to intended goals (Cfr. McKinnon (1973), Shaw (1973), Kane (1984), Fry (1988), Camacho and Gonzalez-Vega (1988), among others).

The agricultural loan market equilibrium specified in chapter II has been obtained with specific values for the exogenous parameters in a market without regulations. Clearly, the borrowers' and lender's decisions in a regulated environment cannot be the same as in an unregulated environment. Therefore, in order to provide a more realistic analysis of the borrower-lender relationship in rural credit markets, it is necessary to consider how borrowers and the typical agricultural lender would behave in a regulated market, and how changes in exogenous and regulatory parameters would affect the optimal solution in a more restrictive environment.
The purpose of this chapter is to provide a theoretical analysis of the impact on the main economic aspects of the basic valuation model of both (a) changes in loan rates of interest and lender's cost of funds (i.e., the exogenous parameters), and (b) changes of regulatory parameters. The regulations considered in this dissertation are regulations that affect credit evaluation and loan recovery operations, and collateral requirements. The analysis begins by modifying the unregulated model to include parameters that are a function of these regulations. Next, I examine how changes in the exogenous and regulatory parameters will affect the optimal decisions of management with respect to the lender's operations. Two aspects of the equilibrium formulated in chapter II will receive attention. First, the direct effects of changes on exogenous and regulatory parameters are investigated. Indirect effects are assumed to be small. Second, the propositions analyzed will be mainly those for which empirical counterparts may exist. The purpose of these propositions is to generate testable hypotheses for the empirical analysis of the next chapter.

3.1 THE REGULATORY MODEL

Before specifying the model for the borrower-lender relationship in a regulated market, it is relevant to define regulation. In this dissertation, regulation is understood as the set of actions taken by a regulatory agency in order to achieve the stated objectives of legislation. In rural financial markets, for instance, regulatory actions taken by a given regulatory body, such as forcing cheap credit or loan targeting policies, are undertaken with the objective of stimulating investment among small rural producers, thereby allegedly increasing agricultural productivity and/or improving rural income distribution. This suggests that regulations are means to an end (i.e., the intended objective of legislation). Hence, the effectiveness of legislation depends on the effec-
tiveness of the actions taken by the regulatory agency to meet these objectives. Thus, it is more appropriate to talk about the effects of regulations (or regulatory impact) than the effects of legislation on rural credit markets.

The fundamental assumption of this chapter is that the regulations considered affect credit evaluation activities, loan recovery operations, and collateral as follows:

1. Regulations that affect the lender's ability to collect from a favored class of borrowers, regions, or activities may be represented by

\[ (1-\kappa)\delta, \quad \text{with} \quad 0 \leq \kappa \leq 1, \]

where \( \kappa \) is the regulatory parameter, and \( \delta \) is the lender's probability of catching a loan defaulter. \( \kappa \to 1 \) with more stringent regulations. At the extreme, when the loan obligation is forgiven \( \kappa = 1 \), hence, expression (3.1) becomes zero, i.e., the probability of collecting from loan defaulters is zero.

2. Regulations that force the lender to grant loans to some sector or group(s) of the borrowing population with a high probability of loan default may be represented as

\[ (1-\gamma)\omega_b, \quad \text{with} \quad 0 \leq \gamma \leq 1, \]

where \( \gamma \) is the regulatory parameter of the credit evaluation operation; \( \omega_b \) is the probability of rejecting loan applications from bad borrowers. When the regulation is considered restrictive, \( \gamma \to 1 \). The typical case is loans allocated to small farmers in an agrarian reform program. The agricultural lender is forced to serve this group of borrowers independently of the risk involved in such activity.

3. Regulations that limit or disallow repossession of collateral, or allow some borrowers to provide less collateral than that desired by the lender may formally be stated as:
\[(1-\chi)\lambda \quad \text{with} \quad 0 \leq \chi \leq 1, \quad (3.3)\]

where \(\chi\) is the regulatory parameter; and \(\lambda\) is the percent of the loan obligation required as collateral. The value of \(\chi\) is also positively correlated with the degree of restrictiveness of the regulation.

Now that regulatory parameters have been defined, they can be easily introduced into the basic model of chapter II.

### 3.1.1 The regulated agricultural borrower loan demand

The borrower's first-period income in a regulated market may be viewed as

\[
y'_1 = \bar{y}'_1 + j(A-(1-\chi)\hat{\lambda}\hat{Z}) + \hat{L} - \tau((1-\chi)\hat{\lambda}\hat{Z})
\]

The expected second-period income in a regulated environment varies depending on whether the borrowers choose a default or non-default path. If the borrower chooses the honest path, the expected second-period income in a regulated environment becomes:

\[
E[y'_2]^h = (1-\alpha)\bar{y}'_2 + j(A-(1-\chi)\hat{\lambda}\hat{Z}) - \hat{Z}
\]  \quad (3.4)

If the dishonest path is chosen, the expected second-period income in a regulated environment can be represented as:

\[
E[y'_2]^d = [\bar{y}'_2 + j(A-(1-\chi)\hat{\lambda}\hat{Z}) - (1-\kappa)\delta((1-\kappa_1)\bar{y}'_2 + j(A-(1-\chi)\hat{\lambda}\hat{Z}) + K_1((1-(1-\chi)\hat{\lambda})\hat{Z} + \hat{\rho}))]
\]  \quad (3.5)

Following the same utility maximization approach of chapter II, it is possible to define loan demand in a regulated market as

\[
L^D = (r, (y)\delta, \rho, \kappa, \gamma, \chi)
\]  \quad (3.6)

with \(L^D_r > 0, L^D_\gamma > 0, \) and \(L^D_\chi > 0\).
3.1.2 The regulated agricultural lender supply formulation

The lender's profit function in a regulated market is

\[ \Pi = N_k \omega_g (1-\alpha)Z - N_k (1-\gamma) \omega_b \alpha [(1-(1-\kappa)\delta (1-(1-\lambda))\lambda Z - (1-\kappa)\delta F] \]

\[ - N_g (1-\gamma) \omega_b \alpha (1-(1-\kappa)\delta \delta (\delta) - N_k \delta (\omega_b \omega_b L) - N_k \omega_g (1-\alpha) + (1-(1-\gamma) \omega_b \alpha ](1+h)L \]

Equation (3.7) represents the regulatory objective function for a typical agricultural lender that operates in a regulated market.\(^{13}\) The optimal management decisions, once again, can be represented by the selection of \( L, \omega_g, \omega_b, \delta, \rho, \) and \( \lambda \), so that \( \Pi \) in (3.7) is maximized. The first and second-order conditions for a maximum solution are identical in form and implication with those presented in chapter II. A set of optimal values for the decision variables can be obtained when these conditions are satisfied. This optimal solution is obtained with specific values of \( r, h, \kappa, \gamma, \) and \( \chi \) derived from a specific set of regulations. If a new regulation is introduced or an old one is abolished, this solution will no longer be optimal. Thus, it is important to discuss how the optimal solution varies with different values of \( r, h, \kappa, \gamma, \) and \( \chi \). This is the task of the next section.

3.2 COMPARATIVE STATICS

A summary of the possible direct impacts on optimal decision variables of changing exogenous and regulatory parameters is presented in Table 1. At the same time, a summary of the impact of regulations on loan default and rationing is presented in Table 2. The details of the analytical technique used to study the impact of changes on the exogenous and regulatory parameters in the equilibrium loan market is presented in appendix B1.

\(^{13}\) It should be clear that when there is no regulation, i.e., \( \kappa=0, \gamma=0, \) and \( \chi=0, \) the regulatory and basic model are identical.
Table 1

Marginal Direct Effects of Regulations on Optimal Decision Variables.*

<table>
<thead>
<tr>
<th>Exogenous Parameters</th>
<th>Optimal Values of Decision Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\omega_g^<em>$ $\omega_b^</em>$ $\delta^<em>$ $\rho^</em>$ $\lambda^<em>$ $L^</em>$</td>
</tr>
<tr>
<td>$r$</td>
<td>+         +       0     +     +</td>
</tr>
<tr>
<td>$h$</td>
<td>-         +       0     0     -       +</td>
</tr>
<tr>
<td>$\gamma$</td>
<td>-         -       +     +     +       -</td>
</tr>
<tr>
<td>$\kappa$</td>
<td>0         +       -     0     +     -</td>
</tr>
<tr>
<td>$\chi$</td>
<td>0         +       +     0     +     -</td>
</tr>
</tbody>
</table>

* Each entry in the Table indicates the direction of change of the optimal value of one of the decision variables as a result of a change in one of the exogenous and regulatory parameters. For example, the - sign under $L^*$ and across from $h$ means that $\frac{\partial L^*}{\partial h} < 0$.

The impact on type I rationing of changes in the exogenous and regulatory parameters may be examined by totally differentiating Equation (2.38), that is,

$$d(T-I) = dL^D - dL^*$$  \hspace{1cm} (3.8)

where, the first term on the right-hand side is the loan size demand response to changes in the exogenous and regulatory parameters, and the second term is the equilibrium loan response. The impact of changes in the exogenous or regulatory parameters, for instance $r$, on loan-size (or type I) rationing may be written as

$$\frac{\partial(T-I)}{\partial r} = \frac{\partial L^D}{\partial r} - \frac{\partial L^*}{\partial r}.$$  

The impact on type II rationing of changes in the exogenous and regulatory parameters, in turn, may be examined by totally differentiating Equation (2.40) as follows

$$d(T-II) = (1-S)dN_R - N_t dS,$$  \hspace{1cm} (3.9)
where, the first term on the right-hand side is the number of loan requests response (while the acceptance rate is held constant), and the second term is the screening policy response (while the number of loan requests remains constant). Since \( S' \), the optimal acceptance rate, is defined as

\[
S' = \frac{(1-\alpha)\omega_b + (1-(1-\gamma)\omega_b)\alpha}{(1-\alpha)(1-\gamma)\omega_b - \alpha(1-(1-\gamma)\omega_b) - \omega_b \frac{\partial \alpha}{\partial h}}.
\]  

(3.10)

the impact of changing an exogenous or regulatory parameter, say \( h \), on the optimal acceptance rate, may be represented as

\[
\frac{\partial S'}{\partial h} = \frac{[(1-\alpha)\frac{\partial \omega_b}{\partial h} - \alpha(1-(1-\gamma)\omega_b) - \omega_b \frac{\partial \alpha}{\partial h}]}{[(1-\alpha)(1-\gamma)\omega_b - \alpha(1-(1-\gamma)\omega_b) - \omega_b \frac{\partial \alpha}{\partial h}]}.
\]  

(3.11)

The first term on the right-hand side of Equation (3.11) is clearly the screening policy response of management to changes in \( h \) (while the initial probability of loan default \( \alpha \) is held constant). The second term gives the adverse selection response to changes in \( h \) (while the screening policy response remains constant). Thus, changes in the exogenous and regulatory parameters affect the selection rate through its effects on \( \omega_b, \omega_e \), and \( \alpha \).

Finally, the impact of regulations on the number of bad-debt loans (BL) may be analyzed as follows: Since the number of bad-debt-loans is defined as:

\[
BL = N_r(1-(1-\gamma)\omega_b)\alpha,
\]  

(3.12)

the impact of changes in the regulatory or exogenous parameters may be analyzed by totally differentiating this expression.

\[
dBL = (1-(1-\gamma)\omega_b)\omega_b dN_r - N_r(1-\gamma)\omega_b d\omega_b + N_r(1-(1-\gamma)\omega_b) d\alpha,
\]  

(3.13)

where the first term of the right-hand side of this expression represents the borrower's response to an increase in \( r \), the second term indicates the lender's response, and the third term represents the adverse selection effect of increasing \( r \).

Interpretations of the entries in Tables 1 and 2 offer the following propositions:
Table 2

Impact of Regulations on Loan Default and Rationing.*

<table>
<thead>
<tr>
<th>Exogenous Parameters</th>
<th>Optimal Values of Decision Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Loan Default</td>
</tr>
<tr>
<td></td>
<td>BL</td>
</tr>
<tr>
<td>r</td>
<td>+</td>
</tr>
<tr>
<td>h</td>
<td>-</td>
</tr>
<tr>
<td>γ</td>
<td>+</td>
</tr>
<tr>
<td>κ</td>
<td>+</td>
</tr>
<tr>
<td>χ</td>
<td>+</td>
</tr>
</tbody>
</table>

* Each entry in the Table indicates the direction of change of the optimal value of one of the decision variables as a result of a change in one of the exogenous and regulatory parameters. For example, the - sign under S' and across from h means that ∂S'/∂h < 0.

3.2.1 Effects of Changes in the Interest Rate Ceiling in Credit Markets.

In the event that a government regulatory agency increases the ceiling rate of interest, r, in the market the following propositions hold:

1. Increases in r would persuade agricultural lender to reformulate its credit evaluation policy so that a higher selection rate S' would result, when adverse selection response of S' is smaller than its credit evaluation response; if adverse selection response of S' dominates the credit evaluation response, the final effect on S' of increasing r depends on the level of restrictions imposed on the lender's credit evaluation operations. If credit evaluation operations are highly restricted, the selection rate will decrease. Otherwise, it will increase.
2. If \( r \) increases, the agricultural lender will tighten its collection policy in order to recover a larger proportion of the delinquent loans.

3. Increases in \( r \) will persuade the lender to increase collateral requirements.

4. Increases in \( r \) will decrease type I rationing, if the adverse selection effects of \( r \) are unimportant. Otherwise, the effect is ambiguous.

5. Increases in \( r \) will increase type II (or loan-quantity) rationing, if the selection rate response to increases in \( r \) is positive. Otherwise, type II rationing will decrease.

6. Increases in \( r \) will increase the number of delinquent loans (BL), if the adverse selection effects of increasing \( r \) are important. Otherwise, BL will decrease.

3.2.2 Effects of Changes in Lender’s Costs of Funds.

If higher costs of funds prevail in the market, the following propositions hold:

7. If \( h \) increases, the agricultural lender will reformulate its credit evaluation (screening) policy so that a lower acceptance rate will result.

8. If \( h \) increases, the agricultural lender will formulate more stringent collection policies so that a larger proportion of delinquent loans will be recovered.

9. If \( h \) increases, the agricultural lender will reformulate its collateral requirement policy so that a lower level of loan collateralization must be required.

10. Increases in \( h \) will increase type I rationing

11. If \( h \) increases, type II rationing will also increase.

12. Increases in \( h \) will persuade the agricultural lender to reformulate its credit evaluation policy so that a lower number of loans will be granted to bad borrowers, thus the number of bad-debt loans will unambiguously decrease.
3.2.3 Effects of Regulations on Credit-Evaluation Operations.

The imposition of restrictive regulations on the lender's credit evaluation operations lead to the following propositions:

13. Increasing $\gamma$ will limit the lender's ability to evaluate correctly the credit worthiness of the loan applicants. This will result in more loan requests approved from bad borrowers, i.e., higher $(1-\omega^0)$.

14. Increasing $\gamma$ will increase the borrower's loan demand, and will decrease the loan size that the lender is willing to offer, thus type I rationing will increase.

15. Increasing $\gamma$ will increase the number of loan requests, and will induce management to reduce the selection or acceptance rate, hence type II rationing will increase.

16. Increasing $\gamma$ will unambiguously increase the number of bad-debt loans.

3.2.4 Effects of Regulations on Collection Operations

The imposition of restrictive regulations on the lender's loan recovery activities will justify the following propositions:

17. Increasing $\kappa$ will persuade management to relax its collection operations with the result that a smaller proportion of delinquent loans will be recovered.

18. Increasing $\kappa$ will induce management to tighten its credit policy, with the result that a higher proportion of loan requests from bad borrowers will be rejected.

19. Increasing $\kappa$ will persuade the lender to reduce loan size, and as a result type I rationing will increase.

20. Imposing restrictive regulations on the lender's loan recovery activities will increase type II rationing.

21. Increases in $\kappa$ will induce the lender to reformulate his credit evaluation policy such that a smaller proportion of loans will be granted to bad borrowers. How-
ever, increases in $\kappa$ will also increase the number of loans requested. Hence, the number of bad debt loans may either increase or decrease.

3.2.5 Effects of Regulations on Collateral Requirements

If more stringent regulations on collateral requirements prevail in the market, the following propositions may be stated:

22. Increasing $\chi$ will induce management to increase loan recovery efficiency in order to increase the proportion of bad-debt loans collected.

23. Increasing $\chi$ will induce management to reformulate its credit evaluation policy so that a higher proportion of bad borrower's requests will be rejected.

24. Increasing $\chi$ will persuade the lender to decrease optimal loan size, which will result in increasing type I rationing.

25. Increasing $\chi$ will unambiguously increase type II rationing.

26. Increases in $\chi$ will induce the lender to reformulate his credit evaluation policy such that a smaller proportion of loans will be granted to bad borrowers. However, increases in $\chi$ will also increase the number of loans requested. Hence, the number of bad debt loans may either increase or decrease.
CHAPTER IV

EMPIRICAL ANALYSIS

The earlier chapters have outlined a theory of credit rationing and loan default equilibrium in formal rural credit markets under various regulatory environments. On the one hand, the basic unregulated model suggests (a) that the adverse selection effects of increasing costs in the terms of the loan contract are necessary and sufficient conditions for loan-size, or type I, rationing; (b) that the lender's credit evaluation operations are a necessary condition for loan-quantity, or type II, rationing; and (c) that the effectiveness of the lender's credit evaluation operations is essential in reducing the number of defaulting loans.

On the other hand, the regulated model suggests (a) that deregulation of the loan rates of interest \( r \) in rural credit markets will decrease both type I and II rationing, if the adverse selection effects of \( r \) are unimportant; (b) that deregulation of \( r \) will also decrease the number of bad-debt loans, if the adverse selection effects of \( r \) are unimportant and there are no restrictions on the lender's screening operations; and (c) that deregulation of the lender's screening and collection operations, and collateral requirements will unambiguously decrease type I rationing, type II rationing, and the number of bad-debt loans.

The theoretical analysis raises two empirical questions:

1. What are the empirical magnitudes of the impact of changes of the regulatory environment on the endogenous variables?

2. Is the postulated credit market consistent with those observed in LICs?
The first question cannot be answered directly, since there is not any publicly available data on variables such as $\omega_g$, $\omega_p$, $\delta$, and $\alpha$. Hence, a direct measure of these variables is impossible. However, it is possible to examine the response of variables related to those probabilities, such as the acceptance rate (S), type II rationing, and the number of bad-debt loans (BL), given certain assumptions about the relations among those variables.

The second question may be answered through estimation of the impact on credit rationing and loan default of the elements of various regulatory environments in a formal rural credit market in a LIC.

The purpose of this chapter is to test the validity of the model developed in chapter III. The justification for carrying out this analysis is to identify the information base required to achieve more definitive studies in the future, while simultaneously helping to refine and to improve the conceptual framework.

The empirical analysis is carried out at a single institution level. For a number of reasons, it is desirable to test the validity of the theory set forth in chapter III at a single institution level rather than in a market area. In the first place, a policy of active or subliminal discrimination is established or controlled at the bank level; thus a single lending institution analysis is more meaningful and useful than a market study. Furthermore, it is much more difficult to develop an accurate model for a market's loan offer function than a single lender's offer function. Finally, a firm level analysis would avoid some of the problems of data comparability than can be expected in a market area study.

The Agricultural Development Bank of the Dominican Republic (hereafter called the BAGRICOLA) has been chosen as a representative specialized agricultural lending institution in a LIC. The BAGRICOLA is a desirable test case for two reasons:
(i) It is the most important formal agricultural lender in the Dominican Republic, with almost 40 percent of the total agricultural loan portfolio in 1987, and with the most extensive network of branches (32 branches) in the country. During the last decade, however, the participation of the BAGRICOLA in the total agricultural loan portfolio, as most rural credit institutions in LICS, has declined, while its financial viability has substantially deteriorated. Thus, the bank is confronted with the necessity of developing new financial and operational strategies, in order to improve its participation in the credit market and its financial viability, due to the growth of its non-performing (delinquent) portfolio. The questions the bank confronts for the development of new financial and operational strategies are not only important on their own right, but also highlight similar problems for other specialized agricultural lending institutions of LICs.

(ii) Despite the fact that the Government and international donors have intervened repeatedly in BAGRICOLA imposing a number of restrictions on the bank's operations, the bank has been able to develop its own lending strategies with its own resources. This condition allows one to analyze the impact of differing lending on the bank's lending efficiency.

This chapter is divided into five sections. The first section analyzes the evolution of the importance of the participation of the BAGRICOLA in the total agricultural loan portfolio in the Dominican Republic during the 1983-1987 period. A description of the sampling technique with a discussion of the main characteristic of the sample of loans are presented subsequently. The main hypotheses considered in the empirical analysis are presented in the third section with a discussion of the econometric technique set forth in the fourth section. The empirical results are presented in the last section.
4.1 THE AGRICULTURAL DEVELOPMENT BANK OF THE DOMINICAN REPUBLIC (BAGRICOLOA).

