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LENDING TECHNOLOGIES, COMPETITION AND CONSOLIDATION IN THE MARKET FOR MICROFINANCE IN BOLIVIA

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Abstract: Innovations in lending technologies and market saturation have made La Paz, Bolivia one of the most rapidly changing and competitive microfinance markets in the world. Two lenders stand out: the pioneer BancoSol, which first profitably expanded the loan market with group liability loans, and the later entrant Caja Los Andes, which offered individual liability loans using costlier screening. Using a simple model of credit market competition with moral hazard and adverse selection we analyse how the terms of loan contracts were adapted to changes in competition and how borrowers' incentive to remain diligent and repay loans was affected. Hypothesized behaviour derived from the model is tested and shown to be consistent with empirical evidence from loan records and a household survey. Copyright © 2003 John Wiley & Sons, Ltd.

1 INTRODUCTION

Two important features characterize microfinance lending: it is an information-intensive activity and it involves high fixed transaction costs relative to loan sizes. When prospective borrowers do not have easy means to signal their own creditworthiness and where lending small amounts doesn't seem worth the costs, lenders must find ways to acquire information and provide incentives in a cost-effective manner. The microfinance market in Bolivia provides a telling example of how this type of financial market innovation can happen and how rapidly it can spread.

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 (Baydas *et al.*, 1997; Christen, 2001; Mosley, 1996; Poyo and Young,

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1999; Robinson, 2001). The introduction of innovative lending technologies and the achievement of economies of scale were key determinants of this expansion. Loan providers that commenced operations with the aid of subsidies have become increasingly self-sufficient and even highly profitable while continuing to reach a target population of very small to medium borrowers, whom conventional formal lenders had traditionally considered not creditworthy (*The Microbanking Bulletin*, 2001).

A number of microlenders coexist and compete in the La Paz market, each using its own organizational structure and lending technology to reach the poor (Navajas *et al.*, 2000). Two lenders have clearly 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. In the empirical section below we analyse micro-data evidence from this market for the year 1995. Measured either by the number of borrowers reached or the amount of portfolio outstanding BancoSol and Caja Los Andes were by that year the two largest microlenders in Bolivia. BancoSol had 63,038 borrowers and Caja Los Andes 15,954 borrowers. Together, they shared around 40 per cent of the microlending market. These are impressive numbers considering that in 1995 the whole commercial bank sector (excluding BancoSol) reached only 126,912 borrowers. The growth in coverage was remarkable as well. In 1990, for instance, the commercial banks *and* non-regulated microlenders combined reached only 120,000 borrowers (CIPAME, 1997; Superintendencia de Bancos y Entidades Financieras, 1997).

By the end of the decade however, a combination of intense competition, limited information sharing amongst microlenders, and a deep recession had brought this expansion to a halt. It was perhaps inevitable that as competition intensified and the microfinance market matured, one would see not only increased outreach but also substantial consolidation, as a few strong financial intermediaries emerged above the crowded field of NGO lenders. Such an outcome might be both expected and welcome. But some observers have worried that excessive competition amongst lenders may be weakening borrower discipline and raising arrears (Rhyne, 2002). What equilibrium market structures will emerge once the dust has settled? Will the same population of poor borrowers continue to be served?

It may still be too early to draw sharp conclusions on these challenging questions, as the microfinance sector is still young and rapidly changing, but theory and available case study evidence allows us to venture some early interpretations and predictions. The objectives of this paper are hence both theoretical and empirical. The theoretical section presents a stylized model, loosely adapted to the circumstances and lending practices of the two Bolivian microlenders. Lenders compete with one another in the market for loans by offering different loan contracts to a population of borrowers. The population of micro-entrepreneurs (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 without incurring a screening cost. A lender who offers a contract without screening 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.

The problems of moral hazard and adverse selection interact on this market. Lenders must design loan products to attract sufficiently large numbers of productive entrepreneurs and to provide incentives for those who get loans to choose behaviour that assures a high

enough expected repayment for the lender to recover costs. To expand quickly and keep the costs of handling each loan application low, a lender may offer a simplified and standardized loan contract as average fixed handling costs are lowered with larger numbers of borrowers (Gonzalez-Vega, 1976). Lenders who offer the wrong contract terms may find the quality of its applicants declining, as measured for example by *ex-post* arrears rate. The nature of these tradeoffs vary, moreover, depending on the nature of the available lending technology, the cost of funds, and the ways that competition from other lenders alters the pool of applicants.

This paper contributes to a growing literature to explore the relationship between credit market structure, loan contract terms, and borrower welfare. One of the very few empirical studies on the topic by Petersen and Rajan (1995) provides evidence that small business loan creditors in the United States are less likely to provide loans to credit-constrained firms in more competitive markets because creditors find it harder to internalize the benefits of assisting firms. Villas-Boas and Schmidt-Mohr (1999) theoretical result that creditors screen credit applicants more intensively in competitive markets to go after the most profitable customers is similar to our own finding. Hoff and Stiglitz (1997), Kranton and Swamy (1999), van Tassel (2002) and McIntosh and Wydick (2002) have each examined theoretically how competition between unregulated lenders might lead to possible adverse effects on borrower welfare and the last two of these studies make explicit passing reference to the Bolivian market to motivate their analysis. Our own analysis is distinguished by our testing of hypotheses against empirical data gathered in Bolivia, our attention to the issue of how moral hazard interacts with adverse selection, the role of costly screening and fixed handling costs.

The paper is organized as follows. After presenting a relevant history of the market for microfinance in Bolivia we analyse a theoretical model under alternative market structure scenarios. We start with a base case of a single lender who designs a loan contract for a borrower of known productivity but whose actions are subject to moral hazard. We next introduce adverse selection by assuming a borrower's ability can no longer be discerned except via costly screening. In this context we first analyse the case of a single socially-oriented microlender who can operate without competition. This is loosely the situation faced by BancoSol in its early years. This lender wants to design a loan contract to attract as broad a segment of the population as possible while continuing to provide enough borrowers with incentives to be diligent on their financed projects so that the bank can expect sufficient repayments to cover all costs. We then ask how a new profit-oriented entrant (modeled loosely after Caja Los Andes) would enter and compete, and the adjustments an incumbent would be forced to make. We show that the entrant's best strategy will be to go after the most productive borrowers most likely to feel limited by the relatively small loan size offered by the incumbent. To attract these borrowers while avoiding also drawing the less-productive and more risky borrowers, the entrant requires costly screening to then provide larger loans better tailored to borrower characteristics. The model suggests at least four hypotheses that we then set out to test. These are that BancoSol borrowers will be on average (i) poorer and (ii) less productive (as measured by educational attainment and other proxies) than Caja Los Andes borrowers, that (iii) borrowers who switch to Caja Los Andes will also be less poor and more productive and (iv) that Los Andes will offer a greater variety of loan contracts. Using data collected from loan records and a socioeconomic household survey we formally test and find quite strong empirical support for these hypotheses. A final section concludes.

