A Theory of Interactions Between MFIs and Informal Lenders[1]

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Abstract

We provide a theoretical model of entry of a microfinance institution (MFI) into an informal credit market. Relative to informal lenders, the MFI has a cost advantage and an informational disadvantage regarding knowledge of borrower-specific default risk. MFI entry is shown to induce selection effects (across risk and landownership dimensions) in shifts of borrowers from informal lenders to the MFI which could raise or leave unchanged informal interest rates, as observed in many LDCs. The model is consistent with evidence from Bangladesh and West Bengal, in contrast to hypotheses based on cream-skimming, scale-diseconomy-inducing, collusion-facilitating or crowding-in effects of MFIs on informal credit. The model implies MFI entry is Pareto improving for borrowers, irrespective of effects on informal interest rates.

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1 Introduction

The ability of microfinance to deliver on its promise of alleviating poverty has recently been questioned. Experimental evaluations have found limited impacts on asset ownership and consumption (Karlan and Mullainathan (2010); Banerjee, Duflo, Glennerster and Kinnan (2011); Karlan and Zinman (2011); Desai, Johnson and Tarozzi (2011)). An added concern relates to negative spillovers on borrowers not served by microfinance institutions (MFIs), arising from adverse impacts on interest rates on informal credit markets. Originally designed to rescue poor households from 'the clutches' of moneylenders, microfinance was expected to reduce the interest rate in informal credit markets. The failure of large infusions of credit from formal financial institutions between the 1960s and 1990s to reduce informal interest rates in many developing countries has been noted by a number of authors (Hoff and Stiglitz (1993, 1998)), von Pichke, Adams and Donald (1983)). Recent studies in the context of Bangladesh (Mallick (2012), Berg, Emran and Shilpi (2013)) have found that growth of microfinance resulted in a significant increase in informal interest rates.

A number of possible explanations for this phenomenon have been advanced in the literature:

(a) *Scale Diseconomies:* competition from MFIs may lead to loss of economies of scale for informal lenders, as fixed costs have to be spread over a smaller volume of lending, and screening and monitoring costs rise (Hoff and Stiglitz (1998), Jain (1999));

(b) *Cream-skimming:* MFIs may cream-skim low risk borrowers, leaving high risk borrowers to be served by informal lenders (Bose (1998), Demont (2012));

(c) *Collusion:* as formal credit is often channeled through informal lenders, the increased volume of credit available on the informal market can facilitate collusion among lenders (Floro and Ray (1997));

(d) *Crowding In:* inflexible and frequent repayment requirements of MFI loans induce increased borrowings from informal lenders, raising demand on the informal market (Jain and Mansuri (2003)); non-exclusive contracting combined with moral hazard can result in higher informal borrowing and higher default risk (Kahn and Mookherjee (1998), McIntosh and Wydick (2005)).

However, the empirical findings are not consistent with most of these explanations. Mallick (2012) finds that the effects of increased MFI penetration on informal interest rates in Bangladesh are robust to inclusion of controls for scale economies, competition among lenders and costs of information collection of lenders. Berg, Emran and Shilpi (2013) find increased borrowing from MFIs in Bangladesh was accompanied by reduced borrowing from informal lenders, contrary to the 'crowding in' hypothesis.[4] And contrary to the 'cream-skimming' hypothesis, a recent experimental study of effects of MFI lending in the neighboring state of West Bengal, Maitra, Mitra, Mookherjee, Motta and Visaria (2013) find MFIs offering joint liability loans disproportionately attracted clients that pay higher interest rates on the informal market, controlling for their landholdings.

This paper provides an alternative model of interaction between MFIs and informal lenders, which is not based on any of the above mentioned channels. Our hypothesis is that informal credit markets are characterized by adverse selection (as in Ghatak (2000)) and segmentation. Borrowers differ on two dimensions: risk type and landholding. Each segment has a privileged lender that knows the risk types of borrowers located in that segment, but not of borrowers located in other segments. External borrowers such as MFIs do not know the risk type of any borrower. Landholdings are observed by all lenders on the other hand.[5]

Prior to the arrival of an MFI, the equilibrium of this market involves Bertrand competition across all segments for high risk borrowers which results in an actuarially fair (high) interest rate for such borrowers. This co-exists with monopolistic behavior of lenders with respect to low risk borrowers within their own segment, owing to their privileged informa-

[4] Maitra *et al* (2013) find the same result in West Bengal.

[5] The notion of 'risk type' may pertain either to the intrinsic riskiness of the project financed by the loan, or to the likelihood that the borrower will be motivated to repay the loan when it is due. Our model can be extended to the case where borrowers have varying time preferences, and safe borrowers are those that are more likely to repay under the threat of future penalties owing to lower impatience. Hence the model is consistent with problems of moral hazard in loan collections, or adverse selection with respect to degree of impatience.

tion of the latter's risk type. So informal lenders earn profits from lending to low risk types, while breaking even on high risk types.

The MFI is assumed to be a non-profit entity that seeks to maximize the welfare of borrowers, subject to a break-even constraint.[6] Informal lenders react to MFI entry and loan offers by possibly altering the contracts they offer to borrowers. Lending contracts are exclusive, consistent with the findings of Berg *et al* (2013) and Maitra *et al* (2013): a borrower borrows either from the MFI or from an informal lender. Hence MFI borrowing leads to crowding out of loans from informal lenders. Lacking access to privileged information concerning risk types of borrowers in any segment, an MFI is at an informational disadvantage *vis-a-vis* informal lenders. On the other hand, it has access to capital at a lower cost. The entry of an MFI then results in competition with informal lenders in which both can co-exist. The MFI overcomes its informational disadvantage by offering joint liability loans which pool the two risk types.[7]

The MFI always succeeds in attracting all high risk borrowers, since it does not suffer from an informational advantage in serving this section of the population; its lower cost of capital implies that the interest rate offered to high risk types undercuts the rate at which they can borrow on the informal market. Among safe types of borrowers, the MFI succeeds in lending only to those with enough land that they are able to shoulder the burden of joint liability, in the case where the MFI is not motivated to cross-subsidize across borrowers of varying lands. If however it assigns a high welfare weight to those with less land relative to those with more land, the MFI would induce the latter to cross-subsidize the former. The likelihood of MFI participation of the safe types could then be decreasing in landholdings.

The effect of MFI entry on informal interest rates (averaging across different landholding levels) is ambiguous: it depends on how participation rates and informal interest rates for the safe type vary with landholdings, and on the relative proportion of safe and risky types

[6] We conjecture similar results obtain when its objective is the size of its clientele rather than borrower welfare.

[7] It could alternatively provide low risk types with a joint liability loan, while offering an individual liability loan to high-risk types. These allocations are payoff-equivalent in our model. In either case the safe types cross-subsidize the risky types.

in the population. We provide a numerical illustration of the model, when parameters are chosen to match observed patterns in West Bengal data in the experimental study of Maitra *et al* (2013). In this context, MFI participation rates were decreasing in landholdings, while informal interest rates were rising over a range of low landholdings (from zero to a half acre) which comprised the majority of the population. If the proportion of risky types is not too large, the average informal interest rate rises consequent on MFI entry. The intuitive reason is that poorer borrowers are more likely to switch from informal lenders to the MFI, and they pay lower interest rates on the informal market. Those safe types left with the informal lender own more land, who tend to pay higher interest rates (because there is more surplus available from them that the lender can extract). The average informal interest rate rises consequent on MFI entry owing to induced selection effects, rather than induced scale diseconomies, collusion effects or 'crowding-in'.

In our model, MFI entry ends up always generating a weak Pareto improvement for borrowers, irrespective of parameter values. A strict Pareto improvement results for a nontrivial range of parameter values (e.g., when the cost advantage of the MFI relative to informal lenders is large relative to their informational advantage). Even for borrowers not served by the MFI, the presence of the MFI can provide an outside option to the poor borrowers that effectively reduces the level of 'exploitation' by informal lenders (also previously noted by Besley, Burchardi and Ghatak (2012)). Hence one should be cautious in inferring negative spillovers from MFIs from evidence showing that they raise informal interest rates. Further research is needed to test and discriminate between competing models on the basis of empirical evidence before any inferences regarding welfare effects of MFI entry can be made.

