

Lending Technologies, Competition, and Consolidation in the Market for Microfinance in Bolivia

Sergio Navajas, Jonathan Conning, Claudio Gonzalez-Vega *

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Abstract

Innovation in lending technologies and market saturation have made La Paz, Bolivia one of the world's most competitive and rapidly changing microfinance markets. Two lenders have stood up: the pioneer BancoSol, which first entered and profitably expanded the loan market with a group loan product, and the later entrant Caja Los Andes, which offered individual liability loans with costlier screening. Using a moral hazard and adverse selection model, we show how lenders compete with different loan contracts and how borrowers make decisions about diligence based on contract terms. Results under different competition conditions are compared against observed patterns in Bolivia.

JEL Classification: D0, G1

Keywords: Microfinance; Lending technologies; Financial intermediation

* Corresponding author: Sergio Navajas (navajas.1@osu.edu), USAID/Bolivia, P.O. Box 13369, La Paz, Bolivia, Phone/Fax; 591-2-2444027;
Jonathan Conning (jconning@williams.edu), Williams College, Williamstown, MA 01267, Phone: 203-432-3639;
Claudio Gonzalez-Vega (gonzalez.4@osu.edu), The Ohio State University, 2120 Fyffe Road, Columbus, OH 43210-1099, Phone: 614-292-6376, Fax: 614-292-7362.

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I. Introduction

Two features best define microfinance lending: it is information intensive and it involves high transaction fixed costs relative to loan sizes. When prospective borrowers do not have the means to show their own creditworthiness and when lending small amounts seems too costly, lenders have to find ways to acquire information in a cost-effective manner. A deeper understanding of the obstacles faced is crucial in comprehending the actual choices of the lending technologies that successful microfinance providers have employed. Indeed, microlenders of different sort have successfully emerged and competed in very close or overlapping market segments. Whereas the literature is extensive in exploring lending behavior (see Jaffee and Stiglitz, 1990, and Besley, 1995, for reviews), it is thin when analyzing the specific lending technologies employed, in the same market segment, by competing microfinance lenders.

The microfinance market has evolved rapidly. The population of borrowers has expanded quickly, as a growing number of public, non-governmental, and private microfinance providers have entered to supply the market (Baydas *et al.*, 1997; Christen, 2001; Marulanda, 1998; Robinson, 2001, Poyo and Young, 1999). By taking advantage

of new lending technologies and of economies of scale, successful lenders have greatly extended the scale of their microfinance operations and have lowered their costs.

Many have become increasingly self-sufficient and even highly profitable while reaching a target population of very small to medium borrowers, whom conventional formal lenders had traditionally considered not creditworthy (*The Microbanking Bulletin*, 2001).

As competition amongst lenders intensifies and the microfinance market matures, we might expect to see not only increased outreach but also substantial consolidation, as a few strong financial intermediaries emerge from the currently crowded field of NGO lenders. What equilibrium market structures will be most likely to emerge? Although it may be too early to draw sharp conclusions on this challenging question, as the microfinance sector is still young and is rapidly changing, theory and case study evidence allow us to venture here some early interpretations and predictions.

In this paper, we focus our attention on the nature of competition in the market for microfinance in La Paz, Bolivia in the late 1990s. Without doubt, this is one of the most interesting, competitive, and rapidly evolving microfinance markets today. Since the early 1990s, the population of borrowers reached by Bolivian lenders exploded, as a number of diverse microfinance providers entered to supply the market. The introduction of innovative lending technologies and the achievement of economies of scale were key determinants of this expansion. By the end of the decade, a combination of intense

competition, limited information sharing amongst microlenders, and a deep recession had brought this expansion to a halt. A number of microlenders coexist and compete in the La Paz market, each one using its own organizational structure and lending technology to reach the poor (Navajas *et al.*, 2000). Two lenders have stood out: Banco Solidario (BancoSol), one of the world's most famous profitable commercial microlenders, and Caja Los Andes (Los Andes), a profitable competitor. Both began operations as not-for-profit NGOs but later transformed into profitable regulated financial intermediaries. Measured either by the number of borrowers reached or the amount of portfolio outstanding, these two microlenders have together supplied over 40 percent of all lending to urban microentrepreneurs and small businesses in Bolivia, a market that hardly existed just over a decade ago (Navajas and Schreiner, 1998).

a. The Development of Microfinance in Bolivia

The development of the microfinance market in Bolivia may be usefully divided into three stages. The first stage was characterized by the dominance of BancoSol. Created in 1992 as a commercial bank, from the client base developed since 1987 by PRODEM, its NGO predecessor, BancoSol established an early presence through the extensive use of its group lending technology.¹ To qualify for a loan, a borrower needs no physical collateral but must belong to a joint-liability credit group. The second stage was marked by the emergence in 1995, as a new microlender and serious competitor, of the non-bank

¹A discussion about the creation and evolution of BancoSol can be found, among others, in Agafonoff (1994), Glosser (1992), Gonzalez-Vega *et al.* (1997) and Mosley (1996).

regulated financial intermediary Caja Los Andes, the offspring of the NGO Procredito, created in 1992 (Solares de Valenzuela, 1997). In contrast to BancoSol, Los Andes uses individual liability loans. Its lending technology also differs in that Los Andes spends substantially more resources in screening applicants. Los Andes asks borrowers to pledge household assets as collateral, even though it is evident that seizing these valuables (*e.g.*, sofa, television set, refrigerator) typically would yield relatively little to the lender (Gonzalez-Vega, 1997). Incentives to repay emerge from the credible threat of seizing assets with high use value for the household in case of default. BancoSol dominated the market until 1994, but since then, both BancoSol and Los Andes greatly expanded the scale of their operations. Although Los Andes grew in part by reaching some larger clients that BancoSol might have reached with its group lending technology, it is evident that their clienteles substantially overlapped. Many of Los Andes' new clients had moved from BancoSol, but the evidence suggests that BancoSol had captured few borrowers in return, even after several years of competition.

A survey revealed, however, some differences. On average, Los Andes' clients possessed more liquid collateral wealth and were more educated than those of BancoSol. These characteristics were also true of the borrowers who had shifted from BancoSol to Los Andes (Gonzalez-Vega *et al.*, 1996). While both lenders offered their clients contingent-renewal loans that grow over time, as borrowers repay punctually, BancoSol offered its first-time borrowers a smaller loan size and more standardized loan contract,

and its loans grew more slowly over time, compared to those provided by Los Andes. By the end of 1995, BancoSol and Caja Los Andes were the two largest microlenders in Bolivia. BancoSol had 63,038 borrowers and Caja Los Andes 15,954 borrowers. Together, they shared around 40 percent of the microlending market. These are impressive numbers, as all commercial banks combined (not including BancoSol) reached only 126,912 borrowers. The growth in scale had been remarkable, when compared to only a few years before. In 1990, for instance, together the commercial banks and non-regulated microlenders reached only 120,000 borrowers (CIPAME, 1997; Superintendencia de Bancos y Entidades Financieras, 1997).

The third stage was characterized at first by increasing competition from new commercial lenders, the failure of some of these new entrants and by a process of consolidation of the initial actors. New microlenders in Bolivia included consumer finance companies, which offered new kinds of credit to a segment of the population that considerably overlapped with the customer base served by BancoSol and Los Andes. By December of 1998, all microlenders reached 415,609 borrowers (Table 1). BancoSol and Los Andes still had the lion's share of this market and together accounted for 43 percent of the microfinance portfolio and 30 percent of all clients.

Recently, most microfinance providers have experienced declining profitability and repayment rates. By mid-2001, the total number of borrowers had declined to 378,037 (Gonzalez-Vega and Rodriguez-Meza, 2001). The problem has been compounded by the

formation of debtors associations that have adversely affected repayment behavior across the sector and by the deep recession experienced by Bolivia. The situation has raised red flags of concern from many quarters (Rhyne, 2001). Has the microfinance sector in Bolivia become undermined by its very own success? Has the level of competition amongst Bolivian microlenders become excessive? Are the outcomes being observed just the natural consequence of credit suppliers being forced by competition and market saturation to look for lending opportunities amongst more marginal clientele, where decreasing returns start to prevail? Has the institutional and regulatory framework been inadequate in the face of increasing competition? Are the new microlending technologies not sufficiently robust during a recession? In either event, how are borrowers in different target groups likely to be affected?