1.1 The Development of Microfinance in Bolivia

The development of the market for microfinance in Bolivia may be conveniently 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. To qualify for a loan, a borrower needs no physical collateral but must belong to a joint-liability credit group (Agafonoff, 1994; Glosser, 1992; Gonzalez-Vega *et al.*, 1997; Mosley, 1996; Rhyne, 2001).

The second stage was marked by the emergence in 1995, as a new microlender and serious competitor, of the non-bank regulated financial intermediary Caja Los Andes, the offspring of the NGO Procredito, created in 1992 (Rhyne, 2001). In contrast to BancoSol, Los Andes uses individual liability loans. Its lending technology also differs in that Los Andes spends substantially more resources 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. 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 both BancoSol and Los Andes have since greatly expanded the scale of their operations. Although Los Andes grew in part by reaching some larger clients that BancoSol might not have attracted with its group lending technology, their clienteles overlap substantially. In fact a large number of Los Andes' new clients switched from BancoSol and the evidence we present suggests that BancoSol has not captured many borrowers in return, even after several years of competition. An empirical survey of clients' characteristics reveals some important differences amongst borrowers (Gonzalez-Vega *et al.*, 1996). On average, Los Andes' clients were better educated and possessed more liquid collateral wealth than BancoSol clients and these differences were also true of the borrowers who switched from BancoSol to Los Andes. While both lenders offered their clients contingent-renewal loans that grow in size over time as borrowers repay punctually, BancoSol offered its first-time borrowers a smaller loan size and a more standardized loan contract, and its loans grew more slowly over time.

The third stage was characterized at first by increasing competition from new commercial lenders, by the failure of some of these new entrants, and by a process of consolidation of the initial actors. New microlenders included consumer finance companies offering new kinds of credit targeted to a segment of the customer base served by BancoSol and Los Andes. As indicated in Table 1, by December of 1998, the microlending sector as a whole reached 415,609 borrowers. BancoSol and Los Andes still controlled the lion's share of this market and together accounted for 43 per cent of the microfinance portfolio and 30 per cent of all clients.

In recent years, almost all 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 sector's problems have been compounded by a deep national recession and the formation of debtors associations that have adversely affected repayment behaviour across the sector. Red flags of concern have been raised from many quarters prompting a series of questions (Rhyne, 2002). Has the microfinance sector in Bolivia become undermined by its own success? Were the new microlending technologies not sufficiently robust to face a recession? Has the level of competition amongst Bolivian microlenders become excessive? Has the institutional and

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 / NGO	16,669	2.2	3.4
AGROCAPITAL / NGO	4,436	11.7	3.3
SARTAWI / NGO	6,581	3.1	5.4
FRIF / NGO	8,020	4.4	3.5
FUNBODEM / NGO	1,358	1.7	3.8
CRECER / NGO	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 the portfolio 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.

regulatory framework been adequate? Are the rising arrears the natural consequence of creditors being forced by competition and market saturation to recruit more marginal and risky groups or due to changes of behaviour of existing clienteles? How are borrowers in different target groups being differentially affected?

2 THE MODEL

We begin with a simple canonical model of moral hazard in the use of borrowed funds. Lenders in this market are also faced with an adverse selection problem as they face a population of heterogeneous borrowers where borrowers' productivity and collateral asset ownership can only be ascertained via costly screening. Lenders compete for clients aware of how their own and their competitor's loan contract terms will affect the quality and composition of the borrowers who apply for their products.

A large number of market equilibrium outcomes are possible in markets with adverse selection and screening depending on how one specifies the nature and timing of the game between lenders and other parameters of the environment (see Villas-Boas and Schmidt-Mohr, 1999 for a characterization of the possibilities). Rather than provide an exhaustive characterization, our approach will be to put theory to work to understand a plausible stylised sequence of events, closely inspired by the historical development of the microfinance market in Bolivia. First we examine a period of early dominance by a

single lender (PRODEM later becoming BancoSol), followed by a period of increased competition, as new lenders enter the market (notably Caja Los Andes).

Lenders are assumed to be able to 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 quality and composition of the resulting pool of borrowers will depend on how the terms of the contract affect entrepreneurs' incentives to apply for and repay loans. The advantages of this lending technology include that it economizes on screening costs and is fairly simple to implement. A disadvantage is that a one-size-fits-all contract might frustrate higher-productivity borrowers, who receive smaller loans relative to their demands and on worse terms than they would if loan contracts had been more closely tailored to their productivity and collateral assets based on information from a screening audit.

2.1 Loans Under Moral Hazard When Borrower Productivity Is Known

Consider a risk neutral entrepreneur with access to a project with stochastic returns. The project requires three inputs: a tradable input (I), a non-tradable input (z), and diligence or effort (p or q). The tradable input I can be interpreted as the money value of purchased intermediate inputs, while z is a productivity parameter determined, for example, by the entrepreneur's skill, ability or entrepreneurial 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, such as for example preventive efforts to protect inputs or produce from the elements or from theft, can lower the probability of project failure.

To simplify we consider just two possible project outcomes for any given level of investment and two possible levels of diligence. When the project succeeds, returns are assumed to be $zf(I)$, where $f(I)$ is a standard concave production function with $f_{\mathrm{I}}(I) > 0$ and $f_{\mathrm{II}}(I) < 0$. When the project fails the returns are zero. When the entrepreneur is diligent, the probability of success is p and the probability of failure $(1-p)$, for an expected project return of $pzf(I)$. When the entrepreneur is not diligent, the associated probability of success is lowered to q, where $p > q > 0$.