The Agricultural Development Bank of the Dominican Republic (BAGRICOLOA), as an agricultural development institution, is not only oriented to provide credit to the agricultural sector, but also to serve as a fundamental instrument of the Government's and international donor's agrarian policies. The Government and international donors have intervened repeatedly in BAGRICOLOA forcing the institution to lend to specific group(s) of rural producers and/or agricultural activities at concessional interest rates and collateral requirements. During the late 1980s, the BAGRICOLOA has experienced major liquidity shortages and operational losses, which have affected the bank's participation in the total agricultural loan portfolio in the Dominican Republic.

During the 1983-1987 period, BAGRICOLOA's share of the agricultural loan market experienced a sharp and sustained decline. As shown in Table 3, the bank's market share declined from 66.3 percent in 1983 to 37.2 percent in 1987. Commercial banks, on the other hand, increased their share from 24.7 percent in 1983 to 45.3 percent in 1987. The development banks, in turn, increased their participation from 9.0 percent in 1983 to 13.6 percent in 1987.

These changing loan market shares were accompanied by an unstable trend in the total agricultural loan portfolio. As shown in Table 4, the banking system's agricultural loan portfolio, measured in 1970 DR$, experienced a declining trend until 1986, when the lowest level of the period was reached (DR$ 108.6 million). A year later, in 1987, the total agricultural portfolio reached its highest since 1983 (DR$ 161.8 million).

The declining share of the BAGRICOLOA portfolio in the banking system's total agricultural loan portfolio appears to be related to: (a) an increase in agricultural loan
# Table 3

Nominal Agricultural Portfolio

Nominal Value of the Agricultural Loan Portfolio of the Banking System in the Dominican Republic, by Type of Institution, 1983-1987. (Million DR $)

<table>
<thead>
<tr>
<th>Year</th>
<th>Value</th>
<th>%</th>
<th>Value</th>
<th>%</th>
<th>Value</th>
<th>%</th>
<th>Value</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(1)</td>
<td></td>
<td>(2)</td>
<td></td>
<td>(3)</td>
<td></td>
<td>(4)</td>
</tr>
<tr>
<td>1. 1983</td>
<td>255.5</td>
<td>66.3</td>
<td>95.2</td>
<td>24.7</td>
<td>34.7</td>
<td>9.0</td>
<td>385.4</td>
<td>100</td>
</tr>
<tr>
<td>2. 1984</td>
<td>243.2</td>
<td>61.6</td>
<td>115.9</td>
<td>29.4</td>
<td>35.5</td>
<td>8.9</td>
<td>394.6</td>
<td>100</td>
</tr>
<tr>
<td>3. 1985</td>
<td>274.3</td>
<td>56.8</td>
<td>146.2</td>
<td>30.2</td>
<td>62.1</td>
<td>12.9</td>
<td>482.6</td>
<td>100</td>
</tr>
<tr>
<td>4. 1986</td>
<td>280.5</td>
<td>47.7</td>
<td>214.4</td>
<td>36.5</td>
<td>92.7</td>
<td>15.8</td>
<td>587.6</td>
<td>100</td>
</tr>
<tr>
<td>5. 1987</td>
<td>388.5</td>
<td>37.2</td>
<td>473.6</td>
<td>45.3</td>
<td>142.4</td>
<td>13.6</td>
<td>1004.5</td>
<td>100</td>
</tr>
</tbody>
</table>


activities by commercial and development banks, and (b) a deterioration of BAGRICO-LA's loan portfolio, due to inflation and arrears problems. As shown in Table 4, the real value of agricultural loans extended by commercial and development banks increased from DR$ 35.8 million and DR$ 13.0 million in 1983, to DR$ 72.3 million and DR$ 22.9 million in 1987, respectively. The BAGRICO-LA's volume of loans declined from DR$ 96.1 million to DR$ 62.7 million during the same period.

The bank, following the Government's agrarian policies, granted loans to rural producers at concessional interest rates, normally below the inflation rate. Thus, it failed to protect the real value of its loan portfolio.
Table 4
Real Agricultural Portfolio

Real Value of the Agricultural Loan Portfolio of the Banking System in the Dominican Republic, by Type of Institution, 1983-1987. (Million of 1970 DR $)

<table>
<thead>
<tr>
<th>Year</th>
<th>Agricultural Bank Value</th>
<th>Agricultural Bank Value %</th>
<th>Commercial Banks Value</th>
<th>Commercial Banks Value %</th>
<th>Development Banks Value</th>
<th>Development Banks Value %</th>
<th>Total Value</th>
<th>Total Value %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 1983</td>
<td>96.1</td>
<td>66.3</td>
<td>35.8</td>
<td>24.7</td>
<td>13.0</td>
<td>9.0</td>
<td>144.9</td>
<td>100</td>
</tr>
<tr>
<td>2. 1984</td>
<td>76.5</td>
<td>61.6</td>
<td>36.4</td>
<td>29.4</td>
<td>11.2</td>
<td>8.9</td>
<td>124.1</td>
<td>100</td>
</tr>
<tr>
<td>3. 1985</td>
<td>62.1</td>
<td>56.8</td>
<td>33.1</td>
<td>30.2</td>
<td>14.1</td>
<td>12.9</td>
<td>109.2</td>
<td>100</td>
</tr>
<tr>
<td>4. 1986</td>
<td>51.8</td>
<td>47.7</td>
<td>39.6</td>
<td>36.5</td>
<td>17.1</td>
<td>15.8</td>
<td>108.6</td>
<td>100</td>
</tr>
<tr>
<td>5. 1987</td>
<td>62.7</td>
<td>37.2</td>
<td>72.3</td>
<td>45.3</td>
<td>22.9</td>
<td>13.6</td>
<td>161.8</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Calculated from Table 3, using the implicit GDP deflator.

Loan default and arrears in the BAGRICOLA loan portfolio have also played a key role in explaining this declining share. The lack of appropriate loan repayment performance measures\(^{14}\) has made it difficult, however, to clearly identify the magnitude and the factors affecting the repayment problems faced by the bank. As shown in Table 5, the loan repayment performance of the bank appears to have improved during this period. The proportion of past due loans fell from 21.1 percent of the portfolio in 1983 to 6.9 percent in 1988. As a result, it has been suggested that loan repayment problems are not a main reason for the declining participation of BAGRICOLA in the system's agricultural loan portfolio. Increasing inflation and the slow down of interna-

\(^{14}\) The loan delinquency indicator is measured by considering the total unpaid amount of past due loans over the total value of the loan portfolio.
tional flows of funds have been pointed out as the most important factors affecting the increasing liquidity problems experienced by BAGRICOLA in recent years.

Table 5

<table>
<thead>
<tr>
<th>Year</th>
<th>Past due (DR Pesos)</th>
<th>Portfolio (DR Pesos)</th>
<th>Default Index (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1983</td>
<td>53,716,257</td>
<td>255,542,211</td>
<td>21.1</td>
</tr>
<tr>
<td>1984</td>
<td>45,296,325</td>
<td>243,190,640</td>
<td>19.9</td>
</tr>
<tr>
<td>1985</td>
<td>45,102,256</td>
<td>272,522,732</td>
<td>16.6</td>
</tr>
<tr>
<td>1986</td>
<td>53,558,211</td>
<td>280,461,565</td>
<td>19.1</td>
</tr>
<tr>
<td>1987</td>
<td>51,160,831</td>
<td>388,462,646</td>
<td>13.0</td>
</tr>
<tr>
<td>1988</td>
<td>43,848,321</td>
<td>633,929,335</td>
<td>6.9</td>
</tr>
</tbody>
</table>


The delinquency indicator utilized by the bank is not adequate, however, for any meaningful analysis of loan repayment performance at BAGRICOLA. The current policy on loan repayment at BAGRICOLA conforms more to the objective of intermittent promoting collection campaigns, to create increasing liquidity for new loan demand, rather than rigorously documenting and analyzing the main dimensions of the loan repayment problems in their own right. In order to analyze the importance of these loan repayment and liquidity problems, a more accurate measurement of loan repayment performance must be adopted. Loan repayment performance must be monitored
by following through time the evolution of the repayment status of loans disbursed during a given period of time.

The declining participation of the BAGRICOLA in the agricultural loan market is just one dimension of the problems faced by the bank during this period. The declining trend of the average loan size is another dimension. As shown in Table 8, the average size per approved loan, measured in 1970 DR$, declined from DR$ 1,936.7 in 1983 to DR$ 1,101.7 in 1987. The average loan size per tarea, in turn, declined from DR$ 28.8 in 1983 to DR$ 20.5 in 1987. The declining average size of loan has been associated more with an increase in the number rather than a fall in the volume of loans granted.

As shown in Table 7, the number of approved loans increased from 31,050 in 1983 to 53,513 in 1987. The number of disbursement increased from 100,306 in 1983 to 182,811 in 1987. In contrast, the volume of approved and disbursed loans declined.

The increasing number of loan operations impacted directly the BAGRICOLA's total operational costs by increasing, on the one hand, expenditures in evaluation and loan processing activities. On the other hand, if the increasing number of loan operations was accompanied by a deterioration in the quality of the bank's screening activities, then expenditures in collection activities must have increased. As the increasing operational costs were not accompanied by an increment in the volume of loans granted, the BAGRICOLA's financial viability deteriorated.

In sum, the BAGRICOLA activity during the 1983-1987 period may be characterized by: (a) a declining participation in the total agricultural loan portfolio; (b) a declining trend in the average size of loans, which is associated with a relative increase in the number of loans and tareas financed; and (c) increasing total operational costs.

15 It is interesting to observe that in average there are approximately 3 disbursement per loan. This, obviously, not only increase the lender's lending transaction costs, but also the borrowers' borrowing transaction costs.
Table 6
Selected Indicators of Loan Activity

Trend of Average Size of Approved Loans and Average Size of Loan per Tarea Financed by the Agricultural Bank in the Dominican Republic During the 1983-1987 Period.

<table>
<thead>
<tr>
<th>Year</th>
<th>Approved loans</th>
<th>Number of Tareas Financed</th>
<th>1970 DR$ per Tarea*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Value** (1970 DR$)</td>
<td>Number (000)</td>
<td>(000)</td>
</tr>
<tr>
<td>1. 1983</td>
<td>60,135,900</td>
<td>31,050</td>
<td>2,089.4</td>
</tr>
<tr>
<td>2. 1984</td>
<td>61,791,100</td>
<td>34,455</td>
<td>2,521.8</td>
</tr>
<tr>
<td>3. 1985</td>
<td>54,415,400</td>
<td>28,787</td>
<td>1,939.8</td>
</tr>
<tr>
<td>4. 1986</td>
<td>37,614,000</td>
<td>18,094</td>
<td>1,571.6</td>
</tr>
<tr>
<td>5. 1987</td>
<td>58,956,000</td>
<td>53,513</td>
<td>2,880.7</td>
</tr>
</tbody>
</table>


* One tarea is equal to 628 m².

** Deflator: Implicit GDP deflator.

which, in turn, affected the financial viability of the institution.
Table 7
Number and Volume of Approved and Disbursed Loans

Selected Indicators of Agricultural Bank Loan Activity in the Dominican Republic during the 1983-1987 Period. (Values in Million of 1970 DR $)*

<table>
<thead>
<tr>
<th>Year</th>
<th>Approved Loans</th>
<th>Disbursed Loans</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Value</td>
<td>Number</td>
</tr>
<tr>
<td>1. 1983</td>
<td>60,135.9</td>
<td>31,050</td>
</tr>
<tr>
<td>2. 1984</td>
<td>61,791.1</td>
<td>34,455</td>
</tr>
<tr>
<td>3. 1985</td>
<td>54,415.4</td>
<td>28,787</td>
</tr>
<tr>
<td>4. 1986</td>
<td>37,614.0</td>
<td>18,094</td>
</tr>
<tr>
<td>5. 1987</td>
<td>58,956.0</td>
<td>53,513</td>
</tr>
</tbody>
</table>


* Deflator: Implicit GDP deflator.

4.2 THE DATA.

To achieve a research design that allows for a comprehensive analysis of the loan repayment problems faced by the Agricultural Development Bank of the Dominican Republic, special emphasis was placed on collecting and constructing the basic primary data set directly from customer dossiers. The data used for this study consists of 3,455 loan applications received in 1987, from 18 BAGRICA branches. These branches represent appropriately the regional variety that characterizes the bank's loan activities. The branches excluded from the sample show similar loan portfolio and

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16 Bani, Ocoa, Barahona, Comendador, Puerto Plata, Santiago, Valverde, Santiago Rodriguez, La Vega, Constanza, San Francisco de Macoris, Salcedo, Rio San Juan, Arenosa, Samana, Hato Mayor, Santo Domingo, and Monte Plata.
client characteristics to those branches selected, thus their exclusion does not compro-
mise the study any way.

The year 1987 was chosen for two pragmatic reasons. First, 1987 was a year of
more normal lending activity than 1986 and 1988. In 1986, BAGRICOLA’s lending
activity was the lowest recorded during the decade. In 1988, the bank received an
important capital contribution from the Government which, obviously, increased the
volume of loans disbursed. Consequently, the year selected, 1987, allows us for a sam-
ple that would reflect more regular market conditions. Second, by studying the bank’s
1987 loan activity it became possible to follow the borrower’s behavior for almost two
years (through August, 1989). This made it possible to more appropriately measure the
loan repayment performance of loans disbursed by the bank that year.

The selected sample of 3,455 loan applications in 1987 represented 8.8 percent of
the total number of loan applications received by the selected sample of branches of
the bank during 1987. During that year, from the 43,251 loan applications processed at
the selected branches, 36,395 applications were approved, and 6,956 were either reject-
ed or withdrawn by the customer.

4.2.1 The Sampling Technique

To maintain a rough balance between accepted, withdrawn, and rejected applica-
tions, the sampling process took 1,114 rejected and 2,228 approved applications. Each
sub-sample was obtained by using systematic random sampling. The sampling design
involved the following procedure for each selected branch.

Step I. Identification of the total number of accepted and rejected applications.

Step II. Division of the total number identified in step I by the target sample size
and rounding of this quotient to the nearest whole number greater than zero.
Step III. Selection at random of any whole number between zero and the quotient obtained in step II.

Step IV. Selection of the initial member of the sample by using the number obtained in step III. For example, if 7 was the random number chosen in step III, the seventh application in the files should be selected as the initial sample observation.

Step V. Completion of the sample by using the quotient obtained in step II to choose each subsequent observation. For example, if the quotient in step II was 10, the 17th eligible application should be chosen as the second observation, the 27th as the third, and so on until the target sample size is achieved.

After selecting the sample, one questionnaire was designed to collect the relevant information. The questionnaire contained 50 questions, where answers were drawn from each selected credit dossier. The questions contained in this questionnaire were grouped into three categories. The first one documented the borrower's characteristics before the bank decided to approve or reject the loan application. This information is associated with the screening process. The second group of questions documents the bank's behavior after the loan was approved but before it was disbursed. The final set of questions documented both the borrower and the lender's behavior after the loan had been disbursed. In particular, I was interested in establishing the nature of the lender's collection activities.

4.2.2 Distribution of the Sample of Loans

Before turning to present the results and analysis of the empirical tests, it is worthwhile to review the main characteristics of the sample of loans disbursed in 1987, with a view of providing the structural framework within which the validity of the model will be tested. The number and volume of loans disbursed by type of borrower, land tenure, investment, source of the funds, collateral, loan size, client credit rating, and repayment performance are used in the following discussion.
(a) Distribution by Type of Borrower

Borrower type consists of four main categories. First, non-reform individuals comprise all those individual borrowers who are not agrarian reform beneficiaries. Second, non-agrarian reform associations refer to groups of borrowers not associated with the agrarian reform process, but organized to obtain loans from the bank. Each member of the association is independently evaluated by the bank before the decision to disburse the loan is made. If any member of the association fails to repay his loan, the association as a whole is considered liable as a defaulting debtor. Third, agrarian reform individuals includes all those borrowers who are beneficiaries of the agrarian reform process with provisional titles to their lands. Fourth, agrarian reform associations correspond to organized groups of agrarian reform beneficiaries.

The total number and volume of disbursed loans and the average loan size are reported in Table 8. Overall, a majority of loans granted in 1987 were granted to non-agrarian reform borrowers (approximately 76 percent of the total number of loans both individuals and associations), which accounted for 60 percent of the total volume disbursed. On the other hand, the 23.1 percent of the number of loans, disbursed to agrarian reform beneficiaries, accounted for 39.3 percent of the total amount disbursed in 1987.

Average loan size for agrarian reform associations was significantly larger than that for non-agrarian reform associations. Agrarian reform associations recorded an average loan size more than three times (DR$ 51,810) as large as that registered for non-agrarian-reform associations (DR$ 16,010). In contrast, the average loan for non-agrarian reform individual borrowers was slightly larger (DR$ 3,220) than that for agrarian reform beneficiaries (DR$ 2,900).
Table 8
Sample Distribution by Type of Borrower

Loans Disbursed in 1987

<table>
<thead>
<tr>
<th>Type of Borrower</th>
<th>Number</th>
<th>%</th>
<th>(000)DR$</th>
<th>%</th>
<th>DR$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Reform Indiv</td>
<td>1702</td>
<td>75.7</td>
<td>5477.2</td>
<td>57.3</td>
<td>3220</td>
</tr>
<tr>
<td>Non-Reform Assoc</td>
<td>17</td>
<td>0.8</td>
<td>272.2</td>
<td>2.8</td>
<td>16010</td>
</tr>
<tr>
<td>Agr Reform Indiv</td>
<td>473</td>
<td>21.0</td>
<td>1373.7</td>
<td>14.4</td>
<td>2900</td>
</tr>
<tr>
<td>Agr Reform Assoc</td>
<td>46</td>
<td>2.0</td>
<td>2383.3</td>
<td>24.9</td>
<td>51810</td>
</tr>
<tr>
<td>Other</td>
<td>10</td>
<td>0.4</td>
<td>60.7</td>
<td>0.6</td>
<td>6070</td>
</tr>
<tr>
<td>TOTAL</td>
<td>2248</td>
<td>100.0</td>
<td>9567.1</td>
<td>100.0</td>
<td>4260</td>
</tr>
</tbody>
</table>

Source: Random Sample

(b) Distribution by Type of Land Tenure

Land tenure status in the sample was also classified into five main categories. First are private land owners with well established property rights. Second are non-agrarian reform occupants of public lands without property rights. Third are tenants, usually rural producers renting or sharecropping in someone else’s lands. Fourth are borrowers whose land has been provided by third parties (usually an extended family member) free of charge. Fifth are agrarian reform owners, with provisional titles.

As shown in Table 9, agrarian reform beneficiaries with provisional titles accounted for 36.5 percent of the total volume of loans granted during 1987. Land owners and borrowers occupying public lands without title accounted for 26.9 and 23.3 percent of the total volume of loans disbursed during 1987, respectively.
An important contrast stands out in Table 9 between the average loan size for agrarian reform beneficiaries and the loan size for land owners and occupants of public lands. Agrarian reform beneficiaries received loans of average size three times (DRS 7,380) larger than those for public land occupants (DRS 2,550), and almost twice as large as that registered for land owners (DRS 4,040). This result is influenced by the relatively large volume of loans granted to large agrarian reform collective groups.

**Table 9**

Sample Distribution by Type of Land Tenure

<table>
<thead>
<tr>
<th>Type Land Tenure</th>
<th>Number</th>
<th>%</th>
<th>(000)DR$</th>
<th>%</th>
<th>DR$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private Owner</td>
<td>637</td>
<td>28.7</td>
<td>2571.6</td>
<td>27.0</td>
<td>4040</td>
</tr>
<tr>
<td>Occupy Public Land</td>
<td>372</td>
<td>39.2</td>
<td>2220.2</td>
<td>23.3</td>
<td>2550</td>
</tr>
<tr>
<td>Tenant</td>
<td>30</td>
<td>1.3</td>
<td>264.0</td>
<td>2.8</td>
<td>8800</td>
</tr>
<tr>
<td>Free-of-Charge Land</td>
<td>191</td>
<td>8.6</td>
<td>621.4</td>
<td>6.6</td>
<td>4300</td>
</tr>
<tr>
<td>Agr Reform Owner</td>
<td>472</td>
<td>21.2</td>
<td>3481.8</td>
<td>36.5</td>
<td>7580</td>
</tr>
<tr>
<td>Other</td>
<td>21</td>
<td>0.9</td>
<td>176.6</td>
<td>1.9</td>
<td>6410</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>2223</td>
<td>100.0</td>
<td>3535.6</td>
<td>100.0</td>
<td>4290</td>
</tr>
</tbody>
</table>

Source: Random Sample

(c) Distribution by Type of Investment

The agricultural activities financed by the BAGRICOLA can be classified into five principal categories. First, non-industrial food crops refer to food crops such as rice, cassava, plantain, potatoes, and vegetables. Second, industrial food crops include tomatoes,
pineapple, melon, and sorghum. Third, agricultural exports comprises activities related to coffee and cacao cultivation. Fourth, livestock refers to the production of beef, milk, pork, and poultry. The last category consists of the purchase of machinery and equipment.