In the next section we introduce the model. Sections 3 and 4 serve as a prelude, where we study a market with only the MFI or only informal lenders operating in isolation. Section 5 then examines the implications of co-existence of an MFI and informal lenders. Section 6 provides a numerical illustration of MFI effects predicted by the model when parameter values are chosen so as to match observed patterns for participation and informal interest rates in the West Bengal experimental study of Maitra *et al* (2013). Section 7 concludes.

2 The Model

All borrowers live in a village with a large population normalized to unity. Each borrower is endowed with a risky investment project. The project requires one unit of land and one unit of capital. Borrowers lack sufficient personal wealth and need to borrow to launch the project. The project can yield either a high or a low return; we refer to these outcomes as success (S) or failure (F). The outcome of a farmer's project will be denoted by the binary random variable $\bar{x} \in \{S, F\}$, which is observable and verifiable. The borrowers are characterized by (i) their (non-collateralizable) wealth $a \geq 0$, which also represents their outside option under autarky, and (ii) their unobservable probabilities of success p_i with $i \in \{r, s\}$ and $0 < p_r < p_s < 1$. We assume these are independent of a, but it is easy to extend the analysis when this assumption is dropped.

Wealth takes the form of land or other inputs of production. If $a < 1$ the borrowers need to lease in the remaining amount of inputs $(1 - a)$ required by the project.[8] Borrowers characterized by probability of success p_r and p_s are refereed to as risky and safe farmers respectively.

Risky and safe types exist in proportions θ and $(1 - \theta)$ in the population, where $\overline{p} \equiv \theta p_r + (1 - \theta)p_s$. The proportion θ is independent of a, but it is straightforward to drop this restriction. The outcomes of the project are independently distributed across borrowers. The return of a project of a borrower of type i is a random variable $\tilde{y}_i$, which takes two possible values: $R_i(a)$ if successful, and 0 if not, where $R_i(a) > 0$; $i = r, s$. Project returns are increasing in a. This reflects reduction in distortions associated with tenancy, ranging from inferior quality of leased in land to Marshallian undersupply of effort. For the sake of exposition, we assume $p_s R_s(a) = p_r R_r(a) \equiv \bar{R}(a)$; this assumption is relatively inessential. Borrowers are risk-neutral and maximize expected returns. Note that each borrower is endowed with only one project, i.e, borrows either from the MFI or the informal lender. Hence borrowing from the MFI will crowd out borrowing from the informal lender.

[8]If a is land, leasing is on a sharecropping contract, where the borrowers retains a fraction of the output, the remaining going to the landlord.

3 MFI in Isolation

To begin with, we assume there are no informal lenders and the MFI is the only provider of credit. This analysis follows Ghatak (2000) closely. The MFI can offer two types of credit contracts: individual liability contracts and joint liability contracts, none of which utilize any collateral. The former is a standard debt contract between a borrower and the MFI with a fixed repayment r in state $\bar{x} = S$, and zero otherwise. The latter involves asking the borrowers to form groups of two, and offering an individual liability component r and a joint liability component c.[9] Owing to limited liability and the fact that MFIs do not use collateral, a borrower does not repay if the project fails. If a borrower's project is successful then he is liable for his own repayment r in addition to c if his partner's project failed.

The cost of capital for the MFI is $\rho > 1$ which is given. It can offer as many loans as it likes in the village, as long as the expected repayment on these loans is at least ρ. All projects are socially productive in the sense that $p_i R_i(a) > \rho + a$ for all a and $i = \{r, s\}$. The objective of the MFI will be to maximize the welfare of borrowers (for some set of welfare weights across risk and land categories) subject to a breakeven constraint, as described further below.

Since landholding a is observable, the market composed of borrowers with a given landholding a can be treated as an independent market. In what follows we focus on a given a, and suppress dependence of parameters on a. We first consider the case where the MFI seeks to break-even on each landholding category separately. Later we shall discuss the consequences of dropping this restriction.

The MFI cannot identify a borrower's risk type. We assume the likelihood of repayment of loans to the MFI is the same as the likelihood of repayment to an informal lender.[10] Given the loan size is fixed, it is impossible for the MFI to screen different types using individual liability contracts. The only instrument controlled by the MFI would then be

[9] See Ahlin (2012) and Maitra et al. (2013) for an analysis of group lending under adverse selection with group size greater than two.

[10] This assumption can be relaxed in either direction, at the cost of complicating the model further, but not changing the main results.

the interest rate, and both types would opt for the loan with the lowest interest rate.

As Ghatak (2000) showed, it is possible for the MFI to screen different types using joint liability loans and asking borrowers to form groups. Assuming borrowers know each other's types, there is assortative matching: safe (resp. risky) borrowers pair up with safe (resp. risky) borrowers. The MFI can induce self-selection between safe and risky groups, as described below. Without loss of generality, the bank offers a pair of contracts (r_r, c_r) and (r_s, c_s) designed for risky and safe groups. The expected payoff for a borrower of type i under a contract (r, c) is

$$U_{ii}(r, c) = p_i R_i(a) - \{p_i r + p_i(1 - p_i)c\}. \tag{1}$$

The MFI's objective is to choose (r_r, c_r) and (r_s, c_s) to maximize

$$V = \lambda U_{rr}(r_r, c_r) + (1 - \lambda)U_{ss}(r_s, c_s), \tag{2}$$

where $\lambda \in (0, 1)$ is the welfare weight that the MFI assigns to risky borrowers, subject to the following constraints: (i) The *breakeven constraint*: $\theta[r_r + c_r(1 - p_r)]p_r + (1 - \theta)[r_s + c_s(1 - p_s)]p_s \geq \rho$. Let $ZPC_{r,s}$ denote the set of pooled joint liability contracts that satisfy the zero-profit constraint with equality, and ZPC_i denote the set of joint liability contracts that satisfy the zero-profit constraint for a borrower of type i $(i = r, s)$ with equality. (ii) The *participation constraint*: $U_{ii}(r_i, c_i) \geq a$, where $i = r, s$. Let PC_i denote the set of joint liability contracts that satisfy the participation constraint of a borrower of type i with equality. (iii) The *limited liability constraint:* $r_i + c_i \leq R_i(a)$, where $i = r, s$. Let LLC_i denote the set of joint liability contracts that satisfy the limited liability constraint of a borrower of type i with equality. (iv) The *incentive-compatibility constraint:* $U_{ii}(r_i, c_i) \geq U_{ii}(r_j, c_j)$, where $i, j = r, s$ and $i \neq j$. Let ICC_i denote the set of joint liability contracts that satisfy the incentive-compatibility constraint of a borrower of type i with equality. (v) The *ex-post incentive-compatibility constraint* for each type which requires that it is in the self interest of the group to report that a project failed when it actually did (see Gangopadhyay, Ghatak and Lensink, 2005): $r_i \geq c_i$ for $i = r, s$. Let ICC_{ep} denote the set of joint liability contracts that satisfy the ex-post incentive-compatibility constraint with equality.

The following assumption ensures that there exists a feasible joint liability pooled contract:

$$p_s R_s(a) \geq \max\left\{\frac{p_s(2-p_s)}{\theta p_r(2-p_r)+(1-\theta)p_s(2-p_s)}\rho + a, \rho\frac{p_s}{\overline{p}} + \beta a\right\}, \tag{3}$$

where $\beta \equiv \frac{\theta p_r^2+(1-\theta)p_s^2}{p_s\overline{p}}$. The two terms on the right hand side represent the relevant thresholds on the safe borrowers' project expected return. The first one ensures that there exists a contract the satisfies the safe type's participation constraint and the ex-post incentive compatibility constraint, whereas the second term guarantees the participation constraint and the limited liability constraint.