We assume all entrepreneurs need to borrow I to engage in the project. Even wealthy entrepreneurs will choose to borrow if their existing assets are illiquid and/or can earn a higher return in alternative investments. Why would not an entrepreneur always be diligent? Lack of diligence is associated with the diverting of entrepreneurial effort and/or funds away from a financed project to private projects and activities that allow the borrower to capture private non-transferable benefits valued at $B(I) > 0$, where I is the size of the loan. This private benefit is assumed to be proportional to total investment, to capture the reasonable assumption that more resources can be diverted away from larger projects.[1] The entrepreneur must forgo such private benefits when he chooses to be diligent. A potential problem of moral hazard arises when the borrower's level of diligence is non-contractible so the borrower bears only part of the consequence of lowering the probability of project success. To make the problem interesting we assume

[1]The consumption of loan funds to cover an emergency or personal event (e.g., wedding) is a good example of a private benefit to the borrower that cannot be captured by the lender even if it were discovered. 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).

$pzf(I) - \gamma I \geq 0$ and $qzf(I) - \gamma I + B(I) < 0$ for all $I > \underline{I}$. In words, all diligent investment projects above size $\underline{I}$ are socially profitable, while all non-diligent projects are not.

First we analyse the case of a single lender who controls the market, to loosely describe the situation BancoSol found itself with in the early nineties. Rather than assume monopoly behaviour we assume that BancoSol has a social mission to maximize the number of clients reached subject only to the constraint that it on average recovers the cost of funds. The sequence of actions is as follows. The borrower and lender agree on the terms of an outcome-contingent loan contract and loan funds are invested in the project. The borrower next decides whether to be diligent or non-diligent after which point nature determines the verifiable outcomes. Outcome-contingent repayments are then made according to the terms of the pre-arranged contract. Incentives to be diligent are embedded in the terms of the loan contract.

Now consider the case where this lender knows the borrower's productivity level z. Under such circumstances, the contract design problem can be captured by the following optimization problem:

$$\underset{R_s}{\text{Max}}\, p(zf(I) - R_s)$$

$$pR_s \geq \gamma I + hc + fc \tag{1.1}$$

$$p(zf(I) - R_s) \geq Ur \tag{1.2}$$

$$p(zf(I) - R_s) \geq q(zf(I) - R_s) + B(I) \tag{1.3}$$

The term R_s is repayment from the borrower to lender in the case of project success. A financial contract will also specify a repayment R_f in the event of project failure, but under the limited liability assumption that a borrower cannot be compelled to repay more than the full value of project returns, the borrower will have no choice but to default and repay nothing ($R_f = 0$) when the project fails. Inequalities (1.1) through (1.3) are respectively, the lender and the borrower's participation constraints and the borrower's incentive compatibility constraint.

The lender's participation constraint (1.1) states that the expected revenue from the loan must be greater than or equal to the lender's opportunity cost of funds γI plus any lending costs. We distinguish between fixed handling costs hc and screening costs fc. The former might include the organization-wide average fixed costs from having a main office and computers to process loans, while the latter will refer to costs incurred only if borrowers are screened carefully. More will be said of these costs below. Inequality (1.3) is the incentive compatibility constraint that states that the borrower's expected return from being diligent under any proposed contract must be at least as high as what he would earn by being non-diligent. Re-arranging this constraint yields

$$(p - q)(zf(I) - R_s) \geq B(I)$$

$$zf(I) - R_s \geq \frac{B(I)}{\Delta} \quad \text{where} \quad \Delta = p - q \tag{1.4}$$

The left-hand side of expression (1.4) is the return to the borrower under success. Rearranging this we obtain $zf(I) - B(I)/\Delta \geq R_s$ which states that there is an upper limit on how high the repayment R_s without destroying incentives to be diligent. Intuitively, if

too large of a fraction of the successful project outcome is promised to the lender the borrower will be left without enough of an incentive to want to raise the probability of success by choosing diligence. Multiplying expression (1.4) through by p yields:

$$pzf(I) - pR_s \geq \frac{p}{\Delta}B(I)$$

Under the assumption that the lender aims only to break even on the investment (or equivalently that market competition drives them to behave that way) we will have $pR_s = \gamma I + hc + fc$. Substituting this into the above inequality yields

$$pzf(I) - \gamma I - hc + fc \geq \frac{p}{\Delta}B(I) \tag{1.5}$$

This states that if the loan is to remain feasible, net expected returns $pzf(I) - \gamma I - hc - fc$ must be sufficiently large as to cover a necessary 'enforcement rent' of size $p/\Delta B(I)$. Since the borrower gets nothing under failure,[2] and must receive at least $B(I)/\Delta$ under success to remain diligent, the borrower must retain an expected return, or enforcement rent of at least $p/\Delta B(I)$.

How large of a loan will be provided? The first-best efficient loan size I_z^* for a borrower of productivity level z would be given by the familiar first-order condition that the marginal product of investment should be set equal to the social marginal cost of funds, or $pzf'(I_z^*) = \gamma$. This is the loan size the borrower would like to request and be offered if inequality (1.5) did not bind. If it does bind, the borrower will be constrained to a loan size I_z between zero and I_z^* that solves equality (1.5). If no solution exists in that range, no loan is feasible that both maintains incentives and allows the lender to recover costs.

The larger the scope for moral hazard (as measured by the size of the private benefit $B(I)$ or the smaller the difference in probabilities Δ), the smaller will be the maximum loan size available to the entrepreneur. Borrowers with lower productivity level z have smaller optimal loan sizes but are also more likely to be constrained, as (1.5) becomes more difficult to meet. Loan size also changes with the assumptions one makes about market structure. If this had been a market with a single lender acting as a profit-maximizing monopolist, loan sizes would have been reduced yet further compared to the social optimum.

The main implication of the introduction of fixed costs hc and fc is to establish minimum loan sizes. In practice handling costs hc are likely to decline with the number of borrowers because many of these fixed costs spread across borrowers. To allow for this let HC, be organization-wide fixed costs. Handling costs per borrower then vary inversely with the number of borrowers n:

$$hc(n) = \frac{HC}{n} \tag{1.6}$$

2.2 Two Lenders, Two Different Loan Contracts

Up to this point the model has assumed the lender knows borrower productivity z. In practice however a lender faces a pool of potential borrowers of varying productivity

[2]The introduction of collateral assets would allow the lender to collect something larger than zero. This case is discussed in section 2.4 for a specific lender.

levels and individual productivity levels can only be discerned via costly screening. In such circumstances lenders have a choice of either offering a standardized contract to all who apply and/or contracts that involve screening costs and then tailor loan size and repayment terms to the revealed productivity levels.