A close look at the number and volume of loans disbursed by BAGRICOLA by type of investment (Table 10) indicates that even though the bank financed a variety of agricultural activities, its loans tended to be fairly concentrated in non-industrial food crops (mainly rice) and livestock activities. Loans for these two purposes accounted for about 90 percent of the total number and 80 percent of the volume. This high concentration of loans in these activities reflects the importance in the cost of living of products such as rice, plantain, beef, milk, and pork. The implied lack of diversification suggests, however, that the bank is very much exposed to the performance of few sectors.

It is also interesting to observe the small average size of loans disbursed for most agricultural activities, specially for livestock (DRS 2,400) and non-industrial food crops (DRS 5,710). This reflects the Government's interest in guaranteeing the access of small farmers to credit.
Table 10
Sample Distribution by Type of Investment

<table>
<thead>
<tr>
<th>Type of Investment</th>
<th>Number</th>
<th>%</th>
<th>(000)DR$</th>
<th>%</th>
<th>DR$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Ind Food Crop</td>
<td>821</td>
<td>36.5</td>
<td>4686.6</td>
<td>49.0</td>
<td>5710</td>
</tr>
<tr>
<td>Indus Food Crop</td>
<td>108</td>
<td>4.8</td>
<td>1050.0</td>
<td>11.0</td>
<td>9720</td>
</tr>
<tr>
<td>Agr Exports</td>
<td>112</td>
<td>5.0</td>
<td>668.7</td>
<td>7.0</td>
<td>5970</td>
</tr>
<tr>
<td>Livestock</td>
<td>1156</td>
<td>51.4</td>
<td>2774.2</td>
<td>29.0</td>
<td>2400</td>
</tr>
<tr>
<td>Mach &amp; Equipment</td>
<td>47</td>
<td>2.1</td>
<td>346.9</td>
<td>3.6</td>
<td>7380</td>
</tr>
<tr>
<td>Other</td>
<td>7</td>
<td>0.3</td>
<td>43.3</td>
<td>0.5</td>
<td>6190</td>
</tr>
<tr>
<td>TOTAL</td>
<td>2251</td>
<td>100.0</td>
<td>9569.7</td>
<td>100.0</td>
<td>4250</td>
</tr>
</tbody>
</table>

Source: Random Sample

(d) Distribution by Source of Funds

The Agricultural Development Bank's funds come from a variety of sources which, for the purposes of this study, have been classified into seven categories. First are the bank's own resources (Plan 1 and Plan 5). The main characteristic of these funds is that they are not subject to any loan targeting criteria. Branch managers are free to choose their clientele. Second are FIDE funds (Fondo de Inversión de Desarrollo Económico). This is a special fund (Plan 19) provided by the Central Bank for agricultural development with the objective of financing predetermined group(s) of small rural producers (mainly agrarian reform beneficiaries). Third are the international sources, which comprise a variety of credit lines from international agencies. One is Plan 37, a special credit line funded by the Inter-American Development Bank (RD$
36.5 million) and the Dominican Government (RD$ 11.0 million). Another one is Plan 3B, a credit line funded with resources provided by the World Bank (US$ 36.6 million), the Dominican Government (US$ 6.59 million), and the final beneficiaries (US$ 2.99 million). This credit line was designed to finance coffee and cacao development projects. Plan 43 is a rotating fund provided by USAID (DR$ 67.0 million) and administered by the Central Bank. This fund was provided to finance investment projects selected by the bank and not subject to any loan targeting criteria. Fourth is a small livestock line of credit, primarily for the financing of pigs, known as the swine fund (Plan 44). This credit line was funded by the Government to provide small rural producers with fixed loans (DR$ 1,000) to finance the purchase of one pregnant sow and feed rations and concentrates to start a small-scale pig production. The intended objective of this fund was to increase the swine cattle population in the hands of poor farm-households and thereby improve their income. In this case, branch managers merely acted as neutral financial intermediaries transferring fixed loans from the Government to predetermined groups of rural producers. The fifth category is the agrarian reform fund (Plan 44). This is a credit line created with Government resources to finance the agricultural and livestock activities of agrarian reform beneficiaries. Sixth are savings accounts funds. This source (Plan 50) uses the funds obtained from the banks deposit mobilization activities. These funds, similarly to own funds, did not impose any restrictions on branch managers' credit evaluation activities. The final category, FIDA (Plan 42) corresponds to a special international credit line funded with resources provided by the Fondo Internacional para el Desarrollo Agropecuario, to finance the agricultural and livestock activities of small rural producers. This credit line represents an extreme case of restrictions on lender's credit evaluation activities. In effect, these funds were allocated not by the bank, but by the Ministry of Agriculture. Thus, in this case, similarly to the swine fund, the bank merely acted as a neutral financial intermediary.
Table 11 clearly indicates that a majority of the loans granted during 1987 were disbursed from the bank's own resources (45.9 percent of the amount). Government-sponsored funds (agrarian reform and swine plans) accounted for 31.7 percent of the total volume disbursed. It is interesting to observe that government funds accounted for about 50 percent of the total number of loans granted. This obviously reflected the interest of the Government in providing credit to small rural producers. This is specially notorious in the case of the small livestock swine fund. International donors provided funds for 14.7 percent of the total volume granted. This clearly reflected the declining participation of international agencies as BAGRICOLA's sources of funds. FIDE, FIDA, and savings accounts funds altogether financed less than 4 percent of the total amount disbursed.

An important contrast stands out in Table 11 between the average size for agrarian reform loans and those granted with resources from the Swine Plan. Loans granted with resources from the agrarian reform fund had an average size about eight times (DR$ 9,480) as large as loans provided with resources from the Swine Plan (DR$ 1,210). This striking difference reflects the importance of loans to finance large agrarian reform groups which in turn retail these resources to individuals within the group. It also reflects the nature of the resources provided for livestock development by the Dominican Government. This fund has been a classic case of social programs designed more to satisfy political objectives than to accomplish production goals. The large number of loans and the small average loan size of the Swine Plan have heavily impacted on the BAGRICOLA's operation costs, thereby affecting its financial viability.
Table 11
Sample Distribution by Source of Funds

<table>
<thead>
<tr>
<th>Source of Funds</th>
<th>N</th>
<th>%</th>
<th>(000)DR$</th>
<th>%</th>
<th>DR$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Own Fund</td>
<td>768</td>
<td>34.1</td>
<td>4395.6</td>
<td>45.9</td>
<td>5720</td>
</tr>
<tr>
<td>FIDE Fund</td>
<td>18</td>
<td>0.8</td>
<td>95.7</td>
<td>1.0</td>
<td>5320</td>
</tr>
<tr>
<td>International</td>
<td>186</td>
<td>8.3</td>
<td>1404.4</td>
<td>14.7</td>
<td>7550</td>
</tr>
<tr>
<td>Swine Fund</td>
<td>896</td>
<td>39.6</td>
<td>1060.9</td>
<td>11.3</td>
<td>1210</td>
</tr>
<tr>
<td>Agr Reform Fund</td>
<td>196</td>
<td>8.7</td>
<td>1857.9</td>
<td>19.4</td>
<td>9480</td>
</tr>
<tr>
<td>Savings Accounts</td>
<td>24</td>
<td>1.1</td>
<td>104.2</td>
<td>1.1</td>
<td>4340</td>
</tr>
<tr>
<td>FIDA Fund</td>
<td>131</td>
<td>5.8</td>
<td>182.9</td>
<td>1.9</td>
<td>1400</td>
</tr>
<tr>
<td>Other</td>
<td>33</td>
<td>1.5</td>
<td>448.8</td>
<td>4.7</td>
<td>13600</td>
</tr>
<tr>
<td>TOTAL</td>
<td>2252</td>
<td>100.0</td>
<td>9570.0</td>
<td>100.0</td>
<td>4250</td>
</tr>
</tbody>
</table>

Source: Random Sample

(c) Distribution by Type of Collateral

Collateral was classified in three main categories: (1) mortgage; (2) crop lien pledges (*prenda*), loans guaranteed with the output of the investment project; and (3) crops in bank custody, loans guaranteed with agricultural produce actually stored under bank control (*pignoraticia*).

Table 12 shows the low quality of the collateral provided by the borrowing clientele. In effect, more than 98 percent of the loans were disbursed with just *prenda* as collateral. Only one percent of the loans were granted with mortgage as collateral. This is a striking result, if we consider the fact that more than 50 percent of the loans were
granted either to land owners or agrarian reform beneficiaries with provisional titles, who allegedly could be in the position of providing a stronger collateral than just a pledge on future agricultural production. The absence of efficient legal and judicial procedures for foreclosing, on the other hand, would make mortgages expensive for both borrowers and the bank and still be of little value as an incentive for repayment.

Table 12
Sample Distribution by Type of Collateral

<table>
<thead>
<tr>
<th>Type of Collateral</th>
<th>Number</th>
<th>%</th>
<th>Volume (OO0)DR$</th>
<th>%</th>
<th>DR$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortgage</td>
<td>31</td>
<td>1.4</td>
<td>654.5</td>
<td>6.8</td>
<td>2110</td>
</tr>
<tr>
<td>Crop Lien Pledges</td>
<td>2210</td>
<td>98.2</td>
<td>8735.4</td>
<td>91.3</td>
<td>3950</td>
</tr>
<tr>
<td>Crop in Bank Custody</td>
<td>10</td>
<td>0.4</td>
<td>179.0</td>
<td>1.9</td>
<td>17900</td>
</tr>
<tr>
<td>TOTAL</td>
<td>2251</td>
<td>100.0</td>
<td>9568.9</td>
<td>100.0</td>
<td>4250</td>
</tr>
</tbody>
</table>

Source: Random Sample

(f) Distribution by Loan Size

The loans granted in 1987 were classified into three loan size categories by using the percentiles of the distribution of loan size. The first category includes the five percent with the largest loans in the overall sample. The second category includes medium-size loans, comprising 90 percent of the sample of loans. Finally, the third category, comprising the remaining five percent, consists of the smallest loans in the sample.

The degree of concentration of the loans disbursed during 1987 can be examined in Table 13. A large proportion of the amount disbursed (53.4 percent) corresponded to
the five percent largest loans, with an average amount of DR$ 46,050. In contrast, the medium loan-size category accounted for 46.2 percent of the total volume granted during 1987, with an average loan size of DR$ 2,180. The small loan-size category, in turn, accounted for 0.32 percent of the total volume of loans disbursed, with an average of DR$ 320 per loan.

Table 13
Sample Distribution by Loan Size

<table>
<thead>
<tr>
<th>Loan Size</th>
<th>Number</th>
<th>Volume (000)DR$</th>
<th>Average DR$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large (DR$14000)</td>
<td>111</td>
<td>5111.4</td>
<td>55.4</td>
</tr>
<tr>
<td>Medium ($459-14000)</td>
<td>2030</td>
<td>4423.9</td>
<td>46.2</td>
</tr>
<tr>
<td>Small (DR$ 459)</td>
<td>111</td>
<td>35.2</td>
<td>0.4</td>
</tr>
<tr>
<td>TOTAL</td>
<td>2252</td>
<td>9570.4</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Source: Random Sample

(g) Distribution by Applicant Credit Rating

Loan applicant's were classified by the branch managers prior to accept or reject the application in six main categories. Applicants classified as excellent, very good, or good, did not have any delinquent loan at the moment of applying for a new loan. Excellent applicants have always paid without arrears, while the very good and good customers could have had some arrears before. Fair customers are clients that normally have their loans with arrears. New are recent bank customers. Finally, loan debtor refers to applicants that had a delinquent loan at the moment of applying for a new loan.
A high proportion are new loan applicants (Table 14). More than 57 percent of the total number of applicants that received loans in 1987 were new applicants. This reflects that high risk exposure faced by the bank. These new applicants are those from the social program funds. As explained above, in this case the lender's credit evaluation operations are absolutely limited by the Government and the FIDA program. The BAGICOLA must accept these new applicants as a condition for receiving these funds. Notice that only 30 percent of the bank's customers are classified as good or better applicants.

### Table 14

Sample Distribution by Client Credit Rating

<table>
<thead>
<tr>
<th>Client Rating</th>
<th>Number</th>
<th>Volume</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>(000)DR$</td>
<td>DR$</td>
</tr>
<tr>
<td>Excellent</td>
<td>190</td>
<td>1297.5</td>
<td>6830</td>
</tr>
<tr>
<td>Very Good</td>
<td>141</td>
<td>1070.5</td>
<td>7590</td>
</tr>
<tr>
<td>Good</td>
<td>300</td>
<td>1482.8</td>
<td>4910</td>
</tr>
<tr>
<td>Fair</td>
<td>144</td>
<td>1632.0</td>
<td>11330</td>
</tr>
<tr>
<td>New</td>
<td>1212</td>
<td>3091.3</td>
<td>2550</td>
</tr>
<tr>
<td>Loan Debtor</td>
<td>84</td>
<td>266.5</td>
<td>3170</td>
</tr>
<tr>
<td>No Rating</td>
<td>49</td>
<td>235.0</td>
<td>4800</td>
</tr>
<tr>
<td>TOTAL</td>
<td>2122</td>
<td>9075.5</td>
<td>4280</td>
</tr>
</tbody>
</table>

Source: Random Sample
(h) Repayment Performance

The loan repayment performance index used by the BAGRICOLA measures the ratio between the unpaid amount of past due loans and the total value of outstanding loans. This is clearly not adequate to analyze loan repayment performance. The index underestimates the true magnitude of the loan repayment problems faced by the institution. On the one hand, the numerator of this ratio includes only the unpaid amount of past due loans that have completed their term maturity and were in default 30 days after the final term due date. Hence, it does not include unpaid installments of medium and long-term loans, rescheduled loans, or loans finally paid with arrears. Rescheduling and arrears are also repayment problems that must be analyzed, since at least in the short-run they may affect the bank's liquidity. On the other hand, the index is not easy to interpret. While the payment of an installment reduces both numerator and denominator by the same magnitude, the disbursement of new loans reduces the index by only increasing the denominator. Thus, portfolio quality may artificially appear to improve with the rapid disbursing of, particularly, new long-term loans.

The repayment performance of these loans as of August 31, 1989 is examined on the basis of a classification of outstanding balances into six categories. First, default refers to the unpaid amount of loans with completed maturity, in arrears at least 30 days after the due date for the final payment (total default), as well as unpaid installments of longer term loans already due for 30 days (partial default). The second class is labelled in litigation, it refers to the amount of unpaid loans in the process of judicial collection. Third, rescheduled loans refer to those for which the repayment period has been extended, without altering the sum of the principal and interest outstanding. Fourth, paid with arrears comprises all loans of completed maturity that were eventually repaid, in full or in part, 30 days after the due date. The fifth category refers to
current loans, for which no payments were yet due. The sixth category refers to loans paid without arrears, for which payment for term installments or completed term loans had been made before or within 30 days of the due date.

Table 15 shows that 44.9 percent of the loans granted in 1987, accounting for 20.1 percent of the total amount, were in partial or total default as of the end of August, 1989. Total or partial default, however, is just one dimension of the loan repayment problem faced by the institution. Payment with arrears and the rescheduling of loans constitute another important dimension of these problems. As reported in Table 15, about 22 percent of the loans disbursed during 1987, accounting for 33 percent of their total value, were paid at least 30 days after the due dates. Furthermore, 5.4 percent of the loans, accounting for 4.2 percent of the amount, had been rescheduled.

Considering not only unpaid installments and completely defaulted loans, but also rescheduled loans and loans paid with arrears, about 73 percent of the number of loans, accounting for 60 percent of the total volume, presented repayment problems. This striking result, obviously, contradicts officials' statement about the magnitude of the loan repayment problem in 1987, affecting in their view only 13 percent of the portfolio (Table 5). Thus, it is clear that these loan repayment problems are not a minor (or declining) issue for the institution. On the contrary, lack of repayment is of primary importance in explaining the increasing liquidity problems experienced by the institution in recent years.
Table 15


<table>
<thead>
<tr>
<th>Repayment Status as of August 1989</th>
<th>Number</th>
<th>Volume</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Default</td>
<td>1010</td>
<td>1921.9</td>
<td>3330</td>
</tr>
<tr>
<td>In Litigation</td>
<td>4</td>
<td>42.2</td>
<td>10660</td>
</tr>
<tr>
<td>Rescheduled</td>
<td>120</td>
<td>392.0</td>
<td>5390</td>
</tr>
<tr>
<td>Paid with Arrears</td>
<td>501</td>
<td>3221.1</td>
<td>6430</td>
</tr>
<tr>
<td>Current</td>
<td>230</td>
<td>1109.2</td>
<td>6200</td>
</tr>
<tr>
<td>Paid without Arrears</td>
<td>381</td>
<td>883.8</td>
<td>2270</td>
</tr>
<tr>
<td>TOTAL</td>
<td>2246</td>
<td>7550.2</td>
<td>4260</td>
</tr>
</tbody>
</table>

* The remaining 22 percent of the volume disbursed corresponds to the amount paid of default, rescheduled, and current loans.

Source: Random Sample

(i) Loan Repayment by Source of Funds

Table 16 shows the percentage distribution of the number and volume of defaulting loans by source of funds. The best repayment performance, measured by the proportion of defaulting loans, for loans disbursed in 1987 was for those funded by the bank's deposit mobilization activities (savings accounts), while the worst repayment performance was for loans funded by resources provided by the Fondo International para el Desarrollo Agropecuario (FIDA), to finance the agricultural and livestock
activities of small rural producers. Only 4.2 percent of the number of loans, accounting for 0.2 percent of the total amount disbursed with funds provided by the savings accounts, were in default, while 74.1 percent of the loans, accounting for 53.7 percent of the total amount disbursed with FIDA funds, were in total or partial default.

Loans funded with the bank's own resources presented a better repayment performance than loans funded with funds provided by international agencies. Approximately 24 percent of the number of loans, accounting for 11.7 percent of the amount disbursed with the bank's own resources, were in default. In contrast, 32.8 percent of loans, accounting for 32.3 percent of the amount disbursed with international resources, were in default by August 30, 1989.

Usually poor recovery stands out for loans from special government funds. In effect, 63.9 percent of the number of loans, accounting for 48.4 percent of the amount disbursed with funds from the swine fund, were in total or partial default. At the same time, 41 percent of the number of loans, accounting for 19 percent of the amount disbursed with agrarian reform funds, were in partial or complete default.

Loans funded through the new savings accounts and the bank's own resources are not subject to targeted lending to selected groups or activities. Branch managers have some degree of flexibility to choose their clientele. International and government-sponsored funds, on the other hand, force bank managers to allocate their funds to targeted groups, regions, or agricultural activities. As shown in Table 16, the repayment performance of targeted loans is notoriously poorer than that of non-targeted loans.

Recently, USAID provided BAGRICOLA with RD$ 67.0 million, to create a special credit line oriented to finance the bank's lending activities without any targeted restriction on the bank's loan allocation operations. Thus, branch managers were able to select their clientele freely. Obviously, a comparison between the status of loans disbursed
Table 16

Repayment Performance by Source of Funds.

Percentage Distribution of the Number and Volume of Bad-Debt Loans as of August 1989 of the Sample of Loans Disbursed in 1987 by Source of Funds.

<table>
<thead>
<tr>
<th>Source of Funds</th>
<th>Bad-Debt Loans as a Percentage of the</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>%</td>
<td>Volume</td>
</tr>
<tr>
<td>Own Fund</td>
<td>24.4</td>
<td>11.7</td>
<td></td>
</tr>
<tr>
<td>FIDE Fund</td>
<td>11.1</td>
<td>7.9</td>
<td></td>
</tr>
<tr>
<td>International</td>
<td>32.8</td>
<td>32.3</td>
<td></td>
</tr>
<tr>
<td>Swine Fund</td>
<td>63.9</td>
<td>48.4</td>
<td></td>
</tr>
<tr>
<td>Agr Reform Fund</td>
<td>41.0</td>
<td>18.6</td>
<td></td>
</tr>
<tr>
<td>Savings Accounts</td>
<td>4.2</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>FIDA Fund</td>
<td>74.0</td>
<td>53.7</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>34.4</td>
<td>4.3</td>
<td></td>
</tr>
</tbody>
</table>

Source: Random Sample

with the international non-targeted loans (USAID) and those disbursed with international targeted funds (IDB, World Bank, and FIDA) is relevant in order to understand the effect of loan targeting on loan repayment problems.

As shown in Table 17, loans disbursed with non-targeted funds provided by USAID showed a remarkably good repayment performance. Only 5.3 percent of the total amount disbursed with these funds in 1987 were in total or partial default by the end of August, 1989, while 38.7, 45.0, and 53.7 percent of the amount disbursed in 1987 with funds provided by the IDB, the World Bank and FIDA, respectively, were in
default. Clearly, these other donors' funds have been provided to finance predetermined default-prone groups of borrowers and agricultural activities, impeding branch managers to select their clientele freely.

Table 17
Repayment Performance by International Source of Funds.

Percentage Distribution of the Number and Volume of Bad-Debt loans as of August 1989 of the Sample of Loans Disbursed in 1987 by International Source of Funds.