Proposition 1 *Consider any given level of landholding a, and suppose that the MFI seeks to break-even on averaage on lending to borrowers of this category. Suppose (3) holds and there are no informal lenders. Then the MFI serves both risky and safe borrowers (of landholding a). If (3) is violated the MFI serves only the risky borrowers (of landholding a).*

Figure 1 illustrates the result and underlying reasoning in $(r-c)$ space. The ex post incentive constraint requires us to focus on points below ICC_{ep}, the 45 degree line. The break-even lines for safe borrowers alone, risky borrowers alone, and pooled contracts are represented by ZPC_s, ZPC_r and $ZPC_{r,s}$ respectively. LLC_s and PC_s represent the limited liability and participation constraints respectively for the safe type, while ICC_{ep} represents the ex post incentive compatibility constraint. The line segment AB represents pooled contracts that break-even and satisfy the limited liability and participation constraints for the safe type. Assumption (3) is equivalent to stating that this segment is non-empty.

A key point to note is that the risky type always attains a higher profit from any feasible contract compared with the safe type.[11] Hence any contract that satisfies the participation

[11]The expected return from the project is the same for the two types, while the expected cost of repayment for the risky type $rp_r + cp_r(1-p_r)$ does not exceed the expected cost $rp_s + cp_s(1-p_s)$ for the safe type as long as $0 \leq c \leq r$.

constraint for the safe type satisfies the same constraint for the risky type. The same is obviously true for the limited liability constraint also. Hence contracts AB are feasible for both types.

To establish the proposition, observe first that it is never optimal for the MFI to not serve any borrowers. It can always offer an individual liability contract with $c = 0$ and $r = \frac{\rho}{p_r}$ which will generate a positive surplus to risky types, while satisfying the limited liability constraint for such types.[12] Such a contract will raise the utility of the risky types and break-even when sold to such types. If safe types are attracted to this contract, it would raise profits of the MFI while raising the utility of the safe types, thereby raising the value of the MFI's objective function even further.

Next note that it is not feasible for the MFI to serve only safe types, because any contract which attracts safe types will also attract risky types. Hence the MFI either serves only risky types, or both types. If condition (3) is satisfied, the MFI must serve both types. Otherwise it would serve only risky types, by offering contracts on or above ZPC_r that lie to the northeast of PC_s. Offering a pooled contract on the segment AB would make both types of borrowers better off, while ensuring the MFI breaks even.

Finally, if (3) is not satisfied, it is not possible to offer a pooled contract that breaks even. Can there exist a separating pair of contracts which breaks even? This can be ruled out by observing that corresponding to any separating pair of contracts satisfying incentive constraints, there exists a pooled contract which leaves both types of borrowers with the same level of utility, and generates the same expected profit for the MFI.[13]

The last observation implies that nothing is gained by considering separating contracts when (3) holds: it is then optimal for the MFI to offer a pooled contract on AB. The precise

[12]Note that $p_r R_r - p_r(\frac{\rho}{p_r}) = p_r R_r - \rho > a > 0$.

[13]For any separating pair, construct the pooled contract which is the unique intersection point of the indifference curves of the safe and risky types passing through their respective contracts. Incentive compatibility of the original pair requires the low risk types to select the contract with higher c and lower r. Hence the constructed pooled contract involves lower c and higher r, and $r + c$ must be smaller (as the indifference curves of the safe type are steeper than the LL_c curve). It therefore satisfies LL_s since the original safe type contract did. By construction it leaves welfares of both types unaffected, as well as expected profits of the MFI.

choice of a contract on this segment depends on the relative welfare weights assigned to the two types. The higher the weight on the risky type, the closer the optimal pooled contract is to A (i.e., involving higher joint liability and lower interest rate). It is also optimal for the MFI to offer a separating pair of contracts, where the safe type is given a contract on AB, and the risky type given any contract on the same indifference curve for this type which involves a lower joint liability and higher interest rate. In particular, offering an individual liability contract for the risky type (which leaves this type indifferent between this contract and the joint liability contract offered to the safe type) is also optimal. Hence the MFI could either offer a single joint liability contract, or a joint liability contract designed for the safe type and an individual liability contract for the risky type.

If we drop the constraint that lending to each landholding category must break even separately, Proposition 1 can be extended as follows. Set a target level of profitability $\pi(a)$ for each level of landholding, and shift the zero profit line for landholding a to the iso-profit line corresponding to the requirement that the MFI earn an expected profit of $\pi(a)$ from borrowers with landholding a. The MFI can then select profit targets for each a subject to the constraint that $\sum_a f(a)\pi(a) = 0$, where $f(a)$ is the fraction of borrowers in category a. Relative to these selected targets, optimal contracts for each land class can be calculated as described in Proposition 1 after replacing the zero profit lines by the corresponding iso-profit lines. Since there exists at least one landholding class a^* with $\pi(a^*) \leq 0$, it follows that the MFI will lend to risky types of at least one such class. If it would also lend to safe types in class a^* under a break-even constraint for class a^*, it will continue to lend to safe types in a^* in the optimal solution.

4 Before the MFI Enters: Informal Lenders in Isolation

In this section we describe the informal credit market. It is convenient to consider the case where MFIs are absent, especially as corresponding to the baseline situation before an MFI enters. The section will examine the consequences of entry of the MFI.

The market is divided into a number of segments, either spatially or on the basis of social relations, wherein residents of each segment know a lot about each other and/or engage in a thick web of social and economic transactions. Each segment has one lender and many borrowers. Owing to the thick interactions and exchange of information within any given segment in the past, the lender knows perfectly the risk types of borrowers in his own segment. Similar results obtain when the lender is better able to enforce loan repayment from safe types within his segment compared to other types or residents of other segments.

For simplicity we suppose all segments and all lenders are identical. Each informal lender has a cost of capital ρ^I which is strictly higher than the cost of capital ρ of the MFI. We also assume absence of any capacity constraints for informal lenders, and that both types of borrowers have projects that are socially viable at a unit capital cost of ρ^I for any landholding a, i.e.,

$$p_i R_i(a) - a \geq \rho^I \qquad i = r, s. \tag{4}$$

We allow informal lenders to offer joint liability contracts. However we assume the following tie-breaking rule: if lenders earn the same expected profit, the informal lenders offer individual liability contracts rather than joint liability ones.

In the absence of the MFI the timing of the game is as follows: At stage 1, the informal lenders offer contracts to other-segment borrowers. At stage 2 informal lenders announce the contract for their own-segment borrowers. At stage 3, each borrower accepts at most one offer. At stage 4, contingent on the project being successful, the loan is repaid. The timing captures the additional advantage of dealing with own-segment borrowers, namely the ability to renegotiate the terms of their contracts following an offer from an external lender.[14] We think it is plausible that lenders can communicate more frequently with members of their own segment, so can react to offers made by lenders in other segments. Finally, we assume borrowers prefer to be served by their own-segment lender whenever they are indifferent and the latter makes positive profit. This assumption is not substantive, and simplifies the exposition.

[14]Assuming instead that the announcements are simultaneous would not alter out main results substantially but it would complicate the analysis of the equilibrium in the informal market. Namely, the equilibrium would not exist whenever the informal lender is able to offer a set of contracts that satisfy the zero profit condition and also attract both risky and safe borrowers from other segments.

Proposition 2 *In the absence of the MFI, an equilibrium*[15] *exists in the informal market. For any landholding a, every equilibrium results in the following outcome. All borrowers receive individual liability contracts from the lender in their own segment. Safe borrowers pay interest rate* $r_s^I(a) = \min\{R_s(a) - \frac{a}{p_s}, \frac{\rho^I}{p_r}\}$*, while risky borrowers pay* $r^I = \frac{\rho^I}{p_r}$.