In Bolivia BancoSol chose the former and entered the market offering a relatively standardized loan arrangement backed by the joint liability of all members of a credit group. Caja Los Andes entered the market later offering individual loans with no joint liability clause, but only to borrowers who were first screened. Caja Los Andes accepts non-traditional collateral (also appraised via costly screening) as a way to further reduce uncertainty about productivity type. Let's examine each type of lending strategy in turn.

2.3 The 'One for All' Contract Offered by BancoSol

BancoSol offers a relatively standardized loan contract to all takers with quite minimal screening. In practice BancoSol also uses joint liability clauses to induce repayment, but for simplicity we abstract from joint liability, noting that such features can be added to the model without changing the main elements of the analysis to follow.[3]

Suppose for simplicity that BancoSol is the only lender on the market, and is motivated to reach as many productive clients as possible while covering all expenses. BancoSol approaches the market with a set of prior beliefs regarding the distribution of productivity types in the population. These prior beliefs can be summarized by a probability density function $g(z)$ over the productivity of the borrowers (z). Assuming that the lowest z in the population is $\underline{z}$ and the highest is $\bar{z}$, then the population average z is simply:

$$E(z) = \int_{\underline{z}}^{\bar{z}} z \cdot g(z) \mathrm{d}z \tag{1.7}$$

Let $G(z)$ be the cumulative distribution function associated with $g(z)$. If, without loss of generality, we normalise the size of the total population to 1, $G(z_{\mathrm{L}})$ represents both the proportion, and the number, of borrowers in the population with a z less than or equal to z_{L}.

The average productivity level $E(z)$ is not the average quality of the borrowers who actually apply to BancoSol's loan desk because when BancoSol offers a standard loan contract not all entrepreneurs find it profitable to borrow. Furthermore, amongst those who do decide to borrow, some will be diligent and not because lower-productivity borrowers (those with lower z) get relatively lower returns to being diligent and will prefer to instead divert funds into projects that generate private benefits $B(I)$ that cannot be observed or seized by the lender.

By choosing contract terms R_s and I, the lender partitions the universe of potential borrowers into three groups, as summarized by Table 2. Entrepreneurs with very low productivity z ($z < z_{\mathrm{L}}$) prefer to remain engaged in their alternative opportunity and earn Ur, the value of the borrower's next best (reservation) activity. Threshold z_{L} is given by the value of z at which the borrower's participation constraint (1.2) just binds. Amongst the remainder of the population that does borrow, those with productivity level $z \geq z_{\mathrm{D}}(R_s, I)$

[3]For surveys of the literature on joint liability contracts see Ghatak and Guinnane (1999) or Morduch (1999). Conning (1999) shows how joint liability loans can be adapted to a model with variable loan size quite similar to the one analysed here.

Table 2. Conditions for self-selection of applicants for BancoSol's contract

Classes of entrepreneurs	Productivity types	Incentive compatibility constraints
Diligent borrowers	$\bar{z} \geq z \geq z_{\mathrm{D}}$	$p(zf(I) - R_s) \geq q(zf(I) - R_s) + B(I) > Ur$
Non-diligent borrowers	$z_{\mathrm{D}} > z \geq z_{\mathrm{L}}$	$q(zf(I) - R_s) + B(I) \geq p(zf(I) - R_s > Ur$
Non-applicants	$z_{\mathrm{L}} > z \geq \underline{z}$	$Ur \geq q(zf(I) - R_s) + B(I) > p(zf(I) - R_s)$

Note: The population is distributed from $\underline{z}$ to $\bar{z}$, where z_{D} is the threshold that separates diligent from non-diligent borrowers and z_{L} represents the lower threshold that separates borrowers from entrepreneurs who decide not to borrow.

will choose to be diligent, where $z_{\mathrm{D}}(R_s, I)$ is defined by the z at which the incentive compatibility constraint (1.3) just binds under the offered contract. Finally borrowers with z given by $z_{\mathrm{L}}(R_s, I) \leq z < z_{\mathrm{D}}(R_s, I)$ earn higher expected returns from being non-diligent. The higher is the proportion of non-diligent borrowers in BancoSol's portfolio, the higher the default rate.

Ceteris paribus, more entrepreneurs decide to stay out of the market (the threshold z_{L} rises) as the interest rate (expected repayment level R_s) is raised, because $\mathrm{d}z_{\mathrm{L}}/\mathrm{d}R_s = 1/f(I) > 0$. The threshold between diligent and non-diligent borrowers is also raised because $\mathrm{d}z_{\mathrm{D}}/\mathrm{d}R_s = 1/f(I) > 0$. Other comparative static results are apparent. For example, fewer entrepreneurs will be interested the larger is the outside opportunity Ur (e.g., the expected compensation from working in a formal factory job rather than being an entrepreneur), since $\mathrm{d}z_{\mathrm{L}}/\mathrm{d}Ur = 1/pf(I) > 0$. In actual practice, BancoSol entered the marketplace at a time when wage-sector job opportunities were dramatically depressed (Sachs and Morales, 1988).

For given contract terms (R_s, I) BancoSol's total expected repayment $\varphi(R_s, I)$ would be a weighted average of its expected average repayment from diligent and non-diligent borrowers in its portfolio.

$$\begin{aligned}\varphi(R_s, I) &= P(\bar{z} \geq z \geq z_D \mid z > z_L) \cdot pR_s + P(z_D > z \geq z_L \mid z > z_L) \cdot qR_s \\ &= \left(\frac{1 - G(z_D)}{1 - G(z_L)}\right) \cdot pR_s + \left(\frac{G(z_D) - G(z_L)}{1 - G(z_L)}\right) \cdot qR_s \\ &= \beta pR_s + (1 - \beta) qR_s \end{aligned} \tag{1.8}$$

Where $P(\bar{z} \geq z \geq z_{\mathrm{D}} \mid z > z_{\mathrm{L}})$ is the fraction (and number) of borrowers that apply and receive loans that are diligent, and $P(\bar{z} \geq z \geq z_{\mathrm{D}} | z > z_{\mathrm{L}}) \cdot pR_s$ is total expected repayment from this group. Likewise $P(z_{\mathrm{D}} > z \geq z_{\mathrm{L}} | z > z_{\mathrm{L}})$ is the fraction (and number) of borrowers that will accept loans but not be diligent and $P(z_{\mathrm{D}} > z \geq z_{\mathrm{L}} \mid z > z_{\mathrm{L}}) \cdot qR_s$ expected repayments from that group. These conditional probabilities are expressed in terms of the cumulative density function G(z). In all of the above expressions we have suppressed the dependence of the thresholds on the terms of the contract (e.g. $z_D = z_D(R_s, I)$) for notational brevity. Since BancoSol does not pay per-loan screening costs fc, but does have to pay handling costs hc, the loan contract will be financially sustainable as long as:

$$\varphi(R_s, I) = \beta\, pR_s + (1 - \beta) qR_s \geq \gamma I + hc \tag{1.9}$$

where by (1.6) we have $hc = HC/[1 - G(z_{\mathrm{L}})]$.