In order to better understand the dynamics of contract choice and competition in this market, we develop a theoretical model to explain behavior by competing lenders faced with both moral hazard and adverse selection problems in a pool of heterogeneous borrowers. The model and equilibria explored here are closely adapted to the circumstances and lending practices of the two Bolivian microlenders. The analysis is enriched by the introduction of fixed transaction costs, which allows the study of economies of scale.

[INSERT TABLE 1 HERE]

b. The Relevance of the Theoretical Framework

The effects of contract design and market competition on the potential pool of entrepreneurs faced by lenders who use different lending technologies are studied within this theoretical framework. Lenders compete with one another in the market for loans by offering different loan contracts to a population of borrowers (Petersen and Rajan, 1995; Van Tassel, 1998). The population of microentrepreneurs (henceforth, entrepreneurs) is assumed to be heterogeneous, as different entrepreneurs possess different levels of productivity and collateral wealth. A lender cannot observe the level of productivity of an entrepreneur unless a screening cost is incurred. A lender who does not screen will attract a different pool of borrowers, depending on the terms of the loan contract that it offers as well as on the features of the contracts from other lenders in the market.

c. The Importance of Economies of Scale

This paper sheds light on an important but frequently overlooked tradeoff between size (number of borrowers) and quality (repayment) in a loan portfolio. Size is important because lenders typically incur substantial fixed costs at the organization's level (handling costs). An increase in the number of borrowers reduces average fixed handling costs of lending (Gonzalez-Vega, 1976). To expand quickly and keep the costs of handling each loan application low, a lender may offer a simplified and standardized loan contract. If the lender economizes, however, on the resources needed to select the best

potential borrowers and to tailor contracts to each borrower, it may find that the quality of its applicants declines, as measured- ex-post- by the arrears rate.

Therefore, lenders will always face a tradeoff between less demanding requirements, in the hope of being able to reach a larger scale (or defend a market share), at a lower average cost, and the fall off in portfolio quality that often accompanies rapid expansion and contract standardization. The nature of this tradeoff varies, moreover, with different lending technologies, with the level of interest rates, and as competition from other lenders alters the pool of applicants.

In summary, the objectives of this paper are both theoretical and empirical. First, most credit market models have analyzed the effects, on the level of investment, of just one type of imperfection due to information asymmetries (either adverse selection or moral hazard) and have examined these effects for a lender with a *given* lending technology. The approach taken in this paper is to model a credit market where both problems are simultaneously present and where the lender chooses among alternative lending technologies to address them.

Lenders have to worry about attracting the best possible borrowers (the most productive entrepreneurs) and, at the same time, they have to worry about the incentives to repay that each borrower has. A diligent borrower, who maximizes the probability of repayment, is preferred to a non-diligent borrower, whose behavior negatively influences the lender's expected profits. In addition to the quality of the pool of borrowers, lenders

are interested in the size of their portfolio, in order to cover their fixed costs. Depending on the degree of available information about the distribution of potential borrowers in the population and on the lender's technology, the terms of different loan contracts can be derived from the model.

The theoretical model developed here makes it possible to explain the type of loan contracts actually offered by two successful competing Bolivian microlenders and to understand the contract revisions they incorporated in response to increasing competition. The empirical evidence illustrates the outcomes of the behavior examined by the model.

II. The Basic Model

We start with a canonical model of moral hazard in the use of borrowed funds. To this we add a potential adverse selection problem, by assuming a population of heterogeneous borrowers, in which each borrower's productivity and the value of household collateral assets can only be ascertained by a lender via costly screening. In this environment, lenders compete with one another for clients via different loan contract terms, aware of the fact that both their own and their competitor's loan contract terms affect the quality and composition of their loan portfolio.

A large number of competitive equilibrium outcomes are possible in such a model of credit market competition, depending on how one specifies the timing and nature of the game between the players and other parameters. Rather than provide an exhaustive characterization of all the possibilities (see Villas-Boas and Schmidt-Mohr, 1999), our

approach is to put theory to work in order to understand a stylized sequence of events, inspired by the historical development of the microfinance market in Bolivia. Thus, we first examine a period of early dominance by a single lender (PRODEM becoming Bancosol), followed by a period of increased competition, as new lenders enter the market (Los Andes). We believe this pattern of increasing competition to be common to the experience of microfinance in most developing markets.

Lenders choose between two broad types of lending technology. One technology involves offering a standardized loan contract, without screening, to all borrowers who care to apply. The resulting quality and composition of the pool of borrowers will depend on how the terms of the contract affect the entrepreneurs' incentives to apply and the repayment behavior of those who do become borrowers. Among the advantages of this lending technology are that it economizes on screening costs and that it is fairly simple to implement. A disadvantage is that the one-size-fits-all loan contract may frustrate higher-productivity borrowers, who receive a smaller loan and on worse terms than they would obtain if they were, instead, offered a contract tailored to the information a lender might obtain from costly screening audits. A competing lending technology involves offering loan contracts closely tailored to the information on borrower productivity and collateral assets obtained from costly screening. The borrower composition of the loan portfolio will also be affected by the lender's objectives (for profit or not-for-profit) and by the degree and nature of competition in the market.

Consider a risk neutral entrepreneur with access to a project that generates stochastic returns. The project requires three inputs: a tradable input (I), a non-tradable input (z), and diligence or effort (P). The tradable input I can be interpreted as the value of purchased intermediate inputs, and z is a productivity parameter determined, for example, by the entrepreneur's skill, ability or drive (Conning, 1999; Navajas, 1999). Project returns are stochastic because random events such as bad weather, theft or merchandise spoilage can suddenly render the project a failure. The entrepreneur's level of diligence (for example, preventive efforts to protect inputs or produce from the elements or from theft) affects the probability of project failure or success.

To keep things manageable, we consider two possible project outcomes and two possible levels of diligence. When the project succeeds, returns are assumed to be $zf(I)$, where $f_I(I) > 0$ and $f_{II}(I) < 0$; when the project fails, the returns are zero. When the entrepreneur is diligent, the probability of success is P^d and the probability of failure ($1 - P^d$), for expected project returns of $P^d zf(I)$. When the entrepreneur is not diligent, the associated probability of success is only P^{nd} , where $P^d > P^{nd} > 0$.

We assume that no entrepreneur has sufficient cash to self-finance investment, so that all entrepreneurs borrow to invest.² Why would an entrepreneur not always be diligent? Lack of diligence will be associated here with the diversion by the entrepreneur of effort and/or funds away from the project, in order to capture a private, non-transferable benefit valued at $B(P^{nd}) \cdot I$. This private benefit is assumed to be proportional to total investment, in order to capture the reasonable assumption that more resources can be diverted away from larger than smaller projects.³ For convenience, the private benefit is assumed to be zero when the entrepreneur is diligent, so $B(P^d)I = 0$.⁴

A potential moral hazard problem emerges when the borrower's level of diligence is non-contractable. Indeed, depending on the loan contract terms, a borrower may be tempted to divert resources away from the project, in order to capture private benefits, because, even though this course of action lowers expected project returns, part of the losses may be passed onto the lender.

² Even wealthy entrepreneurs will want to borrow, if their assets are illiquid and/or can earn a higher return in alternative investments.

³ The consumption of loan funds to cover an emergency or personal event (*e.g.*, wedding) is a good example of a non-tradable benefit to the borrower. This action raises the probability of project failure if, for example, it means purchasing fewer or lower quality inputs (*e.g.*, not buying a good security lock or not properly spraying a crop against a pest, when it was needed).

⁴ For compact notation, the term $B(P^d)$ will be omitted from all expressions below.

The sequence of actions is as follows. The borrower and a competitive lender agree on the terms of a loan contract. The loan funds are invested in a project. The borrower takes some action (diligence or not), and then nature takes its course. Finally, depending on the outcome, the borrower will have enough tradable returns to repay the loan or not. The incentives to repay are embedded in the terms of the loan contract. The optimization problem presented next summarizes the problem in the case of a loan with one lump payment at maturity.

$$\begin{aligned} \text{Max} \quad & P^d zf(I) - P^d Rs - (1 - P^d)R_f \\ & P = P^d, I \\ \text{s.t.} \quad & I_0 = 0, L \geq 0, I = I_0 + L, \end{aligned} \tag{2}$$

$$P^d zf(I) - P^d Rs - (1 - P^d)R_f \geq 0 = Ur, \tag{3}$$

$$P^d Rs + (1 - P^d)R_f = \gamma I, \tag{4}$$

$$Rs \leq zf(I), R_f = 0, \tag{5}$$

$$\begin{aligned} P^i zf(I) + B(P^i)I - P^i Rs - (1 - P^i)R_f &\geq \\ P^j zf(I) + B(P^j)I - P^j Rs - (1 - P^j)R_f &\quad i \neq j \end{aligned} \tag{6}$$

Equations (2) are the non-negativity constraints for the loan and total investment.