To establish this, we first describe properties that must be satisfied in any equilibrium. The main point to be noted is that *there cannot be an equilibrium in which a lender in some segment (j, say) lends to a safe borrower in a different segment (i, say).* Clearly this cannot happen in a way that the lender makes a positive expected profit on the loan, since in that case it would be undercut by the lender in segment i. If the loan to the safe type results in a zero expected profit for the lender in segment j, then observe that it would earn an expected loss if the borrower were a risky type instead. A risky type in segment i would be able to receive the same loan, owing to the inability of the lender in segment j to distinguish safe from risky types in segment i. It must then be the case that risky types in i have access to a loan which gives them an even higher expected utility, which would generate expected losses for any lender that offers it. This cannot be the lender in segment i, since that lender can identify risky types in segment i. So the risky types in i must be borrowing from some lender in another segment k different from i or j. But the same argument as above implies that the lender in segment k cannot earn positive profits from lending to either type in segment i. Hence the lender in segment k must be earning a loss from lending to borrowers in segment i, and would be better off dropping such loan offers.

It follows that lenders in any given segment i will have monopoly power over lending to safe types in i, and will thus be able to charge them an interest rate $r_s^I(a)$ which extracts all their surplus. Since there are no incentive constraints operating on within-segment transactions, there is no benefit to the lender from offering a joint liability contract to the safe types. Given our tie-breaking assumption, safe types will receive an individual liability contract at interest rate $r_s^I(a)$.

Next, note that all lenders compete for risky type borrowers across different segments,

[15] We use the solution concept of a subgame perfect Nash equilibrium throughout this paper.

and must end with earning zero expected profits from lending to them. Since the market for lending to risky types is effectively separated from the market for lending to safe types, there is no benefit from offering joint liability loans, and every risky type will end up with a individual liability loan with interest rate $r^I = \frac{\rho^I}{p_r}$. Given the tie-breaking rule, they will borrow from lenders in their own segment.

Finally it can be checked that the following constitutes an equilibrium: every lender offers individual liability loan to safe types in his own segment at interest rate $r_s^I(a)$, and to any borrower in the village at interest rate r^I.

Our model thus explains why informal lenders do not offer joint liability contracts. Note that the interest rate for risky types does not depend on their landholding. The interest rate for the safe borrowers never exceeds that for risky borrowers, and could depend on their landholding (when it falls below r^I). Effectively, lenders give a 'discount' to safe borrowers in their own segment, which varies with their landholding. Whether the safe interest rate rises or falls in a hinges on the shape of the return function $R_s(a)$: whether $R_s'(a)$ exceeds or falls below $\frac{1}{p_s}$.

5 When MFI and Informal Lenders Co-exist

Finally we arrive at the main object of study: what happens when the MFI enters and competes with informal lenders? To this end, we add an additional stage to the timing presented in the Section 4, namely at stage 0 we allow the MFI to make loan offers. Define

$$\delta \equiv \frac{\beta - 1}{\beta}\left(\frac{\rho^I}{p_s} - \rho\frac{p_s}{[\theta p_r p_r + (1-\theta)p_s p_s]}\right) \tag{5}$$

and

$$\delta_I \equiv \frac{p_s(2-p_s)}{\theta p_r(2-p_r) + (1-\theta)p_s(2-p_s)}\rho. \tag{6}$$

$$\gamma(a) \equiv \frac{p_r}{p_s^2}a + \frac{\rho}{p_r}. \tag{7}$$

To start with, we assume that the MFI is constrained to break-even separately on each landholding category. Later we will discuss the consequences of dropping this assumption. The main result of this paper is the following.

Proposition 3 *For any given landholding a for which the MFI is constrained to break-even, every equilibrium of the game where the MFI and informal lenders co-exist results in the following outcome:*

(i) Risky types borrow from the MFI.

(ii) Safe types borrow from the informal lender in their own segment, if $\rho_I < \delta_I$, or if $\rho_I \geq \delta_I$ and $R_s(a) < \delta$.

(iii) If $\rho_I > \delta_I$ and $R_s(a) > \delta$, safe types borrow from the MFI.

(iv) Every risky borrower is better off compared with the equilibrium of the informal market without an MFI. Safe types are weakly better off, and strictly better off if and only if $R_s(a) > \gamma(a)$.

The argument is illustrated in Figure 2, and proceeds through a number of steps. Region C1 depicts contracts that do not break-even for informal lenders while lending to safe types, while C4 consists of contracts that generate positive profits for informal lenders when they lend to risky types. C3 is the set of contracts where the MFI earns non-negative profits while the informal lender makes losses lending to the risky type. C2 consists of the remaining contracts satisfying the ex post incentive constraint $r \geq c$.

(a) *If the MFI offers a contract (m_1, say) in (the interior of) region C1, informal lenders will not lend to either safe or risky types in any equilibrium of the resulting continuation game.* Otherwise, an informal lender must offer a contract at least as attractive to borrowers as m_1, which will earn losses irrespective of the risk type of the borrower.

(b) *If the MFI offers contracts only in region C4, the subsequent equilibrium outcome will be the same as in the informal market in isolation described in Proposition 2.* In the continuation game among informal lenders, Bertrand competition among lenders will provide risky types with a utility corresponding to contracts on ZPC_r^I, which risky types (weakly) prefer to contracts offered by the MFI. With regard to safe types, their participation constraint *vis-a-vis* their own-segment lender will then be the same as in the case where the MFI is absent. Hence the equilibrium outcome will be the same as when the MFI is absent.

(c) *The MFI must offer at least one contract in the union of C1, C2 and interior of C3.* Otherwise, (b) implies that the MFI will not lend to anyone. The MFI would do better by offering a contract in the interior of C3, as it would attract some borrowers and break-even irrespective of their risk types.

(d) *If there exists a pooled contract (m_2, say) for the MFI which breaks even for the MFI, satisfies the limited liability constraint for the safe type, and does not break even for informal lenders when offered to the safe type, then it is optimal for the MFI to offer such a contract, and lend to both safe and risky types.* If the MFI does not offer any such contract, the safe type will end up borrowing in region C2 from their own-segment informal lender.[16] The MFI would then do better to offer m_2, which would attract and benefit both safe and risky types, and break-even.

(e) *If there exists no pooled contract such as m_2 described in (d) above, the safe type will borrow from the own-segment informal lender. The loan will maximize the expected profit of the lender, subject to a participation constraint for the safe type with an outside option represented by contracts on ZPC_r which satisfy the limited liability constraint for the safe type.* Now it is not possible for the MFI to lend to the safe type, as any loan offered in region C2 will also attract the risky type, so the corresponding pooled contract has to break-even for the MFI. It also must satisfy the limited liability constraint for the safe type. By hypothesis, no such contract exists. Hence the MFI will end up lending only to the risky type in this case, and is limited to offering contracts on ZPC_r, from which (e) follows.

Finally note that if $\rho_I > \delta_I$ and $R_s(a) > \delta$, then (d) applies, and both types are strictly better off compared to the situation where the MFI is absent. This corresponds to Panels

[16] If the best contract from the MFI available for the safe type is in the interior of region C2, it will be optimal for the own-segment informal lender to undercut the MFI and offer a contract to the safe type which will earn positive profit. If it is on ZPC_s^I then also the safe type will borrow from the own-segment informal lender owing to our tie-breaking assumption.

A and B in Figure 3.[17] If $\rho_I < \delta_I$, or if $\rho_I \geq \delta_I$ and $R_s(a) \leq \delta$, condition (e) applies, so the MFI will only lend to risky types in this case, who are strictly better off. This corresponds to panels C and D in Figure 3. In Panel C the safe type is better off despite borrowing from the own-segment informal lender owing to a strengthening of his outside option which now includes contracts on the segment AB on the line ZPC_r which satisfy his limited liability constraint. In Panel D the safe type is not benefitted, as there is no contract on the line ZPC_r which satisfies his limited liability constraint.