For any given loan size I, BancoSol faces tradeoffs as it raises the interest rate R_s. On the one hand, a higher R_s means higher expected returns from all borrowers whose projects

succeed, whether they were diligent or otherwise. On the other hand, the higher interest rate changes the composition of borrowers in the pool, with some previously diligent borrowers (those with z just above the original z_D) switching to become non-diligent and some previously non-diligent borrowers (with z just above $\underline{z}$) dropping out of the pool. The precise manner in which BancoSol's expected returns changes depends in large part on how z is distributed in the population.

Under this pooling contract the more productive borrowers in the portfolio generate profits that allow BancoSol to cross-subsidize less productive borrowers in the portfolio. This helps extend outreach, even though some of the less productive borrowers in the pool will be non-diligent and bring losses to the lender. Given our normalization of the population size of potential borrowers to 1, the number of clients actually served is $[1 - G(z_{\mathrm{L}})]$ which becomes larger, the smaller is $z_{\mathrm{L}}(R_s, I)$.

The expected average repayment must be sufficient to cover the opportunity cost of funds and all handling costs. One indicator of the quality of the portfolio is the average default rate in the portfolio, calculated to be:

$$\text{Proportion of loans in default} = \beta(1-p) + (1-\beta)(1-q) \tag{1.10}$$

2.4 The Screening Contract Offered by Caja Los Andes

Caja Los Andes entered the market offering a personalized loan contract. This was possible because Los Andes uses costly screening to form a more precise estimate of the productivity type (z in the model) of each borrower that applies for its loans. A lender's choice of lending technology is partly shaped by ownership structure and objectives. Although Caja Los Andes' grew out of the earlier NGO Procredito, Caja Los Andes began operations as a private for-profit Financial Fund and has remained consistently one of the most profitable microfinance operations in Bolivia. Its clientele is large, it is not unreasonable to assume that Caja Los Andes places the profit motive ahead of outreach, at least compared to BancoSol.[4] Caja Los Andes was therefore from the start interested in capturing the more productive, and hence potentially more profitable, borrowers in the market.

A screening process can help address the adverse selection problem, albeit at a cost, but the moral hazard problem remains present, as diligence cannot be independently verified. The screening process at Los Andes includes mandatory visits to the borrower's workplace and home. These visits allow loan officers to re-construct the financial statements of their clients with precision. Loan officers also talk to neighbors about their prospective clients' lifestyles to confirm their own initial impressions. These on-site visits are complemented by consultations with the still nascent microfinance credit bureaus in Bolivia and final approval is made in the headquarter office. This screening analysis also allows Los Andes to discover which of the borrower's assets have high consumption value and might therefore potentially be used as imperfect collateral. Los Andes draws up an inventory of household valuables such as TV sets, refrigerators or furniture, and the borrower is asked to pledge some of these as collateral even though the threat to seize such assets is not easily enforceable in court. The use of collateral, imperfect or otherwise, can be readily

[4]BancoSol is also a for-profit bank but several of its major shareholders invested in the bank for its social mission.

incorporated into formal model,[5] but complicates the analysis. To keep the formal analysis simple we shall limit ourselves to an informal discussion of how the use of collateral would alter the results below.

The maximum repayment compatible with diligence is again: $pR_s \leq pzf(I) - p/\Delta B(I)$. Caja Los Andes' participation constraint differs from BancoSol's however because Caja Los Andes faces two types of fixed costs ($fc + hc$) while BancoSol faces only hc. As before, average handling costs hc are assumed to be independent of loan size but to fall with the number of borrowers in a lender's portfolio. Screening costs on the other hand are assumed to not change with the number of borrowers or loan size.

Caja Los Andes screening contract allows it to tailor its loan contracts to each borrower's productivity level z. Starting with the most productive borrower in the population, Caja Los Andes will offer tailored loan contracts to all borrowers to which it can profitably lend. If we assume that Caja Los Andes has lower screening costs BancoSol cannot imitate its strategy and will lose the highest productivity borrowers in its portfolio to Caja Los Andes. These borrowers will be lured away by larger loans and better loan terms. Each Caja Los Andes contract will be determined individually just as in the analysis of individual loan contracts with z known described in the basic model above. Although Los Andes takes away the most productive borrowers, high screening costs keep Caja Los Andes from competing to steal all of BancoSol's borrowers—all borrowers above a new threshold level z_S will switch to screening contracts. A new partition of the population, summarized by $\underline{z} \leq z'_L \leq z'_D \leq z_S \leq \bar{z}$, where Los Andes lends to all borrowers with z in the range $z_S \leq z \leq \bar{z}$ and BancoSol retains borrowers with z below z_S and above z'_L, and z'_D is the new threshold between diligent and non-diligent borrowers.

The changes in welfare brought about by the entry of Caja Los Andes are several and interesting to analyse. Depending on the nature and timing of competition between lenders, a large number of outcomes are possible.[6] Some broad predictions can nonetheless be made that hold under a range of reasonable assumptions. For example, it is clear that Caja Los Andes enters the market by 'cream-skimming' or stealing away the more productive and profitable borrowers from incumbent BancoSol-type lender. The most productive borrowers in the population will want to switch to get larger loans and possibly higher net returns. Another interesting implication is that the least productive borrowers who had previously been receiving cross-subsidies under the pooling arrangement may be left out of the market (i.e. $z_L < z'_L$) as BancoSol is forced to adjust the terms of its pooling contract to the loss of the upper tail of the distribution of borrowers in its portfolio. This last result suggests that a BancoSol-like lender might move 'up-market' and abandon less productive and profitable borrowers.

A further complication is that average handling costs might well rise with the arrival of Caja Los Andes as borrowers become spread over two different lenders. The possibility of such immiserizing competition, also analysed in Hoff and Stiglitz (1997), cannot be ruled out *a priori*. Since there is now screening costs in the new equilibrium it is quite certain that handling costs per borrower will have risen. These higher costs are however compensated by the fact that the more productive borrowers now receive larger loans closer to their socially optimal size.