Total investment is the sum of the borrower's equity (I_0) in the project and loan size (L).

Equity is assumed to be zero. Equation (3) is the borrower's participation constraint. The entrepreneur will not take advantage of this productive opportunity unless the expected returns are greater than those from the best alternative (for example, a factory job). For simplicity, the returns from the alternative opportunity (Ur) are set equal to zero.

Equation (4) is the lender's participation constraint. It states that the expected revenue from the loan should be equal to or greater than the lender's costs. In this case, the opportunity cost of the funds (γI) is the only cost for the lender. If competition prevails in this market, the inequality in (4) becomes an equality, to make profits equal to zero. The term R_s represents total repayment in the case of success of the project, and R_f (assumed equal to zero here) is repayment in the case of failure. Equation (5) represents the limited liability constraint. Repayment never exceeds all the proceeds from the project. In the case of success, $[R_s \leq zf(I)]$. Repayment is equal to zero ($R_f=0$) in the case of failure.

Equation (6) represents the incentive compatibility constraint (ICC). This generic equation states that the borrower's expected returns should be greater when he is diligent (not diligent) than when he is not diligent (diligent). Either outcome is possible, depending on the borrower's choices, given the incentives faced. As the lender seeks diligent borrowers, the ICC under diligence is imposed here. Let us examine the rationale for this ICC more carefully. The borrower compares the returns under each choice of effort. That is, the borrower is interested in expected net income (surplus) after repayment. This surplus depends on diligence, as follows:

$$P^d zf(I) - [P^d R_s + (1 - P^d)R_f] \text{ versus } P^{nd} zf(I) + BI - [P^{nd} R_s + (1 - P^{nd})R_f]$$

To explore under what conditions the borrower will choose to be diligent, first, let us assume that the expected repayment must just cover the opportunity cost of the lender,

namely: $P^d R_s + (1 - P^d) R_f = \gamma L$. Next, replace this expected repayment in the borrower's expected returns function when diligence is chosen. The resulting returns for the borrower are $P^d z f(I) - \gamma L = P^d z f(I) - \gamma I$, which are greater or equal to zero. Thus, if the borrower is diligent, expected returns will cover the promised repayment and the lender will be protected.

Second, let us now see what happens if we set $P^{nd} R_s + (1 - P^{nd}) R_f = \gamma L$. Will expected returns generate the required repayment, to cover the lender's costs? If this expression is replaced into the borrower's expected returns function when non-diligence is chosen, one gets: $P^{nd} z f(I) + BI - \gamma L = P^{nd} z f(I) + BI - \gamma I$. In this case, BI is not tradable and cannot be used to repay the loan; then, the transferable portion of expected returns minus repayment is equal to $P^{nd} z f(I) - \gamma I$, which is negative. In other words, when non-diligence is chosen, the borrower will not generate enough tradable returns to repay the loan. Therefore, the lender will not be able to find any set of contract terms sufficient to induce repayment under non-diligence.

If indeed, the promised repayment became too large, the borrower may prefer non-diligence, because under non-diligence he can always enjoy non-tradable benefits, independently of the outcome of the project. In contrast, if the borrower is diligent, he may end up with no returns at all, since all tradable returns may have to be used to repay

the loan before any borrower surplus is generated. Behavior will depend, therefore, on the borrower's surplus under each choice of action.

The choices depend on the magnitude of private benefits and on the impact of diligence on returns. When the borrower is not diligent, he enjoys non-tradable benefits (the opportunity cost of diligence) at the expense of reduced tradable returns. Hence, the larger non-tradable benefits are, the larger the difference between expected tradable returns under diligence over non-diligence will have to be for the borrower to have sufficient incentives to be diligent. By the same token, the larger the losses in tradable returns from not being diligent [$P^d zf(I) - P^{nd} zf(I)$], the less compensation the borrower needs to be diligent. The losses in tradable returns increase with the difference in the probabilities of success of the debt-financed project ($\Delta P = P^d - P^{nd}$) under diligence and non-diligence.

If the lender cannot be sure that the borrower has enough incentives to be diligent, no loan will be granted. The moral hazard problem may be solved, however, by designing a loan contract that gives the borrower enough incentives to be diligent. This can be done through changing the terms (interest rate, loan size, collateral, debt-equity ratios or monitoring method) of the loan contract (see Navajas, 1999 for a detailed analysis of each case).

To determine loan size and the level of investment, the incentive compatibility constraint (6) can be rearranged so that the maximum expected repayment [$P^d R_s + (1 - P^d)R_f$] compatible with diligence is on the right-hand side of the inequality :

$$P^d R_s + (1 - P^d)R_f \leq P^d z_f(I) - \frac{P^d B}{\Delta P} I + R_f, \quad (7)$$

where $\Delta P = P^d - P^{nd}$

When the incentive compatibility constraint is binding, the maximum expected repayment compatible with diligence would be $P^d z_f(I) - \frac{P^d B}{\Delta P} I$, as $R_f=0$ since there is no collateral⁵. A promised repayment greater than this (via a larger loan size or higher interest rate) is not compatible with diligence. If this constraint is binding, then the limited liability constraint ($R_s \leq z_f(I), R_f = 0$) is also binding.

Figure 1 depicts the solution to the optimization problem. The maximum loan size compatible with diligence is I_{cd} , at an interest rate just enough to cover the opportunity cost of funds, given the assumption about competition (point a in Figure 1). A larger loan size (at the same interest rate) or a higher interest rate (at the same loan size) will exceed the maximum repayment compatible with diligence. As the moral hazard problem intensifies (due to a larger B or a smaller difference in probabilities ΔP), the maximum loan size available to the entrepreneur shrinks.

If the incentive compatibility constraint is not binding, then the level of investment compatible with diligence (I_{cd}) is still equal to the social optimum, ($L = I_{cd} = I_{so}$). At the social optimum, total returns from the project are maximized. Under this choice, the lender still breaks even and the borrower maximizes returns at $I_{cd} = I_{so}$. However, if the ICC is binding, the resulting level of investment (I_{cd}) compatible with diligence will be lower than the social optimum (I_{so}). If this is the case, the maximum loan size offered by a competitive lender is $L = I_{cd} < I_{so}$ (see Figure 1)..

[INSERT FIGURE 1 HERE]

The moral hazard problem has resulted in a level of investment smaller than the social optimum. How much smaller? This depends on how significant the moral hazard problem is. If the opportunity cost of being diligent (measured by the parameter B) increases, then the maximum repayment compatible with diligence, for each loan size, shrinks. The same happens when the difference in probabilities decreases, namely, when the returns from being diligent are not sufficiently larger compared to those from not being diligent. Loan size also changes with the assumptions about market structure. If this were a monopolistic market, loan size would shrink even more, compared to the social optimum.

⁵ The introduction of collateral just changes the returns for the lender, in the case of failure, from zero to the value of the collateral assets. This case is discussed in section III for a specific lender.

III. Two Lenders, Two Different Loan Contracts

To set up the model, let us concentrate in BancoSol and Caja Los Andes, the two most important Bolivian microfinance lenders. BancoSol offers individual loans backed by the joint liability of all members of a credit group. Los Andes offers individual loans with no joint liability clause, but it screens borrowers further and accepts non-traditional collateral, thereby reducing uncertainty about productivity type.