<table>
<thead>
<tr>
<th>Source of Funds</th>
<th>Bad-Debt Loans as a Percentage of the</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
</tr>
<tr>
<td>IDB Fund</td>
<td>33.9</td>
</tr>
<tr>
<td>World Bank Fund</td>
<td>50.8</td>
</tr>
<tr>
<td>FIDA Fund</td>
<td>74.0</td>
</tr>
<tr>
<td>USAID Fund</td>
<td>15.2</td>
</tr>
</tbody>
</table>

Source: Random Sample

(i) Summary

A majority of the loans disbursed in 1987 were granted to non agrarian reform beneficiaries. About 60 percent of the total volume corresponded to this category, whereas less than 40 percent was granted to agrarian reform beneficiaries. The bank was particularly inclined to lend to associations of agrarian reform beneficiaries rather than to individual reform beneficiaries. This reflects the bank's attempt to reduce lending costs, by avoiding a large number of loans to small rural producers.
Loans were mainly disbursed for non-industrial food crops such as rice, plantain, cassava, and potatoes. Almost half of the total amount of loans disbursed during 1987 were granted to finance these activities.

The bank's own resources accounted for almost half of the total funds available during that year, while government-sponsored funds (swine and agrarian reform plans) accounted for about 30 percent of the total amount. Internationally sourced funds accounted for less than 15 percent of the total.

A high proportion of the loans were guaranteed with just the output of the investment project (i.e., prenda). In effect, 98 percent of the loans were granted with only the agricultural output as collateral, and less than 2 percent required mortgages.

Moreover, over half of the total volume disbursed during 1987 was granted to less than five percent of the number of borrowers. This is in part related to the bank's attempts to reduce lending costs. Obviously, it is cheaper to lend to individuals organized through associations than to lend to each member separately.

Near 60 percent of the number of loans were disbursed to new customers, with excellent, very good, and good applicants receiving only 30 percent of the number of loans. This result reflects the level of the restrictions imposed by the Government and international donors to the BAGRICOLA's credit evaluation operations.

Finally, about 45 percent of the total number of loans disbursed in 1987 were in total or partial default as of end of 1989. This result indicates the importance of the repayment problems faced by the institution.
4.3 THE HYPOTHESES.

This section outlines a series of hypotheses based on the propositions developed in chapter III. In formulating these hypotheses four main considerations have been made.

1. Since some of the endogenous variables of the model, such as $\omega_e$, $\omega_b$, $\delta$, and $\alpha$, have no publicly available data, the validity of the model cannot be tested by examining the response of these variables to differing regulatory environments. It is possible, however, to test the validity of the model by examining the response of variables related to these probabilities to differing regulatory environments.

2. Only credit evaluation or screening regulations will be considered. The BAGRICOLA's lending funds proceed from a number of sources, which impose different levels of restrictions on the bank's lending operations, especially on its credit evaluation (or screening) activities. Traditionally, the Government and international financial institutions provided BAGRICOLA with funds to finance predetermined group(s) of borrowers and/or agricultural activities, thereby preventing branch managers from selecting their clientele freely. As will be shown below, the different sources of funds have imposed different restrictions on the bank's screening activities, thus making it possible to classify the various sources according to the degree of restriction imposed on the bank's credit evaluation operations.

3. The direct effects of changing the regulatory parameters are assumed to be more important and to dominate indirect effects.

4. The agricultural lender's screening technology is such that for a good borrower, the conditional probability of being accepted is greater than for a bad borrower, i.e., $(1-\omega_b) < \omega_e$.

With these considerations in mind, the following hypotheses will be tested.
More stringent restrictions on the lender's credit evaluation operations will lead to the following responses:

1. Loan size will decrease.
2. Collateral requirements will increase.
3. Type I or loan-size rationing will increase.
4. Type II or loan-quantity rationing will increase.
5. The number of defaulting loans will increase.

4.4 THE ECONOMETRIC TECHNIQUE

During the process of explaining credit rationing and loan default in formal rural credit markets several propositions were stated in chapter III and appendix B1. From appendix B1, the mathematical equivalents of the propositions stated in chapter III are derived from:

\[ Y = -A^{-1}BX = QX, \]

where each element in the matrix Q represents the change of the optimal values of one of the decision variables as a result of a change in one of the exogenous parameters; each element in the vector Y represents the change in one of the decision variables; and each element of the vector X represents the change in one of the exogenous or regulatory parameters. Since this expression is a multi-equation system, the estimation of the elements in Q will require one of the simultaneous equation estimation techniques.

Data limitation problems make simultaneous estimation of the entire system impossible, however. As discussed above, there are not any publicly available data on endogenous variables such as \( \omega_k, \omega_p, \delta, \) and \( \alpha. \) Since the estimation of the impact of different regulatory parameters on these variables is a test of the verification of the regulated model, it is impossible to test directly the validity of the model. Nevertheless,
the acceptability of the model may be tested indirectly by examining the impact of different regulatory parameters on variables related to the above variables, such as type I and II rationing, and bad-debt loans. This is the methodology adopted in this dissertation.

The empirical analysis of the validity of the model specified in chapter II consists of the estimation of the following system:

\[
\text{LOAN}_i = \beta_1(\text{BORR})_i + \beta_2(\text{TERM})_i + \beta_3(\text{REG})_i + \mu_1 \tag{4.1}
\]

\[
\text{COLL}_i = \beta_4(\text{BORR})_i + \beta_5(\text{TERM})_i + \beta_6(\text{REG})_i + \mu_2 \tag{4.2}
\]

\[
(\text{T-I})_i = \beta_7(\text{BORR})_i + \beta_8(\text{TERM})_i + \beta_9(\text{REG})_i + \mu_3 \tag{4.3}
\]

\[
(\text{T-II})_i = \beta_1(\text{BORR})_i + \beta_2(\text{TERM})_i + \beta_3(\text{REG})_i + \mu_4 \tag{4.4}
\]

\[
(\text{DEF})_i = \beta_4(\text{BORR})_i + \beta_5(\text{TERM})_i + \beta_6(\text{REG})_i + \mu_5 \tag{4.5}
\]

\[
i=1,2,\ldots,n(\text{borrowers}).
\]

where

\[
(\text{T-II})_i = \begin{cases} 
1 & \text{If the applicant } i \text{ is accepted} \\
0 & \text{Otherwise.} 
\end{cases} \tag{4.6}
\]

\[
(\text{DEF})_i = \begin{cases} 
1 & \text{If the borrower } i \text{ default} \\
0 & \text{Otherwise.} 
\end{cases} \tag{4.7}
\]

\text{LOAN}_i \text{ is the loan amount disbursed to the ith borrower, COLL}_i \text{ is the monetary value of the collateral required from the ith borrower, (T-I)_i is the magnitude of type I (or loan-size) rationing, as defined in Equation (4.6), (T-II)_i is a dummy variable representing type II (or loan-quantity) rationing, as defined in (2.38), DEF}_i \text{ is the dummy dependent variable defined in (4.7), BORR}_i \text{ represents the vector of the ith borrower's characteristics, TERM}_i \text{ represents the vector of the price and non-price elements of the loan contract offered to the ith borrower, REG}_i \text{ is the vector of the regulatory parameters affecting the loan transaction of the borrower i, the } \beta \text{s are the coefficients to estimate,}
and \( \mu_i \) (i=1,2,3,4,5) is a random disturbance assumed here to follow a normal distribution with a zero mean vector and unknown variance, \( \sigma^2_r \). Moreover, it is assumed that disturbances are independent across observations and exogenous variables. Since the vector of explanatory variables is the same in each equation, it is possible to proceed to estimate each equation of the system separately. Equations (4.1)-(4.3) by Ordinary Least Square (OLS), while (4.4) and (4.5) may be estimated by probit (or logit) analysis.

Since the data come from a stratified cross section, it is reasonable to suspect the presence of heteroscedasticity in the disturbances of the equations. As is well known, the presence of heteroscedasticity in the disturbances will lead to consistent but inefficient estimates and inconsistent estimates of the covariance matrix (Theil, 1971). As a result, faulty inferences will be drawn when testing statistical hypotheses in the presence of heteroscedasticity.

These difficulties may be easily eliminated by performing an appropriate linear transformation of the data (cfr. Harvey, 1981), if the process generating the differing variance is known. If this process is not known, one can approach the true process by testing several alternative processes, by using several well known tests (Goldfeld and Quandt, 1965, Rutemiller and Bowers, 1968, Glejser, 1969, or Harvey, 1976), and performing the linear transformation of the data with the better alternative available. On many occasions, however, as is usual in Economics, it is not possible to assess precisely the nature of the heteroscedasticity, and all the alternatives fail to pass the test. If this is the case, proper inferences cannot be drawn.

In this dissertation the difficulty of imposing the formal structure on the nature of heteroscedasticity is solved by estimating the parameters' standard errors from White's (1980) Heteroscedastic-Consistent matrix estimator. This estimator is a consistent estimator of the covariance matrix, but in contrast to the other tests, it does not rely on a
(possibly incorrect) specific formal model of the structure of the heteroscedasticity. Moreover, as suggested by White, an appropriate test for heteroscedasticity can be obtained by comparing the heteroscedastic-consistent estimator with the homoscedastic estimator; in the absence of heteroscedasticity, both estimators will be about the same; otherwise, they will generally diverge.

4.5 THE RESULTS AND ANALYSIS OF THE EMPIRICAL TESTS

Prior to the formal estimation of the system (4.1)-(4.5), it is important to point out that data limitations did not allow the estimation of Equation (4.4) since the rejected-loan dossiers did not record information related to the source of the requested funds; thus, it was impossible to separate the rejected-loans sample by source of funds. As will be discussed shortly, however, the analysis of the remaining equations provided reasonably strong support for the present formulations.

4.5.1 Variable Definitions

The set of variables to be employed in the empirical analysis was divided into two distinct subsets: (a) the subset of the dependent variables, and (b) the subset of independent variables. The independent variables subset, in turn, was divided into three different types of variables: (b.1) the borrower-characteristic variables, (b.2) the loan-characteristic variables, and (b.3) the regulatory variables.

1. THE DEPENDENT VARIABLES

a. LOAN

It represents the value, in current Dominican Republic Pesos (DPS), of loans.
b. COLL

It represents the value, in current DR$, of the collateral.

c. T-I

It represents the magnitude of loan-size rationing as defined in Equation 2.38.

d. T-II

It represents loan-quantity rationing. It is a dichotomous (dummy) dependent variable that takes on the value of 1 if the loan request has been granted, and zero if the loan requests has been rejected.

e. DEF

It is a dummy variable that takes on the value of 1 if, by the end of 1989, the loan disbursed in 1987 was total or partially overdue at least 30 days after the due date for the final term payment or the installments of longer term loans, respectively.

2. THE INDEPENDENT VARIABLES

a. THE BORROWER-CHARACTERISTIC VARIABLES

i. OWNER: It is a dummy variable that takes on the value of 1 if the applicant is a private land owner with well established land property rights, and zero otherwise.

ii. OCCUPANT: It is a dummy variable that takes on the value of 1 if the applicant is an occupant of public lands non-agrarian reform member and without any property rights, and zero otherwise.

iii. REFORM: It is a dummy variable that takes on the value of 1 if the applicant is an agrarian reform owner with provisional titles on their lands.
iv. TENANT: It is a dummy variable that takes on the value of 1 if the applicant is a renter, sharecropper, or an occupant of lands ceded by third parties (normally an extended family), and zero otherwise.

v. ASSET: It is the value in current DR$ of the total assets declared by the loan applicant at the moment of requesting a loan.

vi. LIABILITY: It is the value in current DR$ of total liabilities declared by the loan applicant at the moment of requesting a loan.

vii. AGE: It is the age of the loan applicant.

viii. CUSTOM: It is a dummy variable that takes on the value 1 if the applicant was considered either as excellent, very good, or good customer by the bank before deciding to grant or reject the loan, and zero if the applicant was new, fair, or had an unpaid loan.

b. LOAN-CHARACTERISTIC VARIABLES

i. FOODC: It is a dummy variable that takes on the value of 1 if the applicant is requested to finance food crop production (such as rice, yucca, plantain), and zero otherwise.

ii. FOODIND: It is a dummy variable that takes on the value of 1 if the applicant is requested to finance agricultural products of industrial use (e.g., tomatoes, pineapple, melon, sorghum), and zero otherwise.

iii. AGEXP: It is a dummy variable that takes on the value of 1 if the applicant is requested to finance agricultural exports (e.g., coffee, cacao), and zero otherwise.
iv. LIVEST: It is a dummy variable that takes on the value of 1 if the applicant is requested to finance beef, milk, pork, or poultry production, and zero otherwise.

v. MACH: It is a dummy variable that takes on the value of 1 if the applicant is requested to finance the purchase of machinery or equipments.

vi. MORTGAGE: It is a dummy variable that takes on the value of 1 if the loan is guaranteed with mortgage and/or agricultural products stored under bank control, and zero if the loan is guaranteed with the output of the investment project (crop lien pledges).

vii. TERM: It is a dummy variable that takes on the value of 1 if the loan is due at least 2 years after being granted.

c. REGULATORY VARIABLES

i. OWNFUND: It is a dummy variable that takes on the value of 1 if the loan is funded with bank's own or savings accounts funds, and zero otherwise. These funds impose no-restrictions on the bank's credit evaluation operations.

ii. AGREFUND: It is a dummy variable that takes on the value of 1 if the loan is funded with funds provided by the Government with the aim of financing the agrarian reform sector or FIDE funds. These funds impose restrictions on the selection of the type of borrower, but not on the type of activity to finance.

iii. INTFUND: It is a dummy variable that takes on the value of 1 if the loan is funded with funds provided by the Interamerican
Development Bank or the World Bank, and zero otherwise. The main characteristic of these funds is that they impose restrictions not only on the selection of the type of borrowers, but also in the type of activity to finance. Hence, this funds can be considered as more restrictive than the funds above described.

iv. AIDFUND: It is a dummy variable that takes on the value of 1 if the loan is funded with resources provided by the Agency for International Development (USAID), and zero otherwise. This fund is a rotating fund administrated by the Central Bank and not subject to any loan targeting criteria.

v. SOCFUND: It is a dummy variable that takes on the value of 1 if the loan is funded with resources provided either by the Government to incentive the purchase by small rural producers of one pregnant sow, or resources provided by the 'Fondo Internacional para el Desarrollo Agropecuario' (FIDA) to finance small rural producers of the region of Monte Plata in the Dominican Republic. These are funds that restrict absolutely the screening activities of the bank. For example, the fund provided to finance the activities of small swine producers was so restrictive that even the size of the loan was determined by the Government and not by the bank. Moreover, in the case of the FIDA was another governmental institution which screened the borrowing population. It is clear, that these are the more restrictive funds among all funds.
Table 18 lists and summarizes the variables used in the empirical study. Table 19 gives the means and standard deviations of these variables.

From Table 19 note that in 1987 a majority of the loans disbursed were disbursed to occupants of public lands without property rights (OCCUPANT). About 39 percent of the total number of loans were granted to these borrowers, whereas 29 percent, 20 percent, and 10 percent were granted to private owners (OWNER), agrarian reform beneficiaries with provisional titles (REFORM), and land renters, sharecroppers, and cultivators in someone else's land (TENANT), respectively.

About 60 percent of loans were disbursed to borrowers unable to provide mortgage as collateral, due to the fact that either they did not have titles (OCCUPANT) or they had only provisional titles (REFORM). Obviously, these borrowers are excluded from the commercial banks' lending activities. In other words, over 60 percent of the bank's customers probably do not have access to other formal source of credit.

Less than 2 percent of the loans were actually granted with mortgage as collateral. This, together with the fact that more than 60 percent of the bank's customers are small farmers without access to commercial banks, explains the high risk exposure faced by the BAGRICOLA. This high risk is reflected, obviously, in the high level of defaulting on loans found in the sample. In effect, 45 percent of the total number of loans in the sample were in total or partial default by the end of 1989.
Table 18

Variables Used in the Empirical Study

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dependent Variables:</strong></td>
<td></td>
</tr>
<tr>
<td>LOAN</td>
<td>Loan size in DR$.</td>
</tr>
<tr>
<td>COLL</td>
<td>Total value of collateral in DR$.</td>
</tr>
<tr>
<td>T-I</td>
<td>Loan request—Loan disbursed in DR$.</td>
</tr>
<tr>
<td>DEF</td>
<td>Dummy = 1 if default.</td>
</tr>
<tr>
<td><strong>Independent Variables:</strong></td>
<td></td>
</tr>
<tr>
<td>OWNER</td>
<td>Dummy = 1 if private owner.</td>
</tr>
<tr>
<td>OCCUPANT</td>
<td>Dummy = 1 if occupant of public lands.</td>
</tr>
<tr>
<td>REFORM</td>
<td>Dummy = 1 if member of agrarian reform sector.</td>
</tr>
<tr>
<td>TENANT</td>
<td>Dummy = 1 if renter, sharecropper, etc.</td>
</tr>
<tr>
<td>CUSTOM</td>
<td>Dummy = 1 if evaluated at least as good applicant.</td>
</tr>
<tr>
<td>ASSET</td>
<td>Borrower’s total assets in DR$.</td>
</tr>
<tr>
<td>LIABEL</td>
<td>Borrower’s total liabilities in DR$.</td>
</tr>
<tr>
<td>AGE</td>
<td>Borrower’s age.</td>
</tr>
<tr>
<td>MORTGAGE</td>
<td>Dummy = 1 if mortgage.</td>
</tr>
<tr>
<td>TERM</td>
<td>Dummy = 1 if loan is due after years of granted.</td>
</tr>
<tr>
<td>OWNFUND</td>
<td>Dummy = 1 if Own or Savings Accounts Fund.</td>
</tr>
<tr>
<td>AGREFUND</td>
<td>Dummy = 1 if Agrarian Reform or FIDE Fund.</td>
</tr>
<tr>
<td>INTFUND</td>
<td>Dummy = 1 if IDE or World Bank Fund.</td>
</tr>
<tr>
<td>AIDFUND</td>
<td>Dummy = 1 if USAID Rotating Fund.</td>
</tr>
<tr>
<td>SOCFUND</td>
<td>Dummy = 1 if Social Program Fund.</td>
</tr>
</tbody>
</table>

*For a more detailed description of each variable see section above.*
Table 19

Means and Standard Deviation of Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dependent Variables:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LOAN</td>
<td>4,036.38</td>
<td>19,647.56</td>
</tr>
<tr>
<td>COLL</td>
<td>13,338.15</td>
<td>51,713.56</td>
</tr>
<tr>
<td>T-I</td>
<td>1,706.26</td>
<td>15,908.31</td>
</tr>
<tr>
<td>DEF</td>
<td>0.45</td>
<td>0.49</td>
</tr>
<tr>
<td><strong>Independent Variables:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASSET</td>
<td>30,910.47</td>
<td>108,594.58</td>
</tr>
<tr>
<td>LIABIL</td>
<td>2,039.55</td>
<td>19,159.73</td>
</tr>
<tr>
<td>AGE</td>
<td>43.83</td>
<td>14.98</td>
</tr>
<tr>
<td>OWNER</td>
<td>0.29</td>
<td>0.45</td>
</tr>
<tr>
<td>OCCUPANT</td>
<td>0.39</td>
<td>0.49</td>
</tr>
<tr>
<td>REFORM</td>
<td>0.20</td>
<td>0.40</td>
</tr>
<tr>
<td>TENANT</td>
<td>0.09</td>
<td>0.30</td>
</tr>
<tr>
<td>CUSTOM</td>
<td>0.28</td>
<td>0.45</td>
</tr>
<tr>
<td>MORTGAGE</td>
<td>0.02</td>
<td>0.13</td>
</tr>
<tr>
<td>TERM</td>
<td>0.10</td>
<td>0.30</td>
</tr>
<tr>
<td>OWNFUND</td>
<td>0.36</td>
<td>0.48</td>
</tr>
<tr>
<td>AGREFUND</td>
<td>0.09</td>
<td>0.29</td>
</tr>
<tr>
<td>INTFUND</td>
<td>0.05</td>
<td>0.22</td>
</tr>
<tr>
<td>AIDFUND</td>
<td>0.03</td>
<td>0.17</td>
</tr>
<tr>
<td>SOCFUND</td>
<td>0.46</td>
<td>0.49</td>
</tr>
</tbody>
</table>

Source: Random Sample.
4.5.2 The System of Equations

The system of equations estimated was the following:

\[ \text{LOAN}_i = A_1 + B_{11} \text{OCCUPANT} + B_{12} \text{REFORM} + B_{13} \text{TENANT} + B_{14} \text{CUSTOM} \quad (4.8) \]
\[ + B_{15} \text{ASSET} + B_{16} \text{LIABIL} + B_{17} \text{AGE} + C_{11} \text{MORTGAGE} + C_{12} \text{TERM} \]
\[ + D_{11} \text{AGREFUND} + D_{12} \text{INTFUND} + D_{13} \text{AIDFUND} + D_{14} \text{SCOFUND} + \mu_1 \]
\[ \text{COLL}_i = A_2 + B_{21} \text{OCCUPANT} + B_{22} \text{REFORM} + B_{23} \text{TENANT} + B_{24} \text{CUSTOM} \quad (4.9) \]
\[ + B_{25} \text{ASSET} + B_{26} \text{LIABIL} + B_{27} \text{AGE} + C_{21} \text{MORTGAGE} + C_{22} \text{TERM} \]
\[ + D_{21} \text{AGREFUND} + D_{22} \text{INTFUND} + D_{23} \text{AIDFUND} + D_{24} \text{SCOFUND} + \mu_2 \]
\[ (T-1)_i = A_3 + B_{31} \text{OCCUPANT} + B_{32} \text{REFORM} + B_{33} \text{TENANT} + B_{34} \text{CUSTOM} \quad (4.10) \]
\[ + B_{35} \text{ASSET} + B_{36} \text{LIABIL} + B_{37} \text{AGE} + C_{31} \text{MORTGAGE} + C_{32} \text{TERM} \]
\[ + D_{31} \text{AGREFUND} + D_{32} \text{INTFUND} + D_{33} \text{AIDFUND} + D_{34} \text{SCOFUND} + \mu_3 \]
\[ \text{DEF}_i = A_4 + B_{41} \text{OCCUPANT} + B_{42} \text{REFORM} + B_{43} \text{TENANT} + B_{44} \text{CUSTOM} \quad (4.11) \]
\[ + B_{45} \text{ASSET} + B_{46} \text{LIABIL} + B_{47} \text{AGE} + C_{41} \text{MORTGAGE} + C_{42} \text{TERM} \]
\[ + D_{41} \text{AGREFUND} + D_{42} \text{INTFUND} + D_{43} \text{AIDFUND} + D_{44} \text{SCOFUND} + \mu_4 \]

The variables are defined in section above. The B, C, and D are parameters to estimate, and the \( \mu \) are the error terms, which are assumed to be well behaved.