Intuitively, the result of Proposition 5 can be explained as follows. All risky types move to the MFI since there is no distortion in the MFI lending to such types. Hence its information disadvantage *vis-a-vis* informal lenders does not matter, and its cost advantage is decisive. With respect to safe types, its informational disadvantage matters: it is forced to provide safe types a contract in which they are pooled with risky types and which involves a joint liability loan. There are two resulting distortions: the contract has to satisfy a limited liability constraint (which tends to bite for low a borrowers), and the safe types have to cross-subsidize the risky types which reduces the cost advantage of the MFI. If the cost disadvantage of the informal lenders is sufficiently small ($\rho_I < \delta_I$), the MFI cannot compete with the informal lenders in lending to any safe type. Otherwise, if $\rho_I > \delta_I$, the MFI still has a net cost advantage even after allowing for the cross-subsidy burden the safe types have to bear. The MFI can then lend to those safe types with landholding a large enough that the required joint liability contract satisfies the limited liability constraint. Sufficiently poor borrowers (those with $R_s(a) < \delta$) will stay with the informal lender, under the maintained assumption that there is no cross-subsidization across wealth types by the MFI. As we explain below, this may no longer be true when cross-subsidies are allowed.

Note that risky types always benefit from the MFI's entry. So do safe types who obtain an MFI loan. Even other safe types can benefit, as their bargaining position can be enhanced

[17] To obtain the examples presented in the graph we solved the model numerically. We assume that $R_i(a) = 1 + a^2$, and the outside option is normalised to $a - \pi$. In all simulations we set $p_s = 0.7$ and $p_r = 0.4$, and we discretize the interest rate r and the joint liability c using more than 100 grid points for each variable. In Figure 1 $a = 0.7$; $\pi = 0.45$; $\rho = 0.6$; $\theta = 0.6$. In Figure 3 Panel A $a = 0.9$; $\pi = 0.6$; $\rho = 0.6$; $\rho^I = 0.85$; $\theta = 0.6$. In Figure 3 Panel B $a = 0.7$; $\pi = 0.6$; $\rho = 0.6$; $\rho^I = 0.78$; $\theta = 0.6$. In Figure 3 Panel C $a = 0.9$; $\pi = 0.6$; $\rho = 0.6$; $\rho^I = 0.6874$; $\theta = 0.6$. In Figure 3 Panel D: $a = 0.7$; $\pi = 0.6$; $\rho = 0.6$; $\rho^I = 0.6874$; $\theta = 0.6$.

by the MFI's presence. This happens whenever safe types are better off borrowing at the interest rate offered to risky types by the MFI compared with their autarky situation. This happens when $R_s(a) > \gamma(a)$. The informal lender is then unable to extract all the surplus of these safe types.

What are the effects of MFI entry on informal rates, in the case where the MFI does not seek to engage in any cross-subsidization across land classes? This depends on how interest rates for the safe type vary with land a. If they are falling in a, the average interest rate paid by safe types to informal lenders increases, since only borrowers with the lowest amount of land remain in the informal market. On the other hand, all risky types move to the MFI, which tends to reduce the average informal rate. The net effect could go either way, depending on the fraction of safe types in the population. If they are high enough, the average informal rate will rise. Take the numerical examples depicted in Figure 3 and consider a village with $\rho^I = 0.68$ and a population of borrowers with landholding uniformly distributed in the interval $[0, 1.2]$.[18] The entrance of the MFI leaves the informal lenders with safe borrowers with small landholding (approximately less than 0.4). If one were to compute the average interest rate in the informal market before and after the MFI enters, the result is an increase of 5%.

Extension to Incorporate Cross-Subsidies Across Landholding Classes The preceding results were based on the assumption that the MFI does not want to offer cross-subsidies across different landholding levels. We saw above that it may end up not being able to lend to some low wealth safe types, who are unable to take on the burden of joint liability. If the MFI assigns a high enough welfare weight to such 'ultra-poor' borrowers relative to others who it can lend to without running at a loss, it would be motivated to get the latter to cross-subsidize loans to the former group. This would raise the effective interest rate for high a borrowers, and lower it for low a borrowers. If the welfare weight (or demographic weight) of the latter group is large enough, this can reverse participation patterns across landholding classes, with participation rates falling rather than rising in landholdings.

[18] Additionally, set $\pi = 0.45$; $\rho = 0.6$; $\theta = 0.3$

The case of cross-subsidies is illustrated in Figure 4. Without cross-subsidies, borrowers in a low landholding class a' cannot be offered loans (such as M) which pool safe and risky types, provide a better utility to safe types compared to what is offered by the own-segment lender, and meets the limited liability constraint for this class. But those in a higher landholding class a can be offered such a pooled contract, since these borrowers can afford the joint liability burden associated with such contracts. It is then possible for the MFI to lower the joint liability obligation c for the poorer class a' (by offering them the contract $M_{a'}$) and raise it for the wealthier class a (by offering them M_a), in a way that now allows it to lend to borrowers of both classes. This can be operationalized by a principle of graduating the joint liability requirement according to ability to pay, while maintaining the same interest rate for both land classes. It corresponds to an effective tax of $t(a)$ on class a borrowers which finances a subsidy $s(a')$ on class a' borrowers. Such a policy will now bring in the class a' borrowers into the ambit of MFI loans, without losing the class a. If the relative welfare weight assigned by the MFI to class a' borrowers is large, and the proportion of class a' borrowers is not too large relative to those in class a in the population, we may now witness a reversal of MFI participation patterns, with higher participation rates among poorer borrowers. Hence in general, the model is consistent with participation patterns with respect to landholdings that could be either rising or falling in landholdings.

Note similarly that the pattern of variation of informal interest rates across landholding sizes is also ambiguous. For risky types the interest rate does not vary with a, while for a safe type the informal interest rate is $R_s(a) - \frac{a}{p_s}$. This is rising (resp. falling) locally in a if $R'_s(a)$ is larger (resp. smaller) than $\frac{1}{p_s}$.

The net effects of the entry of the MFI on the average informal interest rate is therefore ambiguous in general. If MFI participation rates are rising (resp. falling) in a while informal interest rates are falling (resp. rising) in a, then the average informal rate will rise. The theory places no restrictions on these patterns, so empirical work is necessary to determine what the impact will be. In the next section we therefore calibrate parameters of the model to fit participation and interest rate patterns observed in the West Bengal experiment of Maitra *et al* (2013), and then estimate what the effects of full scale MFI entry would be in that context.

6 Numerical Illustration, Based on West Bengal Experimental Data

The experiment involved provision of two kinds of microfinance loans in different villages in two districts (Hugli and West Medinipur) of West Bengal. One treatment involved offering TRAIL (Trader Intermediated Loans) in 24 villages, while another offered GBL (Group Based Loans) in another 24 villages. The former were individual liability loans offered to borrowers recommended by an agent chosen randomly from trader-lenders operating for some years with an established clientele in the village. The agent was incentivized to recommend 30 safe borrowers owning no more than 1.5 acres of agricultural land, by being paid a commission equal to 75% of loan interest repayments. The GBL treatment offered joint liability loans to groups of five borrowers that formed and met certain eligibility requirements (such as owning less than 1.5 acres, attending frequent group meetings and saving requirements starting six months prior to the beginning of the scheme). 10 out of the 30 recommended borrowers in TRAIL were randomly chosen to receive the TRAIL loans, while in the GBL villages two groups were randomly chosen to receive the joint liability loans. Apart from the nature of liability, TRAIL and GBL loans were similar, charging an annual interest rate of 18%, with a duration of four months in each cycle. Borrowers were incentivized to repay by setting their credit line in the next cycle at 133% of the amount of current loan repaid. The loan amount was set at Rs 2000 at the beginning of the first cycle, which commenced in October 2010. While the experiment is currently ongoing (in the 10th cycle), the credit lines have now expanded to a level larger than the total working capital requirements for most borrowers. Both schemes have experienced high repayment rates, with TRAIL achieving a repayment rates in excess of 95% and GBL in excess of 85% by the end of 2012.