BancoSol offers a standardized loan contract, based on its best guess about the distribution of the quality of projects, because it does not screen borrowers as much as Los Andes does. As a consequence of its more effective screening, over time Los Andes should attract the most productive borrowers in the pool and those endowed with valuable assets. These two lenders compete for clients via the terms in their loan contracts and these differences in contract terms match different segments of the target population.

a. The “All for One” Contract offered by Caja Los Andes

Los Andes offers a personalized loan contract. This is possible because its lending technology allows Los Andes to recognize the borrower’s productivity type (z in the model) through sufficient screening. Thus, the adverse selection problem is minimized, albeit at a cost. The moral hazard problem is, however, still present, as diligence is unobservable. Screening also allows Los Andes to recognize which collateral assets have

high consumption value for the borrower and could potentially be used as non-traditional (imperfect) collateral, as perfect collateral is scarce in this environment.

To reflect the actual practices and circumstances of Los Andes, we need to modify the model as follows. First, to break even, every borrower is charged sufficient to cover the lender's fixed costs ($fc + hc$), made up of a screening cost fc and a handling cost hc . Screening costs are independent of loan size and, in addition, handling costs are given independently of portfolio size. Moreover, each borrower's promise to repay must cover any individual monitoring costs cm that may be incurred to ameliorate moral hazard problems.

Los Andes accepts imperfect collateral. As part of its lending technology, Los Andes draws up an inventory of household valuables such as TV sets, refrigerators or furniture, which the borrower is in effect asked to pledge as collateral even though it would not be enforceable in court. The entrepreneur pledges an asset that is worth CL as use value to the borrower. If Los Andes were to seize the asset, however, it would only collect αCL . The discrepancy reflects differences in valuation or the costs of seizing and reselling property.

Compared to the basic case, first, the maximum repayment compatible with diligence must be revised, to reflect the presence of collateral and monitoring costs:

$$(P^d R_s + (1 - P^d)CL) \leq P^d z f(I) - \frac{P^d B(cm)}{\Delta P} I + CL). \text{ Then, the lender's participation}$$

constraint changes, because collateral is imperfect and two types of fixed costs have been added:

$$P^d Rs + (1 - P^d)\alpha CL = \gamma I + fc + hc + cm \quad (8)$$

For each individual borrower, handling costs (hc) are "fixed", since they do not vary with loan size, but they vary with the size of the lender's pool of borrowers. Average handling costs are equal to the lender's total handling costs divided by the number of borrowers ($hc = \frac{THC}{nb}$).

As in section II, the solution can be calculated by combining the limited liability, incentive compatibility, and break-even conditions of the lender. The solution is such that maximum repayment compatible with diligence is equal to the lender's costs:

$$\gamma I + cm + fc + hc + (1 - P^d)(1 - \alpha)CL = P^d zf(I) - P^d \frac{B(cm)}{\Delta P} I + CL, \text{ or}$$

$$\gamma I + cm + fc + hc = P^d zf(I) - P^d \frac{B(cm)}{\Delta P} I + CL - (1 - P^d)(1 - \alpha)CL$$

This solution implies that part the value of the borrower's repayment is lost in the transfer. The value of the repayment is reduced for the lender by $(1 - P^d)(1 - \alpha)CL$. This term reflects the fact that when the borrower gives up CL , only a portion of this collateral is received by the lender. When default occurs, a proportion $(1 - \alpha)$ is lost in the transfer.

As noted before, its screening investment fc allows Los Andes to reduce uncertainty about each individual z and thereby offer a better contract. Without sufficient collateral or with excessive costs, however, the loan size offered by Los Andes may still be smaller than the loan needed for a socially optimum level of investment.

b. The “One for All” Contract offered by BancoSol

BancoSol must cover handling costs just as Los Andes does. BancoSol does not incur, however, fixed screening costs because it offers a standardized loan contract to all takers (leading to a pooling equilibrium). Neither does BancoSol have the lending technology to assess imperfect collateral. Monitoring costs are also lower than at Los Andes, because BancoSol uses joint liability to induce repayment.⁶ For simplicity, the effects of joint liability can be captured through the introduction of monitoring in the borrower’s returns function but with zero cost to BancoSol.

Thus, BancoSol forms a prior guess about the productivity type of the applicants. These prior beliefs are summarized by a cumulative density function over the productivity of the borrowers (z). Assuming that the lowest z in the population is z_L and the highest is z_H , then the unconditional mean z in this population is:

⁶ Joint liability contracts, including some similar to the contract used by BancoSol, have been explored, among others, by Armendariz de Aghion, 1999; Berenbach and Guzmán, 1994; Besley and Coate, 1996; Benjamin, 1994; Coleman, 1999; Conning, 1997, 1999; Ghatak, 1999; Paxton, 1996; Sadoulet, 1999; Stiglitz, 1990; Untalan, 1996; Van Tassel, 1999; Varian, 1990; and Wenner, 1995). A recent review of the theoretical and empirical literature is in Ghatak and Guinnane, 1999.

$$E(z) = \int_{z_L}^{z_H} z g(z) dz \quad (9)$$

This, however, is not the average quality of the borrowers who actually arrive at BancoSol's loan desk. When BancoSol offers a standard loan contract, some entrepreneurs will find it profitable to accept the terms of the contract and others will not. Furthermore, amongst those who decide to enter into the contract, some will be diligent and others will not, because high-productivity borrowers (high z) will earn higher expected returns from being diligent, while low-productivity borrowers (low z) will earn more by diverting some funds into generating non-tradable benefits. The manner in which entrepreneurs self-select into these categories will obviously have an impact on BancoSol's expected profits. BancoSol must take this into account at the time of designing its contracts, so its operation remains financially sustainable. Results for the three classes of entrepreneurs are shown in Table 2.

[INSERT TABLE 2 HERE]

In other words, for given R_s and I , only those borrowers with productivity $z \geq z_T(R_s, I)$ will choose to be diligent. Any borrower with $z < z_T(R_s, I)$ will earn more by not being diligent. If BancoSol raises its interest rate without changing any other terms of the contract, additional borrowers will become less diligent, because $\frac{dz_T}{dR_s} = \frac{1}{f(I)} > 0$. Low productivity entrepreneurs with $z < z_T(R_s, I)$ are low quality borrowers, because

they are less diligent, and this would lead to higher default rates in BancoSol's portfolio. Not all entrepreneurs with low z , however, will apply for a loan. Very low productivity entrepreneurs ($z < \underline{z}$) will prefer to remain engaged in their alternative opportunity and earn Ur .

Ceteris paribus, more entrepreneurs will decide to stay out of the market (the threshold \underline{z} rises) as the interest rate (expected repayment level R_s) rises, because

$$\frac{d\underline{z}}{dR_s} = \frac{1}{f(I)} > 0. \text{ Also, fewer entrepreneurs will be interested in starting a lending}$$

relationship as outside opportunities (*e.g.*, the expected compensation from working in a

formal factory job rather than being an entrepreneur) improve ($\frac{d\underline{z}}{dUr} = \frac{1}{P^d f(I)} > 0$). In

fact, BancoSol started when these job opportunities dramatically fell in Bolivia (Sachs and Morales, 1988).

BancoSol's total expected repayment $\varphi(R_s, I)$ is a weighted average of its expected average repayment from diligent and non-diligent borrowers:

$$\varphi(R_s, I) = \frac{\int_{\underline{z}(R_s, I)}^{z_H(R_s, I)} g(z) dz}{\int_{\underline{z}(R_s, I)}^{z_H(R_s, I)} g(z) dz} P^d R_s + \frac{\int_{\underline{z}(R_s, I)}^{z_T(R_s, I)} g(z) dz}{\int_{\underline{z}(R_s, I)}^{z_H(R_s, I)} g(z) dz} P^{nd} R_s$$

$$\begin{aligned}
&= \frac{[G(z_H(Rs, I)) - G(z_T(Rs, I))]}{[G(z_H(Rs, I)) - G(\underline{z}(Rs, I))]} P^d Rs + \frac{[G(z_T(Rs, I)) - G(\underline{z}(Rs, I))]}{[G(z_H(Rs, I)) - G(\underline{z}(Rs, I))]} P^{nd} Rs \\
&= \beta P^d Rs + (1 - \beta) P^{nd} Rs
\end{aligned}$$

BancoSol will be financially sustainable only if:

$$\varphi(Rs, I) = \beta P^d Rs + (1 - \beta) P^{nd} Rs \geq \gamma I + hc \quad (10)$$