4.5.3 The Results

Tables (22)-(28) in the appendix to this chapter present the computed heteroscedastic and homoscedastic-consistent standard errors. As shown, both estimators differ enormously, thereby suggesting the presence of heteroscedasticity in the disturbances of the model. Inferences of the empirical estimation are drawn from the heteroscedastic-corrected model. The regression coefficient estimates are summarized in Table 20.

The first stage of the analysis examines the coefficient estimates of borrower- and loan-characteristics variables. Since occupants of public lands without property rights
Table 20

Regression Coefficient Estimates

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>LOAN (OLS)</th>
<th>COLL (OLS)</th>
<th>T-I (OLS)</th>
<th>DEF (PROBIT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OCCUPANT</td>
<td>-0.79</td>
<td>-1135.7</td>
<td>-647.5</td>
<td>0.6E-01</td>
</tr>
<tr>
<td></td>
<td>(-1.7)**</td>
<td>(-0.5)</td>
<td>(-1.7)**</td>
<td>(0.9)</td>
</tr>
<tr>
<td>REFORM</td>
<td>2.88</td>
<td>-1507.6</td>
<td>696.6</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>(1.2)</td>
<td>(-0.7)</td>
<td>(1.1)</td>
<td>(3.3)****</td>
</tr>
<tr>
<td>TENANT</td>
<td>0.66</td>
<td>-69.5</td>
<td>1109.6</td>
<td>-0.12</td>
</tr>
<tr>
<td></td>
<td>(0.8)</td>
<td>(0.03)</td>
<td>(1.5)*</td>
<td>(-1.1)</td>
</tr>
<tr>
<td>CUSTOM</td>
<td>1.13</td>
<td>4582.9</td>
<td>1228.3</td>
<td>-0.41</td>
</tr>
<tr>
<td></td>
<td>(1.3)*</td>
<td>(2.4)***</td>
<td>(2.2)**</td>
<td>(-5.2)****</td>
</tr>
<tr>
<td>ASSET</td>
<td>0.25E-04</td>
<td>0.15</td>
<td>0.02</td>
<td>-0.6E-06</td>
</tr>
<tr>
<td></td>
<td>(2.3)***</td>
<td>(1.5)*</td>
<td>(2.3)**</td>
<td>(-1.6)*</td>
</tr>
<tr>
<td>LIABIL</td>
<td>0.16E-03</td>
<td>0.16</td>
<td>0.10</td>
<td>0.4E-06</td>
</tr>
<tr>
<td></td>
<td>(1.6)*</td>
<td>(0.6)</td>
<td>(2.9)***</td>
<td>(0.2)</td>
</tr>
<tr>
<td>AGE</td>
<td>-0.17</td>
<td>-156.7</td>
<td>-89.7</td>
<td>-0.4E-02</td>
</tr>
<tr>
<td></td>
<td>(2.6)****</td>
<td>(-2.3)***</td>
<td>(-2.7)***</td>
<td>(-2.2)***</td>
</tr>
<tr>
<td>MORTGAGE</td>
<td>7.14</td>
<td>41486.0</td>
<td>10425.0</td>
<td>0.38</td>
</tr>
<tr>
<td></td>
<td>(2.4)***</td>
<td>(1.6)*</td>
<td>(3.4)***</td>
<td>(1.2)</td>
</tr>
<tr>
<td>TERM</td>
<td>1.16</td>
<td>4337.3</td>
<td>1570.1</td>
<td>-2.58</td>
</tr>
<tr>
<td></td>
<td>(2.0)**</td>
<td>(0.9)</td>
<td>(2.5)***</td>
<td>(-10.5)****</td>
</tr>
<tr>
<td>AGREFUND</td>
<td>1.88</td>
<td>9133.9</td>
<td>5140.6</td>
<td>0.17</td>
</tr>
<tr>
<td></td>
<td>(0.6)</td>
<td>(2.1)***</td>
<td>(2.9)***</td>
<td>(1.4)*</td>
</tr>
<tr>
<td>INTFUND</td>
<td>-0.43</td>
<td>23836.0</td>
<td>1326.1</td>
<td>1.04</td>
</tr>
<tr>
<td></td>
<td>(-0.3)</td>
<td>(2.9)***</td>
<td>(1.2)</td>
<td>(6.6)***</td>
</tr>
<tr>
<td>USAID</td>
<td>-1.29</td>
<td>19728.0</td>
<td>616.1</td>
<td>-0.24</td>
</tr>
<tr>
<td></td>
<td>(-1.2)</td>
<td>(0.9)</td>
<td>(0.6)</td>
<td>(-1.1)</td>
</tr>
<tr>
<td>SOCPFUND</td>
<td>-4.01</td>
<td>-4354.2</td>
<td>-2812.4</td>
<td>1.09</td>
</tr>
<tr>
<td></td>
<td>(-2.4)***</td>
<td>(-1.0)</td>
<td>(-5.8)****</td>
<td>(15.7)****</td>
</tr>
<tr>
<td>INTERCEPT</td>
<td>11.37</td>
<td>12962.0</td>
<td>7259.9</td>
<td>-0.3</td>
</tr>
<tr>
<td></td>
<td>(2.8)****</td>
<td>(1.7)**</td>
<td>(4.4)***</td>
<td>(-2.8)****</td>
</tr>
</tbody>
</table>

R-SQUARE  | 0.12      | 0.22      | 0.26      |
F-STAT(13, 2214)  | 25.98    | 48.59    | 61.24    |
LOG-LIKELIHOOD | -1173.8 |

* t-ratio significant at 20 percent level.
** t-ratio significant at 10 percent level.
*** t-ratio significant at 5 percent level.
**** t-ratio significant at 1 percent level.

Standard errors computed from Heteroscedastic-Consistent Matrix (White,1980).
(OCCUPANT) are the smallest borrowers (in terms of asset size) in the sample, they would be expected to receive smaller loans, and be required to provide more (or stronger) collateral than private owners, agrarian reform beneficiaries, and tenants. It would also be reasonable to expect that this group of borrowers would be the more rationed (in terms of loan size), and the more delinquent group in the sample. The empirical analysis confirms the expectation of OCCUPANT receiving smaller loans than other borrower types. However, contrary to these expectations, OCCUPANT borrowers are less rationed than other groups, and less delinquent than the members of the agrarian reform sector (REFORM). The OCCUPANT coefficients, as shown in Table 20, indicate that, while the size of loans disbursed to occupants of public lands was, as predicted, significantly smaller than loans disbursed to private owners (OWNER), type I (or loan-size) rationing and the proportion of defaulting loans, were smaller and similar to those of private owners, respectively.

One possible explanation for the low level of type I rationing with respect to OCCUPANT is the fact that the BAGRICOLA, as a developing lending institution, is forced to provide small rural producers with loans of fixed size in advance of demand, following the supply leading finance strategies of the Government.

The similar proportion of bad-debt loans of OCCUPANT and OWNER is not an indication of a good loan repayment behavior of OCCUPANT. It is more an indication of a poor loan repayment behavior by private owners, possibly due to the poor quality of collateral required by the bank. Note in Table 20 that there is not statistically significant difference in the volume required as collateral among all borrower types.

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17 Recall that more than 98 percent of loans are granted with just crop lien pledges as collateral.
The CUSTOM and the MORTGAGE coefficients reflect two interesting results. In the first place, the BAGRICALA management appears to be able to successfully differentiate good from bad borrowers. In effect, borrowers classified as good (CUSTOM) in the sample received larger loans, and had a significantly better loan repayment performance than those classified as bad borrowers. This suggests that the BAGRICALA's credit evaluation or screening technology is quite efficient. This shows the inappropriateness of restrictions on the BAGRICALA's screening operations.

On the other hand, while the size of loans guaranteed with mortgage as collateral (MORTGAGE) was larger than those guaranteed with crop lien pledges, the former were slightly more delinquent. This result suggests that collateral cannot serve as a signalling mechanism for separating good from bad loan risks.

An important result stands out in Table 20. The coefficient of the variable ASSET is negative and moderately significant in DEF equation. This result indicates that larger farmers (as measured by asset size) are less delinquent than smaller farmers, thereby contradicting some empirical results found elsewhere (see Montiel, 1983). This result, however, confirms the theoretical analysis of section 2.1.5. In that section, I argued that if there exists penalty costs, as effectively they do in the BAGRICALA, larger farmers will be compelled to behave more honestly than smaller farmers.

The second stage of the analysis entails the interpretation of the coefficients of the regulatory variables. Before to start analyzing the influence of each regulatory variable on the lender's decision, I tested the importance of regulations on lender's decisions through an F test for the LOAN, COLL, and TI equations, and a chi-square test for the

---

18 Obviously, branch managers as shown above are able to recognize a variety of classes; however, to facilitate our analysis we have identified just two classes.

19 The explicit penalty costs on overdue loans are between 3 and 4 percent of the unpaid balance. It is interesting to note that implicit penalty costs, such as lower credit rating, may probably be a better deterrent for more honest behavior than explicit behavior.
DEF equation. As we observe below, regulations are very important factors affecting lender's decisions, and more importantly affecting loan default. In each case, the statistic is significant at least at the five percent level.

F and Chi-Square tests.

<table>
<thead>
<tr>
<th>TEST</th>
<th>LOAN</th>
<th>COLL</th>
<th>TI</th>
<th>DEF</th>
</tr>
</thead>
<tbody>
<tr>
<td>F Test (4, 2214)</td>
<td>7.3</td>
<td>13.8</td>
<td>28.9</td>
<td></td>
</tr>
<tr>
<td>Chi-Square (13)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>158.2</td>
</tr>
</tbody>
</table>

The restricted model is without regulatory parameters.

Figures in parenthesis are degrees of freedom.

The results are presented in Table 21. Twelve out of sixteen signs are correct and significantly predicted with only one significant but incorrect sign. An explanation (or attempt thereof) for the inconsistent sign will be given later. The remaining wrong signs are not statistically significant.

As discussed above, funds provided by the government to finance agrarian reform beneficiaries (AGREFUND) and by international financial institutions (INTFUND), in contrast to the bank's own funds (OWNFUND), impose a number of restrictions on the bank's credit evaluation and customer-selection operations. Hence, from the propositions in chapter III, it would be reasonable to expect that loans funded with the more restrictive sources (i.e., AGREFUND and INTFUND) be smaller in size, require more collateral, and be more delinquent than loans funded with OWNFUND. As shown in Table 21, the model predicted correctly almost all the signs. It failed only in predicting the sign of AGREFUND and INTFUND in the LOAN equation. Effectively, as shown in table
the sign obtained for these variables are not statistically significant. This indicates that the sizes of AGREFUND and INTFUND loans are not statistically different from those from OWNFUND loans, thereby suggesting the existence of loan-size restrictions on the bank’s lending activities.

Table 21

Predicted and Observed Signs of Regulatory Parameters.

The signs of each regulatory parameter are compared with those of the less regulated (or unregulated) parameter (OWNFUND).

<table>
<thead>
<tr>
<th>DEPENDENT VARIABLE</th>
<th>AGREFUND</th>
<th>INTFUND</th>
<th>AIDFUND</th>
<th>SOCFUND</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
</tr>
<tr>
<td>1. LOAN</td>
<td>-</td>
<td>0</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>2. COLL</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>3. T-I</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>4. DEF</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

Entries in the Table indicate the direction of change for the different endogenous variables. For example, the - sign under column 1 and across from row 1 means that loans funded with AGREFUND should be smaller than those funded with OWNFUND. The 0 sign under column 2 and across row 1 means that the empirical analysis indicates that the size of loans granted with funds from AGREFUND are not statistical different from those granted with OWNFUND.

* Indicates an incorrect but significant sign.
A contrast stands out between the non-restrictive USAID Rotating Fund and the more restrictive funds mentioned above. Since AIDFUND, contrary to AGREFUND and INTFUND, is not subject to any targeting objective, it would be reasonable to expect that loans funded with AIDFUND would be similar in size, collateral requirements, loan-size rationing, and level of default than OWNFUND loans. Effectively, as shown in Table 21, the sign of AIDFUND was statistically not different from OWNFUND, as expected.

Finally, the results obtained for SOCFUND indicate the special nature of funds provided by the Government and/or international agencies. In effect, as detailed in the description of the variables, this fund consists of two special funds. One is a small livestock credit line designed to provide DRS 1,000 to each small swine producer customer of this credit line. The other is an international credit line (FIDA) oriented to finance the activities of small rural producers in a particular region of the country (Monte Plata). The common characteristic of these two credit lines is that they are so restrictive, that the bank merely acts as a neutral financial intermediary transferring these funds to already predetermined groups of borrowers. In other words, the bank can neither pursue one of its more essential tasks, that of information analyzer, nor can establish the loan contract terms. It is the Government or the international donor who selects the client and determines the size of the loan, the interest rate, collateral requirements, and in many the loan recovery strategies. Consequently, it would not be unreasonable to expect that loans funded with SOCFUND be less rationed in terms of loan size, thereby justifying the significant but negative sign obtained for SOCFUND in the T-f equation in Table 20.

It is important to recognize that the nature of the Social Program Fund is different from the other sources of funds; it is more a subsidy than a credit line. This suggests
that agricultural development banks are financial institutions acting as neutral financial intermediaries, transferring resources of government and/or international donor social programs, on the one hand, and acting as a non-neutral financial intermediary, attempting to reduce risks of loan default by analyzing relevant information, on the other hand. It is clear then, that agricultural development banks cannot be analyzed and/or evaluated without separating these two, obviously contradictory, activities; as a neutral and non-neutral financial intermediary.
CHAPTER V
SUMMARY AND CONCLUSIONS

This dissertation has attempted to develop meaningful theories of regulated agricultural credit markets, to further the understanding of the main economic aspects, credit rationing and loan repayment performance, of these markets and to provide the much needed theoretical basis for empirical investigations.

To accomplish the first objective, an attempt was made

1. to develop a basic theory of equilibrium credit rationing and loan default in an unregulated market with asymmetric information problems and a non-neutral lender using differing types of risk-reducing technologies, and

2. to provide a theoretical analysis of the impact of regulations on credit rationing and loan default in these markets.

The basic valuation model presented in chapter II examined the interaction between a typical agricultural lender and an agricultural borrowing population, in an uncertain and imperfect-information two-period world. Borrowers are farmers deciding how to finance a one-period investment project. The typical borrower’s choice is a two-step choice. First, the borrower must decide whether to self-finance the project or to borrow from an agricultural lender. If he decides to borrow, he must decide whether or not to default. Each borrower’s choice is based upon the expected utility associated with the cash flows from each choice.
The agricultural lender, in turn, is a profit-maximizing financial intermediary formulating goals and policy guidelines for its credit evaluation (screening) and collection technologies, and providing incentives in order to reduce the risk of loan default. The agricultural lender’s task is three-fold. The first task is to dissuade bad applicants from requesting loans, by providing negative incentives, such as rigorous loan recovery procedures and stringent penalty conditions that would apply in the case of default. If the first task fails, the lender must attempt to separate good from bad applicants from the remaining applicants’ pool, by formulating goals and policy guidelines for its credit evaluation operations or signalling mechanisms. Finally, the lender must attempt to collect from bad borrowers that mistakenly received loans by formulating goals and policy guidelines for its collection operations.

The equilibrium analysis of the basic unregulated model led to the following conclusions:

1. Type I, or loan-size rationing arises as a result of the existence of asymmetric information problems. The existence of adverse selection problems in rural credit markets makes the inherent or initial (determined by the environment) risk of loan default (i.e., the quality of the loan) to be augmented by increasing interest rates and loan size. Thus, an increase in loan size, for instance, may change the risk of loan default, and this additional risk cannot be compensated by an increase in interest rates. This reflects the non-homogeneous good character of loans, a necessary and sufficient condition for type I rationing.

2. Type II, or loan quantity rationing arises when the lender, after screening and classifying loan applicants, is unable to offer to some class(es) of borrowers profitable loan contracts. It is shown that screening is a necessary but not a sufficient condition for type II rationing.
3. Incentives and signalling mechanisms are substitute technologies for screening. Incentive mechanisms, such as penalties, will dominate screening if borrowers know with certainty their future income. Collateral will serve as a quality signal, and hence will reduce the value of screening only if: (a) bad applicants have insufficient wealth to offer the amount of collateral required; (b) the cost of collateralization is less for good than for bad applicants; or (c) asset holdings are positively correlated with income. If neither of these three conditions hold, collateral will not serve as a signal of the borrowers' repayment abilities.

4. In equilibrium, the number of bad-debt loans is associated with the effectiveness of the lender's screening technology, the initial risk of loan default, and the effects of interest rate, loan size, and collateral requirements on this initial risk (adverse selection effects). More rigorous screening procedures, and/or lower initial risks of loan default and adverse selection effects will decrease the number of defaulting loans.

Chapter II examined how the equilibrium of the the basic valuation model is affected when regulations are introduced into the market. From the theoretical analysis of the regulated model the following conclusions were drawn:

1. If the adverse selection effect of interest rates is unimportant, deregulation of the loan rate of interest will persuade the lender to increase the optimal loan size and the optimal applicants' acceptance rate. Since the loan demand will decrease with increasing loan rates of interest, type I and II rationing will unambiguously decrease with deregulation of the interest rate. On the other hand, if adverse selection effects are important, the impact of deregulations of loan rates of interest on type I and II rationing will be ambiguous.
2. Deregulation of interest rate may reduce type IIrationing even in the case of strong adverse selection problems, if the lender is not constrained in his credit evaluation operations. The lender may oppose the adverse selection effect of increasing interest rates by reformulating his credit evaluation operations, so that a larger proportion of loans would be granted to good applicants and rejected for bad applicants.

3. Increases in the agricultural lender's cost of funds will induce the lender to reduce the optimal loan size and the applicants' acceptance rate, without affecting loan demand. Hence, type I and II rationing will increase.

4. Deregulation of the lender's credit evaluation and loan-recovery activities, and the capacity to repossess collateral will unambiguously decrease type I and type II rationing.

5. Deregulation of the lender's credit evaluation activities will decrease the number of loans granted to bad applicants, thereby decreasing the proportion of bad-debt loans.

6. Deregulation of the lender's collection operations and his capacity to repossess collateral will induce potential defaulters to leave the credit market. Hence, the number of loan defaulters will decrease.

Finally, in order to test the validity of the proposed regulated model, an empirical analysis of a large sample of loans was undertaken. The empirical results implied strong support for many of the hypotheses put forth in the model.

1. It was found that the Agricultural Development Bank of the Dominican Republic (BAGRICOLA) acts as a neutral as well as a non-neutral financial intermediary, depending upon the source of the lending funds. If the funds proceed from government and/or international social programs, the bank merely acts as a
neutral financial intermediary, transferring these resources to predetermined
group(s) of rural producers. If the funds proceed from other sources (own
resources, other government and/or international funds, savings accounts), the
bank acts as a non-neutral financial intermediary, allocating these funds by
using risk-reducing technologies such as screening mechanisms.

2. It was found that if the bank acts as a non-neutral financial intermediary, credit
evaluation regulations will consistently increase collateral requirements, type I
or loan-size rationing, and the number of defaulting loans. If, on the contrary,
the bank acts as a neutral financial intermediary, type I rationing will be smaller,
than when the loans are granted with funds from unregulated sources, but
the proportion of delinquent loans will be much higher.

3. The empirical results also support the hypothesis that collateral cannot serve as
a signal, and that smaller farmers (in terms of asset size) will be more delinquent,
when there exist well established penalty costs.

4. It was also found that the bank consistently evaluated as good customers those
who at the end presented the best repayment performance.