As shown in Maitra *et al* (2013), TRAIL agents were successfully incentivized to recommend safe borrowers from within their own clienteles. This conclusion followed from estimating differences in informal interest rates paid by those recommended by the agent but were not selected to receive loans ('control 1' households), with those not recommended ('control 2' households): the latter paid significantly higher interest to local lenders, controlling for observable household characteristics. The opposite was observed in the GBL villages: the 'control 1' households for GBL (those who formed groups and applied for a GBL but were unlucky in the loan lottery) paid significantly higher interest than the corresponding 'control 2' households (those who did not form any group). This latter finding is consistent with the prediction of the model in this paper — that MFIs disproportionately attract high risk borrowers, the very opposite of cream-skimming.

Table 1 shows the proportion of households in different landholding classes from among those owning less than 1.5 acres, based on estimated kernel densities for the land distribution in rural West Bengal for 2004 estimated by Bardhan, Luca, Mitra, Mookherjee and Pino (2013). A very large mass of households (in excess of 60%) were landless. Among those owning land, the proportions rose initially (from 7.6% to 9.3%) for those owning less than a quarter acre, and those owning between a quarter and half acre, and falling thereafter. Hence households owning a half acre or less comprised nearly 80% of the population. Participation rates in GBL are provided in the third column: those owning less land comprised a larger fraction of GBL members. The last two columns provide informal interest rates paid by control 1 households in TRAIL and GBL respectively.[19] Consistent with the different selection patterns, interest paid by GBL control 1 households tended to be higher than for TRAIL control 1 households. Averaging across all the landholding groups, the TRAIL control 1 households paid an interest rate of 30.2%, compared with 33.3% in GBL.

The average village population was approximately 300. Offering loans to only 10 households per village is unlikely to have any significant impact on average informal market rates. Hence we do not attempt to estimate actual effects of the treatments on informal interest rates. Instead, we calibrate our model to generate observed participation and interest rate patterns from the experiment, and thereafter use the calibrated model to calculate what the effect of a large scale entry of an MFI offering GBL loans similar to those in the experiment would be.

[19] Interest rates are based on actual repayment. These exclude loans from family, friends, or those with zero (or very low) interest rates which do not appear to be based on regular commercial considerations, or reflect *ex post* interest write-offs by the lender.

Table 1: West Bengal Experimental Data

Landholding (acres)	*Population Proportions*	*GBL Member Proportions*	*TRAIL C1 Interest Rates*	*GBL C1 Interest Rates*
Landless	0.637	0.220	0.306	0.309
(0, 0.25]	0.076	0.162	0.323	0.308
(0.25, 0.5]	0.093	0.150	0.328	0.321
(0.5, 0.75]	0.079	0.139	0.317	0.338
(0.75, 1]	0.052	0.126	0.293	0.350
(1, 1.25]	0.038	0.110	0.278	0.354
(1.25, 1.5]	0.024	0.092	0.269	0.352
Average Interest Rate			0.302	0.333

Notes: Based on data from Maitra *et al* (2013).

Specifically, to calculate the effects of MFI entry, we need to know how MFI participation rates and informal interest rates vary between safe and risky types in different landholding classes. Details of the calibration procedure are provided in the Appendix. We assume a given proportion of safe types in the population, and explore the implications of varying this proportion. Table 2 assumes 300 households in the village, divided into 10 equal segments with one informal lender in each segment. We calculate interest rates for safe types consistent with observed informal rates paid by TRAIL control 1 households, with the agent (one of the informal lenders) recommending first all the safe types within his own segment (within the 1.5 acre ownership ceiling), thereafter filling up the remainder of the quota of 30 recommendations with risky types. The interest rate paid by risky types is assumed to be 40%, for all landholding levels. The interest rate paid by the safe types in any landholding class is calculated by requiring the resulting average of TRAIL control 1 interest rates to be the level that was observed. In this way we derive informal interest rates for safe and risky types of borrowers for each land class.

Assuming that MFI participation rates of safe and risky borrowers in any given land class respond to interest rate differentials between the MFI and informal lenders in the same linear way, we calculate these response coefficients in order to generate the overall MFI participation rates observed in each land class that were shown in Table 1. The generated compositions of the MFI clients across safe and risky types, and their respective informal interest rates are shown in Table 2. MFI participation rates are higher for risky types (as they have a stronger incentive to switch), and decreasing in landholdings (matching the same overall pattern seen in Table 1). This is consistent with our model in the presence of cross-subsidies used by the MFIs to bring poorer borrowers into its ambit of operation, which induce higher participation rates among them. Informal interest rates for risky types do not vary across landholding groups, as in the model. For safe types they are initially rising in landholding, and thereafter falling. This is consistent with the model when $R'_s(a)$ is initially above $\frac{1}{p_s}$ up to half an acre, and thereafter below. Note that the implied average interest rate for the pool of MFI-applicants is 32.5%, close to the observed rate of 33.3% for GBL control 1 households.

Table 2: Calibrated Interest and Participation Rates

Landholding (acres)	*Safe Borrowers*		*Risky Borrowers*	
	MFI Member Proportions	*Interest Rates*	*MFI Member Proportions*	*Interest Rates*
Landless	0.1789	0.282	0.3855	0.400
(0, 0.25]	0.1406	0.304	0.2497	0.400
(0.25, 0.5]	0.1318	0.311	0.2218	0.400
(0.5, 0.75]	0.1182	0.297	0.2223	0.400
(0.75, 1]	0.0963	0.266	0.2466	0.400
(1, 1.25]	0.0760	0.248	0.2466	0.400
(1.25, 1.5]	0.0583	0.236	0.2270	0.400
Average Implied GBL Interest Rate				0.325

Notes:
Proportion of Safe Borrowers $(1-\theta) = 0.8$, Total Village Population $Pop = 300$, Number of Segments $n = 10$.

Based on these calculated MFI participation rates and informal interest rates, we can assess the effect of MFI entry would be on the average rate on the informal market. Table 3 shows the implied average informal interest rate before the MFI enters, and then what it will be after the MFI enters given the calculated MFI participation rates of safe and risky types.[20] With at least 80% of the population comprised of safe types, we see that the average

[20]This is based on the assumption that informal lenders continue to offer the same interest rates to safe types after the MFI enters, i.e., that there is no 'outside option' effect for safe types that do not switch.

informal rate rises as a consequence of MFI entry. The informal rate falls if 70% or less of the population consist of the safe type (where we recalculate the composition of MFI clients and interest rates across different types of borrowers so as to continue to match observed GBL and TRAIL patterns). Then the effect of departure of the high-interest-rate-paying risky types to the MFI dominates the effects of the departure of the low-interest-paying safe types.

Table 3: Simulated MFI Impacts on Informal Interest Rates

Proportion of Safe Types $(1-\theta)$	*Pre-MFI Average Informal Interest Rates*	*Post-MFI Average Informal Interest Rates*	*Percentage Changes*
0.4	0.3075 (0.3630)	0.2951 (0.3609)	-0.0403 (-0.0058)
0.5	0.3075 (0.3537)	0.3002 (0.3524)	-0.0235 (-0.0038)
0.6	0.3075 (0.3445)	0.3043 (0.3441)	-0.0102 (-0.0011)
0.7	0.3075 (0.3352)	0.3071 (0.3358)	-0.0011 (0.0017)
0.8	0.3075 (0.3260)	0.3086 (0.3272)	0.0037 (0.0037)
0.9	0.3075 (0.3167)	0.3087 (0.3179)	0.0041 (0.0038)

Notes:
Total Village Population $Pop = 300$, Number of Segments $n = 10$. Results in parenthesis generated by setting $n = 1$.