For a given loan size I , BancoSol faces two offsetting effects when it raises its interest rate on loans. On the one hand, a higher R_s means that the lender earns higher expected returns from all successful borrowers, diligent or otherwise. On the other hand, the higher interest rate changes the composition of the borrowing pool, as some previously diligent borrowers (with z just above z_T) decide to become non-diligent and some previously non-diligent borrowers (with z just above \underline{z}) decide to drop from the pool. The precise manner in which BancoSol's expected returns will change depends on the distribution of z in the population. The expected average repayment must be sufficient to cover the opportunity cost of funds and all fixed costs (screening and monitoring costs are assumed to be zero for BancoSol). Note that average handling costs change with the number of borrowers in the pool, while the fixed screening cost is constant for each borrower no matter how many borrowers the lender reaches. The quality of BancoSol's portfolio will deteriorate as it raises its interest rate on a given loan size. One indicator of quality is the default rate in the portfolio, which can be calculated as:

$$\text{Proportion of loans in default} = \beta(1 - P^d) + (1 - \beta)(1 - P^{nd}) \quad (11)$$

IV. A Numerical Simulation

a. One lender: BancoSol

Suppose that the distribution of z in the population is standard normal, so $G(z) = N[0,1]$. To be concrete, suppose that with a loan size of $I = 100$, diligent entrepreneurs of productivity level z have a probability $P^d = 0.9$ of successfully generating a return equal to $zf(I) = z \cdot 300$. Since z varies between 0 and 1, the distribution of returns in the population varies between 0 and 300. A non-diligent entrepreneur generates the same returns but does so less frequently, as $P^{nd} = 0.6$. Assume also that the total population of entrepreneurs is 100 and that total handling costs (THC) are \$1,000. Table 3 summarizes the parameters of the simulation.

[INSERT TABLE 3 HERE]

Assume, furthermore, that the only lender in the market is BancoSol and that this lender knows all the parameters of the problem, including those of the distribution of z in the population.⁷ The specific location of each individual entrepreneur in that population is unknown. Table 4 summarizes the results of the simulation on the composition of borrowers and on the lender's expected returns as a function of the interest rate charged (the interest rate is $\frac{R_s}{I} - 1$).

This simple simulation captures several interesting features of the loan market in the presence of moral hazard and adverse selection. As Table 4 shows, raising the interest rate (raising R_s) raises both \underline{z} and z_T . At an interest rate of around 70 percent, 43 percent of the entrepreneurs in the population apply for a loan. Thereby, BancoSol earns an expected repayment of $P^d R_s = 0.9(170) = 153$ on each of its diligent borrowers and $P^{nd} R_s = 0.6(170) = 102$ on each of its non-diligent borrowers.

BancoSol's costs have two components. These are the opportunity cost of funds (\$110 on each \$100 lent) and handling costs (\$1000/number of borrowers). Average handling costs increase as the interest rate increases because the pool of borrowers shrinks, influencing hc .

⁷ The name *BancoSol* is used only to motivate the discussion. The hypothetical numbers in this simulation are in no way related to the actual BancoSol.

When the interest rate reaches 70 percent, the lender breaks even. At this point, the lender will be charging 13 percentage points above its costs of lending to diligent borrowers. This excess interest will offset (cross-subsidize) the 23 percent expected loss on non-diligent borrowers. Since the non-diligent borrowers are $\frac{[G(z_T) - G(\underline{z})]}{[1 - G(\underline{z})]} = 40$ percent of the pool of clients and the diligent borrowers are the remaining 60 percent, the lender's average expected returns on its portfolio are:

$$\begin{aligned} & \frac{[G(z_T) - G(\underline{z})]}{[1 - G(\underline{z})]} P^{nd} R_S + \frac{[1 - G(z_T)]}{[1 - G(\underline{z})]} P^d R_S \\ & = (0.40)(0.6)(170) + (0.60)(0.9)(170) \\ & = 40.8 + 91.8 \approx 133 \end{aligned}$$

Table 4 also shows that at the break-even interest rate (70 percent), the subsidy from diligent to non-diligent borrowers is just enough to cover costs. Before this interest rate is reached, diligent borrowers already pay more than non-diligent borrowers, compared to the cost of lending to them, but they do so in an amount not yet sufficient to cover all the costs of the lender.

The numerical simulation illustrates how one would calculate an interest rate that is consistent with allowing the lender to break even on a loan of a given size. Profits are maximized at an interest rate of around 100 percent.

[INSERT TABLE 4 HERE]

1. Ability to Repay

The break-even loan contract ($R_s=170, I=100$) divides the population of entrepreneurs into three classes, non-applicants, non-diligent borrowers, and diligent borrowers, depending on their ability to repay and best alternative occupation. The breakdown of entrepreneurs is shown in Table 4. The diagonal tells how much repayment an entrepreneur of a given productivity type will generate if the project is successful. For example, a borrower of productivity type z will generate 170 and a borrower of productivity type z_t will generate 220. The probability of being successful depends on diligence. The expected returns from the project that are available for repayment are then the probability of success of the project times the diagonal or $P^i z f(I)$. When the entrepreneur is diligent, so $P^i = P^d = 0.90$, the expected repayment is closer to the diagonal. When the entrepreneur is non-diligent, $P^i = P^{nd} = 0.60$, the expected repayment is farther below. Above the threshold z_t , borrowers are diligent. The relevant expected ability to repay is $0.90 z f(I)$. Below z_t , the expected ability to repay is $0.60 z f(I)$. Under the threshold z , the entrepreneurs prefer not to borrow, because their productivity is very low and the alternative occupation is preferred. For a loan of size 100 and interest rate of 70 percent, all borrowers (entrepreneurs of at least productivity type z) promise to repay 170. Some will generate returns sufficient to repay the loan. Diligent borrowers will generate 198 or more in tradable returns. So, all of them will be able to repay. Borrowers of productivity type below z_t will not generate sufficient returns to repay the loan.

[INSERT FIGURE 2 HERE]

Given the fixed-sum character of the loan contract, borrowers do not pay more than 170, no matter how large the returns generated. The more productive they are, the greater the surplus they can keep after repayment and the greater their incentives to be diligent.

In summary, some borrowers will not be able to repay the loan, but they are observationally equivalent to those who will repay, and the lender cannot separate them. The lender needs to make sure that what it expects to collect from diligent borrowers will more than compensate the lower collection from non-diligent borrowers, so the lender can break even. This is why diligent borrowers end up cross-subsidizing non-diligent borrowers. The proportion of each class of entrepreneurs is shown in the lower graph in Figure 2, which depicts the distribution of entrepreneurs by productivity types.

2. Profits and Interest Rates

As interest rates increase, profits increase only up to a maximum, to decrease afterwards. This occurs because profits are influenced in three ways. First, profits increase because the repayment amount from all successful borrowers (diligent and non-diligent) increases. Second, the proportion of non-diligent borrowers increases, reducing average expected repayment in the portfolio. Third, the absolute number of borrowers drops, making it more difficult to dilute fixed handling costs.

In the simulation, at an interest rate of 150 percent, only 16 percent of the total pool of entrepreneurs will take the loan contract and all borrowers (100 percent) will be non-

diligent. At the break-even interest rate of 70 percent, in contrast, 43 percent of all entrepreneurs will take loans and, of the total number of borrowers, 60 percent will be diligent.

3. Profits and Default Rates

The model also reveals that a lower default rate does not necessarily mean higher profits. In some circumstances, less default might be obtained by charging lower interest rates. At lower interest rates, borrowers are left with large enough surpluses to be diligent, so arrears are minimized. Too low an interest rate may also imply low (or even negative) profits.⁸ In the first case, profits may be improved by accepting higher rates of default but charging higher interest rates. At some point, the positive effect on profits of higher interest rates will be counterbalanced by the negative effect of changes in portfolio quality (less diligent borrowers).

4. Profits and Scale

Another interesting observation is the non-monotonic relationship between profits and the number of borrowers. If BancoSol charges too high interest rates, few borrowers will be attracted. With high fixed handling costs, fewer borrowers may result in lower or even negative profits. It is in the interest of BancoSol to attract a sufficiently large

⁸ The model ignores the negative impact on repayment of the borrowers' perception that the lending operation may not be sustainable when it suffers from steady losses due to low interest rates (Gonzalez-Vega, 1993)

number of borrowers to cover its handling costs. If, in order to attract more borrowers, however, interest rates must be lowered too much, profits will also decline.