[5]See Conning (1999) for an analysis of the use of collateral and imperfect collateral in a model with moral hazard, but no adverse selection.

[6]For example, should we assume perfect competition between lenders, monopolistic competition, or oligopoly behaviour? Do lenders choose the terms of their contracts simultaneously, or is one lender a Stackelberg leader. Is BancoSol allowed to offer its own screening contracts, or do we assume it can't compete with that technology.

All these results pertain to this highly stylised model. In actual practice market size potential had not yet been reached at the time of Caja Los Andes' entry, so lenders also competed by moving into new market territories and niches. Furthermore, competition is likely to have spurred lending technologies to be improved and lending costs lowered, an effect that is likely important in practice but is not captured in this model. Although the model is suggestive of the ways that entry and competition might affect the terms of contracts available to different target groups and borrower welfare, it is by no means certain that competition should force lenders to move upstream or that it should lower the welfare of the poorest. The ultimate answer to these questions is an empirical one. To illustrate some further results and to derive empirical hypotheses to be tested we now turn to a relatively simple numerical simulation, followed by a statistical analysis of actual data.

3 A NUMERICAL SIMULATION

3.1 One Lender: BancoSol

Suppose that the distribution of z in the population is standard normal, so $G(z) = N[0, 1]$. To simplify, suppose the loan size is $I = 100$.[7] Diligent entrepreneurs of productivity level z have a probability $p = 0.9$ 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 less frequently, as $q = 0.6$. Suppose the total population of entrepreneurs is 100 and that total handling costs (HC) are \$1,000. Table 3 summarizes the parameters of the simulation.

At the moment the only lender in the market is BancoSol.[8] The lender knows the distribution of z in the population, but not the productivity level of any specific entrepreneur. Table 4 simulates how the composition of borrowers and the lender's expected returns would vary as a function of the interest rate charged (the interest rate

Table 3. Simulation parameters

Probability of project success		
Diligent	p	0.9
Non-diligent	q	0.6
Other parameters		
Lump sum investment	I	100
Fraction of investment diverted	$B(I)$	$0.15I$
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	HC	1000

[7]Technically speaking, we want to search for both the optimal levels of R_s *and* the optimal loan size I in the pooling contract. It is easily shown however that this problem can be re-stated as a two-stage problem: first determine the optimal R_s for every loan size, and then search over the set of optimal contracts for each loan size to find the loan size that best satisfies the lender's objective function (in this case maximize outreach). Our illustration therefore is without loss of generality and captures the relevant elements of the analysis.
[8]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.

Table 4. BancoSol's portfolio composition as a function of the interest rate

Interest rate (%)	z_L	z_D	Number of borrowers	Average repayment		Average			Default rate (%)
				Non-diligent	Diligent	Repayment	Costs	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

is $(R_s/I) - 1$) given these parameters. As the table shows, raising the interest rate (raising R_s) raises both z_L and z_D. At an interest rate of around 70 per cent, 43 per cent of the entrepreneurs in the population apply for a loan, the largest outreach consistent with the bank being able to remain sustainable.

The break-even loan contract ($R_s = 170$, $I = 100$) partitions the population of entrepreneurs into three groups: non-applicants, non-diligent borrowers, and diligent borrowers. The partitioning of entrepreneurs is shown in the second and third columns of Table 4. BancoSol earns an expected repayment of $pR\text{s} = 0.9(170) = 153$ on each of its diligent borrowers and $qR_s = 0.6(170) = 102$ 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 is raised because the pool of borrowers shrinks, influencing *hc*.

At the break-even interest rate of 70 per cent, the lender is charging 13 percentage points above its costs of funds to the average diligent borrower. This excess interest will offset (cross-subsidize) the 23 per cent expected loss on non-diligent borrowers. Since the non-diligent borrowers are $\frac{[1-G(z_D)]}{[1-G(z_L)]} = 40$ per cent of the pool of clients and the diligent borrowers are the remaining 60 per cent, the lender's average expected return is:

$$
\begin{aligned}
&= \left[\frac{1 - G(z_D)}{1 - G(z_L)}\right] \cdot pR_s + \left[\frac{G(z_D) - G(z_L)}{1 - G(z_L)}\right] \cdot qR_s \\
&= (0.40)(0.6)(170) + (0.60)(0.9)(170) \\
&= 40.8 + 91.8 \approx 133
\end{aligned}
$$

As interest rates increase, profits increase only up to a point and decrease thereafter. This is because profits are influenced in three ways. First, profits increase as the repayment amount R_S from all successful borrowers (diligent and non-diligent) increases. Second, the proportion of *non*-diligent borrowers rises, 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, profits would be maximized at an interest rate of around 100 per cent, but outreach, as measured either by the number of total borrowers or diligent borrowers reached, would be significantly smaller at this point. Once the interest rate has risen to 150 per cent, only 16 per cent of the total pool of entrepreneurs will take the loan contract and all borrowers (100 per cent) will be non-diligent.

3.2 Ability to Repay

The diagonal in Figure 1 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_L is depicted as generating $z_L f(I) = 170$ under success and a borrower of productivity type z_D will generate 220. The *probability* of being successful depends on diligence level. The expected returns from the project that are available for repayment is given by the probability of success of the project times the value on the diagonal $zf(I)$. When the entrepreneur is diligent, so $p = 0.90$, the expected repayment is closer to the diagonal. When the entrepreneur is non-diligent the probability of success falls to $q = 0.60$, and the expected repayment is farther below. Above the threshold z_D, all borrowers are diligent. The relevant expected ability to repay is $0.90zf(I)$. Below z_D, the