5. Finally, the empirical analysis suggests that any financial development institu-
tions in LICs must be evaluated as a neutral as well as a non-neutral financial
intermediary. It is important to recognize that the lender task as a neutral finan-
cial intermediary is completely different in nature to that as a non-neutral
financial intermediary, thus evaluating the lender without considering this
important aspect will lead to inconclusive or erroneous conclusions about the
operational efficiency and/or financial viability of the institution.

Concluding Remarks and Recommendations for further Analysis.
As would be expected in any research on a topic of such a recent vintage, it would certainly be an exaggeration to claim that the preceding analysis exhausted the subject. It has been shown, nevertheless, that equilibrium credit rationing and loan default will exist under certain circumstances in formal rural credit markets. It has been shown, as well, that the loan market equilibrium conditions in a regulated environment cannot be the same as in an unregulated environment. The loan market equilibrium cannot remain the same if a new regulation is introduced or an old one is abolished.

Although the results of the empirical analysis of the proposed regulated model were quite conclusive, it is advisable to extend the theoretical as well as the empirical analysis in several different directions.

1. One of the shortcomings of the theoretical model developed in chapters II and III is its static character. In reality, it can be observed very often that the relationship between the lender and most of its clients extends over many periods. Thus, the model should be extended to several periods, in order to consider this customer-lender relationship.

2. Other important aspect to consider in future research are the linkages of rural credit markets with other markets. It is reasonable to think that regulations in other markets would affect the borrower's repayment capacity and the lender's ability of appropriately evaluating the risk of loan default.

3. Another important extension is to consider the lender's cost of funds as an endogenous variable. It is also reasonable to argue that the lender's efficiency in selecting its clientele and collecting from loan defaulters would induce depositors, the Government, and international donors to increase their flow of funds and/or decrease the lender's cost of funds.
4. It would seem to be particularly useful to extend the empirical analysis to several LICs so that the degree of robustness of the estimation could be determined.

5. An extension of the empirical analysis to several years and different financial institutions would be important, in order to test the importance of adverse selection problems in rural credit markets.

It is hoped that the present dissertation has succeeded in stimulating the interest of other scholars in the theoretical as well as the empirical development of equilibrium credit rationing and loan default in formal rural credit markets. I certainly have succeeded in convincing myself that I have not reached the end, but the beginning of an interesting line of theoretical and empirical research that promises a better understanding of the lender-borrower relationship in rural credit markets. It is also my hope that this study may help lenders and governments in LICs, as well as international donors, in formulating more relevant policy strategies to allow formal rural financial intermediaries to become more financially viable and self-sustaining.
Appendix A
APPENDIX TO CHAPTER II

A1. ISO-UTILITY CURVE PROPERTIES

The properties of the expected iso-utility curves may be shown as follows: Denote the value at which the utility of the self-financing decision ($U^0$) becomes larger than the utility of the borrowing decision ($U^r$), for a given $L$, by $r^0$. Differentiation of Equation (2.18) with respect to $r$ gives

$$U_r = \begin{cases} -U^0_L & \text{as } r < r^0(L) \\ 0 & \text{as } r \geq r^0(L) \end{cases}$$ (A.1)

Now, for $r < r^0(L)$ we can define a function $\theta(L;U^0)$, which for given $L$ indicates the value of the loan rate factor that corresponds to the level of expected utility $U^0$. In the honest borrowing case we have

$$U^0 = [\gamma_1 + L + J(A-L) - \tau(1+\theta L;U^0)L]$$ (A.2)

Proposition (1) follows from the fact that $U_r < 0$ for $r < r^0(L)$, i.e., higher expected iso-profit curves correspond to lower levels of utility ($U$). Proposition (2) may be proven as follows: First, implicitly differentiate Equation A.2 with respect to $L$ and rearrange terms to obtain

$$\frac{\partial r}{\partial L} = -\frac{U_L}{U_r}$$ (A.3)

Notice that whenever $U_L = 0$ (the interior solution) the slopes of the expected iso-utility curves are zero in the $r$-$L$ space. Second, in order to determine the slopes of the expect-
ed iso-utility curves in the neighborhood of \( L^D \) implicitly differentiate Equation A.2 with respect to \( L \). After some manipulation we obtain

\[
\frac{\partial^2 r}{\partial L^2} = -\frac{U_{1L}}{U_r} \left[ \left( \frac{U_{1L}U_{rL} - U_{1L}U_{rr}}{(U_r)^2} \right) \frac{\partial r}{\partial L} \right]
\]

which is unambiguously negative for \( U_r = 0 \). Hence, the expected iso-utility curve changes sign at the point intersection with the demand curve (see Figure 1). If it did otherwise, then this would be a point with a zero first derivative and a positive second derivative, which is ruled out by Equation (A.1). The characteristics of dishonest borrowers' iso-utility curves are similar to those of honest borrowers, and may be derived similarly.

A2. ISO-PROFIT CURVE PROPERTIES.

The main properties of the lender's iso-profit and offer curves, given the optimal values of the other endogenous variables, are proven following Keeton [1979]. In order to make the analysis as simple as possible, these curves are derived ignoring collection and screening operational costs (i.e., \( \omega_g = 1 \) and \( \omega_b = \delta = \rho = \lambda = 0 \)). Given the assumptions specified above, the zero-informational lender's expected profits from an individual loan (\( \pi \)) may be formalized as

\[
\pi(r, L, h) = (1-\alpha)(1+r)L - (1+h)L = U_r(r, L) - (1+h)L
\]

Provided that \( \pi_{1L} < 0 \), Equation (A.5) defines a function \( L^\pi(r, h) \) indicating for each \( r \) and \( h \) the value of \( L \) that maximizes \( \pi(r, L, h) \). Following Jaffee and Modigliani [1969] we shall call the locus \( L^\pi(r, h) \) the agricultural lender's offer curve. Since \( \frac{\partial \pi(r, L, h)}{\partial r} > 0 \), a function \( \phi(L, h, \pi) \) can be defined indicating the loan rate the bank must charge if its expected profits per loan are to equal \( \pi \). Given this function, it is
possible to draw a family of iso-profit curves in the r-L space with the following properties:

1. When the loan rate of interest increases, holding constant L and h, the expected profits of the lender also increase.

2. The expected profit curves in the r-L space are negatively-sloped on the left-hand side of L* and positively-sloped on the right-hand side.

3. The zero profit curve must be upward-sloping throughout.

Property (1) holds because \( \frac{\partial \pi}{\partial r} > 0 \). Property (2) may be proven as follows: Differentiation of (A.5) with respect to L gives

\[
\frac{\partial r}{\partial L} = -\frac{\pi_L}{\pi_r}
\]

so that at the interior solution (\( \pi_L = 0 \)) the slopes of the expected iso-profit curves are zero in the r-L space. The slopes off the offer curve may be found by differentiating

\[
\frac{\partial r}{\partial L}
\]

with respect to L, which yields after some manipulation

\[
\frac{\partial^2 r}{\partial L^2} = -\frac{\pi_{LL}}{\pi_r} - \left[ \frac{2 \pi_r \pi_{Lr} - \pi_L \pi_{rr}}{(\pi_r)^2} \right] \frac{\partial r}{\partial L} > 0
\]

in the neighborhood of the 'offer' curve. Thus, \( \frac{\partial r}{\partial L} (>=0 \text{ as } L(<=)L^*) \) from which property (2) follows.

Property (3) can easily be seen from Figure 8. Given any loan rate, the bank's expected profits per loan will equal zero at the point of the intersection of the curve \( U_p(r,L) \) and the ray \((1+h)L\). At this point, any increase in loan size will raise the opportunity cost of the loan by more than the lender's expected revenues. Thus, for expected profit \( \pi \) to remain equal to zero, the increase in L must be accompanied by an increase in r.
Figure 8: Expected Revenue and Expected Cost Relationship. (Given $r$).
Equation (A.5) may be viewed as the lower bound profit function. It is obvious that the lender will not operate to the left of $L^\star(r, h, \omega_x^x=1, \omega_b=0, \delta=0, \rho=0, \lambda=0)$. It is important to note that the lender will implement collection and/or evaluation procedures as long as they serve to increase the lender’s return. The locus $L^\star(r, h, \omega_x^x=1, \omega_b=0, \delta=0, \rho=0, \lambda=0)$ may be called a zero information offer curve. It is that curve the lender would operate with if it could not gain information about the applicants pool nor could it collect once default occurred.

Having outlined the form of the zero information offer curve, one may also derive the non-zero informational iso-profit curves, $\phi(L, \omega_x^x, \omega_b^b, \delta, \rho, \lambda, h, \Pi, N_R)$, along which the total agricultural lender profit $\Pi$ is held constant. Consequently, one may derive the optimal loan offer curve, $L^\star(r, \hat{\omega}_x^x, \hat{\omega}_b^b, \hat{\delta}, \hat{\lambda}, h)$. These offer curves represent the set of operational variables $(\hat{\omega}_x^x, \hat{\omega}_b^b, \hat{\delta}, \hat{\rho}, \hat{\lambda})$ which satisfy equations (A.8)-(A.13), i.e., that maximize the agricultural lender’s total profits.

### A3. FIRST-ORDER CONDITIONS

The marginal conditions on the decision variables $\omega_x^x, \omega_b^b, \delta, \rho, \lambda$, and $L$ on the supply side may be stated as follows:

\[
\begin{align*}
\Pi_{\omega_x^x} &= 0 \\
&\quad (1-\alpha)Z=g_{\omega_x^x} + (1-\alpha)(1+h)L \quad (A.8) \\
\Pi_{\omega_b^b} &= 0 \\
&\quad \alpha [(1-\lambda)(1-\delta)Z - \delta \bar{P}] = g_{\omega_b^b} - \alpha ((1-\delta)d + (1+h)L) \quad (A.9) \\
\Pi_{\delta} &= 0 \\
&\quad ((1-\lambda)Z + \bar{P}) = (1-\delta)d + \delta \quad (A.10) \\
\Pi_{\rho} &= 0 \\
&\quad N_R(1-\omega_b^b) \alpha \delta \bar{P}_{\delta} = 0 \quad (A.11) \\
\Pi_{\lambda} &= 0 \\
&\quad (1-\omega_b^b) \alpha \delta [(1-\delta)Z + \delta \bar{P}_{\lambda}] - [\omega_b^b Z + (1-\omega_b^b)(1-\lambda)(1-\delta)Z - \delta \bar{P}] \alpha_{\lambda} \\
&\quad = (1-\omega_b^b)(1-\delta)d \alpha_{\lambda} + [(1-\omega_b^b) - \omega_x^x(1+h)L \alpha_{\lambda} \quad (A.12) \\
\Pi_L &= 0 \\
&\quad [\omega_x^x (1-\alpha) - (1-\omega_b^b) \alpha (1-\lambda)(1-\delta)](1+r) - [\omega_x^x Z + (1-\omega_b^b)(1-\lambda)(1-\delta)Z - \delta \bar{P}) \alpha_{\lambda}.\end{align*}
\]
\[
= [\omega (1-\alpha) + (1-\omega_e)\alpha] (1+h) + \left[ (1-\omega_e) (1-\delta) d + \left( (1-\omega_e) - \omega_e \right) (1+h)L \right] \alpha L + g_L \quad (A.13)
\]

The terms on the left-hand side of these equations are the marginal revenues of the specified decision variables. Those on the right-hand side are the corresponding marginal costs. These equations, then, state the familiar conditions that the profit of the firm is maximized at the point where marginal revenues and marginal costs are equal.

Equation (A.8) states that an increase in the number of loans approved to good borrowers, i.e., an increase in \( \omega_e \), increases revenues by \( \$ (1-\alpha)Z \) per loan. The marginal cost of such activity is equal to the additional expenditure in policies that allow the lender to increase the number of loan request from qualified applicants, \( g_{w_e} \), and the additional costs of funds of new approved loans, \( (1-\alpha)(1+h)L \).

Equation (A.9) indicates that more rigorous credit evaluation policies that increase the lender's probability of rejecting loan applications from potentially bad borrowers decrease expected losses in \( \$ \alpha [(1-\lambda)(1-\delta)Z - \delta P] \) per disbursed loan, expenditures in loan recovery activities by \( \$ \alpha (1-\delta) d \) per loan, and cost of funds in \( \alpha (1+h)L \) per loan. On the other hand, increases in \( \omega_b \) force the lender to increase expenditures in credit evaluation activities by \( \$ g_{\omega_b} \) per loan.

Equation (A.10) states that more stringent loan recovery activities decrease expected losses by \( \$ (1-\lambda)Z + \delta P \) per loan, and loan recovery costs by \( \$ d \) per additional bad-debt loan recovered. Marginal costs, in turn, increase by \( \$ (1-\delta) d \).

Equation (A.11) indicates that an increase in penalty costs decreases expected losses by \( \$ N_b (1-\omega_b) \alpha \delta P \), without increasing operational costs. Since the net gain is positive, it may be argued that the lender would increase \( \rho \) as large as possible in order to increase profitability. However, as we have seen in section 2.2.4, it is the nature of the demand-side which limit this fact as an equilibrium possibility.
Equation (A.12) states that the agricultural lender may unambiguously increase the profitability of his lending activities by increasing the level of collateral requirements. An increase in \( \lambda \) has two positive effects on the lender’s profitability. On the one hand, it decreases lender’s expected losses in \( \$((1-\omega_b)\alpha((1-\delta)(1-\lambda))Z+\delta\bar{P}_\lambda)k\alpha_\lambda \), per loan. On the other hand, it decreases the inherent risk of loan default \( \alpha \). The fall in \( \alpha \) determine a marginal decrease in expected losses of \( \$((1-\omega_b)\alpha(1-\delta)(1-\lambda))Z-\delta\bar{P}_\lambda)k\alpha_\lambda \), in loan recovery costs of \( \$((1-\omega_b)\alpha)\delta k\alpha_\lambda \), and in costs of funds of \( \$((\omega_b-1-\omega_b)\alpha k)\alpha_\lambda \). In this case the net gain is also positive, but, similar above, the lender cannot set \( \lambda \) as large as possible because of constrains on the demand side of the market.

Finally, Equation (A.13) shows an interesting and complex relation. An increase in the size of the loan has two opposite direct effects and one indirect effect on the lender’s revenues. On the one hand, it increases revenues by \( \$\omega_g(1-\alpha)(1+r) \) per loan as a result of lending to those initially recognized good borrowers. On the other hand, it decreases revenues by \( \$((1-\omega_b)\alpha(1-\delta)(1-\lambda))Z\alpha_\lambda \) per loan lent to those bad borrowers that can evade the lender’s collection efforts. There is also an adverse indirect effect of increasing the loan size on the lender’s revenues; \( \omega_g(1-\omega_b)\alpha(1-\delta)Z\alpha_\lambda \). This effect is given by the impact of an increase in loan size on the initial distribution of bad borrowers in the borrowing population, \( \alpha \).

An increase in loan size also creates complex effects on the marginal costs of lending. On the one hand, it increases costs as a result of additional opportunity costs incurred of \( \$\omega_g(1-\omega_b)\alpha(1+h) \) per loan. On the other hand, an increase in loan size affects the lender’s costs by changing the risk of loan default of the initial population, \( \alpha \). First, increasing risks increase expenditures in collection activities by \( \$((1-\omega_b)(1-\delta)k\alpha_\lambda \) per loan. Second, there is the effect on the lender’s cost of funds of \( \$((1-\omega_b)\omega_g(1+h)k) \) per loan. Notice that this latter effect is ambiguous. It depends on
the lender's ability to distinguish between good and bad borrowers. If the marginal proportion of bad loan risks accepted, \((1-\omega_e)\), is larger than the marginal proportion of good loan risks accepted, \(\omega_e\), then the acceptance rate will increase and so do the indirect marginal costs. But, if the contrary happens, then the acceptance rate will decrease, and the marginal indirect cost will increase at a decreasing rate. Finally, there is the additional costs of the more rigorous credit evaluation policies adopted by the lender as a result of large loans. In this case, the lender's screening costs increase by \$g\omega_e per loan.

The second-order conditions for a maximum \(\Pi\)

A4. SECOND-ORDER CONDITIONS

The Hessian Matrix of the second-order conditions is defined as

\[
J = \begin{pmatrix}
\Pi_{LL} & \Pi_{L \omega_e} & \Pi_{L \omega_b} & \Pi_{L \beta} & \Pi_{L \rho} & \Pi_{L \lambda} \\
\Pi_{\omega_e L} & \Pi_{\omega_e \omega_e} & \Pi_{\omega_e \omega_b} & \Pi_{\omega_e \beta} & \Pi_{\omega_e \rho} & \Pi_{\omega_e \lambda} \\
\Pi_{\omega_b L} & \Pi_{\omega_b \omega_e} & \Pi_{\omega_b \omega_b} & \Pi_{\omega_b \beta} & \Pi_{\omega_b \rho} & \Pi_{\omega_b \lambda} \\
\Pi_{\beta L} & \Pi_{\beta \omega_e} & \Pi_{\beta \omega_b} & \Pi_{\beta \beta} & \Pi_{\beta \rho} & \Pi_{\beta \lambda} \\
\Pi_{\rho L} & \Pi_{\rho \omega_e} & \Pi_{\rho \omega_b} & \Pi_{\rho \beta} & \Pi_{\rho \rho} & \Pi_{\rho \lambda} \\
\Pi_{\lambda L} & \Pi_{\lambda \omega_e} & \Pi_{\lambda \omega_b} & \Pi_{\lambda \beta} & \Pi_{\lambda \rho} & \Pi_{\lambda \lambda}
\end{pmatrix}
\]  

(A.14)

The necessary second-order conditions require that the principal minors of the relevant Hessian determinant alternate in sign.

That is,

1. 
\[
\Pi_{LL} < 0 \tag{A.15}
\]

2. 
\[
\begin{vmatrix}
\Pi_{LL} & \Pi_{L \omega_e} \\
\Pi_{\omega_e L} & \Pi_{\omega_e \omega_e}
\end{vmatrix} > 0 \tag{A.16}
\]
3. \[
\begin{vmatrix}
\Pi_{1L} & \Pi_{1\omega_g} & \Pi_{1\omega_b} \\
\Pi_{\omega_L} & \Pi_{\omega\omega_g} & \Pi_{\omega\omega_b} \\
\Pi_{\omega_b} & \Pi_{\omega_b\omega_g} & \Pi_{\omega_b\omega_b}
\end{vmatrix} < 0
\] (A.17)

4. \[
\begin{vmatrix}
\Pi_{1L} & \Pi_{1\omega_g} & \Pi_{1\omega_b} & \Pi_{1\rho} \\
\Pi_{\omega_L} & \Pi_{\omega\omega_g} & \Pi_{\omega\omega_b} & \Pi_{\omega\rho} \\
\Pi_{\omega_b} & \Pi_{\omega_b\omega_g} & \Pi_{\omega_b\omega_b} & \Pi_{\omega_b\rho} \\
\Pi_{\rho_L} & \Pi_{\rho\omega_g} & \Pi_{\rho\omega_b} & \Pi_{\rho\rho}
\end{vmatrix} > 0
\] (A.18)

5. \[
\begin{vmatrix}
\Pi_{1L} & \Pi_{1\omega_g} & \Pi_{1\omega_b} & \Pi_{1\rho} \\
\Pi_{\omega_L} & \Pi_{\omega\omega_g} & \Pi_{\omega\omega_b} & \Pi_{\omega\rho} \\
\Pi_{\omega_b} & \Pi_{\omega_b\omega_g} & \Pi_{\omega_b\omega_b} & \Pi_{\omega_b\rho} \\
\Pi_{\rho_L} & \Pi_{\rho\omega_g} & \Pi_{\rho\omega_b} & \Pi_{\rho\rho}
\end{vmatrix} < 0
\] (A.19)

6. \[\|\| > 0\] (A.20)

These conditions can be shown to imply that
\[
\Pi_{1L}, \Pi_{\omega\omega_g}, \Pi_{\omega\omega_b}, \Pi_{\omega\rho}, \Pi_{\rho\rho} < 0.
\] (A.21)
Appendix B

APPENDIX TO CHAPTER III

B.1 COMPARATIVE STATICS: THE TECHNIQUE

Table (1) presents a summary of the possible direct impact on optimal decision variables of changing exogenous and regulatory parameters. The analysis of the impact of changes of the exogenous and regulatory parameters of the model, the loan rate \( r \) and lender's cost of funds \( h \), and the regulatory parameters, \( \kappa \gamma \) and \( \chi \), on the equilibrium loan market will be done by using the following analytical technique: To start totally differentiate first-order conditions of the regulatory model, and arrange the terms so that

\[
\Pi_{LL} dL^\uparrow + \Pi_{Lg} d\omega^\uparrow + \Pi_{Lb} d\omega^\uparrow + \Pi_{L\delta} d\delta^\uparrow + \Pi_{L\rho} d\rho^\uparrow + \Pi_{L\chi} d\chi^\uparrow + \\
\Pi_{Lr} dr + \Pi_{Lh} dh + \Pi_{L\kappa} d\kappa + \Pi_{L\gamma} d\gamma + \Pi_{L\chi} d\chi = 0 
\]  