If the lender is interested in borrower welfare, then it will not charge the profit-maximizing interest rate. At the minimum interest rate consistent with breaking even (around 70 percent in this simulation), the largest fraction of the market is served at the lowest sustainable interest rate.⁹

b. Competition with Caja Los Andes

The cost of asymmetric information and of the little collateral wealth of its clients is that BancoSol offers a single loan contract. This means that higher productivity borrowers obtain smaller loan sizes and pay higher interest rates compared to those available to them if they could reveal their productivity to the lender and obtain a contract tailored to their circumstances.

If Los Andes competes head-to-head in the same market segment, substantial harm can be done to BancoSol's portfolio. If Los Andes would offer a personalized loan contract without requiring any collateral or incurring any additional cost (for both the borrower and the lender), then all of BancoSol's high productivity borrowers ($z \geq z_T$) would be interested in borrowing from Los Andes. With positive screening costs and

⁹ Capitalization of profits is needed, however, to increase future outreach. This requires a higher interest rate.

collateral requirements, a likely scenario is that only borrowers with $z > z_A > z_H$ will switch from BancoSol to Los Andes.

As the most productive borrowers leave BancoSol, the size and quality of its portfolio decline. If BancoSol did not adjust its contract terms, this lender would see an immediate rise in its default rate and a decline in its profitability. This will be the case because the most productive borrowers (those with the most incentive to be diligent) would leave BancoSol.

How should BancoSol optimally adjust? Competition by Los Andes means that the distribution of potential borrowers has changed. Rather than z being distributed between z_L and z_H , BancoSol now faces potential borrowers with z distributed between z_L and $z_H < z_A$. That is, the pool has lost the most productive borrowers (upper tail of the former distribution). The formulas for BancoSol above can be easily revised to reflect this (by simply substituting z_A for z_H).

New applicants, who now have the option to borrow from either BancoSol or Los Andes, will be sorted as follows. The wealthiest entrepreneurs, who at the same time have the greatest chance of being the most productive, will borrow from Los Andes, because they will get a personalized loan contract against which they can pledge some form of imperfect collateral. As a result, they will pay a lower interest rate. Poorer entrepreneurs will choose BancoSol, because they do not have the collateral required by Los Andes. Poorer and most likely less productive borrowers will then prefer the pooling

loan contract of BancoSol, because there is a chance that they will be cross-subsidized by high productivity borrowers who could not borrow from Los Andes.

In summary, due to these differences in lending technologies, borrowers of Los Andes should be wealthier and more productive than those of BancoSol. If switching occurs, it should happen mainly from BancoSol to Los Andes. The borrowers who switch should be the most productive among BancoSol's clients.

V. Reality Check: What happened in Bolivia?

The numerical simulation developed in section IV concluded with four hypotheses: (a) the borrowers of Los Andes are expected to be wealthier than their BancoSol counterparts; (b) the average borrower of Los Andes will be more productive than the average borrower of BancoSol; (c) if the possibility exists, the higher productivity borrowers of BancoSol will switch to Los Andes; and (d) the terms of the loan contract at BancoSol will show less variability (standard loan contracts) than at Los Andes, where the loan terms are adjusted to each class of borrower.

In this section, we explore these four hypotheses with the aid of proxy indicators for poverty, productivity type, and variability of loan terms.

a. The Data

This section is based on the research project conducted in Bolivia in late 1995 by the Rural Finance Program at The Ohio State University. The goal of the project was to

compare key dimensions in the evolution of five microfinance organizations, including BancoSol and Caja Los Andes. A key input for this study was a random household survey in La Paz, which included 239 borrowers from BancoSol and 128 from Los Andes (for more details see Gonzalez-Vega *et al.*, 1996).

1. Hypothesis One: Level of Poverty

According to the model, the typical borrower of Los Andes is wealthier than the typical borrower of BancoSol. This is plausible, since Los Andes always requires some sort of collateral and offers personalized loans. We analyze the characteristics of the borrowers by using two types of indicators: a set of socio-economic features and an index of poverty.

The socio-economic indicators are presented in Table 5. The data reveal that borrowers from Los Andes are on average more educated, are more heavily engaged in manufacturing, and have relatively larger microenterprises, as measured both by the number of employees and monthly sales. The clients of Los Andes look less poor than those of BancoSol.

[INSERT TABLE 5 HERE]

An estimation of the borrowers' poverty resulted from an Index of Basic Needs Fulfillment (*IBNF*), as used in a national assessment of poverty in Bolivia (Ministerio de Desarrollo Humano, 1995). The methodology used to compute an *IBNF* for the borrowers of BancoSol and Los Andes considered three components: housing (*IH*),

access to public services (*IPS*), and education (*IE*). The first two factors evaluated asset accumulation and the household's physical living conditions and the last one evaluated the average education of all of its members.¹⁰ See Navajas *et al.*, 2000 for more details.

The *IBNF* divides borrower households into four categories: those who satisfy basic needs or are at the threshold (the non-poor) and the moderately poor and poorest households (the poor). The results for BancoSol and Los Andes are shown in Table 6.

[INSERT TABLE 6 HERE]

The proportion of the poor (52 percent) in the portfolio of BancoSol is higher than for Los Andes (33 percent). Are these differences statistically significant? Two non-parametric tests were used to answer this question.¹¹ The Kolmogor-Smirnov test rejected the hypothesis that the distributions of the index for the two lenders were equal with more than 95 percent confidence.

The difference in medians was also tested using a Wilcoxon rank-sums test. The median index for Los Andes (0.97) is greater than for BancoSol (0.90), with more than 95 percent confidence. We can safely conclude that the typical borrower of Los Andes is less poor than the typical borrower of BancoSol.

¹⁰ The national assessment had a fourth component, access to health care services. Access to health services was not included in the OSU survey.

¹¹ A Kolmogor-Smirnov test rejected the hypothesis that any of the distributions were normal, therefore non-parametric (or distribution free) tests were used.

2. Hypothesis Two: Productivity Level

The second hypothesis refers to the borrower's level of productivity. We expect the typical borrower of Los Andes to be more productive than the typical borrower of BancoSol. A good proxy for productivity is the level of education of the borrower. The *IE* differs from the other components of the *IBNF* because the norm is adjusted to the age of each member of the household. A non-parametric comparison of the components of the *IBNF* is presented in Table 7.

[INSERT TABLE 7 HERE]

The results of the tests for the *IEB* (our proxy for productivity) confirm the hypothesis. The borrowers of Los Andes are more productive than their counterparts in BancoSol.

3. Hypothesis Three: Productivity Level of the Borrowers who Switch

The model also suggests that, if given the opportunity, the more productive borrowers of BancoSol will switch to Los Andes. To explore this we need to know how many borrowers of Los Andes had had loans with BancoSol in the past.

By 1995, both lenders had already co-existed for three years, so the borrowers of BancoSol had had the opportunity to switch to Los Andes. From the sample, 17 percent of the borrowers of Los Andes had switched from BancoSol. In contrast, less than one percent of BancoSol's borrowers came from Los Andes (see

Table 8).

What are the characteristics of the borrowers who switched? Are they the most productive? The answer is yes. Using the non-parametric test we conclude with at least 93 percent confidence level that the borrowers who switched from BancoSol to Los Andes had a higher median for the index of education than all borrowers of BancoSol (see Table 9).

[INSERT TABLE 8 HERE]

[INSERT TABLE 9 HERE]

4. Hypothesis Four: Type of Loan Contract

According to the model, the loan contract offered by Los Andes should be more closely tailored to the borrower's characteristics than the Bancosol contract. The survey data allow us to explore these differences in the following way.

First, we analyze the correlation between the first loan disbursed and the *IBNF*. A positive correlation will indicate that the lender is able to adjust loan terms to personal characteristics. The correlation coefficient is positive for Los Andes (0.20) and negative for BancoSol (-0.11). Thus, Los Andes has some ability to distinguish across applicants that BancoSol does not have. Second, using the borrower's loan history, we can trace the evolution of loan size and the variability of loan size through several iterations in a sequence of loans. More variability would be an indication of a larger number of

different loan contracts and of less standardized loan contracts. Table 10 shows the mean, median, and coefficient of variation of size, for each rotation in the loan sequence. For the first loan, for example, the median size in BancoSol is \$148 and in Los Andes is \$373. For each iteration, the median loan size is consistently higher for Los Andes. Variability is consistently higher for Los Andes than for BancoSol.