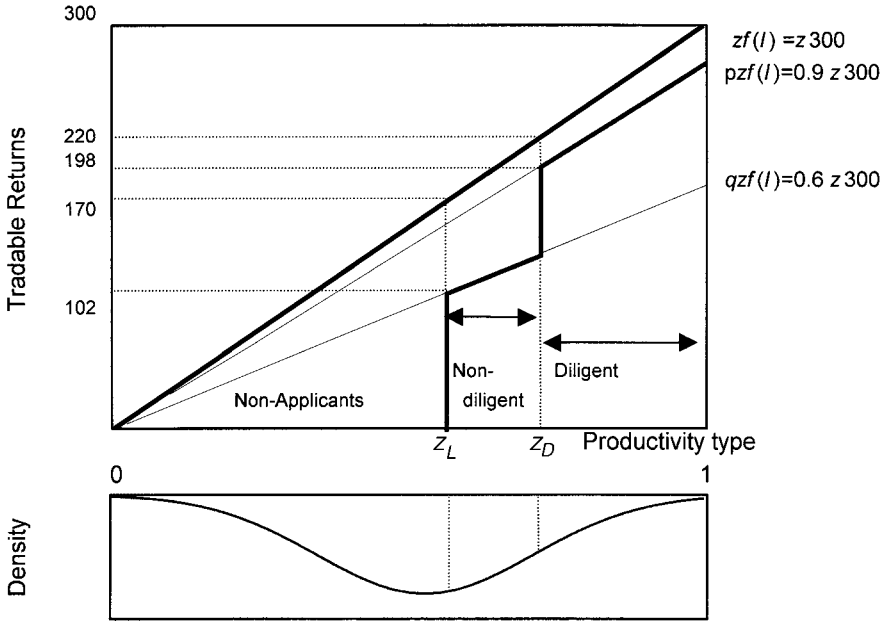

Figure 1. Ability to repay for the Break-Even Loan Contract ($R_s = 170$, $I = 100$)

expected ability to repay is $0.60zf(I)$. Below threshold z_L, entrepreneurs prefer not to borrow, as their productivity is very low and the alternative occupation is preferred. For a loan of size 100 and interest rate of 70 per cent, all borrowers (entrepreneurs of at least productivity type z_L) 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_D will not generate sufficient returns to repay the loan.

Given the fixed-repayment character of the loan contract, borrowers do not pay more than 170 in the event of success, regardless of the size of the returns generated. More productive borrowers therefore retain larger surpluses after repayment and have greater incentives to be diligent. The higher productivity diligent borrowers are however also generating higher net returns for the lender and these proceeds cross-subsidize non-diligent borrowers. The proportion of each class of entrepreneurs is shown in the lower graph in Figure 1, which depicts the distribution of entrepreneurs by productivity types.

3.3 Profits, Default Rates and Scale

At lower interest rates, a larger proportion of borrowers have incentives to be diligent, so arrears are lower. At low initial interest rates profits might be raised by charging higher interest rates even as that means losing borrowers and accepting higher rates of default. At higher rates the positive effect on profits of raising interest rates will become strongly counterbalanced by the negative effect of changes in portfolio quality (i.e. rising fraction of non-diligent borrowers). The relationship between profits and the number of bank borrowers is also non-monotonic. If BancoSol charges very high interest rates, few borrowers will be attracted, raising high fixed handling costs per borrower. But interest

rates can't be lowered too much either without lowering profits. The largest fraction of the market is served at the lowest sustainable interest rate.

3.4 Competition from Caja Los Andes

Under BancoSol's standardized loan contract, higher productivity borrowers obtain smaller loan sizes and pay higher interest rates compared with what they would get if they could costlessly reveal their productivity to the lender and get a contract tailored to their characteristics. If the Bank's objectives are to extend outreach and if screening costs are high enough, then BancoSol's pooling contract may well be the optimal lending arrangement for a single lender on the market. Economies of scale in handling costs give an incumbent a natural monopoly advantage *vis-à-vis* any potential competitor who uses the exact same lending technology. The way to break into this market therefore is by obtaining a different lending technology. Los Andes entered the marketplace offering new personalized loan contract targeted to BancoSol's existing higher productivity and better capitalized borrowers. It made sense for Los Andes to go after the higher-productivity borrowers because this is the segment most frustrated by the small loan sizes under BancoSol's standard loan, and the segment where the gains to trade would be large enough to compensate for the high costs of screening involved in this lending modality.

Suppose that BancoSol had an existing handling cost advantage due to its established scale, while Caja Los Andes is able to screen at lower cost than BancoSol, hence making it hard for BancoSol to pre-empt by emulating Los Andes' loan strategy. A likely outcome in this scenario is that borrowers with $z_S \leq z \leq \bar{z}$ will switch from BancoSol to Los Andes, where $z_S > z_D$. As the most productive borrowers leave BancoSol, the size and quality of its portfolio must decline. If BancoSol did not adjust its contract terms to this new form of competition, it would face by an immediate rise in its default rate and fall in profitability as it saw diligent borrowers leave.

The outcome of the competition process will depend on the nature and the timing of the game between the two rivals. Is BancoSol or Caja Los Andes a Stackelberg leader, or do they choose the terms of their contracts simultaneously? In either case, we would start by calculating reaction functions for each bank. Caja Los Andes' choice of contracts can be viewed as their choice of z_S. BancoSol's best response can then be found by using formulas (1.8)–(1.9) above (substituting z_S for $\bar{z}$) and a new ordered partition of borrowers emerges.

4 REALITY CHECK: EMPIRICAL EVIDENCE FROM BOLIVIA

The theoretical discussion suggests four testable hypotheses: (i) the average borrower of Los Andes will be more productive than the average borrower of BancoSol; (ii) Los Andes borrowers are expected to be wealthier than their BancoSol counterparts;[9] (iii) where switching is observed, higher productivity borrowers of BancoSol will switch to Los Andes; and (iv) the terms of the loan contract at BancoSol display more homogeneity (standardized loan contracts) compared to Los Andes, where the loan terms and loan sizes will be more adjusted to borrower heterogeneity. In what follows we test these hypotheses

[9]This follows from an extension of the model to include imperfect collateral, which screening also helps to establish.

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.

empirically with the aid of proxy indicators for poverty, productivity type, and variability of loan terms.

This section is based on data collected from a research project conducted in Bolivia first started 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 household survey in La Paz, which included 239 randomly selected borrowers from BancoSol and 128 from Los Andes. For more details on this data (see Gonzalez-Vega *et al.*, 1996).

4.1 Hypothesis One: Level of Poverty

Household socio-economic and poverty 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 appear less poor than those of BancoSol.

An estimation of the borrowers' poverty incidence 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 employed 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] The *IBNF* divides borrower households into four categories: the non-poor who satisfy basic needs or are at the threshold, the moderately poor, and the poor.