7 Conclusion

The purpose of this paper has been to describe a novel mechanism by which MFI entry can affect informal credit markets. Key to this is the two dimensional heterogeneity of borrowers by risk type and landholdings. MFI's lack fine-grained information concerning borrower-specific risks that informal lenders know. To overcome this informational problem, the MFI offers joint liability contracts which pool different risk types. In the absence of cross-subsidies across land types, poor borrowers would not be able to afford the joint liability burden necessary to allow the MFI to compete successfully with local lenders and break-even. MFIs assigning a high relative welfare weight to land-poor borrowers would then seek to cross-subsidize on the land dimension as well. This cross-subsidization can be implemented by graduating joint liability obligations according to ability to pay. Poor borrowers may then be motivated to participate in the MFI loans at a higher rate then those owning more land. If the poor borrowers pay lower interest rates to informal lenders (owing to the limited surplus that the latter can extract from such types), the compositional effects among safe types exiting to the MFI would tend to raise observed average informal rates. On the other hand, the departure of risky types to the MFI lowers the average informal interest rate. The overall effect will then depend on the relative proportions of safe and risky types. If the proportion of safe types is not too low, the average informal rate rises. This is a result of the selection effects induced by MFI entry, rather than any negative externality on borrowers remaining in the informal market.

Predictions of the model match empirical evidence from Bangladesh and West Bengal, unlike most existing models of interactions between MFI and informal credit in the literature. It is consistent with institutional features commonly observed in informal credit markets, such as segmentation, and why informal lenders never offer joint liability loans. MFIs attract risky types in the model, consistent with the West Bengal evidence. It can explain observed MFI participation patterns, wherein borrowers owning less land participate in MFI loans at a higher rate. To show this we presented a numerical example, using a version of the model whose parameters were calibrated to match data from a recent microfinance experiment in West Bengal. The effect on the informal rate can be positive or negative, depending on parameter values (such as the proportion of safe types) that are difficult to estimate from the data. The point of the exercise was to show that effects on informal interest rates are not a reliable way to gauge the spillover or welfare effects of microfinance. The model deliberately made assumptions to generate unambiguously positive welfare effects of MFI entry, while generating patterns of MFI participation and interest rate variations across landholding classes that are empirically plausible in the West Bengal context. The exercise does not necessarily imply that MFI entry along the lines of the West Bengal experiment would have no adverse welfare impacts on borrowers. Rather the point is that it is difficult to make any inferences concerning welfare impacts, unless we empirically test competing models with different welfare implications. That is a challenging task for future research.

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Appendix: Calibration Procedure

The number of borrowers in a village is denoted by Pop and landholding is distributed according to density function $g(a)$. Consistent with the structure of the field experiment described in the main text, the number of save borrowers recommended by the TRAIL agent is $S = \min[Pop \int_0^{1.5}((1-\theta(a))/n)g(a)da, 30]$ and the number of risky borrowers is $R = 30 - S$, where n denotes the number of segments in a village and $\theta(a)$ is the fraction of risky borrowers function of landholding. Thus, a risky borrower has probability $\beta = R/(\int_0^{1.5}(\theta(a)/n)g(a)da)$ to be recommended and the density of risky borrowers recommended at landholding a is $(\theta(a)\beta/n)g(a)$ — respectively $((1-\theta(a))/n)g(a)$ for the safe borrowers. The estimated probability of observing a safe borrower in TRAIL is then given by $x(a) = (1-\theta(a))/(\theta(a)\beta + (1-\theta(a)))$. Hence, $TC1(a) = x(a)r_s(a) + (1-x(a))r_r$, where $TC1(a)$ is the observed average interest rate of TRAIL control 1 households and $r_s(a)$ and r_r are the underlying informal interest rates. We postulate that observed participation rates in GBL depend linearly in interest rate differentials between the two sectors, with a response coefficient $\gamma(a)$ for land class a. This response coefficient is calculated by matching observed participation rates for each land class: $P_{GBL}(a) = \theta(a)\gamma(a)(r_r - r_M) + (1 - \theta(a))\gamma(a)(r_s(a) - r_M)$, with $r_M = .18$ denoting the GBL interest rate (consistent with the field experiment). We assume $Pop = 300$ and $n = 10$ and we construct $g(a)$ to match the population proportions in Table 1.

Having computed $\gamma(a)$ for each landholding level, we use it to derive participation rates for safe and risky borrowers: $P^s_{GBL}(a) = \gamma(a)(r_s(a) - r_M)$ and $P^r_{GBL}(a) = \gamma(a)(r_r - r_M)$ respectively. We then calibrate $r_s(a)$ and r_r to match the observed average interest rate in GBL control 1 households. Finally, we derive the simulated average interest rate in the informal market, both pre- and post-MFI entry.