\( (B.1) \)

\[
\Pi_{\omega e} dL^\uparrow + \Pi_{\omega g} d\omega^\uparrow + \Pi_{\omega b} d\omega^\uparrow + \Pi_{\omega \delta} d\delta^\uparrow + \Pi_{\omega \rho} d\rho^\uparrow + \Pi_{\omega \chi} d\chi^\uparrow + \\
\Pi_{\omega e} dr + \Pi_{\omega h} dh + \Pi_{\omega \kappa} d\kappa + \Pi_{\omega \gamma} d\gamma + \Pi_{\omega \chi} d\chi = 0 
\]  

\( (B.2) \)

\[
\Pi_{\omega b} dL^\uparrow + \Pi_{\omega g} d\omega^\uparrow + \Pi_{\omega b} d\omega^\uparrow + \Pi_{\omega \delta} d\delta^\uparrow + \Pi_{\omega \rho} d\rho^\uparrow + \Pi_{\omega \chi} d\chi^\uparrow + \\
\Pi_{\omega h} dr + \Pi_{\omega h} dh + \Pi_{\omega \kappa} d\kappa + \Pi_{\omega \gamma} d\gamma + \Pi_{\omega \chi} d\chi = 0 
\]  

\( (B.3) \)

\[
\Pi_{bL} dL^\uparrow + \Pi_{b\omega} d\omega^\uparrow + \Pi_{b\omega} d\omega^\uparrow + \Pi_{b\delta} d\delta^\uparrow + \Pi_{b\rho} d\rho^\uparrow + \Pi_{b\chi} d\chi^\uparrow + \\
\Pi_{b\nu} d\nu + \Pi_{b\kappa} d\kappa + \Pi_{b\gamma} d\gamma + \Pi_{b\chi} d\chi = 0 
\]  

\( (B.4) \)

\[
\Pi_{\rho L} dL^\uparrow + \Pi_{\rho\omega} d\omega^\uparrow + \Pi_{\rho\omega} d\omega^\uparrow + \Pi_{\rho \delta} d\delta^\uparrow + \Pi_{\rho \rho} d\rho^\uparrow + \Pi_{\rho \chi} d\chi^\uparrow +
\]
\[ \Pi_{\rho_1} dr + \Pi_{\rho_\alpha} dh + \Pi_{\rho_\kappa} d\kappa + \Pi_{\rho_\gamma} d\gamma + \Pi_{\rho_\chi} d\chi = 0 \] (B.5)

\[ \Pi_{\lambda_1} dL^* + \Pi_{\lambda_\alpha} d\omega^* + \Pi_{\lambda_\omega_\beta} d\omega^*_b + \Pi_{\lambda_\omega_\delta} d\omega^*_\delta + \Pi_{\lambda_\rho_\beta} d\rho^* + \Pi_{\lambda_\lambda} d\lambda^* + \]

\[ \Pi_{\lambda_1} dr + \Pi_{\lambda_\alpha} dh + \Pi_{\lambda_\kappa} d\kappa + \Pi_{\lambda_\gamma} d\gamma + \Pi_{\lambda_\chi} d\chi = 0 \] (B.6)

where * denotes optimal values, all other terms have been already defined. Next, define

\[ \mathbf{A} = \begin{pmatrix}
\Pi_{L,L} & \Pi_{L,\omega_\delta} & \Pi_{L,\omega_\beta} & \Pi_{L,\lambda} \\
\Pi_{\omega_\delta,\delta} & \Pi_{\omega_\delta,\beta} & \Pi_{\omega_\delta,\lambda} \\
\Pi_{\omega_\beta,\beta} & \Pi_{\omega_\beta,\lambda} \\
\Pi_{\lambda,\lambda} & \Pi_{\lambda,\beta} & \Pi_{\lambda,\lambda}
\end{pmatrix} \] (B.7)

Notice that \( \mathbf{A} \) is identical to the Hessian matrix of the second-order conditions.

\[ \mathbf{Y} = \begin{pmatrix}
dL^* \\
d\omega^*_g \\
d\omega^*_\delta \\
d\rho^* \\
d\lambda^*
\end{pmatrix} \] (B.8)

\[ \mathbf{B} = \begin{pmatrix}
\Pi_{L,r} & \Pi_{L,\alpha} & \Pi_{L,k} & \Pi_{L,\gamma} & \Pi_{L,\chi} \\
\Pi_{\omega_\delta,\delta} & \Pi_{\omega_\delta,\beta} & \Pi_{\omega_\delta,\lambda} \\
\Pi_{\omega_\beta,\beta} & \Pi_{\omega_\beta,\lambda} \\
\Pi_{\lambda,\lambda} & \Pi_{\lambda,\beta} & \Pi_{\lambda,\lambda}
\end{pmatrix} \] (B.9)

\[ \mathbf{X} = \begin{pmatrix}
\frac{dr}{dL^*} \\
\frac{dh}{dL^*} \\
\frac{d\alpha}{dL^*} \\
\frac{d\gamma}{dL^*} \\
\frac{d\lambda}{dL^*}
\end{pmatrix} \] (B.10)

Using the above matrices, equations (B.1)-(B.6) may be written in the compact form
AY + BX = 0 \quad \text{(B.11)}

With the (assumed) satisfaction of the second order conditions equation B.11 may be solved such that

\[ Y = -A^{-1}BX = QX \quad \text{(B.12)} \]

The elements in the matrix Q may be interpreted as

\[
Q = \begin{bmatrix}
\frac{\partial L}{\partial r} & \frac{\partial L}{\partial h} & \frac{\partial L}{\partial \omega_k} & \frac{\partial L}{\partial \gamma} & \frac{\partial L}{\partial \chi} \\
\frac{\partial \omega_k}{\partial r} & \frac{\partial \omega_k}{\partial h} & \frac{\partial \omega_k}{\partial \omega_k} & \frac{\partial \omega_k}{\partial \gamma} & \frac{\partial \omega_k}{\partial \chi} \\
\frac{\partial \omega_k}{\partial \omega_k} & \frac{\partial \omega_k}{\partial \omega_k} & \frac{\partial \omega_k}{\partial \omega_k} & \frac{\partial \omega_k}{\partial \gamma} & \frac{\partial \omega_k}{\partial \chi} \\
\frac{\partial \omega_k}{\partial \gamma} & \frac{\partial \omega_k}{\partial \gamma} & \frac{\partial \omega_k}{\partial \gamma} & \frac{\partial \omega_k}{\partial \gamma} & \frac{\partial \omega_k}{\partial \gamma} \\
\frac{\partial \omega_k}{\partial \chi} & \frac{\partial \omega_k}{\partial \chi} & \frac{\partial \omega_k}{\partial \chi} & \frac{\partial \omega_k}{\partial \chi} & \frac{\partial \omega_k}{\partial \chi}
\end{bmatrix}
\]

(B.13)

Each element in the matrix Q represents the change of the optimal values of one of the endogenous variables as a result of a change in one of the exogenous variables.

Following the matrix multiplication rule, the elements in Q can be determined.

For instance, consider an exogenous shift in \( h \) on \( \omega_k \), i.e., \( \frac{\partial \omega_k}{\partial h} \).

\[
\frac{\partial \omega_k}{\partial h} = -\frac{1}{|A|}C_{22}\Pi_{\omega_b^h} - \frac{1}{|A|}\left\{C_{12}\Pi_{\omega_k^h} + C_{32}\Pi_{\omega_k^h} + C_{42}\Pi_{\omega_k^h} + C_{52}\Pi_{\omega_k^h} + C_{62}\Pi_{\omega_k^h}\right\}
\]

(B.14)

where \(|A|\) is the determinant of the matrix A and \( C_{ij} \) is the cofactor of the elements in the \( i \)th row and the \( j \)th column of the matrix A.

The first term on the right-hand side (RHS) of Equation (B.14) may be interpreted as the direct effect of \( h \) on \( \omega_k \). From the second-order conditions, \( A \) is positive, and all \( C_{ij} \) with \( i=j \) are negatives. From differentiation of \( \Pi_{\omega_k} \) with respect to \( h \), it can be
shown (see below) that \( \Pi_{\omega_h} = -(1-\alpha)L < 0 \). Hence, the direct effect of \( h \) on \( \omega^*_g \) is negative.

The second term of the RHS of (B.14) represents the indirect effects of \( h \) via \( L \), \( \omega_g, \delta, \rho, \) and \( \lambda \). Since the sign of \( C_{ij} \) with \( i \neq j \) cannot be determined apriori, the signs of the indirect effects cannot be ascertained. Nevertheless, it would not be unreasonable to assume that the direct effects dominate in the event that the indirect effects have opposite signs. Indirect effects are assumed to be small. Thus, \( \frac{\partial \omega_g^*}{\partial h} \) would be negative.

The elements of matrix \( B \) are:

\[
\Pi_{Lr} = N_r \left[ \omega (1-\alpha) - (1-(1-\gamma)\omega_b)\alpha(1-(1-\kappa)\delta)(1-(1-\chi)\lambda) \right] - N_r \left[ \omega' + (1-(1-\gamma)\omega_b)(1-(1-\kappa)\delta)(1-(1-\chi)\lambda)(1+r) \right] \alpha_r
\]

\[
= N_r \left[ \omega Z + (1-(1-\gamma)\omega_b)(1-(1-\kappa)\delta)(1-(1-\chi)\lambda)Z(1-(1-\delta)P) \right] \alpha_r
\]

\[
= N_r \left[ (1-(1-\gamma)\omega_b)(1-(1-\kappa)\delta)d + (1-(1-\gamma)\omega_b) - \omega' \right] (1+h) \alpha_r
\]

\[
(B.15)
\]

\[
\Pi_{Lr} = N_r \left[ (1-\alpha)L - N_r (Z(1+h)\lambda) \right] \alpha_r
\]

\[
(B.16)
\]

\[
\Pi_{Wg} = N_r \left[ \gamma(1-\alpha)(1-(1-\kappa)\delta)(1-(1-\chi)\lambda)L \right] + N_r \left[ (1-\gamma)(1-(1-\kappa)\delta)(1-(1-\chi)\lambda)Z(1-\kappa)\delta P \right] \alpha_r
\]

\[
+ N_r \left[ (1-\gamma)(1-(1-\kappa)\delta)d \right] \alpha_\gamma + N_r \left[ (1-\gamma)(1+h) \right] \alpha_r
\]

\[
(B.17)
\]

\[
\Pi_{Er} = N_r \left[ (1-(1-\gamma)\omega_b)(1-(1-\kappa)\lambda)L \right] + N_r \left[ (1-(1-\gamma)\omega_b)(1-(1-\kappa)\lambda)Z(1-(1-\delta)P) \right] \alpha_r
\]

\[
+ N_r \left[ (1-(1-\gamma)\omega_b)(1-(1-\kappa)\delta)d \right] \alpha_r + N_r \left[ (1-(1-\gamma)\omega_b)(1-(1-\kappa)\delta)d \right] \alpha_r
\]

\[
(B.18)
\]

---

\( \Pi_{\omega_h} \) represents the effects of \( \omega_h \) on the marginal profitability of \( h \). In other words, if the lender is better able to grant loans to good borrowers, i.e., higher \( \omega_h \), it would be reasonable to argue that increasing costs of funds will deteriorate the profitability of lending activities.
\[ \Pi^{\rho\tau} = N R^{(1-1-\gamma)\omega_g}(1-1-\kappa)\delta \rho \alpha_r \]  

(B.19)

\[ \Pi_{\lambda r} = N R^{(1-1-\gamma)\omega_b}\omega_z(1-1-\kappa)\delta (1-1-\chi)\lambda - N R^\omega_g(1-1-\gamma)\omega_b(1-1-\chi)\lambda \delta (1-1-\kappa)\lambda )\lambda )\alpha_\lambda \]

\[ - N R^{(1-1-\gamma)\omega_b}(1-1-\kappa)\delta (1-1-\chi)\lambda + (1-1-\kappa)\delta \rho \alpha_r \]

\[ - N R^\omega_g\omega_z(1-1-\gamma)\omega_b(1-1-\kappa)\delta (1-1-\chi)\lambda \lambda Z (1-1-\kappa)\delta \rho )\lambda )\alpha_\lambda \]

\[ - N R^{(1-1-\gamma)\omega_b}(1-1-\kappa)\delta (1-1-\chi)\lambda \lambda Z (1-1-\kappa)\delta \rho )\lambda )\alpha_\lambda \]

(B.20)

\[ \Pi^{\lambda 0} = -N R^\omega_g(1-1-\alpha) + (1-1-\omega_b)\alpha - N R^\omega_g(1-1-\gamma)\omega_b(1-1-\omega_e)\alpha \lambda )\lambda \]

(B.21)

\[ \Pi^{\omega_k h} = N R^{(1-1-\gamma)\omega_L} \]

(B.22)

\[ \Pi^{\omega_k h} = N R^{(1-1-\gamma)\omega_L} \]

(B.23)

\[ \Pi^{\delta h} = 0 \]

(B.24)

\[ \Pi^{\rho h} = 0 \]

(B.25)

\[ \Pi^{\lambda h} = N R^\omega_g(1-1-\omega_b) - (1-1-\omega_e)\alpha \lambda \]

(B.26)

\[ \Pi^{\lambda \delta} = -N R^{(1-1-\gamma)\omega_b}\omega_z(1-1-\kappa)\delta (1-1-\chi)\lambda \lambda Z (1-1-\kappa)\delta \rho )\lambda )\alpha_\lambda \]

\[ - N R^{(1-1-\gamma)\omega_b}(1-1-\kappa)\delta (1-1-\chi)\lambda \lambda Z (1-1-\kappa)\delta \rho )\lambda )\alpha_\lambda \]

(B.27)

\[ \Pi^{\omega_k \epsilon} = 0 \]

(B.28)

\[ \Pi^{\omega_k \epsilon} = N R^{(1-1-\gamma)\alpha \delta (1-1-\chi)\lambda \lambda Z + \delta \rho )\lambda )\alpha \delta \rho )\lambda )\alpha \]

(B.29)

\[ \Pi^{\omega_k \epsilon} = -N R^{(1-1-\gamma)\omega_b}\omega_z(1-1-\kappa)\delta (1-1-\chi)\lambda \lambda Z + \delta \rho )\lambda )\alpha \delta \rho \]

\[ - N R^{(1-1-\gamma)\omega_b}(1-1-\kappa)\delta (1-1-\chi)\lambda \lambda Z (1-1-\kappa)\delta \rho )\lambda )\alpha \lambda \]

(B.30)

\[ \Pi^{\omega_k \rho} = -N R^{(1-1-\gamma)\omega_b}\omega_z(1-1-\kappa)\delta (1-1-\chi)\lambda \lambda Z + \delta \rho )\lambda )\alpha \delta \rho \]

(B.31)

\[ \Pi^{\omega_k \rho} = N R^{(1-1-\gamma)\omega_b}\omega_z(1-1-\kappa)\delta (1-1-\chi)\lambda \lambda Z + \delta \rho )\lambda )\alpha \delta \rho \]

\[ - N R^{(1-1-\gamma)\omega_b}(1-1-\kappa)\delta (1-1-\chi)\lambda \lambda Z (1-1-\kappa)\delta \rho )\lambda )\alpha \lambda \]

(B.32)

\[ \Pi^{\omega_k \gamma} = 0 \]

(B.33)

\[ \Pi^{\omega_k \gamma} = 0 \]

(B.34)
$$\Pi_{\omega_b \gamma} = -N_R \omega_b \alpha(1-(1-\gamma)\delta)\lambda Z - (1-\gamma)\delta P \alpha - N_R \omega_b \alpha(1-\gamma)\delta \alpha \lambda$$

$$\Pi_{\delta \gamma} = N_R \omega_b \alpha[(1-\gamma)\delta \lambda Z + (1-\gamma)\delta P] + N_R \omega_b \alpha(1-\gamma)\delta \alpha \lambda$$

$$\Pi_{\rho \gamma} = N_R \omega_b \alpha(1-\gamma)\delta \rho$$

$$\Pi_{\lambda \gamma} = N_R \omega_b \alpha[(1-\gamma)\delta \lambda Z + (1-\gamma)\delta P \lambda]$$

$$\Pi_{\lambda \gamma} = -N_R \omega_b \alpha[(1-\gamma)\delta \lambda Z + (1-\gamma)\delta P \lambda] - N_R \omega_b \alpha(1-\gamma)\delta \alpha \lambda$$

$$\Pi_{\lambda \chi} = -N_R (1-\gamma)\omega_b \alpha(1-(1-\gamma)\delta)\lambda \alpha + (1-\gamma)\delta P \alpha \lambda$$

$$\Pi_{\lambda \chi} = -N_R (1-\gamma)\omega_b \alpha(1-(1-\gamma)\delta)\lambda \alpha \lambda$$

$$\Pi_{\rho \chi} = 0$$

$$\Pi_{\lambda \chi} = -N_R (1-\gamma)\omega_b \alpha(1-(1-\gamma)\delta)\lambda \alpha \lambda$$

$$\Pi_{\lambda \chi} = -N_R (1-\gamma)\omega_b \alpha(1-(1-\gamma)\delta)\lambda \alpha \lambda$$

B.2 COMPARATIVE STATICS: THE PROPOSITIONS
B.1.1 Effects of Changes in the Interest Rate Ceiling in Credit Markets.

In the event that a higher ceiling rate of interest, \( r \), prevails in the market the following propositions hold:

1. **PROPOSITION 1**

   Increases in \( r \) would persuade agricultural lender to reformulate its credit evaluation policy so that a higher selection rate \( S^* \) would result, when adverse selection response of \( S^* \) is smaller than its credit evaluation response; if adverse selection response of \( S^* \) dominates the credit evaluation response, the final effect on \( S^* \) of increasing \( r \) depends on the level of restrictions imposed on the lender's credit evaluation operations. If credit evaluation operation are highly restricted, the selection rate will decrease. Otherwise, it will increase.

   **Proof:**

   From Equation 3.11, the impact on the lender's selection rate \( (S^*) \) of changes in \( r \) may formally be represented as

   \[
   \frac{\delta S^*}{\delta r} = [(1-\alpha)\frac{\partial \omega^*}{\partial r} - \alpha(1-\gamma)\frac{\partial \omega_b^*}{\partial r}] - [(1-(1-\gamma)\omega_o)\frac{\partial \omega}{\partial r}].
   \]  

   (B.45)

   where the first term of the right-hand side (RHS) represents the credit evaluation response of changes in \( r \), while the second term is the adverse selection response. Since,

   \[
   \frac{\partial \omega_b}{\partial r} < 0,
   \]

   If the credit evaluation response of \( S^* \) dominates the adverse selection response, the final effects of increasing \( r \) on \( S^* \) will depend on the sign of \( \frac{\partial \omega_o}{\partial r} \), since \( \frac{\partial \omega_b}{\partial r} \) is unambiguously positive. Now, as

   \[
   \frac{\partial \omega_o}{\partial r} = -\frac{1}{|A|} C_{11} \prod_{\omega_o} - \frac{1}{|A|} \{\},
   \]  

   (B.46)
where \(-\frac{1}{|A|}\{\}\) represents the indirect effects on \(\omega_k\) of changes in \(r\), which is assumed to be small and dominated by the direct effect \(-\frac{1}{|A|}C_{11}\Pi_{\omega_k}r\), and \(C_{11}\) and \(|A|\) are positive and negative respectively, the sign of (B.46) will depend on \(\Pi_{\omega_k}r\), which, in turn, depends upon the importance of the adverse selection effects of \(r\) (\(\alpha_r\)). If the adverse selection effects of \(r\) are unimportant, then \(\Pi_{\omega_k}r\) will be positive (see B.16). In that event, \(\frac{\partial \omega_k}{\partial r}\) will be positive. Hence, the sign of the first term of the RHS of expression (B.45) is ambiguous. Therefore, \(\frac{\partial S'}{\partial r}\) is ambiguous. Nevertheless, it is reasonable to assume that \(\alpha\) is relatively small, and it is therefore likely that \((1-\alpha)\frac{\partial \omega_k}{\partial r} > \alpha(1-\gamma)\frac{\partial \omega_k}{\partial r}\).

Hence, it is reasonable to assume that \(\frac{\partial S'}{\partial r} > 0\), if adverse selection effects of \(r\) are unimportant.

On the other hand, if the adverse selection response is unimportant and dominate the credit evaluation response, the sign of (B.45) will depend upon the level of regulations on the lender's credit evaluation operations (\(\gamma\)). If the lender's credit evaluation activities are highly restricted (i.e., \(\gamma \to 1\)), then \((1-(1-\gamma)) > \omega_k\). Hence, \(\frac{\partial S'}{\partial r}\) will be negative. Otherwise, it will be positive.

2. PROPOSITION 2

If \(r\) increases, the agricultural lender would tighten its collection policy in order to recover a larger proportion of the delinquent loans.

This proposition follows from the fact that \(\frac{\partial S'}{\partial r} > 0\)
3. PROPOSITION 3

If \( r \) increases, the lender would increase collateral requirements.

This follows from the fact that \( \frac{\partial \lambda^*}{\partial r} > 0. \)

4. PROPOSITION 4

Increases in \( r \) would decrease type 1 rationing, if the adverse selection effects of \( r \) are unimportant. Otherwise, the effect is ambiguous.