In summary, the data confirm the hypotheses. The borrowers of BancoSol are poorer and less productive than their counterparts in Los Andes. When given the opportunity, the best borrowers of BancoSol seem to prefer Los Andes, where the loan contracts are better tailored to each individual.

[INSERT TABLE 10 HERE]

V. Summary

Access to credit for the poor, especially in the urban areas, dramatically improved in Bolivia during the past decade. This improvement was largely due to the introduction of new microlending technologies. The new technologies differ significantly from the collateral-based lending technology typically used by commercial banks. They also differ significantly across several microfinance organizations.

To compare microlending technologies, a benchmark model was developed in this paper that analyzes moral hazard and adverse selection simultaneously. The lender has to address the effects of information asymmetries about both actions (diligence) and type (productivity). Depending on the lender's technology, available information, and the

borrower's collateral endowment, different loan contracts are offered that match different borrower classes.

Using the benchmark model, the lending technology of two Bolivian microlenders is studied. These lenders are BancoSol and Caja Los Andes. These two lenders enjoy the lion's share of urban microlending in Bolivia. Each one of them, however, employs a different technology to be able to lend to the poor without threatening the financial sustainability of the organization.

An important difference between the services offered by these two lenders is the degree of standardization of their loan contracts. Los Andes offers a personalized loan contract ("one for all"). This is possible because Los Andes screens its borrowers to determine their repayment capacity (productivity type). This lender also accepts imperfect collateral (assets with high use but low resale value) and monitors borrowers, to minimize instances of moral hazard.

In contrast, BancoSol offers a standardized loan contract to all takers ("all for one" type of contract). Personalized loan contracts are not possible because BancoSol does not screen each borrower as Los Andes does. Monitoring costs are also lower because BancoSol uses joint liability in credit groups to control for moral hazard. BancoSol sacrifices some information in order to lower its overall costs. Not every standard loan contract is profitable, however.

BancoSol has been operating since 1987, and since 1992 it has operated as a commercial bank. Over the years, valuable information about its market segment has been collected, which has given BancoSol the capacity to design profitable standard (pooling) contracts. In other words, BancoSol has learned about the distribution of productivity types among its potential borrowers to the point of lowering its costs to attain profitability.

In both cases, portfolio quality and portfolio size matter, because microlenders have to cover substantial fixed handling costs related to lending to the poor.

Each lending technology attracts a different pool of borrowers. Low-productivity borrowers prefer the standard loan contract because, in this case, the possibility of cross-subsidization from high-productivity borrowers exists. If the additional costs are reasonable, high-productivity borrowers prefer a personalized loan contract.

The model predicts that high-productivity BancoSol borrowers (who will most likely be the wealthiest) will switch to Los Andes. The data confirm this prediction. The borrowers who switched to Los Andes are significantly less poor and more productive than the average BancoSol borrower. Also, the average Los Andes borrower is less poor and more productive than the average BancoSol borrower.

Faced with competition, BancoSol has two options. One option is to revise its loan contract to reflect a shrinking and less productive pool of borrowers. Loans would become more expensive for poor borrowers in the absence of cross-subsidization.

Another option is to design new loan products to prevent high-productivity borrowers from switching. BancoSol chose the second option. By 1998, eight percent of its portfolio was in loans made to individuals (Morduch, 1999).

The experience in Bolivia shows that profitable microlending is possible when an appropriate lending technology is used. It also shows that there is not a unique way to achieve this result. In fact, alternative lending technologies have been equally profitable in reaching similar clienteles.

When microlenders eventually faced increasing competition in overlapping market segments, this success was threatened. The ability to adapt to competition will determine the permanence of the incumbents in the market. In turn, competition has changed the type of loan contracts supplied and, thereby, it has influenced the borrowing possibilities of different classes among the poor. Competition can, however, improve access for everyone through a decrease of monopoly rents. The overall effect of competition on the poorest is, therefore, ambiguous.

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Table 1
Microfinance Lenders and the Financial System in Bolivia, December 1998

Institution/ Type	Number of Clients	Portfolio (millions of US\$)	Portfolio at risk ^a (percentage)
All microfinance lenders	415,609	236,6	10.2
BancoSol/Bank	81,155	74.1	4.5
Los Andes/Finance company	34,913	28.6	5.8
FIE/Finance company	20,848	14.1	1.5
PRODEM/Finance company	46,722	24.2	14.4
FONDECO/Finance company	51,121	3.0	11.4
ACCESO/Finance company ^b	62,483	92.7	19.1
FASSIL/Finance company ^b	30,172	21.7	12.4
ECOFUTURO Group/Finance company-NGO ^c	83,868	25.7	4.8
PROMUJER/Finance company	16,669	2.2	3.4
AGROCAPITAL/Finance company	4,436	11.7	3.3
SARTAWI/Finance company	6,581	3.1	5.4
FRIF/Finance company	8,020	4.4	3.5
FUNBODEM/Finance company	1,358	1.7	3.8
CRECER/Finance company	12,863	2.1	2.3
Commercial Banks ^d	252,763	5,814.0	3.3
Savings and Credit Cooperatives ^e	62,981	188.6	10.6
Savings and Credit Mutuals ^f	32,236	283.4	10.1
Total financial system	763,589	6,522.6	4.04

^a Defined as the percentage of all portfolio affected by arrears of at least one day; ^b About 55 % of these two finance companies (ACCESO and FASSIL) is consumption lending; ^c These data corresponds to the ECOFUTURO group: ECOFUTURO finance company, FADES, IDEPRO, ANED and CIDRE; ^d It does not include BancoSol; ^e The data corresponds to the 17 supervised cooperatives only. Non-supervised cooperatives are not included; ^f The data of number of clients of Savings and Credit Mutuals corresponds to June 1998.

Table 2
 Conditions for Self-Selection of Applicants for BancoSol's Contract

Classes of Entrepreneurs	Productivity Types	Incentive Compatibility Constraints
Diligent Borrowers	$z_H \geq z > z_T$	$P^d zf(I) - P^d Rs \geq P^{nd} zf(I) - P^{nd} Rs + BI > Ur$
Non-Diligent Borrowers	$z_T \geq z > \underline{z}$	$P^{nd} zf(I) - P^{nd} Rs + BI \geq P^d zf(I) - P^d Rs > Ur$
Non-Applicants	$\underline{z} \geq z \geq z_L$	$Ur \geq P^{nd} zf(I) - P^{nd} Rs + BI > P^d zf(I) - P^d Rs$

Note: The population is distributed from z_L to z_H , where z_T is the upper threshold that separates diligent from non-diligent borrowers and \underline{z} represents the lower threshold that separates borrowers from entrepreneurs who prefer to stay out of this market.

Table 3
Simulation Parameters

Probability of project success:		
Diligent	P^d	0.9
Non-Diligent	P^{nd}	0.6
Other parameters:		
Lump sum investment	I	100
Fraction of investment diverted	B	0.15
Equity	I_o	0
Opportunity cost of funds	γ	1.10
Entrepreneur's alternative opportunity	Ur	15
Production function	$zf(I)$	z (300)
Total Number of Entrepreneurs	MEs	100
Total Handling Costs	THC	1000

Table 4
 Bancosol's Portfolio Composition as a Function of the Interest Rate

Interest rate (%)	\bar{z}	z_T	Number of borrowers	Average repayment			Average			Default rate (%)
				Non-diligent	Diligent		Repayment	Cost	Profits	
0	0.33	0.50	67	60	90	82	125	-43	18	
10	0.37	0.53	64	66	99	90	126	-36	18	
20	0.40	0.57	60	72	108	98	127	-29	19	
30	0.43	0.60	57	78	117	105	128	-22	19	
40	0.47	0.63	53	84	126	112	129	-16	20	
50	0.50	0.67	50	90	135	119	130	-11	20	
60	0.53	0.70	47	96	144	126	131	-5	21	
70	0.57	0.73	43	102	153	133	133	-1	22	
80	0.60	0.77	40	108	162	139	135	3	23	
90	0.63	0.80	36	114	171	144	138	7	24	
100	0.67	0.83	33	120	180	149	141	9	25	
110	0.70	0.87	29	126	189	153	144	9	27	
120	0.73	0.90	26	132	198	156	149	7	29	
130	0.77	0.93	23	138	207	157	154	3	32	
140	0.80	0.97	19	144	216	156	162	-6	35	
150	0.83	1.00	16	150	0	150	173	-23	40	

Table 5
Selected Socio-Economic Indicators of the Borrowers of BancoSol and Caja Los Andes

	BancoSol	Caja Los Andes
Women (percentage)	78	62
Borrowers with at least third grade education (percentage)	67	81
Borrowers with multiple occupations (percentage)	49	68
Manufacturing is the main occupation of the borrower (percentage)	15	23
Average number of workers in the borrower's microenterprise	1.2	2.1
Borrowers have no written records (percentage)	66	52
Business is separated from the household (percentage)	44	47
Median monthly sales of the borrower's enterprise (US\$) ^a	646	1,735

^a Figures in bolivianos converted into US dollars at the exchange rate as of December 1995.