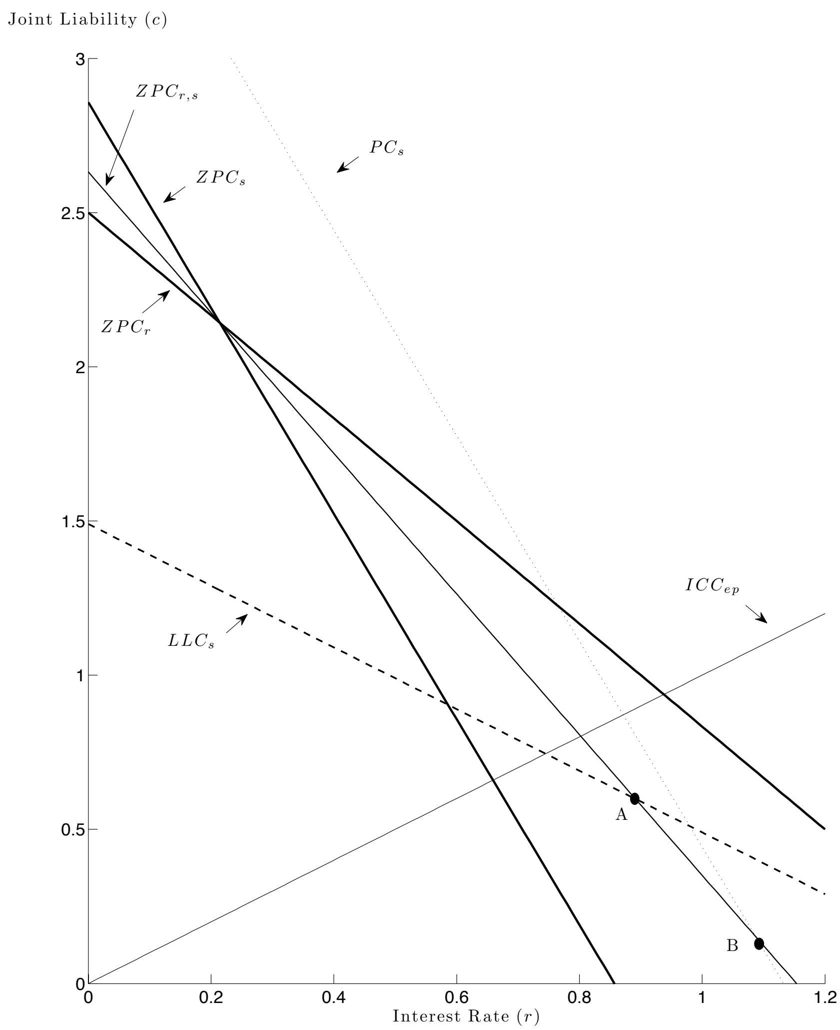

Figure 1: *The credit market when the MFI is the only lender.*

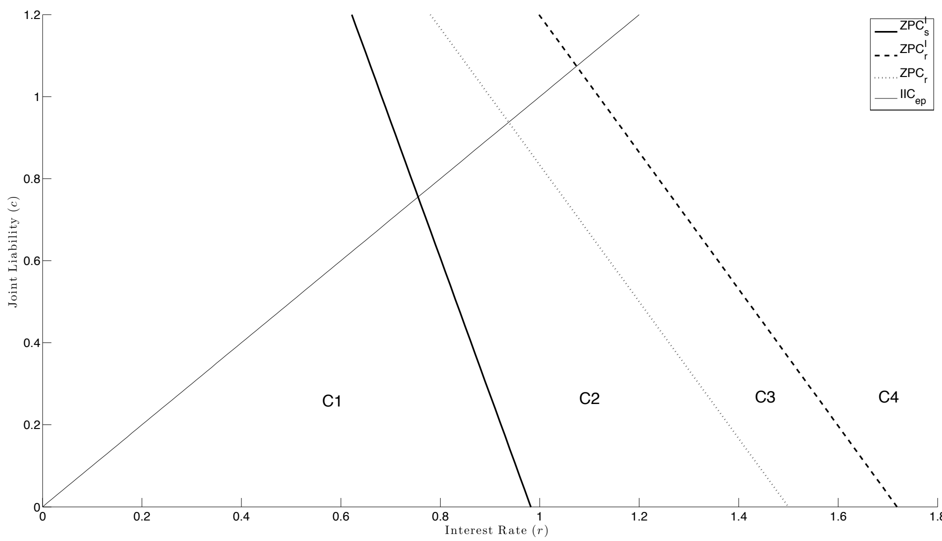

Figure 2: *Four contractual areas.*

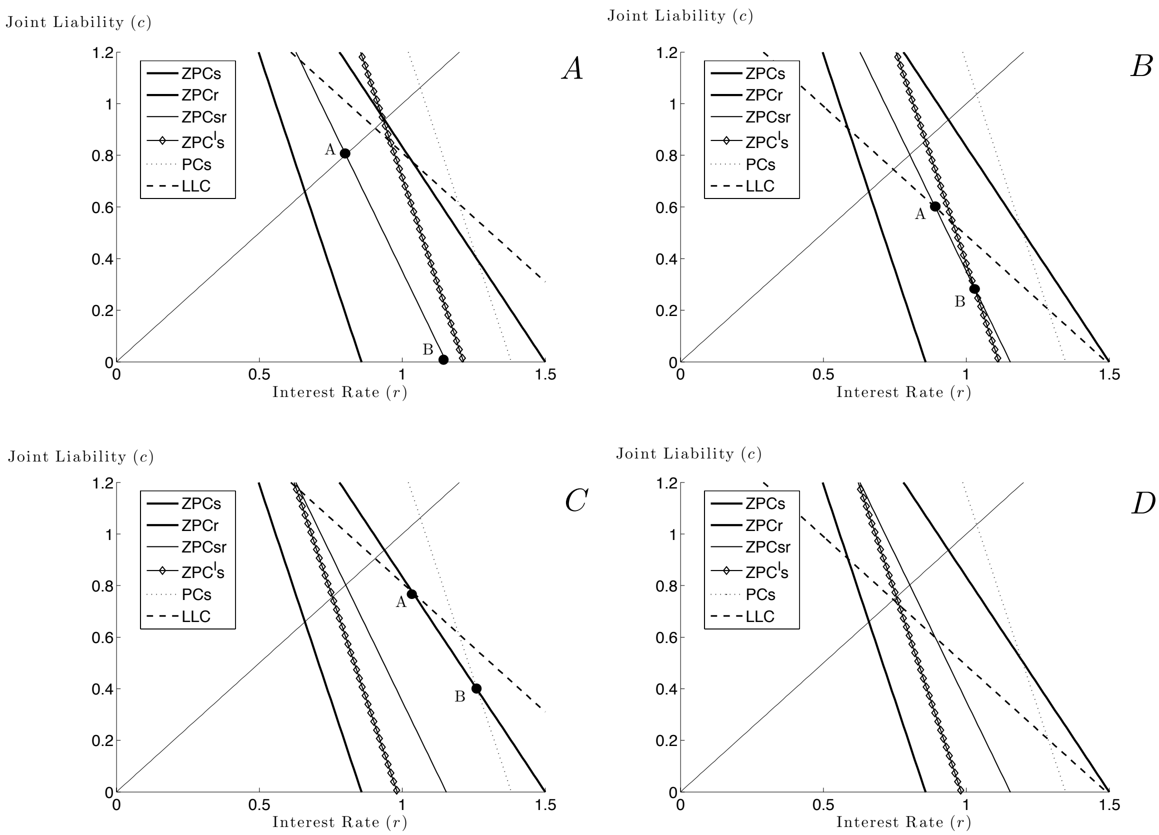

Figure 3: *Interactions between MFI and Informal Lenders.*

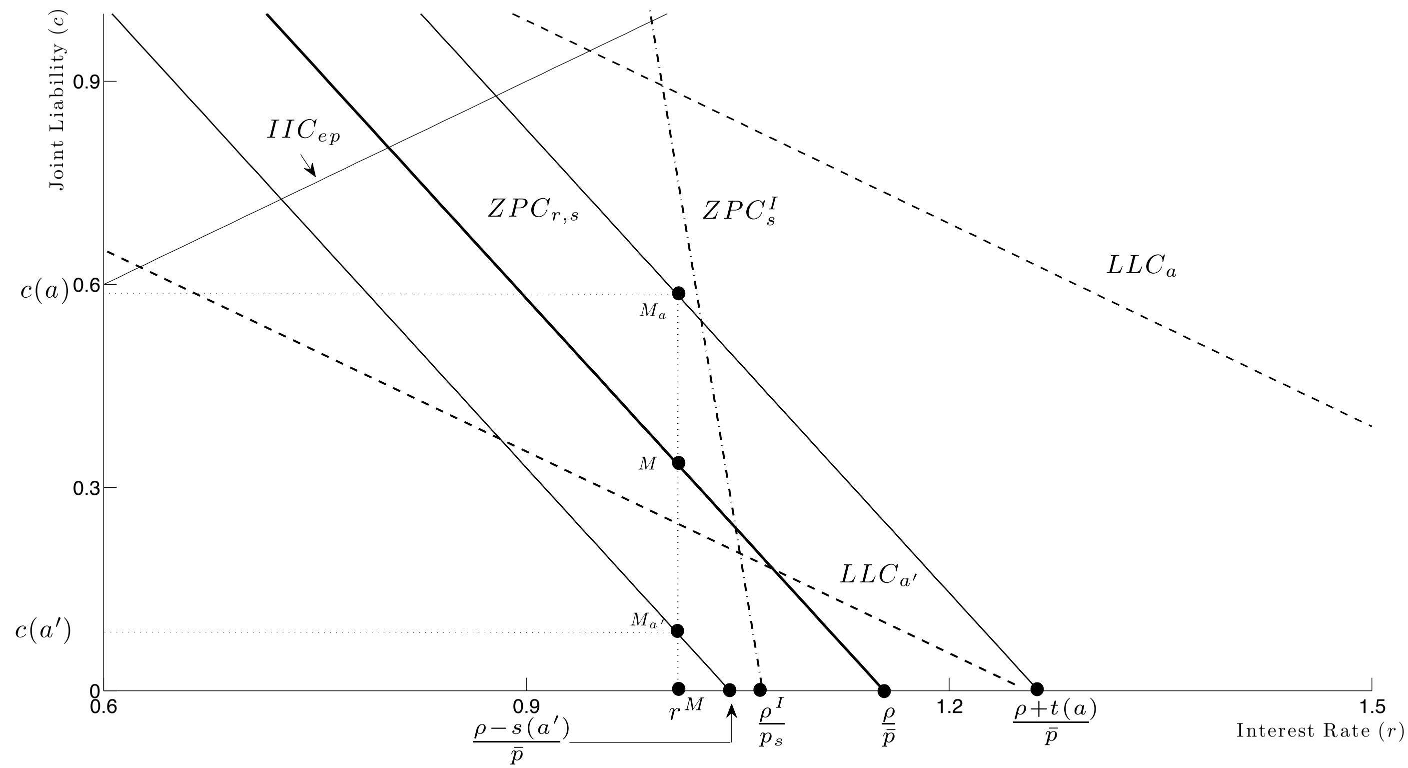

Figure 4: *Cross-Subsidies Across Landholding Classes.*