Proof:

The proof of this proposition follows from the fact that

\[
\frac{\partial (T-1)}{\partial r} = \frac{\partial L^D}{\partial r} - \frac{\partial L^*}{\partial r}.
\]  \hspace{1cm} (B.47)

Since \( \frac{\partial L^D}{\partial r} < 0 \), the final effect of increasing \( r \) depends upon the sign of \( \frac{\partial L^*}{\partial r} \). As

\[
\frac{\partial L^*}{\partial r} = -\frac{1}{|A|} C_{11} \Pi_{L_r} - \frac{1}{|A|} \{ \cdot \},
\]  \hspace{1cm} (B.48)

where \( |A| \) is the determinant of matrix \( A \) defined in equation (B.7); \( C_{11} \) is the corresponding cofactor which is always negative by second-order conditions; and \( \frac{1}{|A|} \{ \cdot \} \) is the indirect effect which is assumed to be very small and dominated by direct effects.

Hence, the sign of \( \frac{\partial L^*}{\partial r} \) depends on the sign of \( \Pi_{L_r} \). If adverse selection effects of \( L \) and \( r \) are unimportant, i.e., \( \alpha_L, \alpha_r \to 0 \), then \( \Pi_{L_r} \geq 0. \) Hence, \( \frac{\partial L^*}{\partial r} > 0. \) Hence, \( \frac{\partial (T-1)}{\partial r} < 0. \) Otherwise, the effect is ambiguous.
5. **PROPOSITION 5**

Increases in $r$ will increase type II rationing, if the adverse selection effects of $r$ are important. Otherwise, type II rationing will decrease.

**Proof:**

This proposition follows from the fact that

$$\frac{\delta(T-II)}{\delta r} = (1-S^*) \frac{\delta N_R}{\delta r} - N_R \frac{\delta S^*}{\delta r}$$  \hspace{1cm} (B.49)

We know that since $\frac{\partial U}{\partial r} < 0$ that $\frac{\partial N_R}{\partial r} < 0$. Thus, the final effect of increasing $r$ on type II rationing depends on the sign of $\frac{\partial S^*}{\partial r}$. From proposition 1, we know that $\frac{\partial S^*}{\partial r} > 0$ when adverse selection effects of $r$ are important. If this is the case, type II rationing would decrease with increasing $r$. Otherwise, increasing $r$ will lead to an increase in type II rationing.

6. **PROPOSITION 6**

Increases in $r$ will increase the number of bad-debt loans ($BL$), if the adverse selection effects of increasing $r$ are important. Otherwise, $BL$ will decrease with increasing $r$.

**Proof:**

The proof of this proposition follows from the fact that

$$\frac{\delta BL^*}{\delta r} = (1-(1-\gamma)\omega_b)\alpha \frac{\delta N_R}{\delta r} - N_R \alpha(1-\gamma) \frac{\delta \omega}{\delta r} b + N_R(1-(1-\gamma)\omega_b^*) \frac{\delta \alpha}{\delta r}$$  \hspace{1cm} (B.50)

Since $\frac{\delta N_R}{\delta r} < 0$, and $\frac{\delta \omega}{\delta r} > 0$, $\frac{\delta BL^*}{\delta r} < 0$ if $\frac{\delta \alpha}{\delta r} < 0$ (i.e., if the adverse selection effect of $r$ is small). Otherwise, it will be ambiguous.
B.1.2 Effects of Changes in Lender's Costs of Funds.

7. PROPOSITION 7

If $h$ increases, the agricultural lender would reformulate its credit evaluation (screening) policy so that a lower acceptance rate would result.

This proposition follows from the fact that $\frac{\partial \delta'}{\partial h} < 0$.

8. PROPOSITION 8

If $h$ increases, the agricultural lender would formulate more stringent collection policies so that a larger proportion of delinquent loans would be recovered.

This follows from the fact that $\frac{\partial \delta'}{\partial h} > 0$.

9. PROPOSITION 9

If $h$ increases the agricultural lender would reformulate its collateral requirement policy so that a lower level of loan collateralization must be required.

This follows from the fact that

$$\frac{\partial \lambda}{\partial h} = \frac{1}{|A|} C_{66} \Pi_{ab} \frac{\partial \alpha}{\partial \lambda} - \frac{1}{|A|} \left( \right),$$  \hspace{1cm} (B.51)

where $|A|$ is the determinant of matrix $A$ defined in Equation B.7; $C_{66}$ is the corresponding cofactor which is always negative by second-order conditions; and $\frac{1}{|A|} \left( \right)$ is the indirect effect which is assumed to be very small and dominated by direct effects.

Since $\Pi_{ab} = -(1-(1-\gamma)\omega_g)\omega_g \frac{\partial \alpha}{\partial \lambda}$ (see B.26), and $\frac{\partial \alpha}{\partial \lambda}$ is negative, the sign of $\Pi_{ab}$ depends on $[(1-(1-\gamma)\omega_g)\omega_g]$, the discriminatory ability of lender. If $\omega_g > (1-(1-\gamma)\omega_g)$, then $\Pi_{ab}$ is negative. Hence, $\frac{\partial \lambda}{\partial h}$ is negative.
10. PROPOSITION 10

Increases in $h$ will increase type I rationing.

Proof:

This proposition follows from the fact that

$$\frac{\partial L^*}{\partial h} = -\frac{1}{|A^1|} C_{11} \Pi_{L^h} - \frac{1}{|A^1|} (\cdot),$$

(B.52)

which sign depends on the sign of

$$\Pi_{L^h} = -[\omega_k(1-\alpha) + (1-(1-\gamma)\omega_v)\alpha] - [(1-(1-\gamma)\omega_v) - \omega_k] \frac{\partial \alpha}{\partial L^*}.$$  

(B.53)

Since $\frac{\partial \alpha}{\partial L^*} > 0$, $\Pi_{L^h}$ is unambiguously negative (see B.21). Hence, $\frac{\partial L^*}{\partial h} < 0$.

Now, as

$$\frac{\partial (T-I)}{\partial h} = \frac{\partial L^D}{\partial h} - \frac{\partial L^*}{\partial h},$$

(B.54)

and $\frac{\partial L^D}{\partial h} = 0$, and $\frac{\partial L^*}{\partial h} < 0$, then $\frac{\partial (T-I)}{\partial h} > 0$.

Since $\frac{\partial L^D}{\partial h} = 0$, then $\frac{\partial (T-I)}{\partial h} = -\frac{\partial L^*}{\partial h}$. Hence, $\frac{\partial (T-I)}{\partial h} > 0$ Otherwise, $\frac{\partial (T-I)}{\partial h}$ would be ambiguous.

11. PROPOSITION 11

If $h$ increases, type II rationing will also increase.

This proposition may be proven as follows: Since $\frac{\partial \omega_k}{\partial h} < 0$ and $\frac{\partial \omega_v}{\partial h} > 0$, the selection ratio $S^*$ unambiguously decreases. Since

$$\frac{\partial (T-II)}{\partial h} = (1-S^*) \frac{\partial N^R}{\partial h} - N^R \frac{\partial S^*}{\partial h},$$

(B.55)

and $\frac{\partial N^R}{\partial h} = 0$, then type II rationing will unambiguously increase.
12. **PROPOSITION 12**

Increases in $h$ would persuade the agricultural lender to reformulate its credit evaluation policy so that a lower number of loans will be granted to bad borrowers, thus the number of bad-debt loans will decrease.

Proof:

Since

$$\frac{\partial BL}{\partial h} = (1-(1-\gamma)\omega_0)\frac{\partial N_R}{\partial h} - N_R\alpha(1-\alpha)\frac{\partial \omega_0'}{\partial h} + N_R(1-(1-\gamma)\omega_0')\frac{\partial \alpha}{\partial h},$$

(B.56)

and $\frac{\partial \omega_0'}{\partial h} > 0$, and $\frac{\partial N_R}{\partial h} = \frac{\partial \alpha}{\partial h} = 0$, then $\frac{\partial BL}{\partial h} < 0$.

**B.1.3 Effects of Regulations on Credit-Evaluation Operations.**

The imposition of restrictive regulations on the lender's credit evaluation operations lead to the following propositions:

13. **PROPOSITION 13**

Increasing $\gamma$ will limit the lender's ability to evaluate correctly the credit worthiness of the loan applicants. This will result in more loan requests approved from bad borrowers, i.e., higher $(1-\omega_0)$. The proof of this proposition follows from the fact that as $\frac{\partial \omega_0'}{\partial \gamma} < 0$, then $\frac{\partial (1-\omega_0)}{\partial \gamma} > 0$.

14. **PROPOSITION 14**

Increasing $\gamma$ will reduce the optimal loan size, and increase type I rationing.

The proof of this proposition is as follows: Since

$$\frac{\partial (T-1)}{\partial \gamma} = \frac{\partial L^D}{\partial \gamma} - \frac{\partial L^-}{\partial \gamma},$$

(B.57)

and $\frac{\partial L^D}{\partial \gamma} > 0$, and $\frac{\partial L^-}{\partial \gamma} < 0$, then $\frac{\partial (T-1)}{\partial \gamma} > 0$. 

15. PROPOSITION 15

Increasing $\gamma$ will induce management to reduce the selection or acceptance rate, and, hence, type II rationing would increase.

The proof of this proposition is as follows: Since

$$\frac{\partial (T-II)}{\partial \gamma} = (1 - s') \frac{\partial N_R}{\partial \gamma} - N_R \frac{\partial S'}{\partial \gamma}.$$  \hspace{1cm} (B.58)

Now, as $\frac{\partial N_R}{\partial \gamma} > 0$ and $\frac{\partial S'}{\partial \gamma} < 0$, then $\frac{\partial (T-II)}{\partial \gamma} > 0$. 

16. PROPOSITION 16

Increasing $\gamma$ will unambiguously increase the number of bad-debt loans.

Proof:

This proposition follows from the fact

$$\frac{\partial BL}{\partial \gamma} = (1 - (1 - \gamma) \omega_y) \alpha \frac{\partial N_R}{\partial \gamma} + N_R \omega_y \alpha - N_R (1 - \gamma) \alpha \frac{\partial \omega_b}{\partial \gamma}. \hspace{1cm} (B.59)$$

Since, $\frac{\partial N_R}{\partial \gamma} > 0$ and $\frac{\partial \omega_b}{\partial \gamma} < 0$, $\frac{\partial BL}{\partial \gamma} > 0$.

B.1.4 Effects of Regulations on Collection Operations

The imposition of restrictive regulations on lender's loan recovery activities will justify the following propositions:

17. PROPOSITION 17

Increasing $\kappa$ will persuade management to relax its collection operations with the result that a smaller proportion of delinquent loans would be recovered.

This proposition follows from the fact that $\frac{\partial \delta}{\partial \kappa} < 0$. 
18. **PROPOSITION 18**

Increasing \( \kappa \) will induce management to tighten its credit policy with the result that a higher proportion of loan requests from bad borrowers would be rejected.

This proposition follows from the fact that \( \frac{\partial \omega^{b}}{\partial \kappa} > 0 \).

19. **PROPOSITION 19**

Increasing \( \kappa \) would persuade lender to reduce loan size, and as a result type I rationing would increase.

The proof of this proposition is as follows: Since \( \frac{\partial L^{P}}{\partial \kappa} > 0 \), and as \( \frac{\partial L^{*}}{\partial \kappa} < 0 \), then

\[
\frac{\partial (T-I)}{\partial \kappa} = \frac{\partial L^{P}}{\partial \kappa} - \frac{\partial L^{*}}{\partial \kappa} > 0
\]

20. **PROPOSITION 20**

Imposing restrictive regulations on lender's loan recovery activities, it would increase type II rationing.

The proof of this is as follows: Since \( \frac{\partial N^{R}}{\partial \kappa} \), and \( \frac{\partial S^{*}}{\partial \kappa} \) are positive and negative, respectively, then

\[
\frac{\partial (T-II)}{\partial \kappa} = (1-S^{*}) \frac{\partial N^{R}}{\partial \kappa} - N^{R} \frac{\partial S^{*}}{\partial \kappa} > 0.
\]

21. **PROPOSITION 21**

Increases in \( \kappa \) will induce the lender to reformulate his credit evaluation policy such that a smaller proportion of loans will be granted to bad borrowers. will be granted to bad borrowers. However, increases in \( \kappa \) will also increase the number of loans requested. Hence, the number of bad debt loans may either increase or decrease.

The proof of this proposition is as follows: Since
\[ \frac{\partial B_t}{\partial \kappa} = \frac{(1-(1-\gamma)\omega_b^*)\partial N_k}{\partial \kappa} - N_k(1-\gamma)\lambda \frac{\partial \omega_b^*}{\partial \kappa}. \]

Now, as \( \frac{\partial N_k}{\partial \kappa} > 0 \) and \( \frac{\partial \omega_b^*}{\partial \kappa} > 0 \), then \( \frac{\partial B_t}{\partial \kappa} \) is ambiguous.

**B.1.5 Effects of Regulations on Collateral Requirements**

In this the following propositions may be stated:

22. **PROPOSITION 22**

   Increasing \( \chi \) would induce to management to increase loan recovery efficiency in order to increase the proportion of bad-debt loans collected.

   This proposition follows from the fact that \( \frac{\partial \delta}{\partial \chi} > 0. \)

23. **PROPOSITION 23**

   Increasing \( \chi \) would induce to management to reformulate its credit evaluation policy so that a higher proportion of bad borrower's requests would be rejected.

   This proposition follows from the fact that \( \frac{\partial \omega_b}{\partial \chi} > 0. \)

24. **PROPOSITION 24**

   Increasing \( \chi \) would persuade the lender to decrease optimal loan size, which would result in increasing type I rationing.

   This proposition may be proven as follows: Since \( \frac{\partial L_D}{\partial \chi} > 0 \), and \( \frac{\partial L^*}{\partial \chi} < 0 \), then

   \[ \frac{\partial (T-D)}{\partial \chi} = \frac{\partial L_D}{\partial \chi} - \frac{\partial L^*}{\partial \chi} > 0. \]
25. **PROPOSITION 25**

Increasing $\chi$ would unambiguously increase type II rationing. 

This proposition follows from the fact that $\frac{\partial N_R}{\partial \chi} > 0$, and $\frac{\partial s^*}{\partial \chi} < 0$, then

$$\frac{\partial (T-II)}{\partial \chi} = (1-S^*)\frac{\partial N_R}{\partial \chi} - N_R \frac{\partial s^*}{\partial \chi} > 0.$$

26. **PROPOSITION 26**

Increases in $\chi$ will induce the lender to reformulate his credit evaluation policy such that a smaller proportion of loans will be granted to bad borrowers. However, increases in $\chi$ will also increase the number of loans requested. Hence, the number of bad debt loans may either increase or decrease.

The proof of this proposition is as follows: Since

$$\frac{\partial BL}{\partial \chi} = (1-\gamma)\omega_b^* \frac{\partial N_R}{\partial \chi} - N_R (1-\gamma) \alpha \frac{\partial \omega_b^*}{\partial \chi}.$$

Now, as $\frac{\partial N_k}{\partial \chi} > 0$ and $\frac{\partial \omega_b^*}{\partial \chi} > 0$, then $\frac{\partial BL}{\partial \chi}$ is ambiguous.
Appendix C

APPENDIX TO CHAPTER IV

C.1 THE EMPIRICAL RESULTS

This appendix contains the results of the empirical analysis of chapter III. Since we are only concerned with the direction of major effects we felt justified in using \( p=0.20 \) as our lower bound significance level. The significance levels used are indicated as follows:

\[
\begin{align*}
* p &= 0.20 \\
** p &= 0.10 \\
*** p &= 0.05 \\
**** p &= 0.01
\end{align*}
\]
Table 22

Heteroscedastic Coefficient Estimates. Dependent Variable: LOAN.

**DEPENDENT VARIABLE LOAN**

\[ \begin{align*}
\text{SUM OF SQUARED RESIDUALS} & = 753565. \\
\text{STANDARD ERROR OF THE REGRESSION} & = 18.4489 \\
\text{STANDARD DEVIATION} & = 19.6476 \\
\text{R-SQUARED} & = 0.123436 \\
\text{ADJUSTED R-SQUARED} & = 0.118289 \\
\text{DURBIN-WATSON STATISTIC} & = 1.8941 \\
\text{F-STATISTIC}(13, 2214) & = 23.9825 \\
\text{LOG OF LIKELIHOOD FUNCTION} & = -9649.01 \\
\text{NUMBER OF OBSERVATIONS} & = 2228
\end{align*} \]

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* significant at 20 percent level.

** significant at 10 percent level.

*** significant at 5 percent level.

**** significant at 1 percent level.

Standard errors computed from Heteroscedastic-Consistent Matrix (White, 1980).
Table 23
Heteroscedastic Coefficient Estimates. Dependent Variable: COLL.

**DEPENDENT VARIABLE COLL**

- **SUM OF SQUARE RESIDUALS** = $0.462728E+13$
- **STANDARD ERROR OF THE REGRESSION** = 45716.6
- **STANDARD DEVIATION** = 51718.9
- **R-SQUARED** = 0.223053
- **ADJUSTED R-SQUARED** = 0.218491
- **DURBIN-WATSON STATISTIC** = 1.9473
- **F-STATISTIC (13, 2214)** = 48.8334
- **LOG OF LIKELIHOOD FUNCTION** = -27061.3
- **NUMBER OF OBSERVATIONS** = 2228

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* significant at 20 percent level.

** significant at 10 percent level.

*** significant at 5 percent level.

**** significant at 1 percent level.

Standard errors computed from Heteroscedastic-Consistent Matrix (White, 1980).
Table 24
Heteroscedastic Coefficient Estimates. Dependent Variable: T-I.

**DEPENDENT VARIABLE T-I**

- **SUM OF Squared Residuals** = 0.202095E+12
- **Standard Error of the Regression** = 9554.08
- **Standard Deviation** = 11107.5
- **R-Squared** = 0.264466
- **Adjusted R-Squared** = 0.260147
- **Durbin-Watson Statistic** = 1.7276
- **F-Statistic (13, 2214)** = 61.2358
- **Log of Likelihood Function** = -23573.4
- **Number of Observations** = 2228

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<th>T-STATISTIC</th>
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* significant at 20 percent level.

** significant at 10 percent level.

*** significant at 5 percent level.

**** significant at 1 percent level.

Standard errors computed from Heteroscedastic-Consistent Matrix (White, 1980).
Table 25
Probit Coefficient Estimates. Dependent Variable: DEF.

**DEPENDENT VARIABLE DEF**

**CONVERGENCE ACHIEVED AFTER 5 ITERATIONS**

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<th>T-STATISTIC</th>
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<td>15.693***</td>
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</tbody>
</table>

* significant at 20 percent level.

** significant at 10 percent level.

*** significant at 5 percent level.

**** significant at 1 percent level.
Table 26
Hosomcdastic Coefficient Estimates. Dependent Variable: LOAN.

DEPENDENT VARIABLE: LOAN

SUM OF SQUARED RESIDUALS = 753565.
STANDARD ERROR OF THE REGRESSION = 18.4489
STANDARD DEVIATION = 19.6476
R-SQUARED = 0.123436
ADJUSTED R-SQUARED = 0.118289
DURBIN-WATSON STATISTIC = 1.8941
F-STATISTIC( 13, 2214) = 23.9825
LOG OF LIKELIHOOD FUNCTION = -9649.01
NUMBER OF OBSERVATIONS = 2228

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<th>T-STATISTIC</th>
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Standard errors computed from Homoscedastic Matrix.
### Table 27
Homoscedastic Coefficient Estimates. Dependent Variable: COLL.

**DEPENDENT VARIABLE COLL**

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Standard errors computed from Homoscedastic Matrix.
Table 28

Homoscedastic Coefficient Estimates. Dependent Variable: T-I.

**DEPENDENT VARIABLE T-I**

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Standard errors computed from Homoscedastic Matrix.
C.2 THE CORRELATION MATRIX

Table 29

Correlation Matrix - Dependent Variables

Pearson Correlation Coefficients / Prob > |R| under HO: Rho= 0 / N=2,228

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<th>TI</th>
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<td>-0.00073</td>
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</table>

   |       | 0.1184 | 0.0124 | 0.9726 | 0.0000 |

1.00000 0.1184 0.0124 0.9726 0.0000
### Table 30

Correlation Matrix - Independent Variables

Pearson Correlation Coefficients / Prob > |R| under HO: Rho= 0 / N=2,228

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<th>CUSTOM</th>
<th>ASSET</th>
<th>LIABIL</th>
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Prob > |R|:

- **OCCUPANT**:
  - REFORM: 0.0001
  - TENANT: 0.0001
  - CUSTOM: 0.0000
  - ASSET: 0.0000
  - LIABIL: 0.0000
  - AGE: 0.0000
  - MORTGAGE: 0.0000
  - TERM: 0.0000
  - AGREFUND: 0.0001
  - INFUND: 0.0001
  - AIDFUND: 0.0001
  - SOCFUND: 0.0001
Table 30 (Continued)

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BIBLIOGRAPHY