Source: OSU survey

Table 6
 Distribution of Borrowers by Poverty Category (percentages)

Categories	BancoSol	Caja Los Andes
Satisfied	16	19
Threshold	33	48
Non poor	48	67
Moderately poor	47	29
Poorest	5	4
Poor	52	33

Source: Authors' calculations

Table 7
 Non-Parametric Statistical Tests Comparing the Components of the IBNF for the Borrowers of BancoSol and Caja Los Andes

Indexes	P-values ^a	
	Two-sided Kolmogorov–Smirnov ^b	Oneb-side Wilcoxon Rank Sum ^c
Housing (<i>IH</i>)	0.6096	0.0353
Public services (<i>IPS</i>)	0.0028	0.0002
Education (<i>IE</i>)	0.7470	0.2975
Education borrower (<i>IEB</i>)	0.0205	0.0048

^a The p-value is the maximum level of significance for which the null hypothesis can be accepted.

^b The null hypothesis is that the distribution of the respective index is equal for the borrowers of both lenders. The alternative hypothesis is that both distributions are different.

^c The null hypothesis is the equality of the medians of the distributions of the two respective indexes. The alternative is that the median of the respective index for the borrowers of Los Andes is greater than for BancoSol.

Table 8

Borrowing Experience: “At about the time of the first loan with the microlender, borrower had loans from (percentages)”

	BancoSol	Caja Los Andes
BancoSol	-	17.2
Caja Los Andes	0.8	-
Formal financial organizations ^a	5.9	0.8
NGOs	7	15.5
Others ^b	83.7	61.0

^a Includes banks, savings and loan associations, and cooperatives.

^b Includes moneylenders, relatives, friends and *pasanakus* (ROSCA).

Source: OSU survey

Table 9
 Non-Parametric Statistical Tests Comparing the Components of the IBNF for the Borrowers of BancoSol and the Switching Group.

Indexes	P-values ^a	
	Two-sided Kolmogorov–Smirnov ^b	One-side Wilcoxon Rank Sum ^c
Basic Needs Fulfillment (INBF)	0.0102	0.0354
Housing (<i>IH</i>)	0.6453	0.1622
Public services (<i>IPS</i>)	0.7183	0.0696
Education (IE)	0.0790	0.1953
Education borrower (IEB)	0.0271	0.0611

^a The p-value is the maximum level of significance for which the null hypothesis can be accepted.

^b The null hypothesis is that the distribution of the respective index is equal for the borrowers of both lenders. The alternative hypothesis is that both distributions are different.

^c The null hypothesis is the equality of the medians of the distributions of the two respective indexes. The alternative is that the median of the respective index for the borrowers of Los Andes is greater than for BancoSol

Table 10
Loan Size by Iteration

Loans		BancoSol	Caja Los Andes
Iteration	1		
N		258	138
Mean		142	373
Coefficient of Variation		114	182
Iteration	2		
N		239	123
Mean		241	512
Coefficient of Variation		80	119
Iteration	3		
N		201	88
Mean		380	693
Coefficient of Variation		77	115
Iteration	4		
N		162	59
Mean		534	1022
Coefficient of Variation		85	201
Iteration	5		
N		117	45
Mean		657	1474
Coefficient of Variation		89	214
Iterations	6 to 23		
N		356	74
Mean		846	1328
Coefficient of Variation		114	103
Total			
N		1,333	527
Mean		476	760
Coefficient of Variation		133	187

Note: Figures in bolivianos converted into US dollars at the exchange rate as of December 1995.

Source: OSU survey

Figure 1
Maximum Loan Size

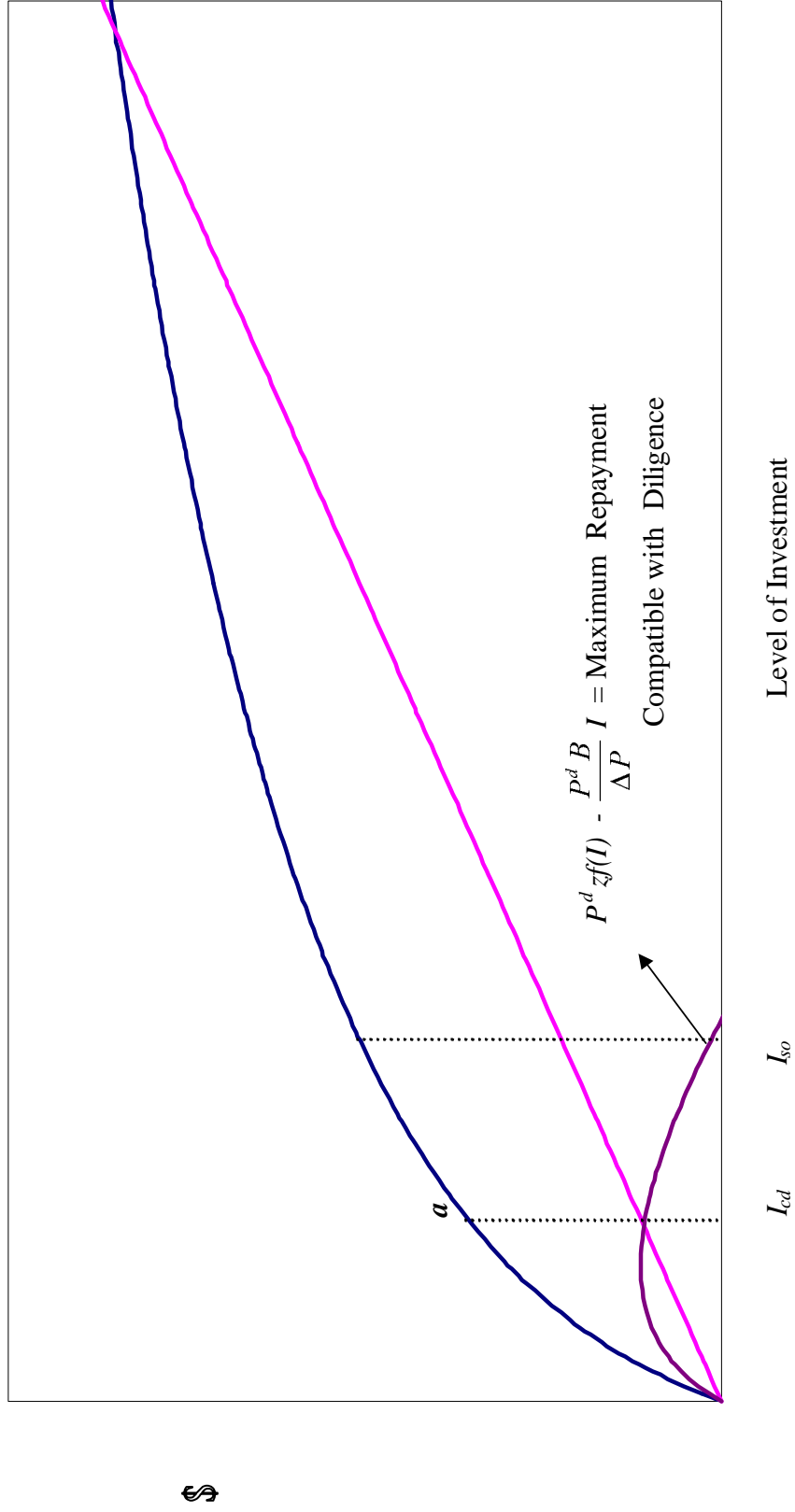


Figure 2
 Ability to Repay for the Break-Even Loan Contract ($R_s=170$, $I=100$)