A classification of borrowers using this scale is shown in Table 6. The proportion of the poor (52 per cent) in the portfolio of BancoSol is higher than for Los Andes (33 per cent) and two non-parametric tests argue that these are statistically significant differences. A Kolmogov–Smirnov test rejected the hypothesis that the distributions were normal, therefore non-parametric (or distribution free) tests were used instead of the usual *t*-tests. The Kolmogor–Smirnov test rejects the hypothesis that the distributions of the index for

[10]The national assessment had a fourth component, access to health care services. Access to health services was not included in the OSU survey. See Navajas *et al.*, (2000) for more details on the data and methodology.

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.

the two lenders were equal with more than 95 per cent confidence. The difference in medians was also tested using a Wilcoxon rank-sums test and the median index for Los Andes (0.97) is also found to be greater than for BancoSol (0.90), with more than 95 per cent confidence. We can safely conclude that the typical borrower in Los Andes loan portfolio is less poor than the typical borrower of BancoSol.

4.2 Hypothesis Two: Productivity Level

The second hypothesis referred 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, suggesting they are capable of managing larger scale projects and businesses. A reasonable 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. The results of the tests for comparing *IEB* levels once again handily confirm the hypothesis. The borrowers of Los Andes are more productive than their counterparts in BancoSol.

4.3 Hypothesis Three: Productivity Level of 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

Table 7. Non-parametric statistical tests comparing the components of the IBNF for the borrowers of BancoSol and Caja Los Andes

	p-values[a]	
Indexes	Two-sided Kolmogorov–Smirnov[b]	One-sided Wilcoxon Rank Sum[c]
Housing (*IH*)	0.6096	0.0353
Public services (*IPS*)	0.0028	0.0002
Education (*IE*)	0.7470	0.2975
Education borrower (*IEB*)	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.

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. In the sample of 128 Caja Los Andes borrowers 17 per cent had switched from BancoSol. In contrast, less than one per cent of the 239 borrowers in the random sample of BancoSol borrowers had previously borrowed from Los Andes (see Table 8).

What about the characteristics of the borrowers who actually switched compared to new borrowers? Using non-parametric tests to compare both means and medians we can again conclude, this time with at least 93 per cent confidence, that the borrowers who switched out of BancoSol to Los Andes had higher median levels of education than all borrowers of BancoSol (see Table 9). They are also appear to be less poor.

4.4 Hypothesis Four: Type of Loan Contract

The theoretical framework suggests that the loan contract offered by Los Andes should be more closely tailored to the borrower's characteristics than BancoSol's more standardized contract. To see whether this was the case or not, we first analysed the correlation between the first loan disbursed and the *IBNF* proxy for productivity. A positive correlation is an indication that the lender is able to adjust loan terms to personal characteristics. The

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-sided Wilcoxon Rank Sum[c]
Basic needs fulfillment (INBF)	0.0102	0.0354
Housing (*IH*)	0.6453	0.1622
Public services (*IPS*)	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.

correlation coefficient is positive for Los Andes (0.20) and negative for BancoSol (−0.11) suggesting that Los Andes is better able to distinguish applicants compared to BancoSol. 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. Higher variability is an indication of a larger number of different 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 this and each subsequent iteration, median loan size and variability remain consistently higher for Los Andes.

5 CONCLUSION

Access to credit for the poor, especially in the urban areas, has improved dramatically in Bolivia over 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 facilitate comparisons of microlending technologies, and to analyse the dynamics of competition we developed a benchmark model to highlight the ways that the problems of moral hazard and adverse selection limit and constrain the nature of loan contracts that can be offered on the market. Lenders have to address information asymmetries about both actions (diligence) and borrower type (productivity). We argued that different types of loan contracts might be offered to match different borrower classes, but that the nature of that diversity depended in part on the intensity of the competition and the objectives of the dominant lenders. Using the benchmark model we examined a stylised history of competition between BancoSol and Caja Los Andes, two lenders that enjoy the lion's share of urban microlending in Bolivia.

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. This contract is based on costly initial screening of borrowers to determine repayment capacity (productivity type) and imperfect collateral assets that have high use-value to the borrower. By way of contrast BancoSol offers a standardized loan contract. Loan contracts are less personalized to the borrowers characteristics because BancoSol does not screen each borrower as intensively as Los Andes does, in order to keep costs low. Screening and monitoring costs may also be lower because BancoSol uses joint liability in credit groups to encourage some peer-screening and peer-monitoring. In following this strategy BancoSol appears to have chosen to sacrifice some information in order to lower its overall costs and increase outreach, even if that has meant letting in some borrowers who are riskier and less likely to be able to manage profitable projects.

BancoSol has been operating since 1987, and since 1992 as a commercial bank. Over the years, valuable information about its market segment has been collected, which has given BancoSol the capacity to adapt its standard contracts over time. In other words, BancoSol has learned about the distribution of productivity types among its potential borrowers and this has allowed it to lower its costs and provide incentives to its borrowers to attain profitability. Caja Los Andes appears to make a larger explicit investment in information gathering activities and this allows it to tailor its contracts to its clients needs somewhat more flexibly. A consequence of these higher fixed costs of screening however are that this lender finds it less profitable to work with clients who take out smaller loans.

Each lending technology therefore attracts a different pool of borrowers. Lower-productivity, and less well capitalized borrowers prefer the standard loan contract in part because it avoids high screening costs and in part because of the possibility that lenders like BancoSol cross-subsidize smaller borrowers because of their focus on outreach and their imperfect ability to screen. High-productivity borrowers prefer a personalized loan contract, so long as the additional costs are not unreasonable. The model predicted that high-productivity BancoSol borrowers (who are also likely to be wealthier) would switch to the new entrant Los Andes. The data confirm this prediction strongly. The borrowers who switched were 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 typical BancoSol borrower.

Faced with competition, BancoSol had two options. One option that can be analysed with the model is for the Bank to revise its loan contract to reflect the shrinking and less productive pool of borrowers it is left with as a consequence of Los Andes' entry. 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 appears to have partly also followed this second option. By 1998, eight per cent 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 serve the market. Alternative lending technologies have both been profitable in reaching overlapping clienteles but increased competition can disrupt and threaten the early outreach successes of pioneer lenders. The ability to adapt to competition will determine the permanence of the incumbents in the market. Competition in turn has changed the type of loan contracts supplied to different segments of the market and thereby has influenced the borrowing possibilities of different classes among the poor. Increased competition can in theory reduce outreach by limiting the extent to which a socially oriented lender can cross-subsidize poorer borrowers. Competition can however also improve access for everyone via a decrease of monopoly rents, and by spurring innovation. The overall effect of competition on the poorest is, therefore, ambiguous.

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